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Recent Experiences and Emerging Cooperation Schemes on TA and Education
An Insight into Cases in Portugal and Germany

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At the beginning of the 21st century there are new expectations and challenges towards Technology Assessment (TA). Among these there is a new awareness on TA issues in education, in particular at universities. While TA was mainly an activity at extra-universitarian research institutions for a long time now there are new developments and initiative towards integrating TA issues in university courses. We will first give an insight into the international development. Secondly we will focus on the "TA and education" landscape in Germany and Portugal in more detail, followed by a description of new and emerging forms of cooperation between Portugal and Germany in this field which might serve as a model or an example for further cooperation between other partners.

1 Current developments in the field of TA

In the past decade, many things have changed in TA and its societal environment. The fields of interest moved from technology in a more classical engineering sense to cross-cutting "techno sciences", ethical questions and innovation issues entered the field, and some of the technology conflicts of the 1970s and 1980s lost relevance.

These changes have been reflected in the concepts used. Classical TA regarded itself in part as an early warning system for risks caused by technology. This classical orientation is still present but has, however, now been quite considerably broadened, understanding TA as a contribution to technology governance and innovation policy, particular in areas of uncertain knowledge. In addition, TA is increasingly involved in the development of a deliberative democracy and a civil society, mainly in the debates on technology-based futures and visions (Grunwald 2007), and there is renewed interest in social sciences and humanities. New concepts such as ethical, legal and social implications of technology (ELSI) or environment – health – safety (EHS) studies can be regarded as specifications of the basic idea of TA to particular ends and purposes.

At the end of the Office of Technology Assessment at the US Congress, upcoming new challenges for TA and increasing needs for TA were also expressed by Senator Kennedy[1] who still defended the programme of OTA in the Senate: "In the years ahead, as we move into the 21st century, there will be even greater need to rely on OTA for impartial assessment of technology-related policies. The world of science and its impact on public policy are becoming more complex, not less. Technology is central to every aspect of American life, from biotechnology to law enforcement, from agriculture to education. It would be a serious mistake to limit our ability as a legislature to evaluate and respond to the scientific and technological challenges facing Congress, the Administration, and the Nation".[2]

In Europe, the European Parliamentary Technology Assessment (EPTA) partners advise the national or regional parliaments on the possible social, economic and environmental impact of new sciences and technologies, such as bioethics and biotechnology, public health, environment and energy, ICTs, and R&D policy. They are European organisations which carry out TA studies on behalf of parliaments. This means also an increased involvement of political structures in the impact analysis of technological development or scientific options.

In fact, at the beginning of the 21st century there are new expectations and challenges towards TA. Usually TA does not have to deal with the consequences of individual technologies, products or plants, but frequently with complex (conflictual) situations between new and emerging technologies, enabling technologies, innovation potentials, patterns of production and cultural and political strategic decisions. Expectations towards "responsible innovation" (MASIS 2009) can be seen as a core to which all of these research and assessment branches contribute, setting out from different starting points, using different perspectives, and applying different TA methodologies. The

complexity of the TA tasks can also be seen by looking at a set of actual TA themes which covers work on, among others, reducing emissions from deforestation, biodiversity and climate change, regenerative medicine, future electricity transmission, biofuels, disruption of the internet, new addiction treatments and possible health effects of the mobile phone.

All of them represent new challenges in terms of technology research and policy decision. Such issues are subjects of an assessment and they should be taken into account when teaching and researching TA at university level. Thus, the ubiquitous and comprehensive role of technology in modern societies should be both strengthened in research and implemented into different curricula. This refers not only at Social Sciences level (knowledge on the technology developments implications) but also at the level of Natural Sciences and Engineering. TA practitioners are needed who are capable of performing such complex tasks but basic TA knowledge should also be available to many other professions. Young researchers but also practitioners in industry have already joined up with the established community. In Germany for example, this phenomenon can be observed through the occasion of the NTA (http://www.netzwerk-TA.net) conferences from 2004 on. This process will continue and will lead to the necessity to provide young people with TA knowledge and skills.

This briefly sketched the current challenges of the implementation of TA issues into education: the importance of supporting education initiatives at post-graduate level to provide TA practitioners with specific competences, and to understand the different educational practices over the same field of topics. This paper will focus on recent and ongoing developments in TA education, especially concerning international collaboration.

2   Tradition(s) of teaching TA

Teaching TA has several background settings. It can be a marginal topic in the courses of Social Sciences (for example Sociology of Technology, Ethics of Science and Technology or even in Science and Technology Policy Management) offered at MA level. But it can also be under-

stood as a marginal topic in the courses of MSc level in Technology or Engineering Education (as for example in Bioengineering, Electronics and Computer Sciences, in Nanotechnology and Material Sciences, or Environmental Sciences and Engineering). Here "marginal" means a complementary field of knowledge in the basic MA and MSc courses.

In the LERU report on universities and innovation states that "at European level, the European Technology Platforms could become valuable means of articulating major cross-disciplinary research needs and stimulating a response from the research community" (LERU 2006, p. 15). This means also that research universities are recognised as one of the main institutions where cross-disciplinarity can be fertilised and where capacities to create and exploit networks of institutions are being offered. These are conditions for an increased activity on TA. And TA research activity is mostly done under collaborative schemes of universities, as well as in research fields that can only be covered by cross-disciplinar technology platforms

A major experience, for instance in the U.S., has been in the field of Health and Medicine Education at university level since the last decade. The Institute for Technology Assessment at the Massachusetts General Hospital, is providing institutional support for doctoral programmes around TA and health. That means a strong collaboration with other universities in the New England region[3] especially with the Harvard School of Public Health. Also other examples can be mentioned of universities where PhD programs on Science, Technology and Management are provided like the Harvard University, the Indiana State University (on Technology Management at the College of Technology), the MIT, (the Technology, Management and Policy track in at the Engineering Systems Division-ESD), and at Georgia Institute of Technology (on "Public Policy" at the School of Public Policy). In all these PhD programmes TA topics are being taught in several courses and they can be taken as experiences for the design of new PhD diploma programme that can have TA as a main topic. To a certain extend if some universities develop their competences in a specific field, a joint programme could possibly be used by the different universities to support the complementarities of education topics.

However, this requires the possibility for universities to cooperate around a common field. And that is not yet the case for the U.S., except the single example of TA on Health and Medicine. All the others develop their own TA-related PhD programmes.

In Japan, there is a PhD programme in Innovation and a MA program on Management of Technology at the TokyoTech-Tokyo Institute of Technology co-ordinated by the Graduate School of Innovation Management.[4] There is also a PhD programme on Technology Management at the Yokohama National University held by the Graduate School of Environment and Information Sciences. They are also important experiences of usage of TA issues in their courses. In both cases (North-American and Japanese) TA education is strongly related with science and technology management dimensions or, in general, with innovation issues.

Finally it can be also mentioned the interesting United Nations University case. Besides the example of collaboration with specific institutions (like MERIT in Holland), UNU provides also e-learning post-graduation courses on the topic of "Technology Assessment". Here, the focus is put on the Strategic Environmental Assessment (SEA) and on the Environment Impact Assessment (EIA) courses. In the case of SEA, it develops an open educational resource with the collaboration of UNU and the Oxford Brookes University in the UK.[5] They use these resources in their respective educational and capacity building programmes. The EIA e-course is developed jointly by UNU and RMIT University[6] in Australia. This course is an instructional learning module on EIA practices and in-depth analysis of this methodology. Initially it was developed for international students enrolled in the MSc on Global Environment and Development Studies at Adger University College in Norway and can be used world-widely.

In Europe there is a wider diversity of experiences. TA courses on the level of higher education take place where there is an awareness process at the political level, especially at the parliamentary level. The MSc in Technology & Innovation Management or the PhD in Science and Technology Policy at SPRU (University of Sussex) or the MSc Innovation Management and Entrepreneurship at MIIR (University of Manchester) can be considered as important examples of post-graduation courses in the UK that involve TA topics in their teaching activities. Usually the students have developed their interest in Science, Technology and Innovation studies through undergraduate projects or work experiences that have convinced them of the value of a systematic approach to specific issues. Those issues can be the need for knowledge expansion on innovation methods or on management of innovative ideas and projects. The aim of such studies is the enhancement of national economic or social performance through more of scientific and technological opportunities. At Manchester University the PhD programme is built upon its reputation for research into the Management of Innovation and Change. It combines a consideration of technological and organisational change and management innovation.

MERIT in Maastricht (Netherlands), the University of Twente and the Utrecht University are Dutch universities with a longer tradition on the coverage of TA in their research activities. At the University of Twente the PhD students can enrol in the MA course of "Philosophy of Science, Technology and Society" (PSTS) and at Utrecht the same happens with the MSc programme of Science and Innovation Management (SIM). In these education experiences the topics are strongly related with TA in both universities that inclusively provide an important experience in the TA research level. The Technical University of Delft is providing courses in this country under the heading of TA as well.

ESST (*European Studies of Society, Science and Technology*) is an association of European universities being involved in an international master programme.[7] The focus of this programme lies in the development of science, technology and innovation policy and practice proposals which are conducive to sustainable development, the improvement of the quality of life and the work of human beings, the enhancement of skills, as well as the attainment of full levels of employment. The ESST association offers a Master's degree on "Society, Science and Technology in Europe". The topics managed by each university under this European consortium can also be developed in a PhD programme on Technology Assessment, although going deeper into the research fields. That

means: Innovation Sciences, History of Science and Technology, Governance, Risk Analysis.

In Germany, TA has developed mostly outside of the universities since the 1970s, namely in Helmholtz national labs and Fraunhofer Institutes, but also in independent research institutes outside the publicly funded science system. However, as non-university research centres they are only marginally involved in education (this is beginning to change, see the KIT case in the remainder of this paper).

There is a specific tradition in the education of engineers with a lose relation to TA issues. The VDI (German Association of Engineers) postulated repeatedly that engineers need much more than engineering expertise. The VDI also proposed an own TA approach, closely related to engineering ethics (The VDI guideline on Technology Evaluation, No. 3780), which was well-perceived by many engineers[8]. By combining both, the VDI demanded to include TA topics and methods in engineering education. Addressees are engineers in education. Another relevant field in the German context is Science Ethics which was established at many universities following the debate on Hans Jonas' "imperative of responsibility". Addressees are mostly natural scientists during their usual university education (see Bora in this Volume for a detailed view on the German situation).

In Portugal, this dimension of teaching content is not disseminated enough among engineers and / or natural scientists. In some few cases it was introduced such topics in graduated courses, but only the courses at UNL (Universidade Nova de Lisboa) and University of Minho. In both cases it was introduced at their Schools / Faculties of Engineering or Sciences, in courses called "Bioethics", "Socio-economic Aspects of Innovation", or "Philosophy of Sciences and Technology". All other university' Faculties of Engineering or Sciences do not provide such topics: they are indeed only technically oriented.

Furthermore, there are several Science, Technology and Society (STS) and related activities in the Social and Political Sciences education of university institutions. Often these activities – which are mostly orientated towards the education and research interests of Social Sciences – touch or include TA issues. In Portugal, examples can be provided with

some courses at ISCTE / University Institute of Lisbon (especially within the topics of "Environment and Society" and "Law and Technology"), or at UTL ISEG-Institute for Economics and Management[9] where topics of STS are been taught, like Economics of Innovation, Public Policy and Technology options. Other universities also provide such subjects in their courses but it has been carried out only by single researcher or teacher. However, these are isolated initiatives.

In Portugal, no research centre or laboratory is exclusively approaching this concept. As it is an inter-disciplinary concept by nature, the actual policy of supporting disciplinary specialised research centres based in single university units has even destroyed such possibility. The few researchers at IET (Research Centre on Enterprise and Work Innovation and UNL), or at UECE (Studies Unit on Complexity in Economics, at UTL-ISEG) stand as an example. Thus, one can say that in Portugal, TA is still without critical mass of researchers, although its political importance is growing very fast and the expectations towards TA seem clearly expressed.

TA thinking is also increasingly present in the Eastern European countries (Banse 2007) and in Russia. While this was mostly the case at Academies of Science in earlier times – often related with certain types of providing political advice – now, more and more universities become involved, and thus the issue of TA and education becomes more important. As an example we want to refer to a cooperation between Russia and Germany on TA-related issues. For many years there was a "German-Russian" College located at the Technical University of Karlsruhe. TA issues as well as Philosophy of Technology were strongly present in the courses of that college. As a successor there is a new MA course on "European Studies" (Europäische Kultur- und Ideengeschichte, EUKLID) which is offered at Karlsruhe Institute of Technology (KIT) and Lomonossow State University, Moscow, which is also including TA aspects.

3 Recent developments in German and Portuguese Universities

Generally, in almost all OECD countries, TA is increasing its presence in Engineering courses as an educational topic. It was mainly debated among the economists' community as a topic related to technology management, investment decision and economical choice, and to a minor extent among the philosophy and / or political science communities (e.g. on ethics issues of technological development, "luddism" behaviours, environmental social movements analysis). What is new is the emergence of TA in S&T courses? In a large amount of engineering courses students have the opportunity to study topics such as Innovation Policies, Bioethics, Environmental Decision Processes, History of Technology, Social Aspects of Technological Change. European technical universities such as Imperial College (UK), the École des Mines (France), the Technische Universität Berlin, the KTH-Royal Institute of Technology of Stockholm, the Helsinki University of Technology-TKK, or the ETH Zurich are also offering post-graduate courses in these fields.

However, at PhD level much fewer European universities offer courses on TA, many of them being from Germany. In particular, the Universities of Karlsruhe, Bielefeld and Stuttgart can be mentioned (see Bora, Mölders in this issue). Historically, the need of teaching TA courses arises mostly at technical universities. This is true for Portugal (either in the field of Engineering – at the Faculty of Sciences and Technology of UNL, or in the area of Economics – at the Institute of Economics and Management of UTL-Technical University of Lisboa) and Germany as well. Examples in Germany are the Technical University of Karlsruhe (today KIT), the University of Stuttgart which is strong in Engineering Sciences, and the Technical University of Darmstadt (with the IANUS group). The University of Bielefeld with its strong focus on sociology is an exception.

In Portugal there are some Higher Education Courses that also include topics on TA. Most of those courses are at the level of a Master's degree, or just post-graduation courses. One is the MA on Economics and Management of Science, Technology and Innovation ("Mestrado em Economia e Gestão de Ciência, Tecnologia e Inovação") at the above mentioned Technical University of Lisbon (Institute of Economics and Management). Additionally, this school has a post-graduate course on "Foresight, Strategy and Innovation". There are also collaborative Doctorate Programmes that are being offered by the Portuguese Government together with some large North-American universities. The Portuguese government (through the Ministry of Science, Technology and Higher Education) started a long-term collaboration with the Massachusetts Institute of Technology (MIT), the Carnegie Mellon University (CMU), Harvard University and the University of Texas at Austin (UT Austin) focusing on basic research and education. Some of the topics to be developed under the doctorate teaching course have indirect relation with TA around the issues of Environmental Life Cycle Assessment, Sustainability Impact Assessment, Assessment of Energy Systems, Advanced Manufacturing Assessment or TA in Bio-engineering Systems. Specifically the doctoral programme on Engineering Design and Advanced Manufacturing offers a course unit on "Innovation Management" including TA.

Thus, in spite of some experiences in the field of TA and education in Portugal, only the mentioned new PhD programme on "Technology Assessment" is a degree in TA. This new programme was proposed by the Universidade Nova de Lisboa (UNL)[10] and was recently recognised by the Portuguese Ministry of Science, Technology and Higher Education. It starts in 2009-10 and aims to prepare high-skilled researchers and decision-making consultants who will be involved in the policy processes for technology options which are expected to become critical in the short and medium term. The proposal was made by social scientists at the Faculty of Sciences and Technology of that university (UNL), but associated also natural scientists and engineers. The field for research under that PhD programme can develop strong links with the technological fields that constitute the main frame of education activities there (such as, among others, Computer Sciences, Chemistry, Environmental Sciences, Robotics, Material Sciences and Nanotechnologies, and Industrial Engineering).

This doctorate programme of Universidade Nova de Lisboa on TA presents itself as

an alternative and advanced training scheme with a great potential for technicians who are held accountable for technological choices or technological investments. Such technicians may already work in public administration offices (large national laboratories or governmental entities with specialisation in these fields), as well as in big companies where that type of option can be placed for technological re-conversion processes, or for entrepreneurial development.

The TA professionals with a PhD degree can also work in medium or small high-tech companies. They can work with anticipation tools of technological development processes (as for example Biotechnology, Nanotechnology, Micro-electronics) or can work for highly-specialised technological consultancy, providing services in TA fields. In any case, they will be experts who – independently of their basic technical education – need to acquire advanced knowledge in fields related to this type of possible options (of investment and/or of advanced research).

In Germany, TA as an issue of PhD studies can be found at various sites, according to particular institutional focusses or research interests of university professors. Among these institutions are the Technical University of Berlin with its Centre of Technology and Society (ZTG), the Fernuniversität Hagen, the already mentioned Universities of Bielefeld and Stuttgart, the Technical University of Clausthal, and the Technical University of Aachen (RWTH). In addition, ongoing TA practice at some extra-universitarian research centres of the Helmholtz association led to involvement of PhD research, in cooperation with neighbouring universities.

Recently there is a process of bringing research centres and universities closer together, with obvious (positive!) consequences for PhD research. The probable most ambitious event in this development is the complete fusion of the Technical University of Karlsruhe and the Forschungszentrum Karlsruhe – which is part of the Helmholtz association – resulting in the foundation of the Karlsruhe Institute of Technology (KIT). For decades, TA has been developed and practised within the Forschungszentrum in its Institute for Technology Assessment and Systems Analysis (ITAS). Since 2000 ITAS has its own PhD programme.

The foundation of KIT, however, brings about new opportunities for a more coherent PhD programme and for a closer cooperation between TA practice and academic research on TA relevant issues. An important step was the very recent foundation of a KIT focus on "Humans and Technology" which comprises Social and Economic Sciences' and Humanities' research on innovation and technology related issues, including TA work being done at ITAS. Within the framework of this focus, new structures for MA and PhD theses will be established, with TA and its relations to Philosophy and Sociology of Technology and Innovation Research as one of its core elements.

As an example we would like to mention the New Field Group "Autonomous Technology – challenges to humans and society" which has been established at the KIT-Institute of Philosophy in 2008. This Group will investigate emerging technologies with regard to their increasing autonomy – the meaning of "autonomy" is itself subject of reflection in the Group – and will look on societal implications of increasingly autonomous technology such as humanoid robots and "cognitive" automobiles. Philosophical and ethical questions but also legal and social ones will be touched, following a model of close cooperation with the related engineering institutes. Essential part of the work will be done in the framework of PhD theses which will have to combine philosophical reasoning, engineering knowledge and TA insights.

In general, up to now teaching TA mostly happens due to personal engagement of TA researchers and practitioners in postgraduate phases – either in Germany or in Portugal. This means there is no university strategy to provide PhD level courses on TA. In Germany there is a much larger number of TA practitioners and academic experts than in Portugal. Thus, the main difference is that a much larger number of TA researchers can be found in academia in Germany than in Portugal and following this a much larger amount of scientific publications stems from Germany.

The collaboration between the academic communities of these two countries is based on a long tradition, in particular in the fields of Cultural Studies and Engineering. In the Social Sciences, however, the collaboration is still very recent because of two reasons: on the one

hand, Social Sciences in Portugal have only been established after the 1974 revolution. On the other, the German academic community is closer connected to larger scientific communities (like North-American or British) than to those of smaller countries (exception given to the Swiss or Austrian scientific communities due to the language issue).

However, with respect to TA both countries started a cooperation programme in 2007: the Portuguese-German Joint Actions of DAAD and CRUP and the development of a Fraunhofer Institute in Portugal are examples. Many joint projects were developed with the support of the European Commission through the European Framework Programmes of Research and Development, but none has a relation to TA issues. The only exception is a recent DAAD / CRUP joint action on Technology Assessment of Autonomous Systems (2009 and 2010) which involves the Technical University of Karlsruhe and the Universidade Nova de Lisboa. This joint action aims to debate the trends of development of autonomous systems, their economic applications and social potential for usage, and societal implications as well as frontier concepts on the technological development possibilities. This debate will take place in both countries and academic communities.

As mentioned above, recently the PhD programme on TA in Portugal at the Universidade Nova de Lisboa (in its Faculty of Sciences and Technology) was implemented[11]. This programme is based on the structure of a 3rd cycle of university studies (according to the Bologna Process) and is situated at a Faculty of Engineering and Natural Sciences of a Portuguese university. The programme was developed cooperatively between the University of Karlsruhe and that university. One of the aims is to settle a pool of European PhD programmes in this field. It will start with a process of close collaboration among UNL (Portugal), the University of Twente (Netherlands) and the former University of Karlsruhe, now Karlsruhe Institute of Technology (Germany).

Since 2008 ITAS-FZK (now also Karlsruhe Institute of Technology KIT), started a cooperation process with FCT-UNL that included the possibility for hosting scholars from both institutions (mostly sabbatical leaves, post-doc scholarships and PhD students), and of support-

ing seminars and colloquia in both institutions. Until now this collaboration is exclusively covering the field of TA. It is, however, expected to enlarge the scopes to other fields of Science and Technology (Energy, Environment, Nanotechnology, Manufacturing Systems) but always with strong links to TA activities in both academic institutions.

4 Conclusion

From the Portuguese perspective the institutional collaboration with other European universities can be considered as a "good practice". The preparation of the PhD programme on Technology Assessment started with the support of ITAS-KIT (in 2007) and some new future steps can be developed in the direction of a joint doctoral programme with the KIT, and to extend it to the University of Twente (Netherlands) and other universities.

Such collaborative experiences are not just reflecting a (good) intension of some personal options of scholars. They are emerging and disseminating once there is an increased need for highly qualified technicians and experts to get involved in large companies that need a critical thinking on technology options. There is an increased need for skill provision on analysis of risks associated with technology and research. There is also an increased need for social analysis capacity and ethical thinking in the fields of technology management and innovation promotion.

These are what we can call "market needs" or "demands" for technology assessors. But there is also the acknowledgement that the establishment of cross-disciplinary research in technical universities can provide such skills. Today universities and the Higher Education in general are confronted with the obligation for further collaborations that enable them to offer a better quality of those "market needs" than they could be able to provide if they were alone. The push towards different universities to cooperate is driven by these new occupational needs. That seems clearly the case for TA.

Consequently, there is an urgent need to develop qualifications and expertise in the different fields of TA and even in the different methods of TA. For such reasons the educa-

tional initiatives in TA are critical at this stage. In Germany several universities have experiences in teaching TA themes, and in Portugal that experience is just being gained.

The basic idea behind Technology Assessment (TA) still is prospective research and assessment of different aspects of technology as a support for decision-making processes in politics for societal developments (Bimber 1996). Through the high importance of technologies in modern societies as well as new ethical and social challenges towards the development of technologies TA has, beyond its traditional self-understanding as research for decision-making and action, also to raise awareness and knowledge at the educational level and to develop structures, curricula and cooperation schemes for education at university level.

Notes

1) Senator Kennedy was the first chairman of OTA's Technology Assessment Board and served on its Board throughout OTA's entire existence, until the agency was disbanded in 1995.
2) See http://fas.org/ota/2009/08/28/memories-of-senator-kennedy/ (download 29.11.09)
3) See http://www.mgh-ita.org/.
4) See http://www.mot.titech.ac.jp/english/doctor.html
5) It began as Oxford School of Art in 1865. Five years later the School of Science was integrated. In 1891 it was renamed as Oxford City Technical School and in 1970 as Polytechnic. After integrating other schools and institutes it became a University with its actual designation in 1993.
6) The Royal Melbourne Institute of Technology has around 60 thousand students and is a member of the Australian Technology Network.
7) Cf. more information at http://www.esst.eu/index.html
8) Cf. http://www.itas.fzk.de/tadb/dbase/singleinst/list.asp?geo_id=1&lang=e&iid=485
9) UTL is the acronym for Universidade Técnica de Lisboa
10) Cf. TATuP nº 2, Vol. 18, September 2009, pp. 92-93
11) Cf. TATuP nº 2, Vol. 18, September 2009, pp. 92-93

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