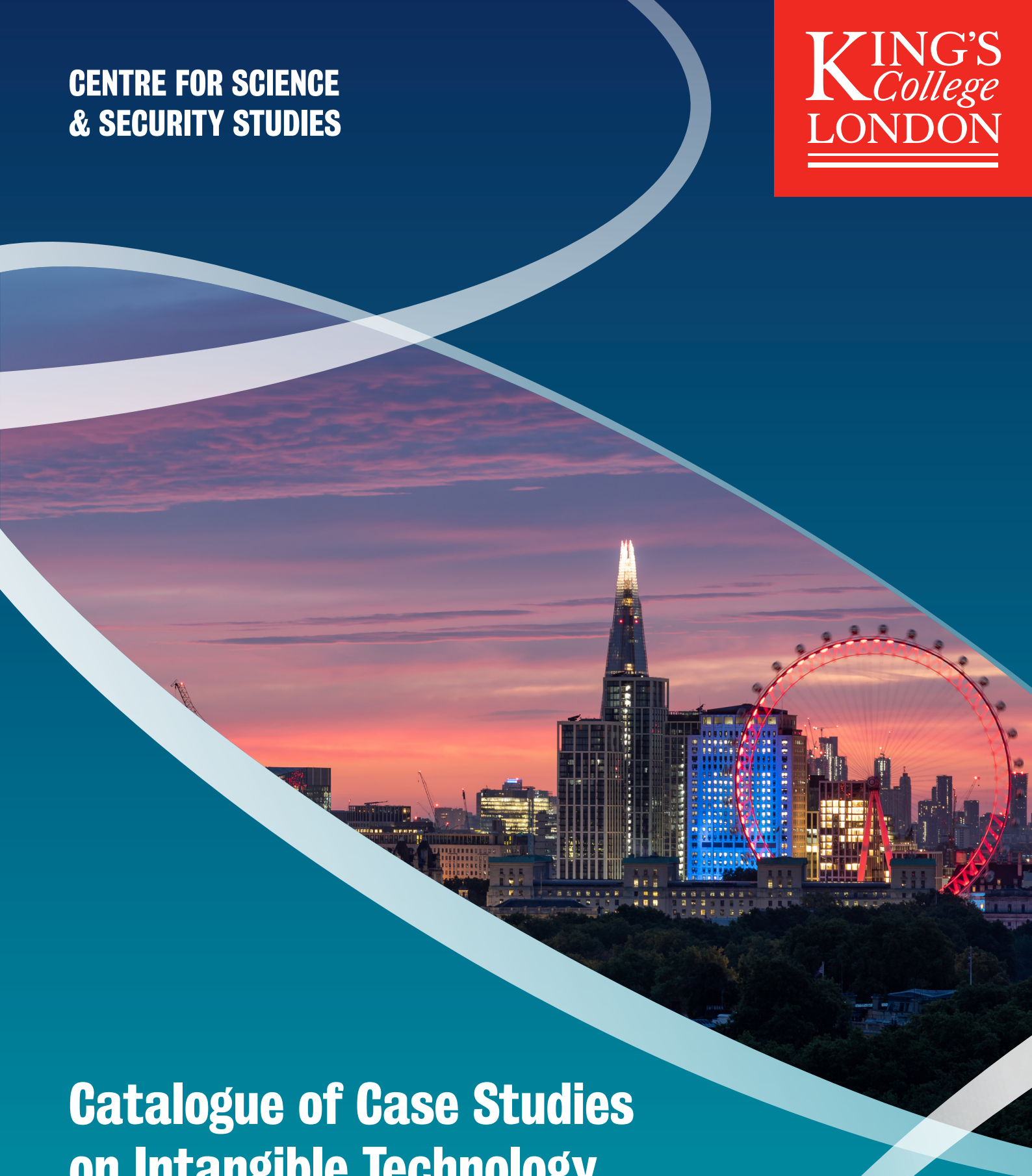
CENTRE FOR SCIENCE
& SECURITY STUDIES

KING'S College LONDON



Catalogue of Case Studies on Intangible Technology Transfers from Universities and Research Institutes

Emma Scott, Ross Peel, Felix Ruechardt & Nick Mitchell

SEPTEMBER 2020

Table of contents

Introduction

In 2016, King's College London (KCL) prepared a report examining the utility of intangible technology transfer (ITT) controls in managing the spread of proliferation-relevant technologies.[1] Following on from this report, KCL has now prepared a new catalogue of case studies of ITT emanating from universities and research institutes across the globe. This catalogue of case studies covers countries with some of the world's most advanced research capabilities and technological expertise, including the US, the UK, and in Europe. It is being published at a time of heightened international concerns about the theft of technology from universities and research institutes by non-aligned states seeking to enhance their military capabilities and by proliferator states pursuing weapons of mass destruction (WMD) programmes.

TECHNOLOGY

THE INFORMATION REQUIRED FOR THE DEVELOPMENT, PRODUCTION OR USE OF A CONTROLLED ITEM

In export controls terminology, *technology* is broadly defined as the information 'required for the development, production or use of a controlled item' [2]. This technology might be tangible, taking the form of, for instance, blueprints, diagrams, or technical and training manuals, or it might be intangible, taking the form of emails, teaching/conversations or other electronically stored information. Many controlled technologies are classed as 'dual-use', meaning they have both civilian and military applications. For instance, the technology to produce high-quality carbon fibre components might be used to manufacture sports equipment, pressure vessels and other civilian goods. Yet, this same technology can also be used to manufacture critical equipment for the production of weapons-grade nuclear materials or components for missiles.

1 Ian J. Stewart, Dominic Williams, and Nick Gillard, Examining intangible controls, Project Alpha at King's College London (June 2016), https://www.kcl.ac.uk/news/examining-intangible-technology-controls.
2 'Transfer of information (technology controls),' updated 16 April 2020, 2019, accessed 11 June 2020, https://www.gov.uk/guidance/export-controls-military-goods-software-and-technology#transfer-of-information-technology-controls.

> THESE CASE STUDIES OUTLINE THE CHALLENGES UNIVERSITIES AND RESEARCH INSTITUES FACE AS HUBS FOR TECHNOLOGY DEVELOPMENT

Universities and research institutes act as hubs for technology development. They are therefore home to many dual-use technologies, which can also include emerging technologies whose full potential has yet to be realised. As such, universities and research institutes need to exercise caution to prevent the technologies they are working with from falling into the hands of those seeking to use them for malign ends. One way universities can prevent illicit technology transfer is by applying to national authorities for an export licence. You will see that several case studies in this catalogue such as the case study on Norway's Institute for Energy Technology (IFE), the case study on Professor Ron Fouchier, and the case study on Professor John Reece Roth concern reluctance or even complete failure by the institute or researcher to apply for an export licence. In these cases, the result was reputational damage and/or criminal penalties.

On the other hand, in instances where the university or research institute cooperated with national authorities, whether that be with the relevant ministry or national export control authority, the universities and researchers ended up being able to pursue scientific exchange. For example, the first case study in this catalogue mentioning Imperial College London shows that following cooperation with UK export control authorities, long-term collaboration with the Chinese aerospace entity Aviation Industry Corporation of China (AVIC) ensued. The case of the North Korean students attending the International School for Advanced Studies (Scuola Internazionale Superiore di Studi Avanzati; SISSA) in Italy and switching from an advanced physics course to neuroscience and maths also proves that solutions are possible when export control and sanction violation concerns arise.

Other cases demonstrate more malign intent by researchers to acquire controlled technology either for the benefit of foreign militaries or more often it seems for monetary and/or professional gain. The case study on the Iranian-German professor, Hamid Reza Karimi, and his Chinese PhD student, Hu Xiaoxiang, researching hypersonic missiles in particular illustrates how sensitive research can give rise to national security concerns. Together, the case study on Yi-Chi Shih and Ishiang Shih – both professors of engineering – from the University of California in Los Angeles and McGill University in Canada respectively, the case study on the two PhD student cousins, Bo Cai and Wentong Cai, and the case study on Yu Long attest that individuals who wilfully violate export control laws will be faced with criminal consequences.

Collectively, these case studies outline the challenges universities and research institutes face as hubs for technology development, and the need for them to have comprehensive and functioning procedures in place for controlling the technologies being researched and developed in their institutions. These case studies also demonstrate that universities and research institutes must be aware of proliferation risks that may arise within proliferation sensitive subject areas where rogue actors may seek access to technology for the benefit of non-aligned or proliferator states. These case studies equally show that performing a sanctions screening check before entering into any cooperation agreements with foreign entities is essential, and that failure to abide by either export controls laws or sanctions designations can result in criminal and administrative penalties, as well as reputational damage.

The structure of this catalogue is as follows:

1. The first section focuses on case studies where the institution was implicated in the case.

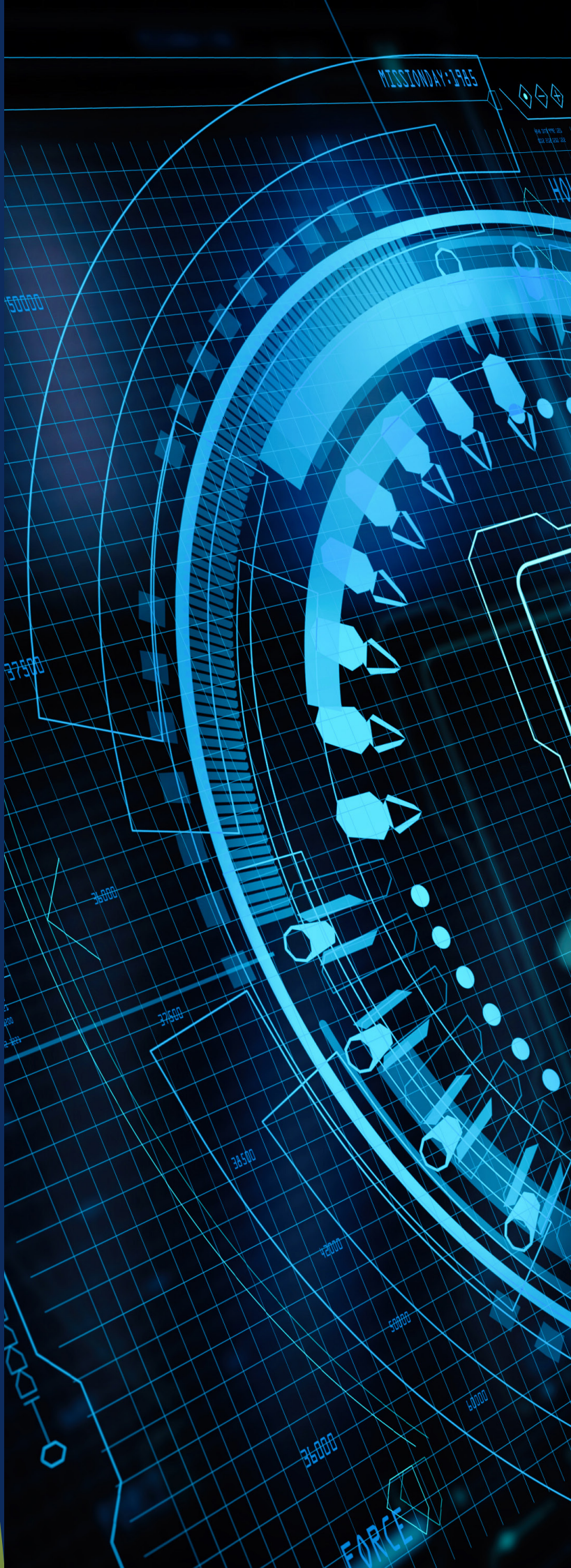
These case studies consider the actions that the institutions themselves took to respond to export control concerns and mention cooperation with relevant authorities to resolve those concerns and work within existing regulations.

2. The second section focuses on case studies involving individual researchers, who have either challenged or violated export control laws.

These case studies emphasise the need for awareness-raising and training for researchers on export control and sanctions regulations. They show the legal consequences a researcher may face if caught purposefully disregarding or breaching the law.

Both the institutional and researcher case studies can inform debate on the struggle between the drive for freedom of academic research and the need to respect national security legislation.

Institutional Case Studies




COMPLIANCE

Case Study 1: British Universities Receive Attention for Research with Chinese Aerospace Manufacturer Linked to the Iranian Missile Programme

In June 2015, the *Financial Times* reported on research connections between two British universities and a Chinese state aerospace manufacturer which had been placed on a United States watch list for supplying goods to Iran's ballistic missile programme.[3] The two British universities discussed in the report were Imperial College London and the University of Birmingham, which had both signed research agreements with the Beijing Aeronautical Manufacturing Research Institute (BAMTRI) and its parent company, the Aviation Industry Corporation of China (AVIC), a Chinese state aerospace group.[4]

In 2014, the United States Department of Commerce placed BAMTRI and several other Chinese entities on an export control watch list 'for their roles in supplying Iran's ballistic missile program' through a notorious Chinese intermediary named Li Fangwei, also known as Karl Lee.[5] It is unclear what sort of technology or expertise BAMTRI had supplied to Li, although Li is known to have supplied Iran with advanced materials and guidance components suitable for missile use, and has been repeatedly censured by the United States government for this activity.[6]

Both Birmingham and Imperial have defended their research involvement with BAMTRI and AVIC, citing factors such as liaison with the UK's Export Control Organisation and projects falling within the scope of 'fundamental research', where basic scientific research controls would be applicable.[7] Today, BAMTRI is no longer on the US Department of Commerce watch list.

About

BAMTRI was founded in 1957 as a Chinese state-owned centre for synthetic research for aeronautical manufacturing technology. Its self-proclaimed mission is to 'provide advanced manufacturing technologies and associated equipment for the aviation industry, meanwhile apply comprehensive technologies to contribute a great deal of efforts in R & D [research and development] of civil products.'[8] AVIC, as the parent company of BAMTRI, is a Chinese state-owned aerospace and defence conglomerate, with both civilian and military aircraft production capabilities.[9]The University of Birmingham and BAMTRI were both members of a European consortium involved in research on large titanium casting processes. Imperial College and AVIC are partners in the AVIC Centre for Structural Design and Manufacture aimed at forming lighter and stronger aircraft components.[10]

3 Charles Clover, 'UK universities under scrutiny over China ties,' Financial Times, 24 June 2015, https://www.ft.com/content/af5ea60e-1578-11e5-be54-00144feabdc0.
4 Clover, 'UK universities under scrutiny over China ties.'
5 United States Department of Commerce Bureau of Industry and Security, U.S. Commerce Department Adds Nine Persons Associated with Missile Proliferator to Entity List, (last modified 29 April 2014).
6 Daniel Salisbury and Ian J. Stewart, Li Fang Wei (Karl Lee), Project Alpha at King's College London (19 May 2014), http://www.projectalpha.eu/proliferation/item/319-li-fang-wei-karl-lee-proliferation-case-study-series
7 Clover, 'UK universities under scrutiny over China ties.'
8 'Beijing Aeronautical Technology Research Institute (BAMTRI) Website,' 05/02/2015, http://bamtri.en.busytrade.com/about_us.html.
9 'Libya: Nuclear Programme Overview,' Nuclear Threat Initiative, 8 November 2011.
10 'New partnership takes off,' 17 April 2012, http://wwwf.imperial.ac.uk/blog/reporter/2012/04/17/new-partnership-takes-off-2/

Imperial College's stated research projects with BAMTRI were carried out through the AVIC Manufacturing Technology Institute (MTI), the AVIC First Aircraft Institute (FAI) and the AVIC Aircraft Strength Research Institute (ASRI). Today, the projects cover materials science topics related to aerospace applications, including the shaping and joining of metallic alloys, the uses of advanced materials for vibration management, the impact resistance and properties of impact-damaged composite materials, and the properties of 3D-printed materials.[11,]

Based on the project descriptions, many projects are related to materials science applications which might potentially find use in advanced aircraft applications. In all cases, a fundamental research exemption could apply based on this project content. However, the research carried out will certainly be of interest for military aircraft designers, as well as in civilian applications. In particular:

- One project exists primarily to test materials samples manufactured by BAMTRI.[12]
- One project uses a high-velocity gun system for impact testing.[13] Such systems are relevant for nuclear weapons development.[14]

Actions of the Universities

Both Birmingham and Imperial have defended their research involvement with BAMTRI and AVIC. Birmingham has stated that its involvement with BAMTRI ended prior to BAMTRI's inclusion on the US Commerce Department watchlist.[15] At the time of writing, this entity is no longer on the watchlist list, and along with a series of other Chinese institutes, is listed on the University of Birmingham's website as a participant in the EMUSIC project (referring to '*E*fficient *M*anufacturing for Aerospace Components *Us*ing Additive Manufacturing, Net Shape HIP and *I*nvestment *C*asting').[16]

Imperial College, while acknowledging that its involvement with BAMTRI has continued, has stated that it conducted due diligence on AVIC before signing the agreement, and that it liaised with the former UK Export Control Organisation – now called the Export Control Joint Unit – on the project before commencement.[17] Imperial also stated that its joint research centre with AVIC 'supports fundamental, non-classified research into new materials and manufacturing methods'.[18] Furthermore, it described the projects as 'fundamental research', a term that equates to 'basic scientific research'. The university argued that even if the technology was controlled, a basic scientific research decontrol would be applicable.

Conclusions

Whether the involvement of these universities with BAMTRI has been in violation of any United Kingdom export control law would depend on factors that are not on the public record. And while the reported connection between BAMTRI and Iran's missile

11 'ASRI,' accessed 9 July 2020, http://www.imperial.ac.uk/avic-design/projects/asri/.; 'MTI&FAI,' accessed 9 July 2020, http://www.imperial.ac.uk/avic-design/projects/mti-fai/.
12 'Structural Integrity Assessment of Additive Manufactured Products,' accessed 9 July 2020, http://www.imperial.ac.uk/avic-design/projects/mti-fai/structural-integrity-assessment/.
13 'Impact testing of laminated glass and composites,' accessed 9 July 2020, http://www.imperial.ac.uk/avic-design/projects/mti-fai/impact-testing-of-laminated-glass-and-composites/.
14 International Atomic Energy Agency, Communication Received from the Permanent Mission of Switzerland to the International Atomic Energy Agency regarding Certain Member States' Guidelines for Transfers of Nuclear-related Dual-use Equipment, Materials, Software and Related Technology.
15 Clover, 'UK universities under scrutiny over China ties.'
16 'Efficient Manufacturing for Aerospace Components Using Additive Manufacturing, Net Shape HIP and Investment Casting (EMUSIC),' accessed 9 July 2020, https://www.birmingham.ac.uk/generic/emusic/index.aspx.
17 Clover, 'UK universities under scrutiny over China ties.'
18 Clover, 'UK universities under scrutiny over China ties.'

programme (as well as between BAMTRI and Li) presents a risk for the leakage of technology or expertise from the United Kingdom to an undesirable end user, the risk is admittedly small.

That said, the case study demonstrates the complications and difficulties involved with signing agreements with Chinese state-owned entities. It highlights the importance of doing a sanctioned entity check before entering into cooperation agreements with foreign entities and maintaining a regime of regular checks thereafter, thereby enabling universities and research institutes to take informed decisions about cooperation.

Due to the links with Iran, the case study further demonstrates the risk of knowledge transfer emanating in university settings that may indirectly reach prohibited countries. In this case, Imperial managed the risks, carried out due diligence on AVIC, and was in contact with the UK government, but at the same time Imperial as well as Birmingham have suffered negative publicity from the cooperation.

Recommendations

Suggested risk management steps that a university could take to mitigate risks before signing cooperation agreements with foreign entities, particularly those active in the defence industry, include:

- A sanctions screening check against the foreign entity with which the research agreement is being signed.
- A thorough assessment of the infrastructure (i.e. laboratory equipment) being used in any proposed research activity to determine its sensitivity and utility in prohibited applications.
- An assessment of the proposed end uses of the technology to ensure that risks of it being diverted to military or WMD-related end uses or end users are understood.
- Vetting of domestic and visiting personnel involved in research and administration.
- Request for export control compliance procedures to be undertaken by the foreign research partner in order to further assure compliance with international requirements regarding non-proliferation.[19]

19 Ian J. Stewart, Antiproliferation: Tackling Proliferation by Engaging the Private Sector, Discussion Paper #2012-15, Harvard Kennedy School: Belfer Center for Science and International Affairs (2012), https://www.belfercenter.org/publication/antiproliferation-tackling-proliferation-engaging-private-sector.

Case Study 2: Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) Under Investigation by UN Panel of Experts for ITT to the DPRK

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) based in India provides another example of how intangible technology transfers to countries of proliferation concern can occur. CSSTEAP was established following an evaluation mission conducted in 1994 by the United Nations, and which identified India as a host nation for a centre for space for developing countries. Subsequently, CSSTEAP has contributed to capacity building in space science and technology across the Asia Pacific region through education, training and research.[20]

Representatives from North Korea and Iran – both of which have active space programmes – sit on the Board of Governors of the CSSTEAP,[21] and students from both the North Korea and Iran are known to have participated in the Centre's taught courses. The UN Panel of Experts (the Panel) on the Democratic People's Republic of Korea (DPRK) has drawn attention to the proliferation risks concerning the DPRK and arising from the Centre's educational offerings, while finding that several of the 30 North Korean students admitted to the CSSTEAP programmes between 1996 and 2016 had ties to the DPRK's sanctioned proliferation programmes.[22]

Under scrutiny, the CSSTEAP informed the Panel that the Consolidated UN Security Council Sanctions List was "diligently taken into account in the selection and admissions process"[23], and following the revelations of the Panel's report, further maintained that it had taken steps to prevent participation of all North Korean students in relevant programmes.[24]

About

In 1995, the CSSTEAP was initially established under an agreement by 10 countries of the Asia-Pacific region. The DPRK signed the agreement in 1997. Since, Iran has also become a signatory.[25] Both North Korean and Iranian representatives sit on the Board of Governors of the CSSTEAP,[26] and students from both the DPRK and Iran are known to have participated in the Centre's taught course offerings. Both North Korea and Iran have

20 'Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) Website,' accessed 12 May 2020, https://www.cssteap.org/

21 'Governing Board, Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP),' accessed 25 June 2019, https://www.cssteap.org/governing-board.

22 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2207, S/2016/157 (24 February 2016). p. 23, paragraph 47.

23 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2207, S/2016/157. p. 23, para 46.

24 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150 (27 February 2017). p. 49, paragraph 132.

25 'International Linkages, Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP),' accessed 25 June 2019, https://www.cssteap.org/international-linkages.

26 Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), 'Governing Board, Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP).'

active space programmes, which has given rise to concerns that these programmes could be used towards military, rather than civilian, purposes.[27,]

According to the CSSTEAP website, the Centre offers six postgraduate-level courses in various fields related to space science and technology, with the objective of enhancing the capabilities of the member states in this area.[28] The satellite communications course stood out during an evaluation of the CSSTEAP's curricula by the Panel on the proliferation relevance of each module. The Panel concluded that the course on satellite communications was one of several teaching participants in areas that could contribute to their respective ballistic missile programmes.[29] Specifically, the satellite communications course includes a module on "modulation, multiplexing and multiple access [...], which could contribute to enhancing telemetry capabilities for the ballistic missile programme" of the DPRK.[30]

The other two courses with sensitive content are the Space and Atmospheric Science (SAS) course whose sub-modules "could be directly relevant to the [DPRK] in designing and testing a launch vehicle using ballistic missile technology, such as those on launch vehicles, attitude control, and telemetry, tracking, command and data handling systems," and the global navigation satellite systems class where the modules on receivers and integrated navigation could be directly relevant [...], especially given that [the DPRK] is working on improving the precision guidance off ballistic missiles through the use of global navigation satellite systems [both GPS and GNSS]".[31]

The CSSTEAP's '5-year Performance Assessment Report 2011-2016' on postgraduate courses that took place from 2010-2015 reported that there were two participants from the DPRK on the SAS programme.[32] Furthermore, four participants from the DPRK and one participant from Iran took part in the Remote Sensing and Geographic Information System (RS & GIS) programme, and two participants from the DPRK in the Satellite Meteorology and Global Climate (SATMET) programme. In terms of short courses held by the Centre and under the remote sensing subject banner, there was one participant from Iran at a two-day workshop on Opensource Geospatial Tools (OSGeo) in 2011, and one participant from Iran at a four-week course on Microwave Remote Sensing and its Applications in 2011.[33]

According to the Panel's report, the participation in courses due to start in 2015 by four DPRK students, including one affiliated with the National Aerospace Development Administration (NADA) – the official space agency of North Korea – was cancelled by CSSTEAP.[34] Previously, in 1999-2000, NADA's Vice-Director of the Scientific Research and Development Department, Paek Chang-Ho, had participated in the satellite communications course at CSSTEAP.[35] Mr Paek was personally designated on the UN Security Council Sanctions List for his involvement in the 12 December 2012 launch

27 'Space Threat 2018: North Korea Assessment,' 12 April 2018, https://aerospace.csis.org/space-threat-2018-north-korea/.; Gawdat Bahgat, 'Iran's Space Odyssey Raises Red Flags for Nuclear Community,' The National Interest, 24 January 2019, https://nationalinterest.org/blog/middle-east-watch/irans-space-odyssey-raises-red-flags-nuclear-community-42397.

28 'Backrgound, Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP),' accessed 25 June 2019, https://www.cssteap.org/background.

29 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2207, S/2016/157. p. 23, paragraph 48.

30 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2207, S/2016/157.

31 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2207, S/2016/157.

32 Centre for Space Science & Technology Education in Asia & the Pacific (CSSTEAP), 5 Years Progress Report (2016), https://www.cssteap.org/upload/documents/Progress_Report_2016.pdf.

33 Centre for Space Science & Technology Education in Asia & the Pacific (CSSTEAP), 5 Years Progress Report.

34 NADA continues to play an important role in the DPRK's space and satellite programme, including the preparation of new launches. DPRK satellite launches and use of associated technologies are prohibited under UNSC resolutions, including 1728 (2006) and 1874 (2009) and 2087 (2013). United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2207, S/2016/157. p. 23, paragraph 47.

35 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2207, S/2016/157. p. 100.

of the Unha-3 rocket that carried a DPRK satellite into orbit for the first time.[36] The continuous attempts by the DPRK's NADA to have researchers trained at CSSTEAP shows the relevance of the courses to NADA's work.

Conclusions

This case study demonstrates that the risks of intangible technology going towards a proliferation programme were significant, in contrast to the previous case study in this booklet which demonstrated cooperation between the universities and national export control authorities to mitigate proliferation risks. In contrast, this case study reveals that action was not taken by the CSSTEAP to prevent DPRK students from enrolling on the sensitive programmes until it came under scrutiny by an internationally body mandated to investigate violations of UN sanctions on the DPRK. Among other explanations, it may be that the proliferation risks arising from registering DPRK nationals on the CSSTEAP courses were not identified due to a lack of awareness of among CSSTEAP representatives of how intangible technology can feed proliferation programmes. The CSSTEAP could have done more such as screening participants against sanctions lists before enrolment, although it should also be recognised that much work is still ongoing in the area of capacity building amongst government officials and research institutes to sensitise them to proliferation risks arising from ITT.

This case study highlights several additional points:

- The DPRK actively attempts to acquire technology for its illicit nuclear and ballistic missile programmes by using the cover of 'peaceful' technological programmes such as its space programme through which it seeks acceptance and access to international organisations.
- Students are sent to courses strategically to fill knowledge gaps on technology in domestic programmes.
- Knowledge about technologies relevant for the DPRK's ballistic missile programme can reach the country via intangible transfers by means of North Korean researchers attending training courses at research facilities.

Recommendations

The case study further highlights numerous measures research institutes can take to prevent unwittingly aiding proliferation programmes. These measures include:

- Vetting of students and researchers from countries of proliferation concern, particularly for courses that may have proliferation relevance, to ensure they do not have ties to illicit proliferation activities.
- Screening of individuals against sanctions lists to ensure that the institutes themselves are complying with all international regimes, such as UN Security Council resolutions.
- Incorporation of intangible technology controls on training and education services offered, particularly when such training and education could potentially be used for proliferation-sensitive activities.

36 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150.; 'Chronology of U.S.- North Korean Nuclear and Missile Diplomacy,' updated May 2020, accessed 9 July 2020, https://www.armscontrol.org/factsheets/dprkchron.

Case Study 3: European Universities Prevent DRPK Students from Pursuing Advanced Physics Programmes

Under United Nations Security Council (UNSC) resolutions 2270 (2016) and 2321 (2016), 'specialized teaching or training' of disciplines that could contribute to prohibited programmes of the Democratic People's Republic of Korea (DPRK) to DPRK nationals is prohibited. This includes, but is not limited to, teaching in 'advanced physics, advanced computer simulation and related computer sciences, geospatial navigation, nuclear engineering, aerospace engineering, aeronautical engineering and related disciplines,'[37] as well as 'advanced materials science, advanced chemical engineering, advanced mechanical engineering, advanced electrical engineering and advanced industrial engineering.'[38]

The UN Panel of Experts (the Panel) on North Korea investigated several instances where North Korean researchers were studying at universities in the above sanctioned areas; of the cases investigated, two were situated in Trieste, Italy, at The International Centre for Theoretical Physics (ICTP) and the International School for Advanced Studies (Scuola Internazionale Superiore di Studi Avanzati; SISSA), and one was at the Politehnica University of Bucharest in Romania.[39]

In response to the investigations, the universities transferred the North Korean students studying in the sanctioned areas to other academic disciplines. The Italian institutes redirected the current as well as future students from the DPRK to mathematics.[40] Romania indicated that, following the adoption of resolution 2270 (2016), the DPRK students had been transferred to the faculty of biotechnical systems engineering in the field of specialised machinery for agriculture and food.[41]

About

The ICTP is an Italian research and training institution that was founded in 1964 specifically to stem the 'brain drain' from developing countries by educating and training scientists from the developing world.[42] Its course offerings range from mathematics to applied physics and quantitative life sciences, as well as a subject 'High Energy, Cosmology and Astroparticle Physics'.[43] The institution has a joint 'Sandwich Training Educational Programme' with the International Atomic Energy Agency (IAEA) that offers PhD fellowships in physics and mathematics.[44] This programme exemplifies the strong cooperation between ICTP and the IAEA, with the institution often hosting conferences and workshops on behalf of the IAEA.

37 United Nations Security Council, United Nations Security Council Resolution 2270 (2016), S/RES/2270 (2 March 2016). 4, No. 17.
38 United Nations Security Council, United Nations Security Council Resolution 2321 (2016), S/RES/2321, (30 November 2016). 3, No. 10.
39 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150. p. 49 paragraph 133, 134.
40 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150. p. 49 paragraph 133.
41 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150. p. 49 paragraph 134.
42 'About ICTP,' accessed 22 October 2019, https://www.ictp.it/about-ictp.aspx.
43 International Centre for Theoretical Physics, 'About ICTP.'
44 'Programmes,' accessed 22 October 2019, https://www.ictp.it/programmes/step.aspx.

The DPRK is one of the institution's supported countries with researchers from the state eligible for special grants to receive training at the Centre.[45] The 2017 and 2018 visitor logs of the Centre show that, in each year, three (male) North Korean scientists spent a total of 24-25 months as visiting researchers.[46]

The PoE investigated several of the North Korean researchers due to their home institution in the DPRK being Kim-Il Sung University – one of the principal actors in the development of nuclear weapons and their delivery systems in the DPRK.[47] Courses such as the one on high energy physics which some of the students were enrolled in would fall under the specialised teaching and training banned under UNSC Resolution 2270 (2016).

Whilst at ICTP, these students were also enrolled at SISSA, another Trieste-based university for physics, neuroscience and mathematics, which has a wide network of international partners.[48] The DPRK nationals were reportedly studying for PhDs in cosmology at SISSA.[49] However, following media reporting and recommendations by the PoE, the students were asked to switch the topics of their PhDs. While two of them chose to switch to mathematics, two others proceeded with PhDs in neuroscience.[50]

A similar situation was faced by Politehnica University of Bucharest in Romania. In 2016, the university became aware that four individuals from the DPRK were studying in its material science and engineering, and electronic telecommunications technology faculties.[51] Following the adoption of UNSC resolution 2270 (2016), these students were transferred to the faculty of biotechnical systems engineering in the field of specialised machinery for agriculture and food.[52]

Actions of the Universities

The option that ICTP, SISSA, and Politehnica University of Bucharest chose to pursue (i.e. to have the relevant students change the subjects of their study) is one suitable course of action and can serve as an example of good practice for compliance units at universities. This type of action still allows the benefits of academic and cultural exchange with nationals of proliferating states to be reaped, while the proliferation threats stemming from intangible transfers of strategic technologies to the countries in question can be countered.

Building on this approach, in March 2019, SISSA concluded an exchange agreement limited to neuroscience with Kim-Il Sung University. SISSA and the Italian Ministry of Foreign Affairs, which signed off on the agreement, believe that neuroscience is exempt from the categories mentioned in UNSC resolutions 2270 (2016) and 2321 (2016).[53] This agreement reflected the lessons learned from the North Korean students changing course. SISSA's consultation with the Italian Ministry of Foreign Affairs (MFA) to find a viable solution towards academic exchange also serves as an example of best practice for university compliance.

45 'Developing Countries,' accessed 22 October 2019, https://www.ictp.it/visit-ictp/developingcountries.aspx

46 This number is dwarfed by the sum of Iranian research months at ICTP, with 359 Iranian researchers spending a total of 190 months at the centre in 2017, and 367 researchers spending 222 months there in 2018. 'Statistical Summary ICTP Visitors 2017,' accessed 22 October 2019, https://www.ictp.it/media/1524476/visitors_17ao.pdf.; 'Statistical Summary ICTP Visitors 2018,' accessed 22 October 2019, https://www.ictp.it/media/1689447/visitors_18ao-1.pdf

47 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150. p.49 paragraph 133, 135.

48 Alison Abbott, 'North Korean physicists forge rare exchange deal with Italian university,' Nature, 27 March 2019, https://www.nature.com/articles/d41586-019-00990-5

49 Abbott, 'North Korean physicists forge rare exchange deal with Italian university.'

50 Abbott, 'North Korean physicists forge rare exchange deal with Italian university.'

51 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150. p. 49, paragraph 134

52 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150.

53 United Nations Security Council Panel of Experts on the Democratic People's Republic of North Korea, Final report of the Panel of Experts submitted pursuant to resolution 2276, S/2017/150.

Conclusions

As pointed out by the director of SISSA, the disciplines referred to in sanctions resolutions are relatively broad, such as advanced physics.[54] Therefore, even if certain sub-disciplines of advanced physics might not be proliferation-relevant, universities might find themselves breaching sanctions if they admit students from countries of proliferation concern to such programmes.

This case study highlights a dilemma that universities and research institutions face when engaging in cooperation with foreign universities and when admitting students from proliferation-relevant countries: Besides the general distinction that needs to be made between 'basic research', which is exempt from export controls, and 'applied research', to which these apply, a determination could have to be made on whether a sub-discipline is covered by the disciplines named in the relevant sanctions.

Recommendations

The actions of the Italian and Romanian institutes point to several general recommendations for universities and research institutes seeking to ensure compliance with national and international laws, including:

- Systematically evaluate the proliferation relevance of courses, particularly when admitting students from countries of proliferation concern.
- Check no international nor national laws are being infringed upon when admitting students from countries of proliferation concern.
- Engage in dialogue with national authorities such as relevant ministries and export control units in order to seek alternatives and workarounds that will not breech sanctions regimes with a view to ensuring the continuation of legitimate academic and scientific exchange.

54 Abbott, 'North Korean physicists forge rare exchange deal with Italian university.'

Case Study 4: University of Massachusetts Lowell Exports Uncontrolled Technology to Entity List Organisation in Pakistan

This case study concerns the export of uncontrolled technology by the University of Massachusetts Lowell (UML) to a sanctioned entity in Pakistan, the Space and Upper Atmosphere Research Commission (SUPARCO), which is the national space agency of the government of Pakistan.

On 1 September 2007, UML exported antennae and cables for an atmospheric control device to SUPARCO, valued at US$12,480.[55] This was followed on 6 October 2007 by an atmospheric testing device, believed to be a DPS4 Four-Receiver Digisonde Portable Sounder, valued at US$191,870.[56] By exporting this equipment to SUPARCO, UML was found by the US Department of Commerce Bureau of Industry and Security (BIS) to be in violation of section 764.2(a) of the Export Administration Regulations (EAR).[57]

In March 2013, UML entered into a settlement agreement with BIS and was issued a civil penalty of US$100,000, suspended for a period of two years, after which the penalty would be waived provided that UML had committed no further violations of the Export Administration Act (1979) or the regulations stemming from it.[58]

About

For many decades, UML has carried out research into the nature of the ionosphere and how it is affected by the sun and other factors. The ionosphere is the upper part of the earth's atmosphere, in which radiation from the sun causes ionisation – the stripping of electrons from the atoms to which they are normally bound to form charged ions and free electrons. The ionosphere allows the long-range transmission of HF and VHF radio waves, allowing radio signals to reflect from the upper atmosphere and travel beyond the 'line of sight' of the transmitter. Analysis of the atmosphere may be carried out using ionosondes, which are specialised RADAR systems built for this purpose.

Much work at UML on the topic of ionosonde development has been carried out with Digisonde equipment (Digitally Integrating Goniometric Ionosonde). These instruments have been manufactured in Lowell since 1969.[59] In December 2009, a UML Professor founded Lowell Digisonde International, which manufactures and supplies these instruments to customers globally.[60] At the same time, the UML Space Science Lab maintains a global network of ionosondes to gather data on the ionosphere and conduct its research activities, often operated by national or international partner organisations.[61]

55 Equipment values as listed in the settlement agreement between UML and the US Department of Commerce Bureau of Industry and Security.
56 'Digisonde Station List,' accessed 9 July 2020, https://www.digisonde.com/stationlist.php.
57 U.S. Department of Commerce Bureau of Industry and Security, Settlement Agreement between the University of Massachusetts at Lowell (UML) and the U.S. Department of Commerce Bureau of Industry and Security.
58 Security, Short Settlement Agreement between the University of Massachusetts at Lowell (UML) and the U.S. Department of Commerce Bureau of Industry and Security.
59 Lowell Digisonde International, 'The World's Most Widely Used HF Radar System for Ionospheric Research and Monitoring.' http://www.digisonde.com/pdfs/DPS4D-Brochure-web.pdf.
60 'Lowell Digisonde International Website,' accessed 9 July 2020, http://www.digisonde.com/index.html.
61 'Station List by Location,' accessed 9 July 2020, https://ulcar.uml.edu/stationlist.html.

Three of these ionosonde stations are in Pakistan, with one in Karachi, one in Islamabad and one in Multan.[62] All stations use Digisonde equipment and are operated by SUPARCO. Between October 2007 and April 2008, the Multan testing station underwent work in order to update its equipment to a newer Digisonde set-up, with equipment supplied by UML.[63]

EAR99 Exports and the Entity List

The supplied equipment was classified under US regulations as EAR99, the lowest level of US export control. EAR99 items are subject to EAR controls, but they are not on the Commerce Control List (CCL) of potential dual-use items and as such do not have Export Control Classification Numbers (ECCN). In general, EAR99 items can be exported without a licence being required, and many exporters rely on their goods being classified as EAR99 to avoid licencing requirements.

However, licences may be required for EAR99 items if being exported to certain countries, end users of certain countries or in support of prohibited end uses. The exporter is responsible for carrying out due diligence to ensure that their export is compliant with restrictions in these areas and to seek licences when it is not. It is in this aspect of the regulations that UML failed in its export control requirements.

US government agencies maintain lists of countries, organisations, individuals, and end uses which are subject to additional export controls, even for EAR99 items. One such list is the US Department of Commerce Bureau of Industry and Security (BIS) Entity List. The US government must approve almost any export application prior to shipment to entities on this list. In general, there is a presumption of licence denial for export to persons and organisations on the list.

Following the testing of nuclear weapons by India and Pakistan in May 1998, the US enacted sanctions against these states in line with the Arms Export Control Act. SUPARCO was determined by the US Federal Government to be an entity involved in nuclear and/or missile activities, and it was ruled that all export of items subject to the EAR to SUPARCO would require a licence, with the presumption of denial.[64] On 22 September 2001, US President George W. Bush waived the sanctions against India and Pakistan, and many entities in these countries were removed from the Entity List. However, SUPARCO remained, with licences still required for export but with a presumption of approval for EAR99 items.[65]

Conclusions

This is another case study that underscores how universities are subject to export control regulations in the same way as individuals or industry. It demonstrates that non-core university programmes such as semi-autonomous research bodies and other affiliated arms of such institutions can equally fall foul of export control rules. The decentralised structure of academia, as compared to industry, means that academics may be carrying out work subject to export control without top-level institutional knowledge.

62 Karachi and Islamabad stations are listed on the UML Space Science Lab station list. See UMass Lowell Space Science Lab, 'Station List by Location.'; Multan station is listed on the Lowell Digisonde International station list: Lowell Digisonde International, 'Digisonde Station List.'

63 Muhammad Ayyaz Ameen et al., 'Variation of hmF2 and NmF2 deduced from DPS-4 over Multan (Pakistan) and their comparisons with IRI-2012 & IRI-2016 during the deep solar minimum between cycles 23 & 24,' Advances in Space Research 61, no. 7 (2018/04/01/ 2018), https://doi.org/https://doi.org/10.1016/j.asr.2018.01.043, http://www.sciencedirect.com/science/article/pii/S027311771830111X.; Muhammad Ayyaz Ameen and Muhammad Ayub, DPS-4 Installation at Multan, Pakistan, Pakistan Space & Upper Atmosphere Research Commission (SUPARCO), https://www.sws.bom.gov.au/IPSHosted/INAG/web-69/2008/08aug_ameen.pdf.

64 Department of Commerce Bureau of Export Administration, 'India and Pakistan Sanctions and Other Measures,' in 63 FR 64322 (US Federal Register, 19 November 1998), Interim Rule. https://www.federalregister.gov/documents/1998/11/19/98-30877/india-and-pakistan-sanctions-and-other-measures. p. 64322

65 Department of Commerce Bureau of Export Administration, 'India and Pakistan: Lifting of Sanctions, Removal of Indian and Pakistani Entities, and Revision in License Review Policy,' in 66 FR 50089 (Federal Register, 1 October 2001), Final Rule. https://www.federalregister.gov/documents/2001/10/01/01-24648/india-and-pakistan-lifting-of-sanctions-removal-of-indian-and-pakistani-entities-and-revision-in. p. 50090

If UML identified SUPARCO on the Entity List at the time of export, it is likely that they could have received an export licence for the equipment. It is assumed that they were operating under the common misconception that so long as the goods being exported are either EAR99 or not subject to the EAR, then they can be exported without a licence.

Recommendations

In terms of recommendations, this case study demonstrates that universities need to:

- Ensure adequate training on export control within their own institutions.
- Check against sanctions lists for each export, particularly the US Consolidated Screening List, which can help exporters to quickly identify restricted parties, as well as other sanctions lists relevant to the exporter's jurisdiction.[66]

66 'Consolidated Screening List,' Export.gov, updated 31 January 2018, accessed 25 June 2019, https://2016.export.gov/ecr/eg_main_023148.asp.

Case Study 5: Georgia Tech Accidentally Releases Restricted Course Materials to the World Wide Web

The Georgia Institute of Technology (Georgia Tech) is a prestigious engineering school which offers training courses for US federal employees and contractors in defence technologies and other areas.[67] All courses are restricted to US citizens, government employees or those with suitable security clearances; the authors found that approximately half of the courses are only offered on a need-to-know basis.[68] For the classified courses, no electronic devices are permitted in the classroom whatsoever.[69]

However, the materials for one of these restricted courses – 'Infrared Technology and Applications' which covers infrared technology used in weapon aiming systems for ships, aircraft and tanks – was accidentally uploaded to a World Wide Web accessible server.[70] The materials were downloaded around the globe including in countries of proliferation concern. To discuss the incident, an internal investigation was conducted. Additional training and controls on restricted course materials were then put in place by Georgia Tech.[71]

About

In November 2010, a total of 69 professional education courses were offered by Georgia Tech for US federal contractors and employees. Eight of these were classified and 15 were restricted under State Department regulations. One such restricted course was 'Infrared Technology and Applications', which was taught by an instructor due to retire.[72]

In order to train the instructor taking over his course, the outgoing instructor videotaped his September course, and provided the video recording and accompanying PowerPoint slides to the university's media staff. He asked them to copy the video to a DVD that could be then given to his successor.[73] The media team encountered technical difficulties in copying the video to DVD, so the Media Quality Control Supervisor suggested they instead upload the data and make it available to download using a hyperlink.[74] The retiring instructor agreed to this alternative proposal, believing that the material would be transferred securely with access only available internally at Georgia Tech. The course video and PowerPoint slides were uploaded to Georgia Tech's servers on 19 November 2009, and the files were open to public access.[75]

Two weeks later, on 4 December 2009, the retiring instructor noticed the error and alerted university staff, who immediately secured the material.[76] Unfortunately, the removal of the material came too late to prevent the release of controlled technology. During this time, it was viewed 676 times by users in 36 countries. Due to the video and slides being stored

67 'Subject Areas: Defense Technologies,' accessed 9 July 2020, https://pe.gatech.edu/subjects#defense-technologies.
68 Based on the authors going to the 'Requirements & Materials' section of each course's webpage during Autumn 2019 and counting the number of need-to-know courses within the Defense Technologies area, as a proportion of the total number of courses within Defense Technologies.
69 'Classified course list,' accessed 9 July 2020, https://pe.gatech.edu/course-restrictions/classified.
70 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
71 John Krige, 'Regulating the Academic 'Marketplace of Ideas': Commercialization, Export Controls, and Counterintelligence,' Engaging Science, Technology and Society 1 (2015).
72 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
73 Brian Starks and Christopher Tucker, 'Export Control Compliance and American Academia,' Strategic Trade Review 3, no. 4 (2017).
74 Starks and Tucker, 'Export Control Compliance and American Academia.'
75 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
76 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'

separately, the video was viewed 16 times, and only from within the US as evident by IP address tracing. However, the PowerPoint files, containing 14 slides showing technical data from export-controlled sources, were viewed 660 times by users from across the globe, including in China, Pakistan and Iran.[77]

Actions of the University

The university managed to trace most of the IP addresses in North America, South America, Western Europe and Australia. However, this was not in the countries of greatest concern; in countries such as Iran and China, large IP address blocks tend to be government registered, rather than being linked to specific users. The retiring instructor stated that as the video and slides were located on separate servers "it would have been difficult for someone to locate all the pieces and put them back together into a coherent whole."[78]

Georgia Tech did not immediately disclose the internet linking of the restricted course materials, waiting six months before notifying the US State Department's Directorate of Defense Trade Controls on 24 May 2010, following an internal investigation. In issuing the notification, the university's Vice Provost wrote that the university had been told by an export control officer for night-vision technology from the US Army that many of the course slides had since been approved for release to the public.[79]

The Army's Night Vision Lab contacted the retiring instructor to deny that it had made this statement. Subsequently, the retiring instructor clarified his comments to state that it was his opinion that most of the images "were to be approved", and that his comments had been misinterpreted to have come from the Army. Three months after its initial disclosure, Georgia Tech retracted its statement regarding the expected approval of slides for public release, issuing an updated report which acknowledged the mistake.[80]

On 23 September 2010, the Deputy Director of the Office of Defense Trade Controls Compliance (DTCC) delivered the State Department's determination that serious violations occurred. The statement said: "This compilation of information is so comprehensive and so sensitive in its description of US Government technology directions that DTCC is concerned over how it was allowed to be placed on a World Wide Web-accessible server."[81]

Georgia Tech discussed the release with all involved parties in its internal investigation. Following the incident, additional training was provided to all staff, and prior written approval is now required in order to make video recordings of restricted courses.[82] Georgia Tech published a paper in 2015 covering its updated export compliance programme.[83]

Conclusions

While it appears that a genuine error was made, this led to a temporary lapse in compliance policy, and for 15 days the restricted material was available globally.

At its heart, this release was caused by insufficient communication between the retiring instructor and the Georgia Tech media team regarding the restricted nature of the course content. The retiring instructor himself said that if the situation arose again, he would do

77 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
78 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
79 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
80 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
81 Golden, 'Military Secrets Leak From U.S. Universities With Rules Flouted.'
82 Krige, 'Regulating the Academic 'Marketplace of Ideas': Commercialization, Export Controls, and Counterintelligence.'
83 Krige, 'Regulating the Academic 'Marketplace of Ideas': Commercialization, Export Controls, and Counterintelligence.'

more to remind the media team members of the "sensitive nature of the material and the need for special handling". This is in line with the statement of the Media Quality Control Supervisor who said that he "completely forgot" about the access restrictions. If video and/or slide file names had included the word 'restricted', media team employees might have treated the material differently.

The question over whether Army officials indicated that material would become publicly available also indicates a lack of clear communication. Even if this release had not occurred, the lack of internal clarity over this point could have potentially led to a release via another route due to it being believed that the slides were soon to be made public.

Recommendations

Several recommendations are applicable for universities and research institutes dealing with restricted access materials. These include:

- Make clearly visible in both digital and physical formats protective markings on course materials.
- Handle restricted technology and information should as befitting its current security classification, and not at any lower level.
- Clearly communicate if information is restricted, so that it can be handled appropriately.
- Disclose any releases of restricted material early and cooperate fully with authorities to minimise potential legal and reputational consequences.

Case Study 6: UK-India Civil Nuclear Research Cooperation Agreement Scrutinised by UK Export Control Authorities

In 2010, the British High Commissioner to India signed a civil nuclear research cooperation agreement between the UK and India in New Delhi.[84] The initiative was launched after UK scientists undertook several fact-finding missions to India with support from the UK's Science and Innovation Network and concluded that pursuing research synergies between the two countries would be mutually beneficial.[85] This arrangement is still in place, and the main participating agencies are the UK's Engineering and Physical Sciences Research Council (EPSRC) and India's Department of Atomic Energy (DAE), represented by the Bhabha Atomic Research Centre (BARC) and the Indira Gandhi Centre for Atomic Research (IGCAR).

As of 2013, both sides had contributed £4.7 million each to the collaboration.[86] Twelve research projects were initiated as part of the collaboration, including on smart monitoring and control systems, waste management and public engagement. Further phases followed in later years, and there have now been five phases of funding, with decisions awaited on most projects in the most recent phase.

TABLE 1 - NUMBER AND TOTAL VALUE OF GRANTS FUNDED UNDER THE UK-INDIA CIVIL NUCLEAR RESEARCH COLLABORATION SINCE ITS INCEPTION.[87]

Phase	Funding decision year	Number of unique funded projects	Total value of UK EPSRC funding awarded (million £)
1	2010	6	1.2
2	2012	6	3.5
3	2015	22	8.3
4	2017	4	2.6
5	2019	1*	0.26*

**Decisions are still awaited on whether additional projects will be funded in the most recent phase.*

The Indian partners in the research collaborations (Department of Atomic Energy, Bhabha Atomic Research Centre and Indira Gandhi Atomic Research Centre) are involved in both the civil and non-civil aspects of India's nuclear programme. As such, the collaborations do have at least the potential for sensitive technology transfer, as UK research could, in

84 'India and UK sign cooperation accord,' 2010, accessed 18 June 2020, https://www.world-nuclear-news.org/NP-India_and_UK_sign_cooperation_accord-1202105.html.

85 Engineering and Physical Sciences Research Council, UK-India Workshop to Identify Areas of Potential Collaboration in Civil Nuclear, https://epsrc.ukri.org/newsevents/pubs/uk-india-workshop-to-identify-areas-of-potential-collaboration-in-civil-nuclear/

86 Research Councils UK (RCUK) India, Five years of RCUK India, https://webarchive.nationalarchives.gov.uk/20180311011045/ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/262633/FINAL_RCUK_India_Timeline_-_electronic_version.PDF

87 Based on data collated from Grants on the Web, the EPSRC portal to access information about funded projects. https://gow.epsrc.ukri.org/NGBODefault.aspx

theory, contribute to the development of Indian nuclear weapons. Being aware of this risk, UK export control authorities rigorously analysed the proposed projects. None of the projects were classified as subject to control under the dual-use list and, based upon the fact that the projects went ahead, it can also be concluded that the WMD end-use control was not invoked.

This case illustrates that international research collaboration on potentially sensitive topics such as nuclear engineering can take place when project scopes are clearly defined to remain outside the scope of export controls. The involvement of the export control authorities, alongside awareness and risk assessment undertaken by the researchers, has allowed fruitful research to be undertaken without breaching export control regulations or putting national security at risk. In this context, it is valuable to examine each of the projects in terms of both its potential control status and contribution to India's nuclear programme.

About

To date, 27 projects have begun under the India-UK civil nuclear research collaboration. None of these projects have been rated by the UK export control authorities as requiring a licence, although each has been closely scrutinised. Several of the projects are clearly outside the scope of controls or are non-technical in nature. For example, one project relates to management of nuclear risk issues to the environment, economy, and human health, while another is entitled 'Sustainability and proliferation resistance assessment of open cycle thorium-fuelled nuclear energy'. Other projects have focused on the vitrification of waste materials, which is of low-proliferation concern. Discounting such projects leaves a list of 16 projects worthy of examination within the context of intangible controlled technology transfer.

The projects have been funded in five phases to date. The first set of projects was funded in 2010, with projects running from 2011 to 2014/15. The second set was funded in 2012 and projects ran from 2013 to 2015 or 2017 depending on the project. The third set was funded in 2015, and projects started in 2016. Some of the projects in the third funding phase are still active at the time of writing, according to information on the UK Research and Innovation Gateway to Research portal, although most have now completed.[88] The fourth set was funded in 2017, with projects starting in 2018 or 2019, with most scheduled to run until 2021 or 2022. The panel to assess the fifth round of funding proposals took place on 4 October 2019, and so far one project from this round has been funded, with a decision not yet announced on other funding proposals submitted to that funding round. The most recent funding round was a closed call and only those who had attended an earlier workshop in April/May 2019 and been selected were eligible to submit a full proposal.[89,90] However, earlier phases were open to anyone eligible to apply for EPSRC funding, in other words universities and selected research institutions.[91]

88 'Grace Time,' UK Research and Innovation, accessed 02.09.2020, https://gtr.ukri.org/projects?ref=EP%2FM018733%2F1.

89 'UK-India Civil Nuclear Collaboration Phase 5: Technical Research. Call Type: Invitation for Proposals,' UK Research and Innovation, 2019, accessed 02.09.2020, https://epsrc.ukri.org/files/funding/calls/2019/ukindiacivilnuclearphase5technical/.

90 'UK-India Civil Nuclear Collaboration Phase 5: Network Plus. Call Type: Invitation for Proposals,' UK Research and Innovation, 2019, accessed 02.09.2020, https://epsrc.ukri.org/files/funding/calls/2019/ukindiacivilnuclearphase5network/.

91 'UK-India Civil Nuclear Collaboration Phase 5. Call Type: Expression of Interest,' UK Research and Innovation, 2019, accessed 02.09.2020, https://epsrc.ukri.org/files/funding/calls/2019/ukindiacivilnuclearphase5eoi/.

Phase 1 – Funded 2010

1. **Irradiation effects on flow localisation in zirconium alloys.**[92]

   This project studied how radiation damage in nuclear fuel cladding materials limits the operating life of the fuel assembly. The proposal noted one aim was "to train Indian researchers to undertake advanced electron back scatter diffraction (EBSD) and synchrotron x-ray diffraction experiments".

2. **Characterisation of the atomic-scale structure of yttria-based particles in oxide dispersion strengthened steels.**[93]

   This project studied the potential of using advanced steel materials to replace structural steels for future "Generation IV" nuclear reactors. Expertise from the UK included atomic-scale characterisation and computational modelling of materials.

3. **Validation and verification for critical heat flux and CFD.**[94]

   Comparing and validating computational fluid dynamics (CFD) computer codes developed in the UK for reactor thermal-hydraulics analysis against data obtained from experimental testing carried out in India.

4. **JOINT: an Indo-UK collaboration in joining technologies.**[95]

   The aim of this collaboration was to study advanced joining technologies, specifically laser-hybrid welding, diffusion bonding and low vacuum electron beam welding. India was to bring joining technology expertise and the UK was to bring weld characterisation expertise.

Phase 2 – Funded 2012

5. **Thermal-hydraulics for boiling and passive systems.**[96]

   Similar to project 3 above, this project aimed to compare CFD and experimental results, focussing on buoyancy-driven flows. Experimental test rig work in India would generate data to validate and refine UK-developed CFD modelling capability.

6. **Transferability of small-scale specimen data to large-scale component fracture assessment.**[97]

   This project studied how materials testing results from small specimens may be used to assess how large components will behave in service. The application was in pipes for Indian heavy water-moderated nuclear reactors.

7. **Fundamental properties of thoria-based mixed oxides.**[98]

   This project studied the behaviour of advanced nuclear fuel materials within reactor

92 'Irradiation Effects on Flow Localisation in Zirconium Alloys' Grant Details,' accessed 9 July 2020 https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/I012346/1

93 'Characterization of the atomic scale structure of yttria-based particles in oxide dispersion strengthened steels' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/I012400/1.

94 'Validation & Verification for Critical Heat Flux and CFD' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/I012427/1.

95 'JOINT: an Indo-UK collaboration in joining technologies' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/I01215X/1.

96 'Thermal Hydraulics for Boiling and Passive Systems' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/K007777/1.

97 'Transferability of small-specimen data to large scale component fracture assessment' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/K007815/1.

98 'Fundamental Properties of Thoria Based Mixed Oxides' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/K00817X/1.

environments. The principal aims were to validate and refine UK-developed materials performance models against real data generated from the post-irradiation examination of material samples carried out in India.

8. **DMW-Creep: Influence of inhomogeneity on creep of dissimilar metal welds.**[99] This project studied the properties and behaviour of welds between differing steel types, particularly how this affects the joint when forces are applied to it over a period of time.

Phase 3 – Funded 2015

9. **Effect of Zr on the microstructure of corrosion resistant ODS steels.**[100]

Following on from project 2 above, this project studies how the addition of zirconium to ODS steels with yttria particles can give improved high temperature strength, corrosion resistance and irradiation performance.

10. **Grace Time.**[101]

Further work related to projects 3 and 5 above, this project seeks to develop models to better predict the buoyancy-driven flows used in passively cooled nuclear reactors. While not stated, it is assumed that the validation of these models will be based on Indian experimental results.

11. **Smart on-line monitoring for nuclear power plants (SMART).**[102]

This project seeks to create a software tool based on artificial intelligence to predict loss of coolant accidents and calculate their impacts in terms of radioactive release and dispersion patterns. The tool will be validated against experimental data.

12. **From Processing to Simulated In-Reactor Performance of Zr Cladding.**[103]

Follows on from project 1 above, expanding the work to understand how the initial processing of zirconium alloys impacts their in-reactor performance. The project includes IGCAR as a new Indian partner for this phase.

13. **Design and Maintenance of Nuclear Safety Systems for Life Extension (DaMSSLE).**[104]

This project studies how existing and future nuclear reactors can have their operating lives extended beyond the design lifetime by a variety of approaches and seeking to develop a decision analysis tool to make recommendations for cost-effective approaches for safe and reliable operation.

99 'DMW-Creep: Influence of Inhomogeneity on Creep of Dissimilar Metal Welds' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/K007866/1

100 'Effect of Zr on the microstructure of corrosion resistant ODS steels' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M017540/1.

101 'Grace Time' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018733/1.

102 'SMART' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018733/1.; "Smart on-line monitoring for nuclear power plants (SMART)' Grant Details, EP/M018709/1,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018709/1.

103 'From Processing to Stimulated In-Reactor Performance of Zr Cladding' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018105/1.

104 'Design and Maintenance of Nuclear Safety Systems for Life Extension (DaMSSLE)' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018210/1

14. **Extension to Transferability of Small-Specimen Data to Large-Scale Component Fracture Assessment (TRANSFER-EXT).**[105]

Follows on from project 6 above. This is a small project to extend the previous validation of the developed model to real, large-scale piping components, exploring specific failure mechanisms.

15. **Indo - UK: Premature, Oscillation-Induced Critical Heat Flux (Premature OICHF).**[106]

Further work related to projects 3 and 5 above. It studies a specific unsteady flow phenomenon in nuclear reactors, which could have potentially severe consequences if not properly understood/managed. The project seeks to build a computer model, as well as carrying out experimental observations and model validation.

16. **Diffusion Bonding Titanium Alloys to Stainless Steels.**[107]

Follows on from project 4 above. The project examines a specific steel-titanium joint type in detail, with the joined samples being subject to microstructural characterisation in India.

Phase 4 – Funded 2017

17. **Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems.**[108]

This project studies a novel class of materials known as high entropy alloys, which appear to have desirable properties for use in nuclear reactor systems. Initial development and testing will be carried out in the UK, with the most promising materials to be sent for testing under radioactive conditions and large-scale manufacturing in India.

18. **Development and Validation of Thermal-Hydraulic ... in BWR's and PWR's: Can modern CFD models reliably predict DNB for nuclear power applications?**[109]

Following on from previous projects on the topic, this project studies how water boils, exploring the process at microscopic scales. The UK will develop computer software to model the boiling process, while India-based researchers will perform boiling experiments to gather data which can be used to validate the models.

19. **Fault tolerant control for increased safety and security of nuclear power plants.**[110]

This project will develop a model control system for a nuclear power plant based on the principle of fault tolerance, under which the system should be resilient in case of faults, increasing plant safety. The project is to be carried out in cooperation with researchers from Bhabha Atomic Research Centre, but the nature of their involvement is not described.

105 'Extension to Transferability of Small-Specimen Data to Large-Scale Component Fracture Assessment (TRANSFER-EXT)' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018040/1.
106 'Indo - UK: Premature, Oscillation-Induced Critical Heat Flux ('Premature OICHF')' Grant Details,' accessed 9 June 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018261/1.
107 'Diffusion Bonding Titanium Alloys to Stainless Steels' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018466/1.
108 'India - UK Civil Nuclear Collaboration: Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems' Grant Details,' Engineering and Physics Sciences Research Council, 2018, accessed 02.09.2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/R021864/1.
109 'India - UK Civil Nuclear Collaboration: Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems' Grant Details.'
110 'India - UK Civil Nuclear Collaboration: Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems' Grant Details.'

20. A Resilience Modelling Framework for Improved Nuclear Safety (NuRes).[111]

This project seeks to examine whether risk analysis approaches in nuclear power plants are suitable for the modern threat and operating environment. The resilience engineering approach is proposed to examine a model nuclear power plant and make recommendations about future plant design. India's contribution to the project is not described.

Conclusions

None of these projects were rated as controlled by the UK export control authorities. The assessment on whether research projects are controlled is often a difficult one since the outcome of research is generally unpredictable. For many of the projects, there are control entries that are potentially relevant, as many projects involve research in support of the development of nuclear reactors or components thereof, such as zirconium tubing, steel pressure vessels or heat exchangers, or software designed for the development of these goods. The question for authorities in these cases was whether the research would result in an export of controlled technology.

Another question to consider in technology controls is whether a technology is required, or necessary, for the development or production of use of a controlled item. However, this can often be difficult to assess. A number of the projects listed above were carried out in order to provide experimental validation of computationally-generated data. Is it necessary to validate a model to build a component?

A relevant, but non-technical project funded under Phase 3 of the collaboration was the creation of an 'Indo-UK Civil Nuclear Network'[112]. More recently, under Phase 5 funding has been granted to set up a UK India Nuclear Network (UKINN), which describes itself as follows:[113]

> *"This network builds upon this success through provision of seed funding for initiation of new collaborations, widen participation, fund joint workshops, secondments, and knowledge exchange between participants. This network is intended to develop the programme further helping it realise its full potential."*

From this it may be inferred that there is an intention to continue with civil nuclear research collaborations between British academia and Indian nuclear research organisations involved with both civil and military applications of nuclear technology. While some UK academics and institutions are now regular recipients of UK Research and Innovation funding in specific areas, new projects and topics have successfully received funding at each phase, and this is anticipated to continue. It is vital that export controls assessment continues to be applied rigorously to all current and future projects to ensure that technology transfers and funding in support of civil nuclear development do not support the development of military applications of nuclear technology.

This case study reports on an example of a long-standing research collaboration where export control concerns would have been raised due to the nature of the research, and where the research was able to proceed following review by export control authorities.

111 'India - UK Civil Nuclear Collaboration: Development of Radiation Damage Resistant High Entropy Alloys for Advanced Nuclear Systems' Grant Details.'
112 'Indo-UK Civil Nuclear Network' Grant Details,' accessed 9 July 2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/M018296/1.
113 'UKINN: UK India Nuclear Network' Grant Details,' Engineering and Physics Sciences Research Council, 2019, accessed 02.09.2020, https://gow.epsrc.ukri.org/NGBOViewGrant.aspx?GrantRef=EP/T016663/1.

Recommendations

From the case study, several lessons can be taken which form the basis of some recommendations for academics and export control officers in research settings:

- Check whether technology or goods could be subject to export controls when preparing to engage in research collaboration.
- Put resources in place to give researchers access to export controls experts and encourage a culture of openness between researchers and export controls staff.
- Consult experts on export controls and approach national export control authorities for assistance when in doubt.
- Contact the International Atomic Energy Agency (IAEA) to make them aware of any research activities related to nuclear technologies.

Case Study 7: Norwegian Institute for Energy Technology Provides Controlled Intangibles to Brazilian Nuclear Submarine Propulsion Project

Norway's Institute for Energy Technology (IFE) is a research institute focused on energy technologies and related topics. IFE, which operates the Norwegian Halden research reactor, regularly provides technical assistance to other states on a commercial basis.[114] According to Norwegian online newspaper *Verdens Gang*, in summer 2013, IFE published a statement admitting that it had provided controlled nuclear technology to five countries without an export licence.[115] Of these, perhaps the most concerning was its assistance to the Brazilian Navy in the testing of nuclear fuel for military submarines.[116]

Brazil's Marine Naval Programme (PNM) seeks to develop and deploy conventionally-armed submarines that use nuclear reactors to supply heat, electricity and power for propulsion. In September 2010, the operator of PNM, Centro Tecnológico da Marinha em São Paulo (CTMSP), enquired whether Norway's Institute for Energy Technology (IFE) could provide support for the development of fuel pellets for a Brazilian naval nuclear submarine propulsion project.

IFE entered into a contract with CTMSP on 30 September 2011. Brazilian newspaper *O Estadão de Sao Paulo* reported that a nuclear fuel qualification was undertaken using 20.2 grams of uranium for the PNM at the Halden facility. The fuel sample was manufactured in Norway to Brazilian specifications and no uranium was exported from Brazil.[117] Digital results from the test were reportedly submitted back to the PNM in Brazil. [118]

About

Nuclear fuel qualification is a vital process in the development of new nuclear fuels, in which test samples of the fuel are subjected to conditions representative of the nuclear reactor within which the fuels are intended to operate, to see how they perform. The fuel samples are monitored within the reactor and are also subject to examination and analysis once the irradiation has been completed.

The case attracted public attention as the cooperation was not authorised by the Norwegian government under relevant export control regulations. A police investigation was launched to investigate whether a violation of these laws had occurred.[119]

114 'The Halden Reactor Project,' accessed 4 February 2016, http://www.ife.no/en/ife/halden/hrp/the-halden-reactor-project. The Halden Project is a joint undertaking of national organizations in 19 countries sponsoring a jointly financed programme under the auspices of the OECD - Nuclear Energy Agency. Discussions are under way for enlarging the member circle. Collaborations with East-European countries in support of plant safety and reliability are also expanding. The programmes are to generate key information for safety and licensing assessments.

115 Bjørn Haugan and Tim Peters, 'Innrømmer ulovlig atomsamarbeid med fem land,' Verdens Gang, 4 September 2013, https://www.vg.no/nyheter/innenriks/i/Jzd87/innroemmer-ulovlig-atomsamarbeid-med-fem-land.

116 Alf Bjarne Johnsen, Bjørn Hauganmay, and Linn Gjerding, 'Atom-tabbe ved Halden-reaktoren,' Verdens Gang, 30 May 2013, https://www.vg.no/nyheter/innenriks/i/GW5gx/atom-tabbe-ved-halden-reaktoren.

117 Alf Bjarne Johnsen, Bjørn Haugan, and May Linn Gjerding, 'Anmelder eieren av Halden-reaktoren,' 12 January 2016, https://www.vg.no/nyheter/innenriks/i/e3r49/anmelder-eieren-av-halden-reaktoren.

118 Roberto Godoy, 'Marinha testa combustível nuclear na Noruega,' Estadão, 12 May 2013, https://politica.estadao.com.br/noticias/geral,marinha-testa-combustivel-nuclear-na-noruega,1031078.

119 Bjørn Haugan and Alf Bjarne Johsen, 'PST overtar atom-etterforskningen,' Verdens Gang, 12 January 2016, https://www.vg.no/nyheter/innenriks/i/RWLnJ/pst-overtar-atom-etterforskningen.

The authors were not able to find any publication of the results of the investigation. However, the authors believe that the 'export' of the intangible technology to Brazil would have required a licence because it was subject to control. Given that this was a commissioned experiment, there can be little doubt that the information gathered from the experiments qualified as information which was 'required' for the development, production or use of a controlled item. Contracted research is invariably intended to produce research outcomes that are necessary. For the same reason, the 'basic scientific research' exemption could not apply as the research is 'applied' in nature.

This case study evidently raises questions about compliance with export controls. Indeed, IFE has admitted that cooperation with several other countries might also include export control issues.[120] However, beyond these issues of compliance, the case study is of interest for several reasons.

First, the business model of the IFE involves irradiating cladded nuclear fuels in its reactor in order to generate data on their performance. For clients outside of Norway, the export is often solely in the form of intangible technology (data) rather than a tangible item.

Second, one purpose of the irradiation of the fuel in the reactor is to provide data to certify the performance of the fuel from a safety perspective, in a process known as fuel qualification. This is a critical stage in the development of any nuclear fuel before it can be used in a power reactor. As such, fuel qualification takes place only once the initial design and development activities have been completed, prototype fuel pellets have been produced, and their performance prior to irradiation is well characterised and understood.

Third, the cladded fuel that is irradiated is produced not by the client but by IFE to the client's specifications. In this context, it can be concluded that the results can verify only the predicted performance of the fuel against a defined specification rather than the actual performance of the fuel as it would be used in practice (since a different producer would produce the actual fuel pellets for use in the client's reactor). Bearing these factors in mind, it is helpful to examine the contribution of controls in this case.

Consideration of these points leads to the question of the utility of controls. The work undertaken by IFE in the case of Brazil is related to relatively mature technology, as submarine nuclear fuels are already in use around the world, if not yet within the Brazilian navy. This was a qualification exercise, which is a relatively advanced stage of technology development. Therefore, the work carried out by IFE was not within the scope of basic/fundamental scientific research.

The data transmitted by IFE appear to consist primarily of explicit information in the form of electronic results, although the possibility that assistance was also provided on either interpreting the results or resolving any issues found with the fuel cladding cannot be discounted. The export of electronic information is controlled in Norway, which adheres to the EU Regulation (EC) No 428/2009 even though it is not a member of the European Union. Technical assistance would be subject to control only where it involves a WMD-related end use.

The implementation of export controls would have provided the Norwegian government with visibility of the export so that it could have intervened by blocking the export or imposing conditions on it, as appropriate.

In this case study, neither of the usual exemptions/decontrols appears to be applicable, for the following reasons:

- The experiment was undertaken for a specific client and the results were not in the public domain.

120 Haugan and Peters, 'Innrømmer ulovlig atomsamarbeid med fem land.'

- The nature of the research was applied and linked to a specific application for an already mature technology.

Analysis of the IFE case study is useful as it involves the export of an intangible technology. Regardless of the outcome of the investigation into potential non-compliance by IFE, it appears that there is a strong rationale for ensuring that such activity is subject to control.

Allegations that IFE was exporting nuclear technology for military purposes were originally reported in the Norwegian press, and the police were subsequently involved. In the ensuing investigation, it came to light that IFE had also participated in other nuclear projects, in Russia, Argentina, France and the United States, for which the institute had also not applied for export licences.[121]

Several of the recipient organisations had close links to military organisations which make use of nuclear technology. Interviewed by the media in 2013, IFE's Research Director and General Manager, Fridtjov Øwre, was asked whether he knew if IFE's input had only contributed to civil nuclear applications, or if the recipient organisations had also used the technology for military purposes. He responded:[122]

> *"We do not know what an organization in another country does with the information they receive. We have secured end-user declarations from those we work with, where they say they should not use this in other ways than the intention was and not spread it. Whether they do or not, yes, we do not know."*

In the case of Brazil, it was known from the outset that the fuel would have a naval use on a nuclear-powered submarine.[123] The Halden reactor's ethical guidelines state that they should not 'export technology or materials that can be used to strengthen another nation's military capability, without export permits from the Norwegian Ministry of Foreign Affairs'. The Halden reactor was shut down permanently in June 2018 due to financial problems.[124] IFE's management acknowledged and regretted that they had not applied for export authorisation and stated that they had already reviewed and improved their export control procedures.[125]

Conclusions

It is clear than IFE should have sought to obtain export control licences, not only for the export of this specific commissioned study to Brazil, but for several other contracts on which the organisation had provided experimental results. While no physical nuclear material was transferred, the movement of intangible technology was still subject to export controls, and especially so given that Brazil was seeking the data to develop military capabilities based on nuclear technology, even though this was not for the purposes of a weapon of mass destruction, against IFE's own ethics policies. This case study is a clear example of how even research institutes working within heavily controlled areas can fail to take proper account of export control regulations.

121 Haugan and Peters, 'Innrømmer ulovlig atomsamarbeid med fem land.'
122 'Atomsjefen i Halden vet ikke om de har bidratt til militært misbruk i utlandet.: Giske om atomsamarbeidet: - Dette er alvorlig,' Verdens Gang, updated 04.09.2013, 2013, accessed 02.09.2020, https://www.vg.no/nyheter/innenriks/i/JzdyJ/atomsjefen-i-halden-vet-ikke-om-de-har-bidratt-til-militaert-misbruk-i-utlandet-giske-om-atomsamarbeidet-dette-er-alvorlig.
123 Haugan and Johsen, 'PST overtar atom-etterforskningen.'
124 Institute for Energy Technology (IFE), 'The Halden Reactor Project.'
125 Haugan and Peters, 'Innrømmer ulovlig atomsamarbeid med fem land.'

Recommendations

Some lessons and recommendations for institutes and researchers that can be taken from this case study include the following:

- When engaging in research collaborations or contracts, ensure that a thorough assessment is made to determine whether export controls are applicable.
- Ensure a regular review of export control compliance is undertaken by independent experts to verify that researchers are not engaging in research partnerships involving the transfer of sensitive information to other states.
- Do not assume that the decontrol provisions will automatically exempt the need to abide by export controls regulations and carefully consider whether research may be exempt on a case-by-case basis.

Researcher Case Studies

Case Study 8: US Professor Jailed for Illegal Export of Data on Plasma Actuators

The case of John Reece Roth, an American academic who was imprisoned for export control violations, highlights several key issues when considering how export controls apply to the transfer of intangible technology in academic settings.

On 1 July 2009, John Reece Roth, a then 72-year-old former Emeritus Professor of electrical engineering at the University of Tennessee (UT) in Knoxville was sentenced to four years in prison, and another two years of supervised release for non-compliance with the Arms Control Export Act (ACEA). The charges in the case centred on Roth's noncompliance with export control requirements for a United States Air Force (USAF)-funded project subcontracted through the private company Atmospheric Glow Technologies (AGT) from 2005-2006. Roth began serving the sentence on 18 January 2012, after an unsuccessful appeal.

About

In April 2005, the USAF awarded a US$749,751 contract to AGT, a private company part-owned by Roth and co-founded by his former student, Daniel Sherman. The contract was for research on the application of plasma actuators to control the motion and direction of air, with the aim of enhancing the flight performance of unmanned air vehicles (UAVs). AGT sub-contracted Roth and UT for US$73,000 per annum to continue developing plasma actuators for flight control of military drones.[126]

Plasma actuators typically use a system of insulators and electrodes to create a plasma of ionised air molecules on a surface.[127] In the aerospace context, these systems can be used to manipulate the flow of air over a surface, such as a control fin or a re-entry vehicle. Potential advantages of plasma actuators in the aviation context include 'lower take-off and landing speeds, shorter runways, increased endurance, improved maneuverability and lower fuel consumption'.[128]

Roth's sub-contract with AGT and USAF explicitly stated that the project was subject to United States export control regulations.[129] Despite this knowledge, Roth insisted that a doctoral student of Chinese nationality, Xin Dai, assist him on the USAF project. Xin had been employed at UT as a graduate research assistant and a graduate teaching assistant under Roth's supervision since August 2002. Sherman, who was concerned about a potential leak of sensitive information to the People's Republic of China (PRC), agreed to appoint Xin to work on basic research whilst a graduate student of American nationality would conduct the more sensitive applied research. This arrangement did not prove sustainable, and the students began to share research with the support of both Sherman and Roth. Sherman later admitted he had known that applied sensitive research should have been restricted to US citizens.[130]

126 Daniel Golden, 'Why the Professor Went to Prison,' Bloomberg 2 November 2012, https://www.bloomberg.com/news/articles/2012-11-01/why-the-professor-went-to-prison#p3.
127 Rasool Erfani et al., 'Development of DBD plasma actuators: The double encapsulated electrode,' Acta Astronautica 109 (2015). 132–143.
128 Erfani et al., 'Development of DBD plasma actuators: The double encapsulated electrode.'
129 United States v. Roth, 642 F. Supp. 2d 796, No. 3:08-CR-69 (United States District Court for the Eastern District of Tennessee 28 July 2009).
130 Golden, 'Why the Professor Went to Prison.'

On several occasions, Roth was warned by university officials not to take sensitive data or files to China, nor to discuss the project on which he was working. In May 2006, upon his return from a lecture trip to China, US federal customs agents met Roth at Detroit airport and photocopied documents in his briefcase and luggage. These documents included one of Xin's reports on the USAF project and an agenda that showed Roth had lectured on the plasma actuator project whilst in the PRC. The FBI then seized both Roth's computer and thumb drive from his Knoxville home. Another report from Xin was discovered on these devices, as well as a draft paper on plasma aerodynamics that Xin had emailed to Roth in China via a Chinese professor. This method of transmission meant that a document that the US government considered to be highly sensitive had been sent to a Chinese scientist.[131]

Legal Case

Roth was accused of one count of conspiracy to export defence articles and services to foreign nationals, 15 counts of exporting defence articles and services without a licence, and one count of wire fraud for defrauding UT of his honest services. Sherman, in the hope of avoiding multiple charges, pleaded guilty to one count of conspiring to violate export controls and supplied emails and journal entries for the prosecution. Sherman was sentenced to 14 months in prison and prohibited from working on federal contracts in the future. AGT was tried for bankruptcy protection in March 2008 and pleaded guilty to 10 counts of export control violations in August 2008.

During his trial Roth testified that he was unaware that hiring the foreign graduate students was a violation of his contract, and that he would not have participated himself had he known.[132] Roth knew the project material was subject to export control laws and did not contend he was unaware of the Arms Export Control Act (AECA) or its licence requirements.[133] Roth's former colleagues had told investigators that "Roth disregarded export control's utility and found them overly restrictive, which contributed to his decision to flout the regulations."[134] After spending four years in prison, Roth was released and is now in retirement. Sherman, for his part, fell short of earning his doctorate because he was not able to publish his results.

The University of Tennessee was not prosecuted, as they claimed to be ignorant of Roth's actions and disclosed his violations to the government as soon as they became aware.

Conclusions

This case study highlights a couple of important and potentially problematic aspects of the intersection of academic research and export controls. Much of this conflict stems from differing interpretations of key terms.

While Roth was not responsible for the removal of sensitive physical goods from the USA, his actions in transferring expertise and data indeed constituted exports, and thus violated the controls placed on the project. The case study is useful in that it highlights several different examples of technological transfers that might not be immediately identified as exports. This is primarily due to the fact that the transfers involved intangible technology, that is, technology that does not necessarily need to take a physical form.[135] First, the employment of a Chinese national on the project and the subsequent sharing of sensitive

131 Golden, 'Why the Professor Went to Prison.'
132 Borrell Brendan, 'Tennessee physicist sentenced to 4 years for sharing drone plans with foreign students,' Scientific American, 2 July 2009, https://blogs.scientificamerican.com/news-blog/tennessee-physicist-sentenced-to-4-2009-07-03/.
133 United States v. Roth, 642 F. Supp. 2d 796.
134 Starks and Tucker, 'Export Control Compliance and American Academia.'
135 This includes, but is not limited to, software, instructions, working knowledge, design drawings, models, operational manuals, skills training, and parts catalogues.

research and knowledge while on US soil. Even though no goods had left US soil, this was still an export of technology.

Roth's visit to China involved three methods of transfer that again, may be identified as exports. The act of bringing a laptop containing sensitive documents relating to the USAF project, presenting on aspects of the project to audiences in China, and the emailing of documents to Chinese nationals, all represent technology transfers.[136]

The Roth case study appears to demonstrate a tension in academia between academic activities and export controls, in terms of what activities should be subject to control. Information enjoys exemption from export controls if it is deemed to be in the public domain. That is to say, it is 'technology or software which has been made available without restriction upon its further dissemination'.[137] Information in the public domain has been published generally and is accessible to the public. Its subsequent transfer cannot therefore be controlled. The threshold at which information can be considered to be in the public domain is somewhat nebulous and subjective. In general, novel technical research will not be public domain, as it represents an addition to the total of what is known. This is true even if the research conclusions were reached using methods and information that are in the public domain, as ruled by courts in the case of Dr Ron Fouchier, discussed elsewhere in this catalogue.

One could argue the research being conducted by Roth on the use of plasma actuators for aerodynamics was already in the public domain. There were several countries researching the same technology at the time. However, the US Air Force specifically restricted the contract because the research was part of a weapons program. Governmental restrictions on dissemination and access made as a condition of funding supersede any exemption that could be made on the grounds that the work was already in the public domain.[138]

Academic research is also exempt from control if it is deemed to be 'fundamental' or 'basic'. That is; it is work undertaken principally to acquire knowledge of fundamental principles or phenomena and not primarily directed toward a specific practical aim or objective.[139] Though Roth had a contract with USAF that he clearly violated, opening him up to criminal prosecution, Roth still perceived the research he was conducting as 'basic' or public. This disagreement illuminates the gap between what some academics might perceive to be 'basic research' and what the law actually considers to be 'basic research'. Roth could simply have asked the US authorities for their advice on the export control status of what he proposed to do, and thereby avoided breaking the law.

Travelling abroad to foreign universities is an activity that the majority of researchers/academics undertake at some point in their career; therefore, the risks emanating from this case can be present for a wide number of academics in relevant disciplines. The broader lesson is that researchers and academics are not exempt from export control law and can be held personally liable for illicit technology transfers.

Roth disregarded repeated warnings from his institution, reportedly insisting that the university's non-discrimination policy overrode federal export law.[140] While the consequences for Roth were severe in that he served a four-year prison term, upon his release from prison, he was able to enter retirement. For his colleague Sherman, however, his academic career was effectively over, demonstrating the career and reputational risks for academics breeching export control regulations.

Although the University of Tennessee managed to preserve its reputation largely because it had warned Roth about the risks involved in carrying data and files to China, the publicity

136 Starks and Tucker, 'Export Control Compliance and American Academia.'
137 Department for Business Innovation & Skills, Export Control Organisation: Guidance on Export of Technology (London, March 2010).
138 'Exclusions/Exemptions from Export Control Regulations,' accessed 9 July 2020, https://research.missouri.edu/compliance/export_controls/exclusions.
139 Project Alpha, Project Alpha and the Association of University Legal Practitioners, Higher Education Guide and Toolkit on Export Controls, King's College London (2015), http://kcl-digi-prod-wa-wordp-ne-04.azurewebsites.net/alpha/wp-content/uploads/sites/21/2015/07/20150407_Guidance_for_Academia_on_Export_Controls_UpdatedCR.pdf
140 Rohrlick, Justin, Air Force Scientist Spilled No Secrets. He Still Went to Prison. The Daily Beast, 27 May 2018. https://www.thedailybeast.com/he-said-he-was-just-a-plasma-scientist-they-said-he-was-a-chinese-spy

it received from the case cannot be considered as positive.

It is clear from this case study that US government authorities are prepared to assert export control regulations in the domain of academia. This case study also serves as an example for other governments worldwide seeking to enforce controls on intangible technology transfers.

Recommendations

That said, a number of recommendations can be provided to ensure compliance and avoid falling foul of export control regulations in the first place:

- Ensure researchers do not export sensitive or controlled technology when travelling internationally.
- Ensure researchers working on projects which fall under export control regulations are allowed to do so, taking into consideration citizenship and nationality restrictions.
- Put internal compliance programmes and export control officers in place to ensure the institution is wholly compliant with the regulations.
- Report any wrong doings to the authorities as soon as possible.

Case Study 9: Dutch Scientist Brings Legal Challenge Against the Applicability of Export Controls for Publishing Virology Research

This case study concerns a Dutch scientist, Ron Fouchier, who was preparing to submit academic research articles on the work of his team into the transmissibility of modified avian flu H5N1 between ferrets.[141] This was considered by both the Dutch and US export control authorities to present a risk, as the technology could in theory be of use in the weaponisation of the virus by increasing its transmissibility. When submitting the articles for publication in the journal *Science*, the journal requested a review from the US National Science Advisory Board for Biosecurity (NSABB) before agreeing to publish.

Fouchier initially resisted encouragement from Dutch export control officers to seek an export licence and sought to publish the research without doing so. However, he did eventually request a licence, and the Dutch government issued him one for a revised version of his manuscript. The manuscript was submitted to the academic journal, *Science* and subsequently published in June 2012. However, a series of court cases ensued where Fouchier sought a ruling that he should not have needed to apply for a licence in the first place.[142] This case study illustrates the difficulties surrounding the scientific publication of research on controlled technologies.

About

In November 2011, Professor Ron Fouchier of the Department of Viroscience at Erasmus University Medical Centre (Erasmus MC), Rotterdam, the Netherlands, was preparing to submit academic research articles on the work of his team into the transmissibility of modified avian flu H5N1.[143] Having modified the pathogen in the laboratory, the newly created strain was found to survive airborne transmission and be passed between the study's animal models – ferrets – in adjacent cages. A second paper, produced by a team led by Professor Yoshihiro Kawaoka at University of Wisconsin, Madison, was also being submitted at this time – studying airborne transmission of a second strain of avian influenza.[144]

The research was of concern to export controls authorities and others in the field, as the technology involved could be classed as dual use: having both civilian and military applications. The publication of the team's research could potentially give indications on how to produce the airborne strain, which is information that could be used to create biological weapons.

Fouchier strongly believed that his research should not be subject to export controls under

141 S. Herfst et al., 'Airborne transmission of influenza A/H5N1 virus between ferrets,' Science 336, no. 6088 (Jun 22 2012). p. 1534-1541; Colin A. Russell et al., 'The potential for respiratory droplet-transmissible A/H5N1 influenza virus to evolve in a mammalian host,' Science (New York, N.Y.) 336, no. 6088 (2012). p. 1541-1547.

142 Christos Charatsis, 'Setting the publication of 'dual-use research' under the export authorisation process: 'the H5N1 case',' Strategic Trade Review 1, no. Autumn (2015). p. 56-72.

143 Herfst et al., 'Airborne transmission of influenza A/H5N1 virus between ferrets.'; Russell et al., 'The potential for respiratory droplet-transmissible A/H5N1 influenza virus to evolve in a mammalian host.'

144 Masaki Imai et al., 'Experimental adaptation of an influenza H5 HA confers respiratory droplet transmission to a reassortant H5 HA/H1N1 virus in ferrets,' Nature 486, no. 7403 (2012/06/01 2012). p. 420.

EU law,[145] as the information was already in the public domain and should be considered as basic/fundamental scientific research. However, when submitting the articles for publication in the academic journal *Science*, a review was requested from the US National Science Advisory Board for Biosecurity (NSABB).[146] The Board's Chair commented, "I can't think of another pathogenic organism that is as scary as this one... I don't think anthrax is scary at all compared to this."[147]

NSABB's verdict, issued 1 December 2011, was that Kawaoka's paper could be published in full. However Fouchier's research could only be published if the methodological sections were removed.[148] While the team at Erasmus MC disagreed strongly with the verdict, they sent a revised manuscript to *Science*, which the journal then sent on to NSABB for a second review. After this review, on 30 March 2012 NSABB reversed its earlier decision, stating that the papers could be published in full, as the revised paper gave them a better understanding of the risks.[149] In particular, they noted that the revised manuscript contained new information indicating that the airborne virus was much less dangerous. This stands in contrast to Fouchier's remarks to journalists when originally preparing to submit his paper, when he described the modified flu strain as "probably one of the most dangerous viruses you can make."[150]

In early April 2012, Kawaoka and Fouchier presented their research at an international conference in London.[151] However, while Kawaoka's talk was full of methodological detail,[152] Fouchier was forced to avoid such topics,[153] as the Dutch government had not yet granted an export control licence.[154] Fouchier became increasingly frustrated with the Dutch export control authorities, going so far as to say that he would submit a revised manuscript to *Science* without applying for an export permit, as he was convinced that this would not be necessary.[155] He eventually requested a licence, while maintaining that it was unnecessary and that such requirements curtail the flow of scientific discourse.

Later that month, the Dutch government issued a licence to Fouchier to submit a revised manuscript. The government's decision was based on European Council regulation No 428/2009, which seeks to prevent the proliferation of chemical, biological, radiological and nuclear weapons through export control on both tangibles and intangible technology. The manuscript was submitted to *Science* and subsequently published on 22 June 2012.

Legal Case

In 2012, Erasmus MC filed an appeal against the government's decision that a licence was required. This was rejected by the Dutch government, and Erasmus MC elected to take the issue to the district court. The licence had, at this point, been granted, used and the manuscript published.[156]

145 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,' in 428/2009 (Official Journal of the European Union, 5 May 2009). p. 1.
146 Charatsis, 'Setting the publication of 'dual-use research' under the export authorisation process: 'the H5N1 case'.'
147 Martin Enserink, 'Scientists Brace for Media Storm Around Controversial Flu Studies,' Science, 23 November 2011, https://www.sciencemag.org/news/2011/11/scientists-brace-media-storm-around-controversial-flu-studies.
148 National Institutes of Health (NIH), 'Press Statement on the NSABB Review of H5N1 Research,' news release, 20 December 2011, https://www.nih.gov/news-events/news-releases/press-statement-nsabb-review-h5n1-research.
149 David Malakoff, 'Breaking News: NSABB Reverses Position on Flu Papers,' Science, 30 March 2012, https://www.sciencemag.org/news/2012/03/breaking-news-nsabb-reverses-position-flu-papers.
150 Ian Sample, 'US government urges scientists to censor findings on new strain of bird flu,' The Guardian, 21 December 2011, https://www.theguardian.com/world/2011/dec/21/bird-flu-mutation-nationa-security
151 'H5N1 research: biosafety, biosecurity and bioethics,' accessed 9 July 2020, https://royalsociety.org/science-events-and-lectures/2012/viruses/ (Event).
152 Yoshihiro Kawaoka, 'Transmission of an influenza virus possessing an H5 hemagglutinin via respiratory droplets,' (London: The Royal Society, 3-4 April 2012). https://www.youtube.com/watch?v=ZlmqmQNolxg&feature=youtu.be.
153 Ron Fouchier, 'Aerosol transmission of influenza A/H5N1 virus in ferrets,' (London: The Royal Society, 3-4 April 2012). https://www.youtube.com/watch?v=bN0DpkENrO8&feature=youtu.be
154 Martin Enserink, 'Free to Speak, Kawaoka Reveals Flu Details While Fouchier Stays Mum,' Science, 3 April 2012, https://www.sciencemag.org/news/2012/04/free-speak-kawaoka-reveals-flu-details-while-fouchier-stays-mum.
155 'Fouchier plans to flout Dutch export law, publish H5N1 study,' Center for Infectious Disease Research and Policy (CIDRAP) at the Univeristy of Minnesota, accessed 17 April 2012, https://www.cidrap.umn.edu/news-perspective/2012/04/fouchier-plans-flout-dutch-export-law-publish-h5n1-study.
156 Charatsis, 'Setting the publication of 'dual-use research' under the export authorisation process: 'the H5N1 case'.'

In 2013, Fouchier appeared in court on behalf of Erasmus MC to bring a claim against the Dutch Minister for Foreign Trade and Development Cooperation, Lilianne Ploumen. Fouchier requested the court to find that a licence should not have been required, and argued that the requirement to apply for a licence caused international legal inequality between researchers.[157]

The desired outcome for Erasmus MC was that they would avoid a legal precedent requiring them to seek export controls authorisation prior to publishing future work.[158] Fouchier sought to use an annex to the EU law which applies an exception to technology transfer rules. The relevant part of this 'General Technology Note' reads as follows:

> Controls on "technology" transfer do not apply to information *"in the public domain"*, to *"basic scientific research"* or to the *minimum necessary information for patent applications.*[159]

The principal argument that Fouchier laid before the court was that the research he and his team conducted was not aimed at a specific practical purpose, and instead sought to generate fundamental knowledge about the principles of aerosol transmission of the virus in ferrets. No specific application or concrete product was described in the papers, which examined whether aerosol transmission was possible and the development of related mathematical models. He stated that the EC Regulation's definition of 'basic scientific research' must be interpreted in a general, rather than limited, sense, as it is a general concept, and that this is apparent from the system of regulation in the EU. As the regulations are ordered to present the exceptions before a list of the controlled technologies, the exceptions must take precedence.[160]

Crucially, Fouchier argued that it is up to the researcher themself to decide whether research is fundamental and thus whether they should apply for a licence; and while researchers can make mistakes in this assessment, only then must export controls be enforced upon them. He also argued that all the methods used in the study already existed in the public domain, and that his team simply systematically applied these methods to the avian flu virus. As such, this new article should also be considered to be information 'in the public domain'.[161]

In defence, Ploumen argued that the basic scientific research and public domain exceptions did not apply to Fouchier's research. Ploumen stated that the definition of basic scientific research must be interpreted within the aims and scope of the regulations as a whole, namely, the prevention of weapons proliferation. The regulations contain an exhaustive list of items and technology subject to control. As such, exceptions must be interpreted strictly, not broadly. Export control permits must be required if there is a risk of proliferation or terrorism, trade or cooperation. She argued that the manuscripts contain the goal of making the virus air-transferable, and thus that the information presented could be used in the development of a biological weapon. The mutations required are presented, as is information on where these mutations already occur in nature. Others have previously failed to make an airborne virus, but Fouchier's team succeeded, and so must have done something new that had not been done before. She stated that if the information were already widely available in the public domain, the paper would have no novelty and as such would not have been accepted for publication in a prestigious scientific journal such as Science.[162]

The court agreed that the regulations must be interpreted in line with the aim of proliferation prevention and thus that exceptions must be applied strictly. Fouchier's argument was found to be lacking, as he had only argued that the regulations did not

157 ECLI:NL:RBNHO:2013:8527, No. HAA 13/792 (Rechtbank Noord-Holland 20 September 2013).
158 Wappes and Schnirring, 'Fouchier plans to flout Dutch export law, publish H5N1 study.'
159 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.' Annex I.
160 ECLI:NL:RBNHO:2013:8527. Paragraph 5.2.
161 ECLI:NL:RBNHO:2013:8527. Paragraph 5.2.
162 ECLI:NL:RBNHO:2013:8527. Paragraph 5.1.

state that the exceptions should be interpreted in a limited way. The court agreed with Ploumen that the exceptions must be interpreted in a limited way in order to prevent erosion of the regulations; if individual researchers are the ones who decide if their research is 'basic' or not, EU Member States cannot appropriately discharge their duties under the regulations.[163] Making the virus air-transmissible was found to be a practical goal of the research,[164] and the manuscripts were found to contain new information that was not yet in the public domain.[165] This information was judged to be suitable for development of a product. It was therefore the judgement of the court that the exceptions did not apply.[166]

The court refused to comment on Fouchier's assertion that the requirement to obtain an export controls licence led to international inequality, as this argument was hypothetical with no proof. It was also found that the Netherlands acted in accordance with EU law.[167] While it was acknowledged that the requirement to apply for a licence would hamper accessibility of research, it stated that this disadvantage does not outweigh the importance of non-proliferation of biological weapons, and that in balancing the interests of the state and the researcher, non-proliferation must be paramount.[168] Researchers want to publish their work, and if they are the only ones making judgements about whether the work is 'basic scientific research' then EU Member States will not be able to fulfil their obligations to create systems that prevent proliferation.[169]

The court therefore dismissed Fouchier's appeal against the 2012 decision as unfounded.[170] This decision was expected to make it more difficult for Fouchier to publish future research on the topic, as it set a precedent that export control licences would be required. Fouchier was given six weeks to lodge an appeal against the decision, and he and Erasmus MC chose to do so.[171]

The appeal was heard in July 2015.[172] At the appeal, the judgement of the 2013 court proceedings was rejected.[173] The appeal court ruled that as the licence had been granted and used, Erasmus MC and Fouchier did not have a legal interest in pursuing the case in the first place. The court felt that the reason they had brought proceedings was simply to set a precedent that would allow them to use exceptions to avoid obtaining export control licences in the future, while the court could only rule on the contested decision itself.[174] The court decided that Ploumen should have declared Erasmus MC's original objection in 2012 inadmissible.[175] It should be noted that Ploumen only took up the role of Minister in November 2012, which for two years previously had been vacant.[176,] Erasmus MC, for its part, should have either applied for the licence, or objected to the requirement to obtain one; the court seemed to suggest that by applying for the licence, Erasmus MC had acknowledged the need to acquire one.[177] The result of this judgement was that the original court decision rendered in 2013 that the research was neither fundamental nor in the public domain was rendered no longer applicable – arguably a victory for Fouchier and his team, although this only placed them back in the same position as they were in in mid-2012.

163 ECLI:NL:RBNHO:2013:8527. Paragraph 5.6.
164 ECLI:NL:RBNHO:2013:8527. Paragraph 5.7.
165 ECLI:NL:RBNHO:2013:8527. Paragraph 5.8.
166 ECLI:NL:RBNHO:2013:8527. Paragraph 5.8.
167 ECLI:NL:RBNHO:2013:8527. Paragraph 5.10.
168 ECLI:NL:RBNHO:2013:8527. Paragraph 5.11.
169 ECLI:NL:RBNHO:2013:8527. Paragraph 5.11.
170 ECLI:NL:RBNHO:2013:8527. Paragraph 7.
171 ECLI:NL:RBNHO:2013:8527. Section 'Rechtsmiddel'.
172 ECLI:NL:GHAMS:2015:2913, No. 13/00661 (Gerechtshof Amsterdam 18 June 2015).
173 ECLI:NL:GHAMS:2015:2913. Paragraph 6.5.
174 ECLI:NL:GHAMS:2015:2913. Paragraph 6.2.
175 ECLI:NL:GHAMS:2015:2913. Paragraph 8.
176 'Kabinet-Rutte-Verhagen (2010-2012),' Rijksoverheid, accessed 02.09.2020, https://www.rijksoverheid.nl/regering/over-de-regering/kabinetten-sinds-1945/kabinet-rutte-verhagen; 'Kabinet-Rutte-Asscher (2012-2017),' Rijksoverheid, accessed 02.09.2020, https://www.rijksoverheid.nl/regering/over-de-regering/kabinetten-sinds-1945/kabinet-rutte-asscher.
177 ECLI:NL:GHAMS:2015:2913. Paragraphs 6.1 and 6.2.

Conclusions

The case study illustrates how the definitions of 'basic' or 'fundamental' scientific research are potentially ambiguous. While it was not referenced in the court documents, it has been argued[178] that the court's reasoning suggests that Erasmus MC was using definitions from the Organisation for Economic Co-operation and Development (OECD)'s 'Proposed Standard Practice for Surveys on Research and Experimental Development', a document also known as the 'Frascati manual'[179]. The manual defines fundamental and applied research as follows:

> *"Fundamental or basic research is defined as the experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view."*

> *"Applied research is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective."*

Erasmus MC claimed that Fouchier's work had no practical application and was thus fundamental in character. In 2015, the Frascati manual was updated, with more extensive information defining basic and applied scientific research.[180] A detailed discussion of what distinguishes fundamental research is beyond the scope of this case study but can be found in work by Charatsis.[181] However, this decontrol provision is regularly used by researchers to carry out work without export controls oversight, to the point where there is a risk that those conducting work which would require a licence may mischaracterise their work as fundamental.

Recommendations

Recommendations for universities and researchers from this case study include the following:

- Offer training in export controls, which details the decontrol provisions, with a particular focus on their applicability and limitations.
- Consider the full range of applications stemming from the technology, focusing not only on what the technology will or should be used for, but also what it could be used for in the wrong hands.
- Seek export controls advice and authorisation, even when the researcher feels that the research should not be subject to controls, and even when the researcher feels under pressure to publish.

178 Charatsis, 'Setting the publication of 'dual-use research' under the export authorisation process: 'the H5N1 case'.'
179 OECD, Frascati Manual 2002: Proposed Standard Practice for Surveys on Research and Experimental Development, The Measurement of Scientific and Technological Activities (Paris: OECD Publishing, 2002). https://www.oecd-ilibrary.org/content/publication/9789264199040-en.
180 OECD, Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development (Paris: OECD Publishing, 2015). https://www.oecd-ilibrary.org/content/publication/9789264239012-en.
181 Charatsis, 'Setting the publication of 'dual-use research' under the export authorisation process: 'the H5N1 case'.' p. 64-67, 'Lesson II: The Applicability of the 'Basic Scientific Research' Exemption is Contentious'.

Case Study 10: Chinese Scientist with Iranian-German Supervisor Expelled from Norway for Research on Hypersonic Vehicles

The case of a Chinese PhD student, Hu Xiaoxiang, and an Iranian German professor, Hamid Reza Karimi expelled from Norway demonstrates how academic research interests can overlap with national security concerns. In January 2015, Hu and Karimi, both working at the University of Agder (UiA) in Norway, were expelled from the country. The expulsion occurred after Norwegian authorities determined that the work of the Hu – deemed relevant to hypersonic missiles – was "part of a research exchange who is using the information to benefit military authorities in China".[182]

Hu and Karimi sought to overturn the expulsions, and on 14 September 2015, Norway District Court ruled in their favour[183] The Norwegian government later successfully appealed the overturning of the Karimi's expulsion; it is not known whether an appeal was made for the Hu.[184] Much of the evidence used in these cases was not made available to the public.

The university largely stood behind the researchers and questioned whether it was right to accuse them of breaking export control regulations if the charges against the two were only based on contact with Chinese scientists.[185] However, Karimi who continued to work for the University from Germany following the deportation order received instructions not to research anything that goes high or fast.[186] He resigned some months later fearing "intense control and surveillance of his work."[187]

About

According to newspaper reports, events began in June 2014, when the Norwegian Police Security Service (PST) showed up at the office of the Director of UiA to inform him that they suspected two UiA employees were breaking the Norwegian Export Control Act.[188] The two employees concerned were Hu Xiaoxiang, a PhD student of Chinese nationality, and Hamid Reza Karimi, a dual citizen of Germany and Iran, who acted as Hu's supervisor. Six months later, the two UiA employees were issued a deportation decision by the Norwegian Ministry of Justice, upon which Hu Xiaoxiang returned to China, and Karimi initially carried on working for the university based in Germany. However, Karimi later resigned from his post.[189]

182 Bree Feng, 'Chinese Student to Contest Expulsion From Norway, Lawyer Says,' Sinosphere, The New York Times, 6 February 2015, https://sinosphere.blogs.nytimes.com/2015/02/06/chinese-student-to-contest-expulsion-from-norway-lawyer-says/.
183 'China glad to see court ruling against scholar's expulsion from Norway,' China Daily, 21 September 2015, http://www.chinadaily.com.cn/china/2015-09/21/content_21942351.htm.
184 Joske, Picking Flowers Making Honey: The Chinese Military's Collaboration with Foreign Universities.
185 Rein Terje Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet,' Fædrelandsvennen, 20 August 2015, https://www.fvn.no/nyheter/lokalt/i/QWK08/anklage-uia-ansatte-truer-norges-sikkerhet.
186 Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet.'
187 News in English.no, 'Iranian professor quits amidst controversy,' 18 February 2016, https://www.newsinenglish.no/2016/02/18/iranian-professor-quits-amidst-controversy/.
188 Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet.'
189 News in English.no Iranian professor quits amidst controversy.; Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet.'

Reportedly, the PST referred to research articles that the two employees had co-authored as the basis for their initial suspicion; these were articles written before Hu Xiaoxiang had moved to Norway. [190] Papers published by the pair include:

- Xiaoxiang Hu, Hamid Reza Karimi, Ligang Wu and Yang Guo, 'Model predictive control-based non-linear fault tolerant control for air-breathing hypersonic vehicles', *IET Control Theory and Applications,* Vol. 8:13, 04 September 2014, p. 1147-1153.

- Xiaoxiang Hu, Hamid Reza Karimi and Zhang Yan, 'MPC-based tracking control for air-breathing hypersonic vehicles with input constraints', Proceedings of the 32nd Chinese Control Conference, 2013.

- Xiaoxiang Hu, Hamid Reza Karimi, Huijun Gao and Changhua Hu, 'Fuzzy Non-fragile H_∞ Tracking Control for Flexible Air-breathing Hypersonic Vehicles', Proceedings of the 1st IFAC Conference on Embedded Systems, Computational Intelligence and Telematics in Control, CESCIT 2012 242-247, April 2012. Würzburg, Germany.

- Xiaoxiang Hu, Hamid Reza Karimi, Zehao Zhang and Huijun Gao, 'Non-fragile Sliding Mode Control for Flexible Air-Breathing Hypersonic Vehicle', Proceedings of the 2012 7th IEEE Conference on Industrial Electronics and Applications (ICIEA).

The papers focus on control systems air-breathing hypersonic vehicles –missiles that fly so fast that they cannot be intercepted by any current missile defence system[191] – with some listing Xi'an Research Institute of High Technology as Hu's affiliation. The Xi'an Research Institute is reportedly a cover institute for China's Rocket Force Engineering University (RFEU) and seems to exist only on paper.[192]

At least some of the authors' work, as outlined above, was supported by a Norwegian Government grant for offshore wind energy research.[193] The intention of the grant was to fund PhD students working on wind power as well as meteorological and oceanographic measurements.[194] While Karimi has published on the subject of control systems for offshore wind energy,[195] these methods can be applied widely in control systems engineering, and the use of the methods for wind energy does not automatically lead one to carrying out research in hypersonic vehicle control systems.

Legal Cases

In the initial court cases heard before Oslo District Court, the Norwegian State argued that Hu is likely "part of a military research collaboration for the benefit of China" and therefore "there is a danger that he will contribute to the illegal export of technology/knowledge. However, the court found it doubtful that Hu was linked to a research collaboration with military purpose in favour of China at the time of the decision to expel him from Norway. Thus, the focus of the Court's argument seems to have been on the timing of the work carried out. The court also found Hu not to have knowledge of aerial vehicles that may be of interest to Chinese scientists, and that Hu could not acquire such

190 Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet.'
191 James Bosbotinis, 'Hypersonic Missiles: What are they and can they be stopped?,' Defence iQ, 28 August 2018, https://www.defenceiq.com/defence-technology/articles/hypersonic-missiles-what-are-they-and-can-they-be-stopped.
192 Joske, Picking Flowers Making Honey: The Chinese Military's Collaboration with Foreign Universities. p. 12.
193 Xiaoxiang Hu et al., 'Model predictive control-based non-linear fault tolerant control for air-breathing hypersonic vehicles,' IET Control Theory & Applications 8, no. 13 (2014). https://digital-library.theiet.org/content/journals/10.1049/iet-cta.2013.0986. 1147-1153. See the acknowledgement section.
194 'FME- NORCOWE- Norwegian Centre for Offshore Wind Energy, Project Number 193821,' ProsjektBanken, accessed 13 July 2020, https://prosjektbanken.forskningsradet.no/#/project/NFR/193821.
195 Yulin Si and Hamid Reza Karimi, 'Gain Scheduling H2/Hffi Structural Control of a Floating Wind Turbine,' IFAC Proceedings Volumes 47, no. 3 (2014), https://doi.org/https://doi.org/10.3182/20140824-6-ZA-1003.02775, http://www.sciencedirect.com/science/article/pii/S1474667016426790. p. 6788-6793; Tore Bakka and Hamid Reza Karimi, 'Hffi static output-feedback control design with constrained information for offshore wind turbine system,' Journal of the Franklin Institute 350, no. 8 (2013), https://doi.org/https://doi.org/10.1016/j.jfranklin.2013.05.028, http://www.sciencedirect.com/science/article/pii/S001600321300207X. p. 2244-2260.

knowledge in Norway.[196] Therefore, the legal basis for his expulsion was rejected by thecourt. In the case of Karimi, the court found that he had co-authored five articles on aerial vehicles with Chinese researchers, and that he had cooperated with at least two Chinese professors on another subject, but it did not find him guilty of exporting knowledge from Norway for the benefit of the Chinese military by working with Chinese scientists.[197] Equally, Karimi overturned the deportation ruling.

The question also arose as to whether hypersonic/scramjet engines about which the research was conducted had exclusively military uses, and was therefore hostile, as the PST and Norway's Defense Research Institute (FFI) had claimed.[198] Conversely, both lawyers for the two UiA employees claimed that the purpose of the research and its field of application cannot be limited or claimed to be of primary military interest. Hu's lawyer argued that the research conducted by Hu was basic research, which all countries carry out including the EU through the 7th Framework Programme.[199] He also maintained that all large, international universities conduct research on the management of high-speed vehicles, and therefore this would be considered as ordinary research in the field. The lawyer maintained that the contributions of the two UiA employees have no practical significance for the development of rocket systems.[200]

The researchers won their initial legal case, which were subsequently appealed by the state of Norway, although little information is available in the public domain on the outcomes of those appeals. It is known that the Norwegian Government successfully appealed the overturning of the supervisor's expulsion; it is not known whether an appeal was made for the PhD student.[201]

Conclusions

The case study raises questions as to whether students and/or professors from countries of proliferation concern or non-aligned countries researching advanced military technologies in Western universities potentially increases the risk of controlled intangible technologies being transferred to them.

While the legal outcomes of the initial court cases ultimately hinge on technical matters of legal reasoning, Hu has since published again from China – from the Xi'an Research Institute of High Technology[202] and the Air and Missile Defense College, Air Force Engineering University in Xi'an.[203] Evidence more explicitly ties Hu to the RFEU. As Alex Joske reports:

> *'The website of RFEU's missile research centre states that Hu Xiaoxiang won an award in 2014 for his PhD thesis on hypersonic aircraft, supervised by General Hu Changhua [one of the People's Liberation Army's leading missile experts]. The website also says that in 2014 he received 250,000 renminbi [32,000 €] from the Chinese Government for a three-year research project on hypersonic aircraft[...]. In 2016, he was described as a lecturer at the centre, which received 14 awards for missile research between 2010 and 2014.'*[204]

196 Agder-forskere vant mot PST (Translation: Agder scientists and deportation), Pa Hoyden, 17 September 2015, https://pahoyden.no/industrispionasje-iran-iranersaken/agder-forskere-vant-mot-pst/362123.
197 Agder-forskere vant mot PST (Translation: Agder scientists and deportation), Pa Hoyden, 17 September 2015, https://pahoyden.no/industrispionasje-iran-iranersaken/agder-forskere-vant-mot-pst/362123.
198 Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet.'
199 Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet.'
200 Thorstensen, 'Anklage: UiA-ansatte truer Norges sikkerhet.'
201 Joske, Picking Flowers Making Honey: The Chinese Military's Collaboration with Foreign Universities. p. 12.
202 Yixin Cheng et al., 'HOSM observer based robust adaptive hypersonic flight control using composite learning,' Neurocomputing 295 (2018), https://doi.org/https://doi.org/10.1016/j.neucom.2018.03.022, http://www.sciencedirect.com/science/article/pii/S0925231218303084. p. 98-107.
203 Yuyan Guo et al., 'Two controller designs of hypersonic flight vehicle under actuator dynamics and AOA constraint,' Aerospace Science and Technology 80 (2018), https://doi.org/https://doi.org/10.1016/j.ast.2018.06.025, http://www.sciencedirect.com/science/article/pii/S1270963818301548. p. 11-19.
204 Joske, Picking Flowers Making Honey: The Chinese Military's Collaboration with Foreign Universities.

Ultimately, this case study demonstrates the legal consequences an individual researcher may face if their work raises national security concerns. In this case, both researchers were initially deported from Norway and had to return to their respective countries and were embroiled in legal battles which ultimately cost them their international reputation.

Recommendations

Various recommendations can be derived from the case study based on the actions of the national authorities, the universities, and the researchers themselves. Particularly, universities should:

- Maintain dialogue with state authorities to increase awareness of export control regulations, with a view to preventing proliferation.
- Scrutinise the work of researchers and students in areas of sensitive technology, particularly the work of those in sensitive technology areas coming from countries of proliferation concern in order to support authorities in safeguarding against proliferation.
- Raise awareness through training amongst researchers about export control laws and the need to apply for the necessary licences if the research might be deemed by state authorities to have military applications.
- Support researchers if their research is challenged by state authorities, for example by helping them identify a suitable lawyer or by granting them continued employment during the investigation process.

Case Study 11: Iranian Researcher in Extradition Case for Seeking to Obtain High-Powered Microwave Industrial Systems and Counter-Drone Technology

This case study concerns an Iranian researcher/engineer who stands accused by the United States of attempting to export to Tehran high-powered industrial microwave systems and anti-drone systems from the US. It is claimed that these systems are to be employed for military purposes in Iran after some modifications.[205]

The researcher in question, Jalal Rohollahnejad, was arrested on 2 February 2019 at Nice airport in France based on an extradition request from the United States.[206] During detention in France, Iran in turn arrested two French researchers – Fariba Adelkhah, an anthropologist, and, Roland Marchal, a sociologist researching civil wars in Africa.

A French court ultimately granted the United States extradition request, following which a prisoner swap between France and Iran took place. The US sharply criticised the swap maintaining that it was "regrettable that France had not upheld its treaty obligations".[207]

About

In April and May of 2019, a report appeared in the French media about Jalal Rohollahnejad – an Iranian researcher/engineer who was wanted by two judges in the United States on charges of attempting to export to Iran high-powered industrial microwave systems and anti-drone systems from the US.[208] According to the report, these systems were to be later used for military purposes in Iran after some modifications.[209] However, Rohollahnejad insisted he was merely an engineer and researcher and had committed no crime.[210]

High-powered industrial microwave systems have applications in directed energy weaponry. The most known of this type of weapon is the US-developed Active Denial System, which can project energy beams that cause intense pain in those affected, incapacitating the victim.[211] While the Active Denial System is a long-range non-lethal weapon, the technology can also be used to kill – and developers are seeking ways to minimise the technology into a hand-held weapon.

Anti-drone systems, also known as counter-drone or counter-UAV (Unmanned Aerial Vehicle) technology, are used for detecting, identifying, tracking and/or controlling unmanned aircraft. The strategic value of counter-drone technology is on the rise because it seeks to counter the potential security threats that drones pose to both civilian and

205 Luc Leroux, 'Le sort d'un Iranien entre justices française et américaine,' Le Monde, 30 April 2019, https://www.lemonde.fr/international/article/2019/04/30/le-sort-d-un-iranien-entre-justices-francaise-et-americaine_5456844_3210.html.
206 Leroux, 'Le sort d'un Iranien entre justices française et américaine.'
207 U.S. Department of State, 'France's Unilateral Release of Iranian National Jalal Rohollahnejad,' news release, 22 March 2020, https://www.state.gov/frances-unilateral-release-of-iranian-national-jalal-rohollahnejad/.
208 Leroux, 'Le sort d'un Iranien entre justices française et américaine.'
209 Leroux, 'Le sort d'un Iranien entre justices française et américaine.'
210 Leroux, 'Le sort d'un Iranien entre justices française et américaine.'
211 'Non-Lethal Crowd Control Weapon: Active Denial System: burns the skin at up to 700 yards,' (4 July 2019), Video. https://www.liveleak.com/view?i=df1_1331395700.

military entities in conflicted airspaces.[212]

Rohollahnejad is a fibre optic specialist, who was arrested on 2 February 2019 at Nice airport after travelling from Tehran via Moscow on the basis of an extradition request from the United States.[213] According to the French daily *Le Monde*, two federal American judges from the District of Columbia claimed that allegedly illicit activities of Rohollahnejad took place between April 2016 and June 2018.

Rohollahnejad stands accused of using a Chinese pseudonym to cover up an export to the United Arab Emirates destined for the Iranian company, Rayan Roshd Afszar, described by the newspaper as being linked to the Iranian Islamic Revolutionary Guards Corps (IRGC). Rayan Roshd Afszar is a US Office of Foreign Assets and Control (OFAC)-designated entity which, according to an OFAC press release, produced technical components for the IRGC's unmanned aerial vehicle (UAV) programme and has sought to repair IRGC military equipment.[214] The value of the operation is said to have allegedly resulted in several transactions via front companies amounting to a value of US$1 million (900,000 €).

Le Monde reported that Rohollahnejad studied for 10 years in China. Rohollahnejad obtained his PhD in optical engineering from the Huazhong University of Science and Technology in Wuhan, China, prior to which he studied for a Master's degree in the Department of Physics at Tarbiat Modares University in Tehran.[215] A Scopus search revealed that "his research areas include fibre optic sensors, adaptive optics, high power fibre lasers, and ultra-fast measurement and temporal imaging". He has published a number of scholarly journal articles on these topics since 2009, listing Huazhong University as his affiliation.[216]

Amongst Rohollahnejad's scientific articles is one on military missile technology titled "Using Infrared to Detect Missiles" presented at the "Electronic Defense Seminar" in Tehran.[217] Another research paper by the same authors is on edge detection in videos for target tracking purposes[218] – probably for a missile guidance system. On the former paper, he listed Shahid Alamolhoda Industries as his affiliation, which has been described as both a subsidiary of Iran's Naval Defence Missile Group (SAIG), and as a subsidiary of Iran's Aviation Industries Organisation (AIO) as recently as 2013.[219] These are all sanctioned entities. The AIO, for its part, is a subsidiary of Iran's Ministry of Defense and Armed Forces Logistics (MODAFL), responsible for overseeing Iran's missile production.[220] Numerous individuals and entities associated with AIO are subject to U.N. Security Council sanctions, as well as US sanctions because of their support for Iran's ballistic missile programme.

Rohollahnejad maintains his innocence, stating that he was never in contact with the Canadian and British companies mentioned. He asked, "If I had set up an organised crime group, why would I use my personal email account, the one that I had used my entire career as a researcher?" However, he admitted in Court to working for the AIO, for about 10 years "on research projects that were 100% scientific".[221]

212 Arthur Holland Michel, Counter drone systems, Center for the Study of Drones at Bard College, February 2018, https://dronecenter.bard.edu/files/2018/02/CSD-Counter-Drone-Systems-Report.pdf

213 Leroux, 'Le sort d'un Iranien entre justices française et américaine.'

214 U.S. Department of the Treasury, 'Treasury Targets Persons Supporting Iranian Military and Iran's Islamic Revolutionary Guard Corps,' news release, 18 July 2017, https://www.treasury.gov/press-center/press-releases/Pages/sm0125.aspx.

215 Jalal Rohollahnejad, Research Gate, accessed 13 July 2020, https://www.researchgate.net/profile/Jalal_Rohollahnejad.

216 Valerie Lincy, 'Extradition of Iranian Engineer, Suspected of Missile-Related Procurement, Moves Forward,' Iran Watch, 21 June 2019, https://www.iranwatch.org/our-publications/international-enforcement-actions/extradition-iranian-engineer-suspected-missile-related-procurement-moves-forward.

217 Peyman Moallem, Jalal Rohollahnejad, and Ahmadreza Javadi, Using Infrared to Detect Missiles, https://web.archive.org/web/20140701012945/ http://www.roboeq.com/PDF/ashkar%20saz.pdf..; 'جلال روح‌الله نژاد که فریبا عادلخواه برای آزادی او گروگان گرفته شده، کیست؟' Iran Wire, 19 September 2019, accessed 13 July 2020, https://iranwire.com/fa/features/33000.

218 جلال روح اله , جلال روح اله نژاد , and پیمان معلم .' ,روشی سریع در ردیابی تصویری به کمک تعقیب قالب لبه هدف) دومین کنفرانس ماشین . , 'دومین کنفرانس ماشین بینایی و پردازش تصویر نویسندگان). 2002,

219 U.S. Department of the Treasury, ' Treasury Designates the IRGC under Terrorism Authority and Targets IRGC and Military Supporters under Counter-Proliferation Authority,' news release, 13 October 2017, https://www.treasury.gov/press-center/press-releases/Pages/sm0177.aspx.

220 'Aerospace Industries Organization (AIO),' Iran Watch, 26 January 2004, accessed 13 July 2020, https://www.iranwatch.org/iranian-entities/aerospace-industries-organization-aio.

221 Leroux, 'Le sort d'un Iranien entre justices française et américaine.'

Legal Cases & Prisoner Exchange

On 30 April 2019, the Court of Appeal of Aix-en-Provence examined the US extradition request, which concerned five alleged offences. The Public Prosecutor of Aix-en-Provence had requested the Court of Appeal to issue a favourable opinion, and on 22 May 2019, the French Court approved the request.[222] However, Rohollahnejad made a final appeal to the Court of Cassation – a court of last resort – in Paris.[223] On 11 March 2020, that court rejected Rohollahnejad's appeal in effect validating his extradition towards the United States. For the extradition to come into effect, this would have to be further validated by a decree from the French Prime Minister. [224]

In the meantime, and during Rohollahnejad's detention in France, Iran had arrested two French researchers: Fariba Adelkhah, a French Iranian anthropologist, who specialises in Shia Islam, and Roland Marchal, who researches African civil wars and who had visited Fariba Adelkhah in Iran. Both researchers worked at *Sciences Po* in Paris. On the 20 March 2020, a prisoner swap between Iran and France occurred where Roland was released in exchange for Rohollahnejad.[225] On the 16 April 2020, Adelkhah was sentenced to six years in Iranian prison.[226]

Conclusions

The events in the case study have proven to be somewhat problematic as they occurred within the context of growing tensions between the United States and Iran. An export control case has essentially being politicised. Rohollahnejad was the subject of a US extradition request for charges against him related to the supposed illegal export of equipment with military applications in violation of US sanctions. The French Executive choose not to proceed with the extradition of Rohollahnejad, opting instead to secure the release of at least one of its own citizens, while Iran secured the release of Rohollahnejad.

Therefore, as the case against Rohollahnejad was never heard, the charges against him have of course yet to be proven. However, if the charges against him were proven true in fact, then the export of the equipment could potentially have national security implications for the United States and its allies. In addition, the case study demonstrates that researchers can have ties to defence organisations, which may be sanctioned entities. Although no Western-aligned university was implicated in this case, it shows that researchers working on proliferation sensitive topics and trained in universities from non-aligned or proliferation-relevant countries have the potential to act as conduits of sensitive technology towards those countries.

Recommendations

Therefore, the recommendation for universities in this case study is to:

- Be aware of proliferation risks within their own institutes, particularly those that might occur in research areas covering dual-use topics.
- Be aware of potential insider threats, so screen incoming researchers in sensitive topic areas and particularly those from countries of proliferation as well as their affiliations against sanctions lists.

222 Jean-Francois Rosnoblet, 'French court approves extradition of Iranian engineer to U.S,' Reuters, 23 May 2019, https://uk.reuters.com/article/uk-iran-engineer/french-court-approves-extradition-of-iranian-engineer-to-u-s-idUKKCN1ST22U.
223 Lincy, Extradition of Iranian Engineer, Suspected of Missile-Related Procurement, Moves Forward.
224 Georges Malbrunot, 'La justice française valide l'extradition d'un ingénieur iranien vers les États-Unis,' Le Figaro, 11 March 2020, https://www.lefigaro.fr/international/la-justice-francaise-valide-l-extradition-d-un-iranien-vers-les-etats-unis-20200311.
225 AFP, 'Echange de détenus entre Paris et Téhéran, Roland Marchal peut-être bientôt en France,' Le Point International, 21 March 2020, https://www.lepoint.fr/monde/echange-de-detenus-en-vue-entre-paris-et-teheran-espoir-pour-roland-marchal-20-03-2020-2368083_24.php#.
226 Conrad Duncan, 'Fariba Adelkhah: Iran sentences French-Iranian academic to six years in prison on national security charges, lawyer says,' The Independent, 16 May 2020, https://www.independent.co.uk/news/world/middle-east/fariba-adelkhah-iran-france-academic-jail-lawyer-saeid-dehghan-tehran-a9518336.html.

Case Study 12: US & Canadian Professors Export Semi-Conductor Chip Technology to China

This case study is about a professor, in a Canadian University, by the name of Ishiang Shih, a professor, in a US university, by the name of Yi-Chi Shih, and a US citizen called Kiet Anh Mai. These individuals were all indicted for illegally obtaining and exporting high-powered semi-conductor chips to China. The semi-conductor chips in question, known as monolithic microwave integrated circuits (MMICs), were listed as export-controlled technology with various military applications – meaning a licence from the US Government was required to export them. The defendants in the case were charged with exporting the goods at hand to a company on the US Entity List for which a licence would have presumably been denied.[227]

Yi-Chi Shih and Mai were found guilty following trial of 18 federal criminal charges including engaging in a scheme to illegally obtain the chips, mail fraud and wire fraud.[228] While Mai pleaded guilty to one felony and faced a maximum statutory sentence of 10 years in federal prison, Yi-Chi Shih was convicted of all 18 counts in a federal grand jury indictment and faces life imprisonment.[229] The United States has reportedly requested that that Ishiang Shih be extradited from Canada.[230] The universities were not implicated in the case.

About

In June 2019, Yi-Chi Shih (Shih), a dual citizen of Taiwan and the US, who lived in both the US and China, was found guilty of 18 federal criminal charges including engaging in a scheme to illegally obtain wide-band high-power semiconductor chips known as monolithic microwave integrated circuits (MMICs) which were later illegally exported to China. Shih's co-defendants were his brother Ishiang Shih (Ishiang), a native of Taiwan and resident of Canada, and Kiet Anh Mai (Mai), a US citizen.[231] All three individuals were electrical engineers. Shih and Mai were former employees of a US defence contractor and Shih was an Associate Professor in engineering at University of California in Los Angeles. His brother Ishiang was an Associate Professor in engineering at the McGill University in Canada.[232]

MMICs are listed on the US Commerce Control List as an export-controlled technology. They have various commercial and military applications. As well as reportedly having applications in cell phones, MMICs are also typically used in missiles, missile guidance systems, military fast jets, electronic warfare, electronic warfare countermeasures and radar applications.[233] Customers of the company that manufacturers these items – listed in the indictment only as Company B[234] – include the US Air Force, US Navy and the Defence

227 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment (United States District Court for the Central District of California June 2017).
228 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.
229 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.
230 Tom Blackwell, 'U.S. seeks to extradite McGill professor accused of conspiring to send technology to China,' The National Post, 5 July 2019, https://nationalpost.com/news/u-s-seeks-to-extradite-mcgill-professor-accused-of-conspiring-to-send-technology-to-china.
231 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.
232 Agence France-Presse, 'Professor brothers in Canada and US are both 'suspected of spying for China',' South China Morning Post, 26 January 2018, https://www.scmp.com/news/world/united-states-canada/article/2130657/professor-brothers-canada-and-us-are-both-suspected.
233 U.S. Department of Justice Office of Public Affairs, 'Electrical Engineer Convicted of Conspiring to Illegally Export to China Semiconductor Chips with Missile Guidance Applications,' (Justice News, 2 July 2019). https://www.justice.gov/opa/pr/electrical-engineer-convicted-conspiring-illegally-export-china-semiconductor-chips-missile.
234 According to newspaper reports, this company was Cree Inc, which produces semiconductor products for power and radio-frequency applications

Advanced Research Projects Agency (DARPA).[235]

From approximately 2011 until at least 2016, Shih received payment for work he did for Chengdu Gastone Technology Company (CGTC), a Chinese company which established a semiconductor fabrication plant in Chengdu, China, in which MMICs were allegedly to be made.[236] Shih was at times President and Technical Consultant for CGTC. Ishiang was the company's Technical Director, and the Vice President and a Director of a company called JYS Technologies based in a suburb of Montreal, Canada.[237]

In August 2014, the US Department of Commerce placed CGTC on its Entity List because it had been involved in the illicit procurement of goods and technologies for unauthorised military end use in China. The listing of CGTC meant that a licence was required from the US Government to export, re-export or transfer in-country any item subject to export control to CGTC.[238] There was a presumption of denial attached to this,[239] and so in effect, CGTC would be denied all access to export-controlled equipment or technology from the US, and by any means.

Shih, Ishiang and Mai set up and used several US and Canadian-registered companies to receive money from China, and to use it in support of their attempts to obtain the semiconductors and its technology. Specifically, JYS Technologies had reportedly transferred substantial funds to other companies – Pulman Lane and Microex Engineering, set up by Mai and Shih respectively.[240]

Company B was identified as the target of the procurement attempts and Mai approached it, falsely posing as a domestic US customer. Mai requested use of Company B's MMIC design service. Having successfully convinced the company of his credentials, including by completing an Export Compliance Questionnaire, Mai managed to obtain electronic access to the company's design portal, and he passed on access details to Shih.[241]

In September 2013, Mai used his US-based front company Microex to email a purchase order to Company B for the delivery of four MMICs, the value of which was about US$130,000 – in effect paying the firm to manufacture some of the circuits.[242] Payments to Company B followed until December 2013, shortly after which Mai took delivery of the semiconductors. In January 2014, some of the MMICs were illegally exported (without an export licence, but also deliberately mis-described and mis-valued) from California to Hong Kong using a commercial courier.[243]

One MMIC was also sent to an unnamed researcher at an unnamed US University for testing. The researcher responded in January 2015 with a 30-page report summarising testing that had been carried out on the MMIC, and which Shih had requested.[244] Another MMIC was exported to Canada.[245]

A further purchase of MMICs was requested from the same US company in mid-2014. The stated end use was for development within the US (and so not for export). After various payments, which were facilitated by all three defendants, these were delivered to Mai in March 2015.[246]

---

including MMICs.

235 U.S. Department of Justice Office of Public Affairs, 'Electrical Engineer Convicted of Conspiring to Illegally Export to China Semiconductor Chips with Missile Guidance Applications,' (Justice News, 2 July 2019).

236 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

237 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

238 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

239 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

240 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

241 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

242 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

243 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

244 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

245 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

246 United States of America v Yi-Chi Shih, Ishiang Shih, and Kiet Anh Mai, Indictment.

Shih and CGTC are said to have illegally obtained access to the Company B's proprietary technology so that CGTC could use it to establish a MMIC foundry in China, and a number of MMICs were said to be illegally exported to China. Shih and Mai have both been convicted of various charges (many of which are for related matters such as tax fraud).

Conclusions

This case study demonstrates that researchers working with technologies that have military applications need to keep abreast of export control law. Falling foul of export control regulations can ultimately bring about negative life changing circumstances. It also demonstrates the need for researchers to constantly check against international and national sanctions screening lists to ensure they are not cooperating with designated entities. One question that might be asked in this case study is why a company listed on the US Department of Commerce Entity List was able to transfer the funds into a registered US company, which leads into the realm of proliferation finance.

Recommendations:

Recommendations for researchers include:

- Work with the university's export control officer to screen against export control lists and apply for any necessary licences whether a presumption of denial principal applies or not.
- Work with the university's compliance team to screen against international and national sanctions screening lists to ensure projects do not involve collaboration with any designated entities.
- Keep in mind the need to abide by the regulations that seek to prevent and counter fraud when buying and exporting goods in monetary value.

Case Study 13: PhD Students Jailed for Attempting to Export Military Sensors to China

This case study concerns a Chinese national who violated the US Arms Export Control Act and the International Traffic in Arms Regulations (ITAR) by attempting to export a military sensor to China without a licence. To do this, a PhD student Bo Cai invoked the help of his cousin who was a graduate in Iowa State University (ISU), by falsely listing him as the end user of the equipment.[247] Following an intelligence-led investigation by the US Department of Homeland Security, both individuals were indicted and later prosecuted.[248]

There is no information to suggest that the US manufacturer of these sensors nor the university was in any way negligent. In an official statement, ISU said that the university cooperated with federal investigators who contacted them as they were investigating the student, and that they did not have specific information about the allegations against the graduate.[249] However, they maintained that he was a PhD candidate at ISU the time of his arrest and had been at ISU since 2009.[250]

About

In July 2014, Bo Cai, a Chinese national, pleaded guilty in New Mexico, US, of violating the Arms Export Control Act and the International Traffic in Arms Regulations (ITAR) by attempting to export, without the necessary export licence, a military sensor to China.[251]

In 2012, Bo Cai was employed in China by a technology company. Before beginning his PhD programme in the US, Bo worked for a high-tech company, Nanjing Shuntai Electronics Corporation (南京顺泰 科技公司).[252] The company, based in Nanjing, controls two subsidiary companies, including one which specialises in optoelectronics.[253] Despite being a private company, its CEO has stated his desire to act in step with provincial state-owned enterprises.[254] The company has a party board and its stated corporate goals include promoting Chinese Communist Party leadership and advancing national technology.

Within this context, Bo Cai embarked on an illegal scheme to smuggle a military-specification Angular Rate Sensor out of the US to China. The sensors targeted in this case were a type primarily manufactured for the US Department of Defense for use in high-level applications such as line-of-sight stabilisation and precision motion control systems, which themselves featured on military platforms such as military aircraft and ground vehicles.[255]

247 Greg Zwiers, 'ISU student Wentong Cai arrested on charge of attempting to smuggle military technology to China,' Iowa State Daily, 12 June 2014, https://www.iowastatedaily.com/news/isu-student-wentong-cai-arrested-on-charge-of-attempting-to/article_108b3446-f2b7-11e3-9bfa-001a4bcf887a.html.
248 United States of America v. Bo Cai and Wentong Cai, Superseding Indictment (United States District Course for the District of New Mexico).
249 Zwiers, 'ISU student Wentong Cai arrested on charge of attempting to smuggle military technology to China.'
250 Zwiers, 'ISU student Wentong Cai arrested on charge of attempting to smuggle military technology to China.'
251 United States of America v. Bo Cai and Wentong Cai, Superseding Indictment.
252 Zwiers, 'ISU student Wentong Cai arrested on charge of attempting to smuggle military technology to China.'
253 'Nanjing Shuntai Technology Co. Ltd.,' accessed 4 October 2019, www.jsshuntai.com/+&cd=1&hl=en&ct=clnk&gl=uk.
254 'Nanjing Shuntai Technology Co. Ltd..'
255 U.S. Department of Justice Office of Public Affairs, 'Chinese Nationals Sentenced in New Mexico for Conspiring to Violate Arms Export Control Act,' (Justice News, 23 April 2015). https://www.justice.gov/opa/pr/chinese-nationals-sentenced-new-mexico-conspiring-violate-arms-export-control-act.

Their export is controlled by the ITAR, which includes a list of defence equipment and services known as the US Munitions List. Their export from the US could only legally happen with a licence issued by the Department of State. Additionally, the ITAR prohibits re-exports, transfers or transhipments from foreign countries of such items that had previously been exported, without State Department approval.[256] US policy was not to issue export licences for these items to China.[257]

Realising that he could not export the military sensor legally, Bo Cai enlisted the help of his cousin, Wentong Cai, who was in the US on a student visa as a graduate of veterinary microbiology and preventative medicine at Iowa State University (ISU).[258] The falsely stated end use was that the sensor would be used by Wentong Cai at ISU. Subsequently, Nanjing Shuntai Technology Co. Ltd. reportedly transferred US$27,000 to an undercover agent Wentong was in contact with.[259] In essence, the US authorities became aware of Bo Cai's intentions and an investigation began in October 2013.

Shortly afterwards, on 11 December 2013, Bo Cai was arrested at an airport in Los Angeles as he attempted to export the sensor to China. Officials discovered the sensor concealed in a computer speaker in Cai's luggage.[260] Wentong Cai was arrested in Iowa in January 2014.[261] Bo Cai was later sentenced to 24 months in prison and his cousin Wentong Cai was sentenced to 18 months in prison. Both would be deported after completing their prison sentences.[262]

Conclusions

China is known to aggressively target the acquisition of equipment and technologies in operational use by US armed forces. Whilst it is not known whether Bo Cai was acting on the orders of the Chinese authorities, if he had been successful in exporting the sensor to China, it may have ended up with China's state apparatus. There is no information to suggest that the US manufacturer of these sensors or the university was in any way negligent. The prosecution of the Cai cousins resulted from an intelligence-led operation and it is therefore possible that the US authorities were alerted and became suspicious during Bo Cai's enquiries about the sensors.

Although the case study demonstrates how academic routes can be used to pursue the illegal export of controlled goods abroad, the university seems to have suffered limited reputational damage as it cooperated with the authorities concerning investigations regarding one of its researchers. Moreover, this case study appears to concern a researcher gone rogue rather than a lapse in export control policies on behalf of the university. Equally, the case study demonstrates the penalties which can be incurred by a student for violating export control regulations.

Recommendations

A number of recommendations for universities and researchers can be derived from this case study:

- Cooperate fully with authorities regarding suspected export control violations and be vigilant of insider threats.
- Keep abreast of export control regulations and requirements, and the need to apply for any licences required.
- Do not be enticed by monetary value on offer for illicitly obtaining sensitive and export-controlled goods and technology, as the reputational and criminal consequences and record for engaging in such action are real.

256 United States of America v. Bo Cai and Wentong Cai, Superseding Indictment.
257 U.S. Department of Justice Office of Public Affairs, 'Chinese Nationals Sentenced in New Mexico for Conspiring to Violate Arms Export Control Act.'
258 U.S. Department of Justice Office of Public Affairs, 'Chinese Nationals Sentenced in New Mexico for Conspiring to Violate Arms Export Control Act.'
259 Zwiers, 'ISU student Wentong Cai arrested on charge of attempting to smuggle military technology to China.'
260 U.S. Department of Justice Office of Public Affairs, 'Chinese Nationals Sentenced in New Mexico for Conspiring to Violate Arms Export Control Act.'
261 U.S. Department of Justice Office of Public Affairs, 'Chinese Nationals Sentenced in New Mexico for Conspiring to Violate Arms Export Control Act.'
262 U.S. Department of Justice Office of Public Affairs, 'Chinese Nationals Sentenced in New Mexico for Conspiring to Violate Arms Export Control Act.'

Case Study 14: Research & Development Centre Employee Jailed for Exporting Military Grade Titanium Technology to China

This case study deals with the theft of military trade secrets from US defence contractors by a Chinese national, who was also a legal permanent resident of the United States. On 16 December 2016, Yu Long pleaded guilty to charges related to the theft of numerous documents from a sensitive US military programme and transporting them to China.[263] The exports made were found to be contrary to the US Arms Export Control Act and the International Traffic in Arms Regulations (ITAR), the latter requiring exports of military goods and technologies to be first licensed by the US Department of State.[264]

Long had stolen the documents from his employer, which required its employees to execute non-disclosure agreements, to undergo training on the protection of sensitive and export-controlled information, and to certify that they had returned all such documents to the company. From the beginning of his employment in 2008 to its end in 2014, Long signed these documents. He underwent the relevant training courses as required, and executed the Company Export Control Personal Responsibility acknowledgements which bound him not to transfer sensitive or export-controlled information.[265]

This case study demonstrates serious breaches of export-controlled requirements where export controls do not appear to have been enforced rigorously enough. The case study also hints at system failures in the protective system employed by the US defence industry.

About

Between 2008 and 2014, Yu Long worked as a Senior Engineer/Scientist for United Technologies Research Centre (UTRC), a research and development centre that formed part of United Technologies Corporation (UTC) – a major US defence contractor based in Connecticut. UTRC performed research and development and delivered advanced technology to a range of United Technology Corporation entities such as UTC Aerospace Systems, Pratt & Whitney, UTC Climate, Controls & Security, and Otis.[266]

In 2013, Long, whilst still employed by UTRC, was actively seeking employment with Chinese state-controlled universities. In particular, Long contacted the Chinese Academy of Sciences (CAS) which is a ministry under the Chinese State Council. CAS offers a variety of highly competitive 'Talent Plans', which are Chinese government-run programmes designed to recruit talent and obtain information and technology from abroad to benefit and modernise China's industry, economy and national security.[267]

263 US Department of Justice, 'Chinese National Admits to Stealing Sensitive Military Program Documents from United Technologies', Justice News, 19 December 2016, https://www.justice.gov/opa/pr/chinese-national-admits-stealing-sensitive-military-program-documents-united-technologies.
264 US Department of Justice, 'Chinese National Admits to Stealing Sensitive Military Program Documents from United Technologies', Justice News, 19 December 2016.
265 United States of America v. Yu Long, No. 3:16-cr-00229-AVC, Information (United States District Court for the District of Connecticut 19 December 2016).
266 United States of America v. Yu Long, Information.
267 United States of America v. Yu Long, Information.

In 2013, Long also contacted various Chinese universities, including the Guangzhou Institute of Advanced Technology (GIAT) and the Shenyang Institute of Automation (SIA). These are both state-run and affiliated to CAS. In his employment application to SIA, Long claimed, "In the past 5 years I have been working with Pratt and Whitney ……. these ….. experiences have provided me with a great starting point to perform R & D and further spin off business in China. I believe my efforts will help China to mature its own aircraft engines".[268] SIA responded to Long in August 2013 stating, "You are the talent we need".[269]

Sometime later in 2013, Long attended an interview with SIA in China. In November SIA's Director informed him that he had successfully passed his interview for the 'Hundred Talent Plan A', and soon after he was offered a position at SIA. As part of the final assessment process SIA instructed Long to provide samples of his work in the USA to prove the claims made in his application.[270] Long then emailed several documents to the Director of the SIA, including information about Long's claim to hold certain patents. One of the documents that Long emailed to China was clearly marked as being controlled for export from the USA.[271]

In May 2014, Long emailed SIA confirming his intention to join the organisation that month and asked what documentation he should bring. In June 2014, Long travelled to China taking with him an external hard drive issued to him by UTRC, and which he had unlawfully retained after his employment had ended. The hard drive contained various company documents including company trade secrets, as well as several other company documents, data, and source codes relating to highly sensitive, proprietary, trade secret, and export controlled material.[272] Whilst in China in August 2014, Long accessed one of these documents on the hard drive.[273]

On 19 August 2014, Long returned to the US through John F. Kennedy International Airport in New York. His bags were searched by US Customs and Border Protection officers, and officers found Long to be in possession of US$10,000 in undeclared cash, registration documents for a new corporation being set up in China, and a largely completed application for work with a state-controlled aviation and aerospace research centre in China.[274] Long claimed in his application that, whilst working in the US, he had worked on the F119 and F135 engines, which are employed respectively on the US Air Force F-22 Raptor and F-35 Lightning II combat aircraft.[275]

The following day, he emailed a Professor at Tsinghua University in China attaching an 'Achievement and future plan'. In it, Long stated that he knew about unpublished company projects in which the US Air Force was interested. He also discussed his work on the F119 and F135 fighter jet engines, both of which are manufactured by Pratt & Whitney, a division of UTC.[276]

Three months later, Long was arrested at Newark Liberty International Airport in the US as he attempted to return to China again. Whilst in transit through the airport, Long's checked-in baggage was searched and found to contain electronic copies of sensitive, proprietary, and export-controlled documents. The sensitive proprietary documents contained detailed equations and test results used in the development of technologically-advanced titanium to be used on US military aircraft.[277] These documents found in

268 U.S. Department of Justice Office of Public Affairs, 'Chinese National Admits to Stealing Sensitive Military Program Documents From United Technologies,' (Justice News, 19 December 2016). https://www.justice.gov/opa/pr/chinese-national-admits-stealing-sensitive-military-program-documents-united-technologies.
269 United States of America v. Yu Long, Information.
270 United States of America v. Yu Long, Information.
271 U.S. Department of Justice Office of Public Affairs, 'Chinese National Admits to Stealing Sensitive Military Program Documents From United Technologies.'
272 United States of America v. Yu Long, Information.
273 United States of America v. Yu Long, Information.
274 Aruna Viswanatha and Andrea Shalal, 'Man charged with trying to take U.S. military documents to China,' 9 December 2014, https://www.reuters.com/article/us-united-tech-china-arrests/man-charged-with-trying-to-take-u-s-military-documents-to-china-idUSKBN0JN2LI20141209.
275 U.S. Department of Justice Office of Public Affairs, 'Chinese National Admits to Stealing Sensitive Military Program Documents From United Technologies.'
276 United States of America v. Yu Long, Information.
277 Viswanatha and Shalal, 'Man charged with trying to take U.S. military documents to China.'

Long's possession were later reviewed by Rolls Royce, which formed part of a major defence consortium convened by the US Air Force to see whether they could collectively lower the costs of the metals used. Member of the consortium, which also included Pratt & Whitney, shared technical dated with each other subject to restrictions on further dissemination.[278] Rolls Royce confirmed that Long had never being employed by them. A subsequent review of UTCR computer records indicated that Long had printed the documents while employed by UTRC.[279] Thus, despite export control restrictions in place governing unauthorised use, Long had been able to print the documents and take them from his employer. Long served two and a half years in prison.

Conclusions

The technology to which Long had access, and which he took to China, was clearly sensitive and subject to export control. It concerned the manufacture of engine components for US military aircraft, and it focused on additives and distortion modelling. This type of information is generally protected very closely by the US defence industry, both to safeguard the commercial interests of the companies that own the technology, and to maintain the integrity, safety and security of US operational military aircraft. Successful acquisition of this technology by China would further its understanding of the F119 and F135 fighter aircraft engines, enabling China to better defend against them, and, likely, to copy the technology for its own programmes.

Despite the existence of internal procedures that were designed to prevent unauthorised access to sensitive materials, Long was able to download documents onto a hard drive provided to him by his employer and print them off. He was then allowed to remove not only printed documents but also the external hard drive belonging to his employer. Whilst Long appears to have undergone all the requisite export control-related training and signed the necessary documents to be compliant with internal procedures, there appears to have been no follow-up mechanism in place such as inspections, searches, random checks to reinforce the procedures. This hints at failures in the protective system employed by US industry, and possibly by the authorities themselves.

Additionally, although Long was a lawful permanent resident of the US, he remained a Chinese citizen. US law requires an export authorisation for any foreign national working for a US company. Long succeeded in obtaining the necessary security clearances which allowed him to be employed at UTC, and to access sensitive information. Despite this, he was able to fly back and forth to China with sensitive documents on his person.

Recommendations

The main recommendations for research institutes to be drawn from this case study include:

- Implement internal compliance programmes (ICPs) that are robust enough to not only control the behaviour of employees who handle and have access to sensitive information, but also to detect breaches.
- Promote reporting of suspicious activities to detect and counter insider threats.

278 U.S. Department of Justice Office of Public Affairs, 'Chinese National Admits to Stealing Sensitive Military Program Documents From United Technologies.'
279 U.S. Department of Justice Office of Public Affairs, 'Chinese National Admits to Stealing Sensitive Military Program Documents From United Technologies.'

Summary

The case studies in this catalogue on intangible technology transfer from universities and research institutes to non-aligned states seeking to enhance their military capabilities and to proliferator states pursuing WMD programmes are varied and diverse. They are divided into two sections: case studies involving institutions, and case studies involving individual researchers.

The institutional case studies indicate that universities and research institutes involved in teaching, research, or the use of sensitive and/or export-controlled technologies must put in place comprehensive compliance programmes and a team of compliance professionals to support and implement those programmes. Particularly, in the case of CSSTEAP where proliferation risks were clearly present, adoption of a compliance programme incorporating both intangible technology controls on the training and education services offered, as well as a screening mechanism against sanctions designations may potentially have aided in preventing intangible technology transfer to WMD proliferators. The institutional case studies also attest the need to ensure the necessary export control licences are applied for and obtained. For instance, UML could have also avoided penalties if it had more stringently followed the regulations. The challenge therefore for universities and research institutes is to continuously keep abreast of changing export control regulations and sanctions designations.

A number of these case studies also underscore the need for managing risk by cooperating with national export control authorities. This finding is notably evident in the case studies on Imperial College London and SISSA, which after cooperation with authorities secured long-term collaboration agreements with universities and research institutes in non-aligned countries, notably China and the DPRK respectively. On the other hand, the Georgia Tech release demonstrates that even when compliance measures are in place and even when there is willingness to comply with all regulations, errors can occur. In such instances, full disclosure as early as possible and full cooperation with authorities is necessary.

The case studies focused on individual researchers show that government authorities are increasingly keen to enforce export control regulations in the academic domain. These case studies, particularly that of Roth and Fouchier, put on full display the reluctance of certain researchers to comply with export control requirements, apparently believing that their right to academic freedom trumps national security concerns. However, in these two cases, as well as in the case of Hamid Reza Karimi, national security and weapons proliferation concerns ultimately prevailed. The Fouchier case study also lays bare the debate between basic and applied research. However, here also, the legal precedent set is that the definition of basic research must be interpreted with a view to preventing proliferation. The Roth and Fouchier case studies further illustrate the challenge for universities in raising awareness about export control laws amongst their own researchers, yet this awareness-raising is essential so that researchers themselves do not suffer any negative or criminal consequences.

On those occasions where individual researchers chose to purposefully violate the regulations governing exports of controlled technologies for either professional or monetary gain, jail sentences ensued. Such criminal penalties were evident in the cases of Roth, Shih, the Cai cousins and Long. These case studies emphasise the need for universities and research institutes to be aware of insider threats that may result in the theft of intellectual property or technology and may bring disrepute upon the institution. While these case studies are likely exceptional in that these researchers seemingly wilfully

violated the regulations, most researchers are likely willing to comply.

Actions universities may wish to take into account when dealing with problematic scenarios include immediate notification to, and full cooperation with, national competent authorities. Universities may also consider whether continued support to a researcher involved in a problematic scenario is appropriate or not. Universities themselves should have procedures in place to scrutinise the work of researchers and students, particularly those working in sensitive topic areas and when institutes or individuals from countries of proliferation concern are involved. Such scrutiny is necessary to support national authorities in safeguarding against proliferation. Through dialogue with governments, universities and research institutes may be able to seek alternatives to export control challenges with the aim of ensuring that researchers continue to benefit from legitimate academic exchange without prejudicing international non-proliferation efforts. Cooperation and dialogue between governments and universities as well as with individual researchers will ultimately lead to more beneficial outcomes.

Centre for Science and Security Studies
Department of War Studies
King's College London
Strand
London WC2R 2LS
United Kingdom

www.kcl.ac.uk/csss
@KCL_CSSS