



Science and Technology Options Assessment

Annual Report 2015

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Scientific Foresight Unit (STOA)

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Science and Technology Options Assessment (STOA)

Annual Report for 2015

March 2016

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Statement by the EP Vice-President responsible for STOA



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Ladies and Gentlemen,

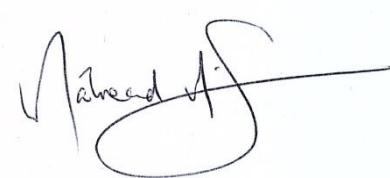
I would like to take this opportunity to express my thanks to the Chairman, Members and the secretariat of the STOA Panel for their work throughout 2015.

European society benefits enormously from progress in science and technology. The speed of development in this area raises challenges in policy development. An effective science-policy interface is crucial to ensure that legislators and policy-makers are equipped with the expertise needed to deliver effective responses to the opportunities and challenges facing European society.

The STOA process supports mutual understanding between the science and policy communities and ensures that quality research is available to policy-makers at the right time. It delivers independent, impartial and accessible expertise to support the European Parliament in a wide range of key areas, including agriculture, food security, robotics, mobility, education, health and manufacturing. Furthermore, STOA is active in science communication, promoting evidence-based knowledge and ensuring it is accessible to all citizens and stakeholders with regular publications, an active presence on the EPRS blog, and the public workshops, seminars and annual lectures.

Given that science and technology issues are present in so many of the opportunities and challenges facing European society, the analysis provided by the work of STOA enriches our parliamentary debates and activities. In 2016, I look forward to continuing to engage actively with STOA, promoting its development and communicating its activities with fellow Members of Parliament.

Kind regards,

A handwritten signature in blue ink, which appears to read 'Mairead McGuinness'.

Mairead McGuinness

Vice-President of the European Parliament

Preamble by the STOA Chairman

STOA has been supporting parliamentary work since 1987. During that time, it has grown into an indispensable service, supporting the Parliament in responding to the wide-ranging opportunities and challenges presented by rapidly developing science and technology.

I have been involved with STOA since 2007 as Panel member, Vice-Chairman, and now as Chairman, and am particularly proud to witness the recent expansion of the Panel and enhanced support for its work. In 2015, STOA Panel membership has grown from 15 MEPs to 24, including representatives of two more parliament committees: Culture & Education (CULT) and Legal Affairs (JURI). Furthermore, STOA has established its capacity to generate proactive anticipatory expertise through scientific foresight studies. These will support Members of Parliament, and many others, to prepare for the long-term (20-50 year) impacts of science and technology on European society.



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As demonstrated in the present report, 2015 has been a very productive and interesting year for STOA. It has delivered projects on mass surveillance, technology options for deep-seabed exploitation, learning and teaching technologies, the collaborative economy and Information and Communication Technologies (ICT) in the developing world. Additionally, STOA hosted 11 workshops, providing crucial fora for interaction between policy-makers, researchers and the public, and oversaw the 4th edition of the MEP-Scientist Pairing Scheme, enabling 31 partnerships between parliamentarians and active researchers. Celebrating the end of a successful year, STOA welcomed Professor Serge HAROCHE – co-winner of the 2012 Nobel Prize for Physics – to deliver its Annual Lecture to an audience of hundreds, including MEPs, scientists and other citizens. The subject, aligned with the United Nations (UN) International Year of Light, was *A Discovery Tour in the World of Quantum Optics*.

With 11 projects ongoing and more to be launched throughout the year, 2016 will be another active year for STOA, which will seek to maintain its record in delivering quality expertise to the right people at the right time, while developing its role at the interface of **science and policy**. The programme of activities will focus on five key areas. These are eco-efficient transport and modern energy solutions; sustainable management of natural resources; potentials and challenges of the internet; health and new technologies in the life sciences; and science policy, communication and global networking. STOA is committed to facilitating the exchanges between science and policy, but also between **disciplines and policy areas** that all too often operate in isolation. In pursuing these activities, we also seek to overcome disciplinary boundaries and build connections between people, spaces and ideas. To maximise the impact of STOA's work, showcasing the scope and better targeting its communication will be a priority. For this we will implement a so-called '**silo and pipe strategy**' in order to identify information flows, namely which communities/institutions ('silos') information is going out from and coming into, and which channels are used for information sharing ('pipes').

Finally, I wish to thank EP Vice-President Mairead McGuinness, and STOA Vice-Chairs Eva Kaili and Evžen Tošenovský, for their continued support and commitment to our common work. We look forward to pursuing our cooperation, to fulfil STOA's mission, throughout 2016, for the rest of this 8th parliamentary term, and beyond.

Paul Rübig
STOA Chairman

The STOA Bureau



European Union, 2015

From left to right:

Evžen TOŠENOVSKÝ, Second STOA Vice-Chair

Eva KAILL, First STOA Vice-Chair

Paul RÜBIG, STOA Chair

Mairead McGUINNESS, EP Vice-President responsible for STOA

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List of abbreviations

ACER	Agency for the Cooperation of Energy Regulators
AGRI	Committee on Agriculture & Rural Development
ALDE	Alliance of Liberals and Democrats for Europe
AT	Austria
BE	Belgium
BEREC	Body of European Regulators for Electronic Communications
BG	Bulgaria
CEO	Chief Executive Officer
CERN	European Organization for Nuclear Research
COP21	21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change
CPS	Cyber-Physical System
CULT	Committee on Culture & Education
CZ	Czech Republic
DE	Germany
DG COMM	Directorate General for Communications, European Parliament
DG CONNECT	Directorate General for Communications Networks, Content & Technology, European Commission
DG RTD	Directorate-General for Research and Innovation, European Commission
EC	European Commission
ECR	European Conservatives and Reformists
EEA	European Environment Agency
EFDD	Europe of Freedom and Direct Democracy
EL	Greece
EMPL	Committee on Employment & Social Affairs
ENVI	Committee on Environment, Public Health & Food Safety
EP	European Parliament
EPP	European People's Party
EPRS	European Parliamentary Research Service
EPTA network	European Parliamentary Technology Assessment network
ES	Spain
ESOF	EuroScience Open Forum
ESPAS	European Strategy and Policy Analysis System
ETS	Emissions Trading System
EU	European Union
FI	Finland
FR	France
GDP	Gross Domestic Product
Greens/EFA	The Greens/European Free Alliance
GUE/NGL	European United Left - Nordic Green Left
HR	Croatia

HU	Hungary
ICT	Information and Communication Technologies
IE	Ireland
IGF	Internet Governance Forum
IMCO	Committee on Internal Market & Consumer Protection
IPTS	Institute for Prospective Technological Studies
IT	Italy
ITRE	Committee on Industry, Research & Energy
JPI SRIA	Joint Programming Initiative Urban Europe Strategic Research and Innovation Agenda
JRC	Joint Research Centre
JURI	Committee on Legal Affairs
KET	Key Enabling Technology
LED	Light-emitting diode
LIBE	Committee on Civil Liberties, Justice and Home Affairs
LMIC	Low- and middle-income country
LU	Luxembourg
MA	Malta
MEP	Member of the European Parliament
NGO	Non-governmental organisation
OPECST	Office parlementaire d'évaluation des choix scientifiques et technologiques
PA	Precision agriculture
PACITA	Parliaments and Civil Society in Technology Assessment
PL	Poland
PT	Portugal
POST	UK's Parliamentary Office of Science and Technology
S&D	The Progressive Alliance of Socialists and Democrats
S&T	Science and technology
SAM	Scientific Advice Mechanism
SF	Scientific Foresight
SL	Slovenia
SME	Small and Medium-sized Enterprise
STEM	Science, Technology, Engineering, and Mathematics
STOA	Science and Technology Options Assessment
STS forum	Science and Technology in Society forum
TA	Technology Assessment
TRAN	Committee Transport & Tourism
UK	United Kingdom
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
WHO	World Health Organisation

Executive summary

2015 was an important year for STOA, as the membership of its Panel grew from 15 to 24 MEPs. The Committees on Agriculture & Rural Development (AGRI), Employment & Social Affairs (EMPL), Environment, Public Health & Food Safety (ENVI), Internal Market & Consumer Protection (IMCO), and Transport & Tourism (TRAN) have one additional Member each, while Industry, Research & Energy (ITRE) has two more Members, and two additional Committees - Culture & Education (CULT) and Legal Affairs (JURI) – are now also represented in the Panel by one Member each.

The following projects were completed in 2015:

- Technology options for deep-seabed exploitation
- Learning and teaching technology options
- Impact and potential of collaborative Internet and additive manufacturing technologies
- ICT and developing countries

STOA also delivered 11 workshops and high-level conferences, either as part of projects or as *ad hoc* events on the request of the Panel. In parallel with these activities, the Scientific Foresight Service, established in September 2014 within the Scientific Foresight Unit (STOA), consolidated its presence along with the STOA Secretariat as another service within the unit. STOA launched a number of new foresight and technology assessment projects in the course of 2015:

- Ethics of cyber-physical systems
- Precision agriculture and the future of farming in Europe
- The impact of new technologies on the labour market and the social economy
- Towards a circular economy: Waste management in the EU
- Assistive Technologies for the inclusion of people with disabilities in society, education and jobs.

In addition to project reports, STOA increased its online presence through the EPRS blog and use of social media, including through the live tweeting of all events, and it also produced other publications to support parliamentary activities.

The 14th edition of the STOA Annual Lecture, 'A discovery tour in the world of quantum optics', was held on 9 December 2015. STOA welcomed Nobel Prize winner Professor Serge HAROCHE to deliver a keynote speech on how quantum optics and photonics have changed our lives, and may change our future. The lecture was chaired and moderated by Paul Rübig, STOA Chair.

2015 also saw a 4th round of the MEP-Scientist Pairing Scheme, which enhances mutual understanding and establishes long-term, intensive cooperation between Members and researchers. 108 scientists were selected and 31 were matched with Members, a substantial increase since the previous edition.

STOA maintained and developed its links with the wider communities and networks of key actors in science and technology (S&T) policy. This included participation in the annual Council meeting and Conference of the European Parliamentary Technology Assessment (EPTA) network in Paris and the Science and Technology in Society (STS) *forum* in Kyoto. Delegations from the STOA Panel visited the EXPO in Milan and the Joint Research Centre of the European Commission in Seville, and attended the World Science Forum in Budapest and the Internet Governance Forum in João Pessoa, Brazil.

1. Scientific evidence for policy-making

The Science and Technology Options Assessment (STOA) Panel of the European Parliament (EP), was established in 1987 as a scientific advisory body. It has a mission to provide Members of the European Parliament (MEPs) with independent expert assessment of scientific and technological developments and related policy options for informed political decision-making. In addition, STOA has recently been tasked with a foresight role within the EP in order to provide MEPs with a more long-term view on techno-scientific developments and their implications across many policy areas, affecting the society and the environment in a broad sense.

STOA focuses on independent scientific evidence and advice for decision-makers in the following five priority thematic areas, all with the view towards a world of close to 10 million people in 2050:

- Eco-mobility and modern energy solutions;
- Sustainable management of natural resources;
- Potentials and challenges of the Information Society;
- Health and new technologies in the life sciences ('perfect life');
- Science policy, communication and global networking.

Projects

STOA **projects** aim to provide scientific evidence to underpin policy decisions in the EP, based upon a state-of-the-art overview of cross-cutting topics that have a scientific or technological dimension, such as: security and privacy on the Internet, harnessing the resources from the seas, technologies for education and training, the 'collaborative economy', secure and sustainable energy supply, waste management, and precision agriculture.

Technology Assessment projects assess the impacts of relatively known and understood scientific and technological advances and try to identify middle to long-term challenges and opportunities. The main outcomes of these projects are evidence-based policy options for responsibly promoting and deploying existing and emerging technologies. STOA studies give policy options rather than recommendations, as MEPs may base their decision-making on other factors, such as their political or ethical standpoints. *Scientific foresight projects*, on the other hand, identify and assess techno-scientific trends and the widest possible range of societal impacts (also unlikely ones) of relatively unknown or uncertain techno-scientific trends over a potentially long time period (20 to 50 years). In this case, existing legislation is analysed in relation to possible future scenarios, based on the techno-scientific trends identified and their consequences in all societal areas. This identification of legislative pathways should empower MEPs to anticipate desired futures and avoid undesirable ones.

The projects are mostly carried out in collaboration with external experts under strict contractual agreements. These can be research institutes, universities, laboratories, consultancies or individual researchers. This allows for independent expert assessments of legislative, technical, economic, environmental and societal aspects of techno-scientific developments. The publications resulting from projects are available on the STOA website for everyone who might be interested, thus disseminating information to the wider public and encouraging a dialogue between citizens and legislators.

Events

STOA is working to bridge the gap between the scientific community and decision-makers in a more direct way. This is done by organising discussion fora, mostly in the form of **workshops**, which are often part of a project, on emerging and relevant topics. Representatives of specialist organisations, institutes, other European institutions and external experts in the scientific field are invited to ensure the appropriate full 'science-policy ecosystem' is brought together, including not only the scientific and political communities, but also the relevant actors in innovation, industry, NGOs and citizens at large. These events are open to the public and their outcomes are published on the STOA website.

The STOA **Annual Lecture** is the high point of STOA's activities every year. This event gives the opportunity to MEPs, officials, researchers, students and other interested stakeholders to listen to eminent scientists - often Nobel Prize laureates - speaking about subjects placed high on the political agenda, such as the information society, an oil-free future, sustainability, advances in medical research or major discoveries in fundamental science. In 2015 the Panel invited Prof Serge HAROCHE, co-winner of the 2012 Nobel Prize in Physics, who spoke about the importance of quantum physics and light-based technologies (see chapter 9).

MEP-Scientist Pairing Scheme

The development of a close relationship between experts and policy-makers is essential for improving the flow of information from the research and development arena to the decision-makers. STOA is dedicated to developing and expanding such relationships and interactions by running the **MEP-Scientist Pairing Scheme**. This initiative, first organised in 2007 in cooperation with the European Commission (EC), aims at establishing long-term, intensive cooperation between MEPs and researchers and it can serve as a tool for enhancing knowledge-based decisions, facilitating a better public awareness of European Union (EU) policies and fostering a greater mutual understanding. The scheme has mutual advantages for all participants:

- MEPs gain awareness of scientific processes and better understanding of the way scientists consider policy issues. The Pairing Scheme facilitates the process of bringing scientific advice into EU policy discussions;
- Scientists learn about the role of science in policy-making and the policy-making process in the EU, which should enable them to interact more effectively with politicians. Additionally, they can contribute to the dissemination of information to universities and other scientific institutions on the structure and implementation of relevant European policies and programmes, e.g. Horizon 2020.

In 2015, STOA ran the Pairing Scheme for the 4th time. This round attracted a lot of attention, both from the scientific community, with the record number of applicants and MEPs, with 31 pairs established at the end of the selection process. The pairs met in Brussels in January 2016. See Chapter 8 for details of this project.

Networks and collaborations

In 2015 STOA continued to play a role in **S&T policy networks** on an international level. STOA is a founding member of the European Parliamentary Technology Assessment (EPTA) network, and maintains strong connections and actively cooperates with European institutions and organisations, including notably the EC's Joint Research Centre (JRC) and the Directorate-General for Research and Innovation (DG RTD). On a global scale, STOA has strong links to the EuroScience Open Forum (ESOF), the STS *forum* and the World Science Forum. In 2015 members of the Panel took part in a number of delegations and international meetings related to S&T policy (see chapter 11).

The STOA Panel

The STOA Panel is politically responsible for STOA's work. It is composed of 24 MEPs:

- the Vice-President of the European Parliament responsible for STOA;
- six members appointed by the Committee on Industry, Research and Energy (ITRE);
- three members appointed by the Committee on Employment and Social Affairs (EMPL);
- three members appointed by the Committee on the Environment, Public Health and Food Safety (ENVI);
- three members appointed by the Committee on the Internal Market and Consumer Protection (IMCO);
- three members appointed by the Committee on Transport and Tourism (TRAN);
- three members appointed by the Committee on Agriculture and Rural Development (AGRI);

- one member appointed by the Committee on Legal Affairs (JURI);
- one member appointed by the Committee on Culture and Education (CULT).

The members of the STOA Panel are appointed at the beginning of each parliamentary term for a renewable two-and-a-half-year period. A constituent meeting is held at the beginning and the middle of each parliamentary term, in which the Chair and two Vice-Chairs are elected by the Panel members. The Panel meetings are held in Strasbourg during the EP plenary sessions. The meetings are open to the public and can be followed via webstreaming. All MEPs may participate, but only Panel members vote.

The **STOA Bureau** prepares the Panel meetings. It is composed of four MEPs, namely the EP Vice-President responsible for STOA, the STOA Chair and the two Vice-Chairs. During the first half of the 8th legislative period, members of the Bureau are Mairead McGuinness, Paul Rübig, STOA Chair, Eva Kaili and Evžen Tošenovský, First and Second Vice-Chair, respectively.

The Scientific Foresight Unit (STOA), mainly its STOA Secretariat with the support of the Scientific Foresight Service, runs the everyday business and executes the decisions of the STOA Panel, with the assistance of external experts and trainees when appropriate (see chapter 15).

In 2015, meetings of the STOA Panel and Bureau took place on the following dates in Strasbourg:

- January 15
- February 12
- March 12
- April 30
- May 21
- June 11
- July 9
- September 10
- October 29
- November 26
- December 17

Agendas and minutes of the STOA Panel meetings are available on the STOA website at www.europarl.europa.eu/stoa.

STOA Panel members

STOA Bureau



Mairéad **McGUINNESS** (EPP, IE)
EP Vice-President responsible for STOA

Paul **RÜBIG** (EPP, AT)
STOA Chair

*Committee on Industry, Research and Energy
(ITRE)*



Eva **KAILI** (S&D, EL)
STOA First Vice-Chair











*Committee on Industry, Research and Energy
(ITRE)*

Evžen **TOŠENOVSKÝ** (ECR, CZ)
STOA Second Vice-Chair










*Committee on Industry, Research and Energy
(ITRE)*



STOA Panel¹

 <p>Tiziana BEGHIN (EFDD, IT) <i>EMPL Committee</i></p>	 <p>Renata BRIANO (S&D, IT) <i>ENVI Committee</i></p>
<p>Carlos COELHO (PPE, PT) <i>IMCO Committee</i></p> 	<p>Mady DELVAUX (S&D, LU) <i>JURI Committee</i></p> 
 <p>Vicky FORD (ECR, UK) <i>IMCO Committee</i></p>	 <p>Andrzej GRZYB (EPP, PL) <i>ENVI Committee</i></p>
<p>Danuta JAZŁOWIECKA (EPP, PL) <i>EMPL Committee</i></p> 	<p>Andrew LEWER (ECR, UK) <i>CULT Committee</i></p> 
 <p>Bogusław LIBERADZKI (S&D, PL) <i>TRAN Committee</i></p>	 <p>Anthea McINTYRE (ECR, UK) <i>AGRI Committee</i></p>

¹ The TRAN Committee is still to appoint one of its members to the STOA Panel

<p>Clare MOODY (S&D, UK)</p> <p><i>ITRE Committee</i></p> 	<p>Momchil NEKOV (S&D, BG)</p> <p><i>AGRI Committee</i></p> 
 <p>Marijana PETIR (EPP, HR)</p> <p><i>AGRI Committee</i></p>	 <p>Georgi PIRINSKI (S&D, BG)</p> <p><i>EMPL Committee</i></p>
<p>Virginie ROZIERE (S&D, FR)</p> <p><i>IMCO Committee</i></p> 	<p>Claudia SCHMIDT (EPP, AT)</p> <p><i>TRAN Committee</i></p> 
 <p>Kay SWINBURNE (ECR, UK)</p> <p><i>ENVI Committee</i></p>	 <p>Dario TAMBURRANO (EFDD, IT)</p> <p><i>ITRE Committee</i></p>
<p>Cora VAN NIEUWENHUIZEN (ALDE, NL)</p> <p><i>ITRE Committee</i></p> 	<p>Parliamentary Committees: AGRI: Agriculture and Rural Development CULT: Culture and Education EMPL: Employment and Social Affairs ENVI: Environment, Public Health and Food Safety IMCO: Internal Market and Consumer Protection ITRE: Industry, Research and Energy JURI: Legal Affairs TRAN: Transport and Tourism</p>

2. Scientific Foresight: a new tool for future-oriented policy advice

We live in a technological culture, where technology and science are deeply integrated in all structures of our society, such as communication and mobility, to its less obvious aspects, such as norms, values and identity. Therefore, the STOA Panel decided at the end of the 7th legislative period (April 2014) to give greater attention to scientific foresight issues as part of its routine work, backed by the creation, in September 2014, of a Scientific Foresight Service within the Scientific Foresight Unit (STOA) of the European Parliamentary Research Service (EPRS).

Techno-scientific innovations are often designed to make our lives 'easier' or to solve some societal issues. For example, cars and airplanes decrease our travelling time, while the Internet and mobile phones enable us to stay connected and share knowledge globally. However, technologies often have unintended and unwanted impacts. Cars pollute the environment and cause accidents, and the Internet has changed our identity, language and forms of communication and what we value in personal relationships.

Technologies also have **soft impacts**, which can often not be calculated in a way that, for example, health risks can, or impacts which do not show a direct link between cause and effect, making it impossible to determine who should be held responsible for such impacts. For example, autonomous cars promise a greater fuel and time efficiency, and greater safety of the drivers and pedestrians. But, who is to be held responsible for possible damages and security failures, when your child is driven to school alone?

2.1 Scientific foresight approach

Scientific Foresight taps into the power of a science-policy ecosystem, which is able to generate sound and future-oriented scientific evidence to inform policy-making. The scientific foresight process goes beyond the traditional 'science-policy interface', by including a diverse set of relevant stakeholders, including industry, NGOs and the society as a whole. The main added value of the scientific foresight approach is the exploration of possible impacts of techno-scientific trends, by close teamwork between technical experts and social scientists. This new future-focused approach makes technical experts, who investigate possible trends, debate with social scientists together with selected relevant stakeholders. They do it by following a systematic approach of looking into the impacts - looking in depth into future trends and analysing the possible long-term impacts of these techno-scientific trends on society. The overall goal is to help MEPs and committees to anticipate unintended consequence of the legislation on the European society.

This in-depth investigation of foresight practices led to the EPRS publication entitled 'Towards Scientific Foresight in the European Parliament' in January 2015. This presents a framework for the scientific foresight approach to be used in the EP. It focuses on the above-mentioned emerging concerns that techno-scientific innovations could cause in the long-term future. Specifically, it focuses on the societal impacts, including soft impacts, and therefore encourages the EP to bridge the gap between society and policy on techno-scientific issues. The approach was discussed by the STOA Panel in its meeting of 15 January 2015 in Strasbourg Members' feedback was incorporated.

Part of the framework developed for scientific foresight also offers a suitable methodology for the non-foresight STOA studies. For instance, the STEEPED framework for technical horizon-scanning (explained below) could be systematically applied in Technology Assessment (TA) studies, enhancing the impartiality and credibility of the TA approach. The STEEPED framework facilitates investigation of plausible impacts of techno-scientific trends from an interdisciplinary perspective, looking into:

- **Social** aspects covering changes in social and cultural values and lifestyles;
- **Technological** aspects including how, and in which directions, technology is developing and the diversification of the use of techno-scientific devices;
- **Economic** aspects covering issues related to conjuncture, production systems, different distribution and trade systems, and consumption of goods and services;
- **Environmental** aspects embracing interactions with our natural habitat and our biophysical environment which is our planet; this category also includes the availability of natural resources;
- **Political/legal** aspects describing developments or changes in various policy-making and legislative systems or forms of governance;
- **Ethical** aspects covering individual preferences about the diverse values embedded in the broader society;
- **Demographic** aspects entailing various aspects of society, looking at the society as a collection of a varied set of social groups based upon parameters such as age, gender, religion, origin, skills, (dis)abilities, profession, education, income level etc.



EP 'Scientific Foresight Studies' are of a strategic nature, assessing legislative pathways for the MEPs to realize a range of several possible futures. The ultimate aim of the foresight studies is to support informed decision-making by MEPs. The studies will allow MEPs to consider a broad range of possible long-term outcomes of techno-scientific innovations; understand the relevance of present actions for desirable futures; and align decisions with anticipation of the possible, and desirable, long-term future outcomes during the agenda-setting and forward-planning phase of the legislative cycle. The Scientific Foresight approach is an attempt to introduce foresight as an in-house activity in the EP. To take the approach forward, the impact of the first few pilot projects will be thoroughly assessed. This will inform future use of the Scientific Foresight methodology.

The [publication](#) 'Towards Scientific Foresight in the European Parliament' is available on the STOA website. The summary is available in a [video clip](#) on YouTube.



2.2 Scientific Foresight Studies

The STOA Panel discussed a diverse range of requests for Scientific Foresight Studies. STOA is currently running three projects in line with the above-mentioned approach. The first one and thus a pilot study is being conducted on 'The Ethics of Cyber-Physical Systems', proposed to STOA by the EP Committee on Legal Affairs (JURI) as support to the JURI Working Group on Robotics and Artificial Intelligence. The outcomes of this project will be used as input by the Working Group to put forward proposals as a basis for future legislative activities. This study is covered in more detail in chapter 7.

Two further Scientific Foresight Studies were prepared in 2015 and started at the beginning of 2016: one on 'Precision Agriculture and the future of farming in Europe', and another one on 'Assistive Technologies for the inclusion of people with disabilities in society, education and jobs'.

2.3 Techno-scientific trends publications

Beyond this, the Scientific Foresight Service will regularly analyse techno-scientific trends in order to raise awareness about their consequences, including notably possible societal and legislative implications. Examples of these first trends analyses are the following publications:

- 'Ten technologies which could change our lives - Potential impacts and policy implications', which was widely read and debated in an event in the EP on 17 March 2014.
- Two two-page publications: 'What if your shopping were delivered by drones?' and 'What if injections weren't needed anymore?' (on synthetic biology).

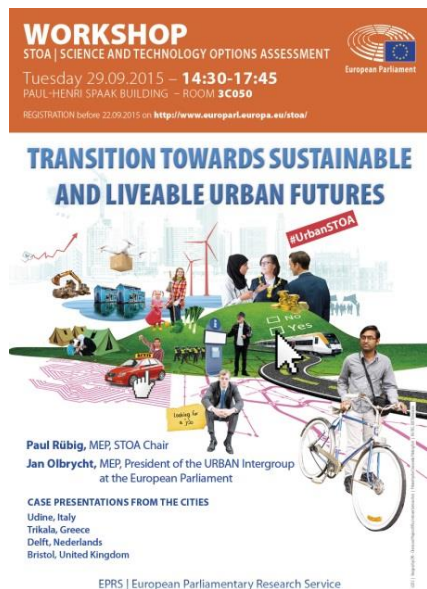
These 'trends' publications are available on the [STOA website](#).



The aim is to continue regularly publishing trends analyses of this kind. Each techno-scientific trend is covered in these publications by four sections. First, there is an overview and description of the technology in question. This is followed by a summary of ongoing developments and expectations, based on the work and views of researchers, academics and enterprises. The next section is an exploration of the possible ethical and societal concerns and the unexpected impacts which may arise if the technology takes hold in society. Finally, there is a section on anticipatory law-making, which provides legislative pathways for mitigating the negative, unexpected and unavoidable impacts of the particular technology.

3. STOA activities in the area of eco-efficient transport and modern energy solutions

3.1 Workshop | How can European cities become smart and sustainable?



Urban stakeholders, urban policy-makers and representatives from the European institutions and beyond joined the STOA workshop 'Transition towards Sustainable and Liveable Urban Futures' on 29 September 2015 in Brussels. The event was chaired by Paul RÜBIG, STOA Chair, and moderated by Jan OLBRYCHT, MEP, President of the EP's URBAN Intergroup.

The workshop marked the launch of the Joint Programming Initiative (JPI) Urban Europe Strategic Research and Innovation Agenda (SRIA) for European urban areas and cities and was jointly organised by STOA and the URBAN Intergroup, together with the EC's DG RTD. The aim of the workshop was to discuss the role of research and science in transforming cities into smart and sustainable thriving areas.

Interdisciplinary approach for inclusive urban research

In his opening statement, Ingolf SCHÄDLER, Chair of the JPI Urban Europe Governing Board, said on the Urban Europe initiative: "We are the missing link that can make a difference, bridging silos with an integrated approach, linking national and European funding and linking science and policy". Paul RÜBIG elaborated upon and emphasised the work of STOA in tackling urban-related challenges and made a special reference, along with Jan OLBRYCHT, to the "need to involve cities as partners in inter- and transdisciplinary research and innovation with the cities' challenges in focus."

All speakers praised the timely character of this interdisciplinary approach in relation to other important urban initiatives on a European and global level, for example the EU Urban Agenda, and the UN-Habitat's Global Urban Agenda. The role of cities as key actors and partners of research and innovation was repeatedly mentioned. Lambert VAN NISTELROOIJ, MEP, Vice-President of the URBAN Intergroup, suggested that cities should let go of the controlling government approach and instead apply an invitational approach opening up to more research and closer cooperation with citizens, NGOs and activists to implement action-driven policies at the local level.

Cities as laboratories for balancing innovation, social equality and inclusion

The notion that cities can be used as laboratories for jointly developing and testing new solutions is supported by European policy-makers and by decision-makers in cities. During a panel discussion, the mayors from four European cities – George FERGUSON (Bristol, UK), Furio HONSELL (Udine, Italy), Dimitris PAPASTERGIOU (Trikala, Greece), and Bas VERKERK (Delft, the Netherlands) – shared their thoughts about the future and showcased examples of how they use their cities as laboratories for technological experiments that could improve the quality of urban life. Kurt VANDENBERGHE, from DG RTD, EC, announced a call within Horizon 2020 for financing urban living labs to test new concepts and nature-based solutions in real-life urban settings, in order to create a global market for cost-efficient answers to combat local heat island effects, extreme weather events etc.



To conclude, speakers emphasised that innovation, social equality and inclusion in cities should go hand in hand. However, proving how innovation leads to social benefits and cohesion in cities remains a challenge. According to George FERGUSON, Mayor of Bristol: "Research can provide data and help evaluate the social benefits of innovation, so that city leaders are armed with the arguments for change, since citizens do not see these benefits before they happen."

Further concerns were expressed about how smart city concepts can increase the divide among citizens, and the challenges posed by the escalating refugee crisis.

More information about this [workshop](#) is available on the STOA website.



4. STOA activities in the area of sustainable management of natural resources

4.1 Project | Technology options for deep-seabed exploitation - tackling economic, environmental and societal challenges

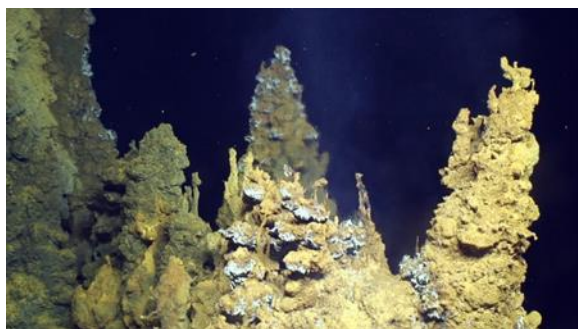
Lead Panel Member: Marijana PETIR

Project duration: October 2014 to March 2015

Presentation to STOA Panel: 12 February 2015

Relevant for EP Committees: ENVI, ITRE

Exploration and exploitation of the deep sea in search of marine minerals and genetic resources have received increased attention over the past 15 years. Developments in biotechnology and sub-marine technologies, together with the scarcity and rising prices of new materials, are changing the business case for extending activities in the marine environment. However, many caveats remain concerning knowledge gaps and risks. These need to be clarified before large-scale deep-sea exploitation could take place.



The study introduced the state-of-play and the main legal and technological issues and economic considerations related to exploration and exploitation activities concerning mineral and biological resources in the deep sea. Raw material resources include minerals of high interest to miners, which contain copper, manganese, cobalt, zinc and rare earths, but also gold and silver. Genetic resources are used by the pharmaceutical, biotechnology and cosmetics industry to develop new medicines, chemicals and cosmetics.

Industry and researchers have a good overview of sites that could be interesting for further exploration and the harvesting technologies are sufficiently developed. However, robust assessments of the commercial viability of mining projects are very difficult to carry out. Uncertainties in the legal framework and large gaps regarding environmental and societal impacts of large-scale deep-sea mining further complicate the situation. With regard to bioprospecting, the main challenges are related to the technologies for analysing samples in labs on land. In comparison with marine mineral resources, the environmental and societal impacts of exploration and exploitation are expected to be less significant.

European industry is at the forefront of exploration and exploitation of deep-sea resources. The EU has actively supported a number of research initiatives on deep-sea resources. However, public support and an adequate legal framework for operation are also important. The policy options range from supporting a pilot mining project, contributing to the development of a legal framework, encouraging cooperation and knowledge sharing among different industrial sectors and between industry and research, improving the knowledge base, or alternatively resorting to increased recycling rather than deep-sea mining.

The [study](#), [summary](#) and [policy options briefing](#) are available on the STOA website.



4.2 Workshop | Graphene in Europe: From Nobel Prize to technology, innovation and industrial competitiveness

During this workshop on 2 June 2015 researchers, scientists, industry representatives, societal and environmental stakeholders, and policy-makers, took stock of current graphene-related research and development in Europe, and discussed opportunities and challenges for turning graphene's outstanding properties into innovation and growth.

Although only one atom thick, this game-changing, Nobel-Prize-worthy carbon sheet has the potential to create new products and jobs for Europe, as Paul RÜBIG, STOA Chair, stressed in his opening speech. He pointed out that graphene was selected in a recent STOA Scientific Foresight report as one of 10 technologies that could change people's lives. He argued that the Graphene Flagship – explained below – should translate graphene from a Nobel Prize into European competitiveness, also reminding the audience of the objective set in the EC communication on industrial policy (COM(2012)582) to raise the contribution of industry to GDP (Gross Domestic Product) to 20% by 2020. Jerzy BUZEK, Chair of the EP's ITRE Committee, and Zoran STANČIČ, DG CONNECT, EC, emphasised the importance of high-level discussions on the topic. The speakers stressed the huge progress that had been made and pointed out how much impact European research programmes can have on the research landscape, and how they play a role in enabling innovation and in bringing together different actors across Europe.



Jari KINARET, coordinator of the Graphene Flagship, and Konstantin NOVOSELOV, winner of the 2010 Nobel Prize for Physics, presented graphene as a revolutionary material, considering its full range of outstanding physical, mechanical, electrical and optical properties. While asserting their satisfaction with the results achieved so far, they also stressed the importance of fostering research on graphene to maximise its beneficial impact on the European economy and society. The speakers emphasised how new possibilities emerged from building custom-made structures (called hetero-structures) by stacking different 2D materials on top of each other to provide specific electrical, thermal, physical or mechanical properties and functionalities. Hetero-structures could lead to a new wave of innovation, but, to achieve that, the Flagship was necessary for establishing a balance between academic-led and industry-led research. With the aim of bringing “graphene disruptive technologies from academic laboratories to society” – as Mr KINARET put it – close collaboration between industry and research centres is key to identifying common needs and paving the way forward together, argued Mr NOVOSELOV.

The innovative potential of this nanomaterial was repeatedly highlighted during the debate. The workshop highlighted in particular the Graphene Flagship, a 10-year, € 1-billion research initiative, involving hundreds of researchers from academia and industry and launched by the European Commission in 2013 to help Europe exploit graphene's outstanding properties and turn them into economic growth and jobs. The speakers unanimously recognised graphene's ground-breaking impact on the economy and society, considering, for instance, that the potential market for new products incorporating graphene amounts to hundreds of billions of euro worldwide. The challenges pinpointed during the discussion mainly related to the difficulty in bridging the gap between graphene development in labs and real-life applications. Potential health, environmental and safety issues of graphene were also addressed. Ways of measuring its success and maximising coordination

with the Member State efforts in the field were also discussed. The way forward was identified as continuous support for the excellent research done in Europe, to fill the gap between theory and practice; educating and training future generations of scientists to take up the challenges in the years to come; and opening a dialogue with as many stakeholders as possible across the full supply chain.

Eva KAILI, First STOA Vice-Chair, concluded the workshop by underlining the results already achieved and graphene's promising future, calling graphene "the first among the ten technologies that could change our lives". She noted that Europe was a front-line player in turning graphene's outstanding properties into economic growth, jobs and societal benefits and pointed out that graphene was already used and had the potential to have a significant impact over the next 10 years. The Flagship would help to nurture academic excellence and educate the future engineers and entrepreneurs in the field. It can further help European industry to develop innovative products and services, but, in order to do so, it must create and maintain close links with the scientific community to ensure the take-up of new research results.

More information about this [workshop](#) is available on the STOA website.



4.3 Project | Precision agriculture and the future of farming in Europe

Lead Panel member: Mairead McGuinness

Project duration: Started in December 2015: expected to end in December 2016

Relevant for EP committees: AGRI, CULT, ENVI, ITRE

The major challenges for global agriculture in the years to come are well-known and well-defined: rapid population growth, dietary changes, climate change, an increasing demand for energy, resource shortages, accelerated urbanisation, ageing populations in rural areas, lack of access to credit in developing countries. It is broadly accepted that Precision Agriculture (PA) has the potential to help governments to address many of these challenges in a substantial way. However, in the EU-28, PA will only expand further if it proves to be beneficial for European farmers.

PA uses technology for improving farming efficiency. It benefits not only yields and farmers' revenues, but also the environment. Precision agriculture practices are applicable both for crop and animal farms. To apply the emerging and future farming technologies, such as those linked to PA, a shift in farmers' skills is needed. This project will focus - amongst other things - on the question 'what could be the main orientations for a better and more attractive education for farmers (attracting more young people to the farmer's profession)'.

The aim of the study is to identify legislative pathways towards an efficient agriculture in the EU and skilled workforces in the farming sector in the EU. According to the latest developments in modern agriculture the study will focus on the following topics:

- An overview of the available PA practices, focussing on barriers and opportunities (including costs and benefits, and feasibility on farms of different scale and type) and related legislation;
- ICT (computer science, data management, integrated systems), including issues such as data ownership and use of collected data;
- Advanced machinery: auto-steered equipment, robots, drones;
- Environmental management (sustainable use of water, efficient use of land, yield optimisation, energy) and environmental impact of precision farming;
- Alternative education systems for compensating school dropouts (Internet-based courses, self-learning using computer-based modules, mentoring);
- Managerial skills for competing on global markets/trade;

- Benefits of the 'service industry' developed to support PA for other economic sectors in Europe.

The first phase of the project will analyse the techno-scientific trends in PA in the context of the farming practices throughout Europe, business models in EU agriculture, farmers' skills, existing legislation, changing ICT landscape. This will be completed by May 2016. During the second (foresight) phase (starting in June 2016), the project will (i) identify the main factors and issues that will need to be covered in the scenarios, and reflect on social and societal impacts of PA, its uptake by farmers and the respective education development, and (ii) identify potential future impacts of PA and related technologies until 2050.

The project aims to give MEPs a clear idea of the link between, on the one hand, alternative futures, relevant uncertainties and risks of PA in the long term and, on the other hand, strategies that can be implemented to deal with change in the short term. Therefore the project will look beyond today's perspectives and map alternative paths into 2050, focussing on social concerns concerning future PA.

4.4 Project | Towards a circular economy - waste management in the EU

Lead Panel member: Eva KAILI

Project duration: Started in December 2015; expected to end in September 2016

Relevant for EP Committees: ITRE, ENVI

In December 2015, the EC presented a new strategy on the circular economy ('Closing the loop - An EU action plan for the Circular Economy', COM/2015/0614), covering four revised legislative proposals on waste (Directives on Waste, Packaging Waste, Landfill, and on Electrical and electronic waste, on end-of-life vehicles, and batteries and accumulators and waste batteries and accumulators), aiming to achieve significant economic, environmental and societal benefits. The purpose of this STOA project is to examine the situation in the EU and its Member States with regard to waste management, with a focus on technologies for integrated management of waste waters and solid waste, energy recovery and recycling.

The study will provide a snapshot of the state-of play with regard to waste management in the EU: legislative and policy framework, but also situation in the Member States. Special attention will be paid to the differences among the EU Member States and their performance. A more in-depth assessment of waste management technologies (integrated management of waste waters and solid waste, energy recovery, recycling) would focus only on selected waste streams and waste types, such as plastics, food waste, and the construction and demolition sector. It will aim at identifying gaps, barriers and benefits related to these technologies, from a legal, logistical, technological, economic, environmental and societal perspective.

The project will also cover trans-boundary waste streams, including movements of waste waters via rivers, and technology options for waste water management. The second part of the study will focus on economic, logistical and societal issues, and cover topics such as business opportunities, jobs and employment in the waste management sector in the EU, Small and Medium-sized Enterprises (SMEs), and regional specificities of the EU. A set of policy options shall be outlined and assessed based on the outcomes of the overall analysis.

STOA is planning to organise a workshop on the subject in May or June 2016, the conclusions of which will feed into the study.

5. STOA activities in the area of potentials and challenges of the Internet

5.1 Workshop | Collaborative economy: will our lives change?

Internet-related technologies are already shaping the world in previously inconceivable ways. The collaborative economy, big/open data, crypto-currencies and additive manufacturing (such as 3D printing) are just some of these technologies, and their potential to change the world, our lives and society. Many different sectors are affected by the developments, such as manufacturing, design, funding mechanisms, or even communications and transport.



STOA's workshop on 27 January 2015 dealt with this topic. The workshop was part of a project to assess the impact and potential of collaborative Internet and additive manufacturing technologies. The project findings are summarised in the next section. The event was chaired by Virginie ROZIÈRE, STOA Panel member, and addressed, among other issues, the following:

To measure economic value in new and different ways

The collaborative economy, with its increased level of co-creation and social innovation, creates a need to measure economic value in new and different ways (beyond conventional indicators like GDP). Issues like Intellectual Property Rights become more complicated when co-creating and therefore need to be better addressed than under current legislation.

Much quicker and cheaper prototyping

Additive manufacturing can improve the world. It can provide access to more designs and facilitate the production of objects with physical properties impossible to reach via traditional manufacturing processes, such as the production of lighter and more reliable cars or building cheaper and better insulated houses. Additive manufacturing and 3D printing will certainly allow much quicker and much cheaper prototyping.

New frontiers in medicine

Human tissue has already been bio-printed – lungs, liver, kidneys or bones. In the near future the major application of these techniques may not be in the replacement of organs, but for testing of new pharmaceuticals. However, barriers to this technology remain, such as patenting issues related to the use of 'ink-jet printing' and 'stem cell' technologies.

Bitcoin is not anonymous

Although many may think so, Bitcoin is not strictly anonymous. Digital signatures are used to confirm or deny transactions. Bitcoin protocols can be used for other purposes too, such as the use of 'blockchain' technology for crowdsourcing and creating sound contracts, since it builds on a distributed consensus mechanism. However, at the moment we are facing some limitations to this, as for example Bitcoin currently has a programmed limit of about 7 transactions per second, while Visa's limit is more than 40,000 transactions. Nevertheless the potential is enormous.

More information about this [workshop](#) is available on the STOA website.



5.2 Project | Impact and potential of collaborative Internet and additive manufacturing

Lead Panel Member: Virginie ROZIÈRE

Project duration: October 2014 - May 2015

Presentation to STOA Panel: June 2015

Relevant for EP Committees: ITRE

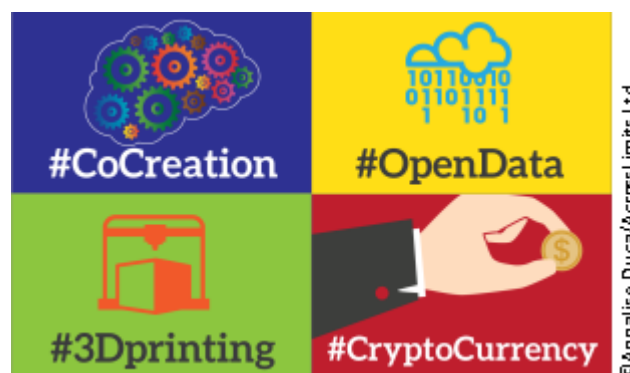
The above-mentioned workshop was part of work on a STOA study, which included a review of the latest developments in the field, a forecast of the likely breakthroughs in the next 10 years, an assessment of their potential impact, identification of key stakeholders, and the formulation of policy options.

Impact and Potential

New technologies look set to become part of the accelerating co-creation process, which will drive a fast-changing market for goods and services. As an example, 3D printing is changing the manufacturing and healthcare industries, as users become an active part of the process and products are personalised. In the near future, we can expect to have 3D-printed drugs, furniture, food and clothes. It will also become increasingly common for new businesses to be crowdfunded. Cryptocurrencies may enable new economic relations and the creation of crypto-contracts. In another development, open data allows people to access, use and distribute information freely, without any legal, economic or sociocultural restrictions.

EU needs to rethink Intellectual Property rules

The study also points to the need to rethink EU Intellectual Property rules, fair use policies and consumer protection policies that reflect these emerging capabilities. Increasing European competitiveness in a collaborative economy also has implications for copyright and patent rules across the Member States. The EU could also consider creating new, enforceable regulations, capable of supporting and protecting all stakeholders in the collaborative economy and eliminating the legal uncertainties that follow from the usually transnational nature of collaborative technologies.



'Personal' and 'private' need new definitions

Decentralised stock exchanges and insurance companies will very likely emerge, and it is possible that, in a collaborative cyber-currency market, authorities will have difficulty regulating the activities which take place using current approaches. The collaborative economy is likely to heighten the tensions between traditional legal approaches of ownership and the introduction of modern practices that focus on open access creative licences and flexible licensing structures. 'Personal' and 'Private' need new definitions in a world where data are universal and even personal data sets are a tradable good, and a distinction needs to be made between data subject, data owner, data collector and data user.

An official recognition for crypto-currencies is needed

An official recognition process should be established for crypto-currencies, to include them in the rest of the economy, with similar status to that of conventional currencies. Similarly, politicians should engage a wider set of advisory bodies in the debate on additive manufacturing policy, currently limited to established traditional manufacturers.

Global policy formulation is required in the collaborative economy

The study suggests that the EU should stimulate a free flow of co-created ideas and support those which work across borders to boost economic growth. It argues that global policy formulation is required in the collaborative economy, which operates on a global scale, regardless of national or regional borders. Furthermore, the report considers that policy should strive to be ahead of developments, as digital technology evolves so fast that policy implementation always lags behind, harming its prospects and development. As an example, policy should be informed by the disintermediation and decentralisation processes occurring in the manufacturing sector, as these will have profound effects upon society and market structures. Other policy issues addressed in the study include the provision of Internet access and availability for all societal sectors, objective consideration of fears of criminal use, and protecting and regulating the notion of 'individual identity'.

The [study](#) and [policy options briefing](#) are available on the STOA website. The [video clip](#) summarising the study is accessible on YouTube.



5.3 Project | Teaching and learning technologies

Lead Panel Member: Paul RÜBIG

Project duration: October 2014 - May 2015

Presentation to the STOA Panel: 12 March 2015

Relevant for the EP committees: CULT, ITRE

Technology arouses great expectations as far as its impact on learning and teaching is concerned; yet to date these are only partially satisfied. Although there has been huge public investment and progress has been made, the pace of integration of technology in education is slower than expected. This may be due to the fact that evidence of its benefits remains elusive. This study looks into technology options for education in Europe, presenting both the opportunities and the risks involved.

Education technologies: a wide range of tools

Education technology encompasses a wide range of tools, services and methodologies that, when used correctly and in combination, help develop the potential of the education environment. The study identifies four underlying trends affecting this environment. Firstly, enabling technologies improve broadband Internet access for European households and schools, thus promoting full and fair access to online educational resources. Secondly, cloud technologies allow delivery of on-demand services through the network by third parties, encouraging information and content sharing, and collaborative working environments. Thirdly, mobile devices facilitate a more dynamic and user-friendly use of technology by shifting the focus from fixed connectivity, based on shared personal computers, towards mobile and multimedia personal connectivity. Lastly, technical support is a core issue for the long-term availability of technological improvements, which require constant maintenance.

New ways of teaching and learning

When coupled with content quality and equal access to tools, these trends generate great opportunities for developing better, innovative educational systems that generate new ways of teaching and learning. On the other hand, whilst government investment in technology for education is unquestionably necessary, emerging learning and teaching technologies engender complex and intertwined factors which might hinder process outcomes. To put this more plainly, varying levels of government investment could foster inequalities among and within European countries, thus contributing to broadening the gap between the 'consumers' and 'producers' of online content (known as the 'second digital divide').

Privacy and data protection

Personalised education based on learner data analytics might also spark legal and security concerns in terms of privacy and data protection. Successful massive collaborative development and use of online content also needs to be based on standards that allow interoperability on different devices and platforms. Additionally, the study raises awareness of the potential effects of new technologies on the publishing industry, as increased demand for digital content threatens to reduce revenue for traditional publishers.

Technology by itself does not lead to better education

Technology for education could revolutionise the teaching and learning process; yet technology by itself does not lead to better education. It rather depends on whether the various stakeholders are able to effectively integrate the technology in the educational process. How can policy-makers draw upon the potential benefits of using emerging technologies in education, whilst simultaneously avoiding their less-desirable effects? To tackle this complex question, the STOA study identifies several policy options on four themes: technology deployment, fostering stakeholder engagement, improving competitiveness and evaluating the effects of different policy actions on educational outcomes.

Within a scope of the study a workshop was organised in May 2015.

The [study](#), [summary](#) and [policy options briefing](#) are available on the STOA website.



5.4 Workshop | How could technology change the way we teach and learn?

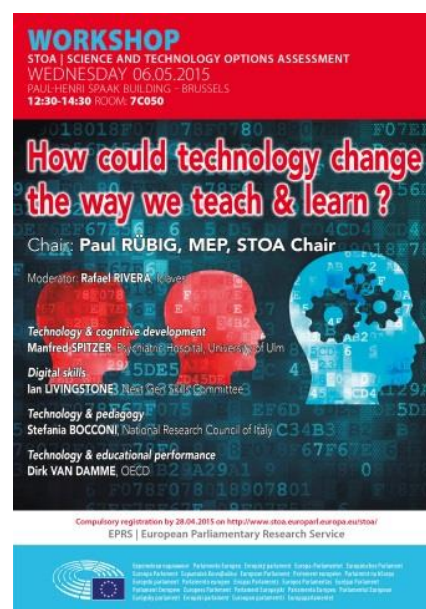
On 6 May 2015, STOA hosted this workshop as a follow-up to the STOA study described above. The event was chaired by the STOA Chair, Paul RÜBIG. The workshop focused on the debate on how technology influences the skills and knowledge we acquire and how we acquire them.

The European educational systems need innovation

Experts participating in the workshop agreed on the fact that there was a skills gap in Europe and the need of innovating in our educational systems was a generally accepted idea. Introducing technology in the educational system was the goal of many educational policies in the last 20 years. In most cases this focused on significant investments in hardware and connectivity for schools and universities.

New educational policies are also needed

The introduction of technology in schools has not always been efficient and it has not resulted in clear positive effects on the educational outcomes. There was a general consensus on the need of implementing new educational policies, where technology would not be in the centre. In this sense speakers identified three key factors of success: innovative pedagogical practices, new assessment methodologies, and training and empowerment of teachers.



How and when should technology be implemented?

However, there was no unanimity among speakers regarding how and, particularly, when technology should be implemented in the educational process. The potential negative effects of the early use of technology in children divided the experts. In particular, the danger of addiction and of disturbance in the emotional and cognitive development of children was a main concern for some experts, who advocated the need of restricting the use of technology among younger children.

Right pedagogical approaches are required

On the other hand, the need of developing e-skills seems to require an early adoption of technologies at the school level. Speakers agreed on the need to overcome simplistic ideas about the implementation of technology in the educational process to truly exploit the great potentials of technological learning environments, such as enhancing collaboration, personalising education, improving access for groups of excluded learners etc. However this requires the right pedagogical approaches, quality and appropriate contents, and a stronger collaboration with the industry.

Gathering convincing evidence on the impact of technology on children

There was also agreement on the need of gathering enough compelling evidence to understand the real impact of technology especially on young children, and identify which were the best strategies to define and implement technological learning environments in an effective and efficient way.

More information about this [workshop](#) is available on the STOA website.



5.5 Project | ICT in the developing world

Lead Panel Member: Dario TAMBURRANO
 Project duration: January 2015 - September 2015
 Presentation to STOA Panel: 29 October 2015
 Relevant for EP Committees: DEVE, ITRE

Delivering the full benefits of ICT to the developing world



Over recent years, there has been an increasing awareness of the potential of ICT to tackle a wide range of health, social and economic problems and provide opportunities for inhabitants of low- and middle-income countries (LMICs). By improving access to information and enabling communication, ICT can play a role in fighting poverty, combating major infectious diseases and accomplishing better educational outcomes. However, the benefits of ICT are not fully realised in many countries, as these technologies are often

out of reach for the poor and those in rural areas. In addition unequal provisions for access to information, knowledge and networks ('digital divide') mean that many LMICs are unable to seize the opportunities offered by ICT. This study builds on the conclusions of two past STOA studies on 'Developing Countries and the ICT Revolution' (March 2001) and 'Health and ICT in Developing Countries' (February 2004).

The study was divided in three sections: (i) the connection between ICT and poverty reduction, (ii) the link between ICT and health in LMICs, and (iii) the EU approach for promoting ICT diffusion in LMICs. Evidence from desk analysis was complemented by the opinions of 145 surveyed experts.

ICT and poverty reduction

ICT have become an essential component of modern life in developed countries and LMICs alike. However, access to ICT benefits and opportunities is unequally distributed across and within nations. Even if ICT could positively affect society as a whole, they are not sufficient to guarantee a positive impact on economic development and especially on poverty and inequality reduction. A series of conditions have to be fulfilled depending on a combination of technical, political and cultural factors,

including the choice of technology, overcoming resistance to change, lack of local capabilities, and institutional support for developing competitive telecommunications markets.

ICT and health in LMICs

Most evaluations of the impact of eHealth projects in LMICs focus on the projects' outcomes and processes, rather than on providing evidence of clinical impacts. At the most basic level, poor telecommunications and electricity infrastructure hamper a more widespread and efficient use of ICT in health systems. Specific constraints relate to uncertainty about the lack of policy support and incomplete legal frameworks (concerning e.g. ownership, confidentiality and security of data), skills shortage and insufficient interoperability of health information systems. Finally, implementation of eHealth in LMICs appears to be strongly donor-driven.

The EU approach for promoting ICT in LMICs

The lack of a central repository of initiatives related to ICT for development made it difficult to reconstruct the contribution of EU institutions in promoting ICT in LMICs. EU interventions in support of ICT in LMICs could be grouped in four main areas: (i) support to the development of ICT infrastructure; (ii) harmonisation and alignment of ICT-relevant policy and regulatory frameworks; (iii) establishing national research and education networks of EU Member States and LMICs; and (iv) ICT capacity-building initiatives.

Policy options for future actions

The study also carried out an online survey among 145 experts in the field of development cooperation and ICT. Experts' opinions confirm the evidence of desk analysis pointing to health and education as the main areas in which ICT can play a significant role in LMICs development. Building upon the evidence collected, the study provided policy options for future action which the EU could undertake to help LMICs profit from all the opportunities that ICT offer. The study calls for balancing top-down and bottom-up initiatives, so as to address access and capacity constraints in parallel, achieving thus better results in terms of economic growth and poverty reduction. This would expand the range of possible interventions for EU development cooperation in this area.

The [study](#), [summary](#) and [policy options briefing](#) are available on the STOA website.



5.6 High-Level Conference | Protecting Online Privacy by enhancing IT Security and strengthening EU IT Capabilities

Information Technology (IT) security and protection of online privacy is a complex and multi-faceted issue, at the crossroads of legal, technological, societal, industrial, geopolitical and economic considerations. In order to discuss and interact with outstanding academics, legislators and professionals of various fields on policies for fostering an online privacy protection and security strategy for the next years in the EU, the EP Committee

on Civil Liberties, Justice and Home Affairs (LIBE), STOA Panel and the Luxembourg Presidency of the EU Council jointly organised a High-Level Conference on 'Protecting Online Privacy by enhancing IT Security and strengthening EU IT Capabilities'. The event took place on 8 and 9 December 2015 in



Brussels. It was chaired by Claude MORAES, LIBE Chair, Paul RÜBIG, and STOA Chair, and Vicky FORD, IMCO Chair and STOA Panel member. EP President Martin SCHULZ gave a keynote address.

The discussions focussed on developments around the digital economy and cybersecurity, with the Internet of Things and big data at the forefront. The conference applied a format of 'brainstorm-like' thematic breakout sessions with the aim of creating a stimulating atmosphere to freely debate these issues from different angles and come up with bold, innovative, out-of-the-box ideas for addressing the topic of online privacy and security. A total of nine break-out sessions focussed on the three discussion themes briefly summarised below:

Policies stimulating adoption of privacy-enhancing technologies (PETs) including end-to-end encryption (E2EE) and anonymisation tools

The lack of adoption of PETs is primarily attributed to political forces that still assess E2EE as a threat to national security interests. Maturity, usability and user-friendliness of existing PETs are considered to have reached a level that excludes these factors from being responsible for the lack of adoption. Raising user awareness through education from undergraduate to university and adopting regulations for increasing the incentives to establish default security and privacy in products and services have been named as the major provisions for increasing the adoption rate of PETs. Giving an example by adopting PETs in EU institutions and considering security and privacy as first-hand requirements in public procurement processes are other means for reaching this objective.

Policies addressing software and hardware vulnerabilities and the Internet architecture/backbone

The three measures that are considered of most relevance for reducing the threat of Hardware (HW) and Software (SW) vulnerabilities are: (i) establishing liability schemes for HW and WS, (ii) promoting the development of resilient systems and solutions, and (iii) promoting and procuring open HW and SW systems. SW liability schemes have been discussed in various sessions and were generally considered one of the most powerful means for reducing vulnerabilities. However, they need to be fine-tuned to the particular circumstances of businesses and markets, in order not to stifle innovation. Resilience is considered the way forward for building trustworthy systems in a world where absolute security cannot be achieved.

Open HW and SW systems offer the possibility of verification and validation in contrast to closed systems. Openness in this context must not be confused with licensing or intellectual property schemes, but relates to the open access to designs and implementations.

Policies for developing the EU potential for a stronger and more capable IT industry

The principal issue identified for developing a stronger EU IT industry is the need to reduce fragmentation at the level of national regulations and standards. A truly integrated and pan-European approach has been called for, in order to create a level playing field for the IT industries of different Member States and enable EU markets of scale. Establishing vertical independence in critical infrastructure value chains could be a long-term goal. While some of its benefits were questioned, the approach helps to justify directed industrial support for a vital EU industry, especially delivering into critical infrastructure organisations. A potential unique selling proposition for the EU IT industry has been identified in relation with the provision of technology that allows building secure systems out of potentially insecure components. Combined with adequate regulations and certifications this could help establishing a pioneering role of the EU IT industry in terms of secure and trustworthy solutions.

More information about this [conference](#) is available on the STOA website.



6. STOA activities in the area of health and new technologies in the life sciences

6.1 Workshop | The Ebola outbreak: challenges and perspectives

The Ebola crisis topped media and political agendas for months as a number of countries in West Africa experienced the worst Ebola epidemic in history. In response, STOA convened a workshop on 4 March 2015, drawing together experts from international institutions, NGOs and European political parties to discuss this issue in depth. The workshop was focused on the importance of surveillance, rapid diagnostic testing for Ebola and the prospects for vaccination against the disease. It also provided an opportunity to deliberate upon the importance of Ebola research alongside competing research priorities and the lessons already being learned so as to prevent future crises from arising. Paul RÜBIG, STOA Chair, chaired the event.

Guinea, Sierra Leone and Liberia, the most affected countries

The Ebola outbreak occurred in a densely populated region, which sits at the intersection of three countries, close to large urban centres and characterised by significant cross-border population mobility. The three worst affected countries (Guinea, Sierra Leone and Liberia) did not have adequate means by which to assess and manage the outbreak effectively, due to many years of political instability and crippling poverty. When the outbreak began, healthcare systems were simply not able to cope with the treatment of the disease effectively and could not prevent it from spreading further.

Public Health Emergency of International Concern

On the 8 August 2014, the World Health Organisation (WHO) declared the outbreak a 'Public Health Emergency of International Concern'. The Ebola virus had caused the rapid erosion of basic health infrastructure in affected countries, resulting in a dramatic reduction of the capacity of such health systems to conduct basic preventative activities. Typical operations such as routine vaccinations and provision of access to emergency surgery and obstetric services decreased dramatically. The sum of these factors was the transformation of the Ebola epidemic into a medical humanitarian emergency.

Lessons learned

The Ebola epidemic reached unprecedented levels, with far-reaching humanitarian implications and implications for development, health, economics and security. Although the EU and its Member States had the resources and opportunities for effective humanitarian and medical action during crises, they did not coordinate an effective response. The Ebola epidemic, particularly in its first phase, revealed the gap between opportunity and much-needed action. Lessons learned from this crisis should be used to improve the role of the EU in similar situations in the future, ensuring that European aid can be effectively deployed to set up an improved emergency response system and supporting the establishment of sustainable health-care services in West Africa.

A peer-reviewed scientific article was published following the event: Quaglio GL, Goerens C, Putoto G, Rübzig P, Lafaye P, Karapiperis T, Dario C, Delaunois P, Zachariah R. 'Ebola: Lessons learned and future challenges for Europe', *Lancet Infect Diseases*, 2015. doi: 10.1016/S1473-3099(15)00361-8.

More information about this [workshop](#) is available on the STOA website.



6.2 Workshop | Robots, enabling the disabled or disabling the abled?

On 23 June 2015 STOA hosted a workshop on assistive technologies. The workshop was chaired by Ádám KÓSA, MEP. Mr KÓSA had requested from STOA a Scientific Foresight project on assistive technologies and their role in the creation of an inclusive environment for persons with disabilities. The purpose of this event was to acquire knowledge that would be useful in defining and refining the project specifications. A Scientific Foresight study on assistive technologies began in December 2015.

Robots: a potential revolution in assistive technologies



The first speaker, Ron McCALLUM, from the UN Committee on the Rights of Persons with Disabilities, revealed that the latest revolution in assistive technologies for the blind happened with the advent of computers and software technology, beginning in the 1980s. He predicted that perhaps robots would represent a similar revolution in the near future. Mr McCALLUM explained that assistive technologies had enabled him to easily access legal material online with braille-designed websites and assistive apps. However, a lot has to be done to make the Internet fully accessible for persons with disabilities. Guaranteeing equal Internet access is important, because it is nowadays the major means of communication and knowledge transfer, meaning that it can expand the possibilities and the horizons of persons with disabilities.

Assistive technologies could offer opportunities for enterprises

The second speaker was Antal KUTHY, whose presentation included an explanation of the assistive technology called 'KONTAKT'. It is an online system that connects deaf and hard of hearing users with sign-language interpreters in real time and also provides real-time speech-to-text interpretation. It is an example of an assistive technology he developed and which was economically viable as an investment. He argued that assistive technologies could offer a great opportunity for enterprises, because the market is enormous, as one in every seven persons in the world can be considered to have some form of disability. In his words, "disability can fuel innovation in many ways and offer multiple opportunities for technological investment". Finally, Mr KUTHY pointed to brain-computer interfaces as a particular technology with far-reaching potential implications for society in general.

The ethical dimensions of assistive technologies

The final speaker of the workshop was Marjo RAUHALA, from the Technological University of Vienna. In her speech, she recounted her experience as the ethics manager for the Centre of Applied Assistive Technologies. Part of her job consists of working in close cooperation with a number of students with disabilities, some of whom have been co-developers of their own assistive technologies, enabling them to complete their studies. Ms RAUHALA gave an overview of the ethical dimensions of assistive technologies, as well as of the main ethical challenges – among which, ethics creep and the perception of research subjects as moral entities and not agents – and stated that very often these were ignored because they were considered minor.

More information about this [workshop](#) is available on the STOA website. A [video clip](#) about the workshop is accessible on YouTube.



6.3 Workshop | Health literacy in Europe

Health literacy constitutes an emerging field for policy, research and practice. In relation to this topic, STOA organised, on 1 July 2015, a workshop chaired by Paul RÜBIG, STOA Chair. The meeting conveyed recommendations of different European stakeholders on how to accelerate the health literacy agenda in Europe.

Health literacy: a definition

Health literacy refers to the capacity to make sound health decisions in the context of everyday life – at home, in the community, at the workplace, in the healthcare system, in the market place, and in the political arena. It concerns the knowledge and competences of people to meet the complex demands of health, particularly in modern society. A widely-accepted definition is the following one: health literacy is linked to literacy and entails people's knowledge, motivation and competences to access, understand, appraise and apply health information, in order to make judgments and take decisions in everyday life concerning health care, disease prevention and health promotion to maintain or improve quality of life during the life course.



Including health literacy in EU policy

Health literacy is necessary to understand instructions for self-care, to plan and achieve desired lifestyle adjustments, to know how and when to access health care etc. With the demographic change, the rise in chronic diseases and a scarcity of health personnel, health literacy will play a central role: it recognises the critical role of citizens and patients in healthcare systems. The panellists agreed that including health literacy as an overarching objective in EU health and related policy areas contributed to the overall aim of EU's health strategy, which was to strengthen citizens' role with regard to their health, improve health outcomes and reduce the growing burden on healthcare systems.

Guaranteeing citizens' capacity to make sound health decisions

In an era where technology and innovation are key for improving the efficiency of healthcare systems and ensuring better health outcomes for European citizens, it is critical to guarantee that patients and healthy citizens have the capacity to make sound decisions about their health. Moreover, speakers agreed that, in light of current austerity measures in Europe, the demographic change and the increasing prevalence of chronic diseases, it was also critical to make the most efficient use of existing resources and ensure that health systems are sustainable to bear the burden of the coming decades.

Increasing health literacy at all levels

The current EU strategies for integrating health literacy at different levels in Europe were discussed during the meeting, as were the challenges threatening the further development of health literacy in the EU. There was consensus among the panellists on that the EC, as well as the EU Member States would take the necessary steps to increase health literacy at individual, organisational, community, regional and national levels.

More information about this [workshop](#) is available on the STOA website.



6.4 Workshop | The impact of the organic food on human health

This STOA workshop, on 18 November 2015, was an opportunity to discuss the effects of organic food on human health with experts from different EU countries. While the sustainable nature of organic farming is generally conceded, its health and nutritional benefits are still widely debated. The intention of this workshop was to give policy-makers access to a review of current knowledge with respect to the question of whether the choice of organic versus conventional food has an impact on human health. The event was chaired by Momchil NEKOV, STOA Panel member.

Organic food: a market with a dynamic development



Over the last 10 years the organic food market has been characterised by dynamic development driven by strong growth in demand. The area under organic production in the EU has doubled since 1999. Consumers have started to look for safer and better controlled food, produced in more environmentally friendly and local systems. Organic production is a system of farm management and food production that aims at sustainable agriculture, high-quality products and the use of processes that do not harm the environment, or human, plant or animal health and welfare. EU consumers spent over €22 billion in 2013 on organic products, helping the EU organic market grow by nearly 6%.

The 'safety and healthfulness' debate

The overall number of studies analysing the safety of organic vs. conventional foods is growing rapidly. It may be surprising to know that only a small number of scientific studies have addressed the question whether organic food is more or equally or less healthy compared to conventional food. The panellists agreed that this was because there were serious difficulties in the implementation of these types of studies. In order to measure healthiness, one would need to have a group of humans eating only organic and another one eating only conventional food, and then after a while compare which group was healthier.

The impact of different farm management systems on human health

In the public debate, discussions regarding organic food are often polarised and simplified to the question whether organic or conventional or neither food is 'better'. However, during the workshop, scientists underlined the importance of understanding the impact of different farm management systems on human health, animal well-being, food security and environmental sustainability, with the long-term goal being to create sustainable food systems.

More information about this [workshop](#) is available on the STOA website.



6.5 Workshop | E-health in Europe: reality and challenges ahead

This workshop was held on 1 December 2015 and was chaired by Eva KAILI, First STOA Vice-Chair. Major objective of this event was to report on lessons healthcare delivery organisations have learned from different ICT deployment experiences and care delivery transformation in Europe. The meeting tried to identify areas where policy support, at regional, national and European level, would be welcome. The event was also an opportunity to recognise barriers and facilitators for devising strategies and interventions to improve the use of e-health as an enabler for the necessary transformation of healthcare systems in Europe.

E-health in Europe

There are many different definitions of e-health and of its sub-categories. The WHO simply defines e-health as 'the use of information and communication technologies for health'. EU Member States and Regions are facing a growing demand for healthcare services. Here, healthcare solutions provided by ICT can provide an effective support.

Innovative health and care service models

In order to adequately respond to the growing demand for healthcare, the European health policy must ensure that full use is made of all resource-saving approaches, including e-health. This implies not only adopting ICT-based tools and solutions, but also – and more importantly – innovative health and care service models. This means increasing the engagement of patients in healthcare, and delivering services in a cost-efficient and care-effective manner. The EC states that e-health will play a key role in structural reforms that are needed to ensure the sustainability of health systems, while securing access to services for all citizens.



Barriers to implementation of innovations within the healthcare setting

There are several reports providing interesting examples for e-health evolution across Europe. Implementations of potentially transformative e-health technologies are currently under way in many EU Member States. Despite the potential benefits of e-health, implementation of these systems is often reported as problematic. Barriers to implementation of innovations within the healthcare setting may arise at the individual, organisational and wider levels of the healthcare systems. The implementation of e-health interventions in healthcare needs adequate financial resources, as well as a strong administrative and policy support.

More information about this [workshop](#) is available on the STOA website.



6.6 Project | Technological innovation strategies in substance use disorders

Lead Panel Member: Kay SWINBURNE

Project duration: Started in June 2015; expected to end in July 2016

Relevant for EP Committees: ENVI, ITRE

This STOA study focuses on the application of technology to the delivery of interventions for the treatment and recovery management of substance use disorders. The study will highlight the current and future state of the science in this area of intervention delivery.

The potential of technology in the management of substance use disorders

The field of substance abuse treatment has seen considerable advances in identifying effective interventions, such as pharmacotherapies and psycho-social therapies. Despite being at an early stage, a growing line of research has highlighted the promising role that technology may play in improving the effectiveness, cost effectiveness and reach of efforts to assess, prevent, treat and support the recovery management of substance use disorders. Using technology to deliver evidence-based interventions allows for these complex activities to be implemented with enhanced fidelity and at lower cost, without placing further demands on the time of healthcare professionals. Furthermore, technology may enable entirely new models of care for substance use disorders within, and outside of, current systems of care.

Understanding how much these technologies are used in Europe

Research is needed to understand how much these technologies are, at present, part of the everyday activities of health personnel working in the addiction field in the EU, which are the technologies more frequently used, if caregivers consider these technologies potentially useful, best ways to engage patients in using these tools, the types of individuals who do (or do not) benefit from these approaches, how to best integrate these tools into different settings of addiction treatment in the EU, and the strengths and weaknesses of these approaches.

A survey in support of the literature review

The study includes a literature review, a survey and semi-structured interviews. The survey will collect the responses of at least 300 European experts on drug addiction representing the following EU Member States: UK, Poland, Germany, France, The Netherlands and Italy. Results of the survey will be discussed in semi-structured interviews with European leading experts in the field of drug addiction.

7. STOA activities in the area of science policy, communication and global networking

7.1 Event | Science meets Parliaments



Scientists from all over Europe met with members of the European and national parliaments on 15 September 2015 for 'Science meets Parliaments', an event co-hosted by the STOA Panel and the JRC. The event launched the 4th round of STOA's 'MEP-Scientist Pairing Scheme', which aims to promote a culture of science-based policy-making in the EP by helping create lasting links between scientists and MEPs. Matching the objectives of the new JRC initiative 'Science meets

parliaments', which stresses the importance of science for evidence-informed policy-making, the project raises awareness of politically relevant, cutting-edge scientific issues, to create a structured dialogue between scientists and policy-makers.

Speakers at the opening session included Tibor NAVRACSICS, EU Commissioner for Education, Culture, Youth & Sport, whose responsibilities include the JRC; Carlos MOEDAS, EU Commissioner responsible for Research, Science and Innovation; Mairead McGUINNESS, EP Vice-President responsible for STOA; and Jerzy BUZEK, Chairman of the EP's ITRE Committee. The session was moderated by Paul RÜBIG, Chairman of the STOA Panel, and Vladimír ŠUCHA, JRC Director-General. At the end of the event, Eva KAILI, First STOA Vice-Chair, presented the 'MEP-Scientist Pairing Scheme', for which she was responsible within the STOA Panel.

Building a relationship based on trust

The speakers underlined the need for more effective use of existing EU institutional scientific expertise (e.g. JRC, agencies, EP research services) and the importance of better communication between policy-makers and scientists. Mairead McGUINNESS stressed the time constraints politicians often face, but also that technological developments facilitate ever faster access to information. She also reiterated Commissioner Moedas's comments on the importance of trust among scientists, politicians and citizens. Jerzy BUZEK added that the role of science is to provide evidence-based options to decision-makers, not final answers.

More information about this [event](#) is available on the STOA website.



7.2 Project | Ethics of Cyber-Physical Systems

Lead Panel Member: Mady DELVAUX-STEHRRES

Project duration: Started in September 2015; expected to end in May 2016

Relevant for EP Committees: JURI

The objective of this project is to analyse possible scenarios for the development of the Cyber-Physical System (CPS) technology by 2050 and the related societal and ethical concerns in terms of unintended impacts. In a first phase, the project will address the likely techno-scientific development of the CPS technology, the societal impacts in the context of the foreseeable future and subsequently the unknown and uncertain factors that may arise in relation to CPS by 2050 in the following areas:

1. Persons with disabilities
2. Healthcare
3. Agriculture and food supply
4. Manufacturing
5. Energy and critical infrastructures
6. Transport and logistics
7. Community security and safety

The second phase will be the pilot experience for STOA in applying the new scientific foresight approach. During this phase, the study will explore how CPS may affect existing practices. This includes stakeholder dispositions, but also perceptions of what is right and wrong, what is considered as a form of harm that politicians are accountable for and what is not etc.

The results of this part will be a major source of information for developing a diverse set of future scenarios. The scenario stories will depict the findings that are important to be communicated to policy-makers about the future possible impacts of CPS, including societal and ethical impacts. Therefore the purpose of this study is to make MEPs discover new areas for policy-making to anticipate possible futures.

The outcomes of this study will also be used as input by the Working Group of the JURI Committee on Robotics and Artificial Intelligence in relation to legal questions about the development of robotics and especially to pave the way for the drafting of civil law rules in connection with robotics and artificial intelligence.

7.3 Project | The impact of new technologies on the labour market and the social economy

Lead Panel Member: Georgi PIRINSKI

Project duration: Started in December 2015; expected to end in September 2016

Relevant for EP Committees: EMPL

This STOA project aims to first examine the situation in the EU and its Member States with regard to the impact of new and emerging technologies upon the labour market. It will assess the employment trends in combination with the introduction of new and emerging technologies and the respective challenges, before putting forward solutions that may address the problems of technological unemployment and inequality. In a second part, the study will cover the effects of technological innovation upon the social economy.

Technology impacts on professions that are under threat

There is a lack of studies that examine the complexities of the connection between technological innovation and employment and, more importantly, on the effects of specific technological trends

upon specific employment sectors and professions in the EU, and their long-term impacts on our societies. Given that most of the employment effects of service digitalisation remain unacknowledged, especially in the context of the social economy, and thus poorly addressed in related policy measures, the purpose of this project is to provide such a long-awaited assessment that could serve as a basis for legislative and policy initiatives that could safeguard meaningful employment.

This assessment includes a thorough literature survey on the employment impact of selected technological domains, as well as of computerisation, automation or digitalisation in general. Given the lack of a uniform definition of what constitutes a new technology and the high variety of forms that the social economy can acquire across Europe, the study will provide an exploratory analysis of what may be the determining factors of the observed patterns of technological progress upon employment change. The first part of the study should finally highlight the main economic and legal instruments that have thus far been used to mitigate the employment effects caused by the introduction of new technologies.

Tailored employment needs in EU Member States

The second part of the study should examine whether technological developments can in fact be used as a response to ongoing unemployment problems and facilitate the design of social and labour market policies in a socially acceptable manner. The project objective is not only to gain knowledge about the potential employment risks and opportunities associated with specific technological trends, but also to create a basis of discussions and analysis of active policy responses that could prevent or mitigate the technological unemployment in concrete professional contexts and would be tailored to the needs and particularities of the employment markets of EU Member States. Finally, a set of policy options for their political management will be outlined and assessed based on the outcomes of the overall analysis that should include 'smart' regulatory and legislative pathways.

8. MEP-Scientist Pairing Scheme

The MEP-Scientist Pairing Scheme aims at enhancing mutual understanding and establishing a long-term, intensive cooperation between Members and researchers. In 2015, STOA ran the 4th round of the Pairing Scheme. The project was officially introduced by the First STOA Vice-Chair Eva KAILI at the 'Science meets Parliaments' event on 15 September 2015 in the European Parliament.

Great interest from both MEPs and researchers

In the 4th round of the scheme, launched in May 2015, STOA received 326 applications from scientists and researchers from all over Europe. After the eligibility screening, 108 applicants were selected and placed on a list, which was then shared with the MEPs. Finally, 31 MEP-scientist pairs were established (see table below). This number of pairs shows an encouraging overall evolution compared to previous rounds of the scheme (in 2011, for example, there were 12 pairs). Another indicator of success and importance of this initiative is the fact that a number of Members involved in the previous round participated again in 2015.

'Brussels week'

For the first stage of the scheme, from 25 to 27 January 2016, the paired scientists were welcomed to the European Parliament. They had an opportunity to present their research activities to their MEP counterparts and get acquainted with the work of the European Parliament and its different services, such as research (EPRS, policy departments) and communication services (DG COMM), as well as with parliamentary committee secretariats (of the AGRI, CULT, ITRE and IMCO Committees). The JRC organised a short workshop on practical tips for communicating science to policy-makers. Finally, and most importantly, scientists shadowed their MEP counterparts in their daily activities, including in committee and political group meetings.

This hands-on experience with the political decision-making processes of the European Parliament was highly appreciated by scientists. They felt that direct contact with decision-makers was the best way for communicating science. The Members benefited too, as they were able to have intense and in-depth discussions with their academic counterparts about topics with a scientific dimension currently on the EP agenda.



Cooperation to continue

After this meeting in Brussels, the MEP-scientist pairs are encouraged to organise a follow-up activity, such as a workshop, a visit to a research and innovation facility, or an exhibition. STOA is already considering repeating the project for the 5th time in 2016.

More information about this [project](#) is available on the STOA website.

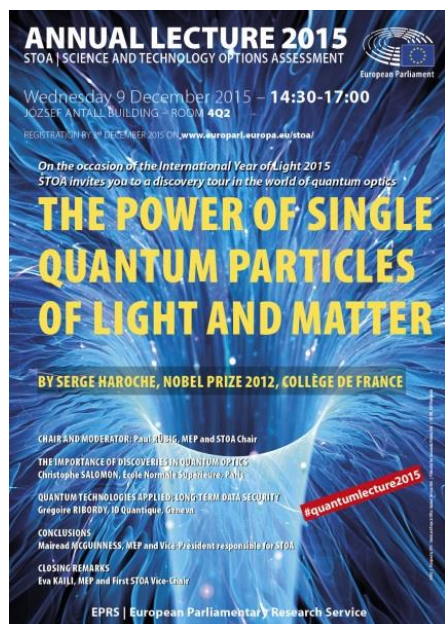
List of participants

	MEP	Scientist	Scientist's affiliation	Scientist's filed of expertise
1	CABEZON RUIZ Soledad (S&D, ES)	CARVAJAL Micaela	Centro de Edafología y Biología Aplicada del Segura, CSIC (Murcia)	Biology
2	CHILDERS Nessa (S&D, IE)	HULL Richard	University of Central Lancashire	Chemistry
3	CLUNE Deirdre (EPP, IE)	GARCIA Andres Higuera	University of Castilla-La Mancha	Engineering
4	COMODINI CACHIA Therese (ALDE, MA)	DIMITROVA Maya	Institute of Systems Engineering and Robotics at Bulgarian Academy of Sciences (ISER-BAS)	Artificial or Hybrid Intelligence
5	DE BACKER Philippe (ALDE, BE)	VAN POPPEL Henrik	University Hospitals Leuven	Urology
6	DLABAJOVÁ Martina (ALDE, CZ)	STOKIN Gorazd	St. Anne's University Hospital, Brno	Neuroscience
7	EHLER Christian (EPP, DE)	SCHWALBE Harald	Center for Biomolecular Magnetic Resonance (BMRZ)	Chemistry
8	FORD Vicky (ECR, UK)	BALK Janneke	University of East Anglia	Biology
9	GERBRANDY Gerben-Jan (ALDE, NL)	VAN MONTAGU Marc	Ghent University	Organic Chemistry; Biochemistry
10	GIRLING Julie (ECR, UK)	WALSH Patrick	University College Dublin	Political Science
11	HELMER Roger (EFDD, UK)	ABRAM Simone	Durham Energy Institute	Social sciences; Energy
12	KAILI Eva (S&D, EL)	CRISTIANINI Nello	University of Bristol	Artificial Intelligence
13	KYLLONEN Merja (GUE/NGL, FI)	CALDERON Carlos	Newcastle University	Urban Energy
14	LEWER Andrew (ECR, UK)	CARRETERO-GOMEZ Stephanie	European Commission, Joint Research Centre (JRC)	Psychology
15	LIBERADZKI Boguslaw (S&D, PL)	SMALLBONE Andrew	Newcastle University	Energy
16	McGUINNESS Mairead (EPP, IE)	FLITSCH Sabine	The University of Manchester	Chemical Biology
17	MCINTYRE Anthea (ECR, UK)	HESLOP HARRISON John Seymour	University of Leicester	Genetics, plant breeding, environmental biology

18	MOODY Clare (S&D, UK)	CONNOR Peter Michael	University of Exeter	Renewable Energy Policy
19	MORGANO Luigi (S&D, IT)	DE GIROLAMO Giovanni	St. John of God Clinical Research Centre (Brescia)	Psychiatry
20	NIEDERMAYER Ludek (EPP, CZ)	PUST Ladislav	ELI Beamlines (Prague)	Engineering
21	PEDICINI Piernicola (EFDD, IT)	HAYS John	Erasmus MC (Rotterdam)	Medicine
22	RIVASI Michèle (Greens/EFA, FR)	UNGER Jean-Pierre	Institute of Tropical Medicine (Antwerp)	Medicine
23	ROZIERE Virginie (S&D, FR)	DECHER Gero	CNRS Institut Charles Sadron	Physical Chemistry
24	RÜBIG Paul (EPP, AT)	LENS Piet	UNESCO-IHE Institute for Water Education (Delft)	Environmental technologies
25	KÓSA Ádám (EPP, HU)	MOLNAR Elek	University of Bristol	Neuroscience
26	SMITH Alyn (Greens/EFA, UK)	DREW Janice	University of Aberdeen (Scotland)	Molecular Biology
27	STIHLER Catherine (S&D, UK)	COLE-HAMILTON David	European Association of Chemical and Molecular Sciences	Chemistry
28	SWINBURNE Kay (ECR, UK)	ARDEN Nigel	University of Oxford	Orthopaedics, Rheumatology, Musculoskeletal Sciences
29	TOŠENOVSKÝ Evžen (ECR, CZ)	FRIAK Martin	Institute of Physics of Materials, Academy of Sciences of the Czech Republic	Physics
30	DE BACKER Philippe (ALDE, BE)	COENYE Tom	Ghent University	Pharmaceutical Microbiology
31	WINKLER Hermann (EPP, DE)	DOELLER Christian	Centre for Cognitive Neuroimaging (Nijmegen, The Netherlands)	Neuroscience

9. STOA Annual Lecture

A discovery tour in the world of quantum optics



The 14th edition of the STOA Annual Lecture, held on 9 December 2015, was dedicated to the topic of light and light-based technologies. Fittingly, as 2015 had been declared by the UN General Assembly the International Year of Light, the STOA Panel decided to broaden awareness how quantum optics and photonics have been changing our lives. The audience had the opportunity to listen to Professor Serge HAROCHE, who, jointly with Professor David J. WINELAND, won the 2012 Nobel Prize in Physics for their study of the particle of light, the photon, and more specifically for the 'ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems'.

Other speakers included Professor Christophe SALOMON, professor of quantum optics at the École Normale Supérieure, Paris, and Grégoire RIBORDY, CEO of ID Quantique, Geneva. The lecture was chaired and moderated by Paul RÜBIG, STOA Chair. Mairead McGuinness, EP Vice-President

responsible for STOA, and Eva KAILI, First STOA Vice-Chair, made the concluding remarks.

The importance of light

Quantum optics 'is the study of the interaction between atoms and light. Most information comes to us through light, from information on stars and the universe to information on the objects that surround us. Of course, as well as looking at visible rays, we study infrared and ultraviolet light and the radio- and micro-waves shooting through space in all directions that give us a huge quantity of information! Quantum optics helps us to understand natural phenomena and to develop new technologies', Professor HAROCHE explained.² While quantum optics often refers to fundamental science, photonics usually signifies the applied science and technology of generating, controlling, and detecting photons. What is remarkable about this field of research is that the usual macroscopic laws of physics do not apply at the scale of subatomic particles, indeed it was long believed that, with these tiny particles, only fundamental research was possible.

Photonics and quantum optics have given us the keys of modern technologies. Most of the devices that we use in our daily lives are light-based and use physics to create and manipulate light and particles: TVs, cameras in our mobile phones, computer screens, LED lighting, navigation systems and fibre-optic cables. The EU funds photonics research within Horizon 2020 and considers photonics to be a Key Enabling Technology (KET) for Europe in the 21st century. Light-based technologies also attract the attention of business: the current global market of € 300 billion is expected to double by 2020.



² interview, website of the Université Pierre et Marie Curie: www.upmc.fr/en/research/talents_and_discoveries/talents/serge_haroche_quantum_theory.html

Making the information age possible

Christophe SALOMON asserted that important discoveries in quantum physics, such as laser beams in 1960, improved navigation, earth monitoring and geodesy, notably thanks to the new precision tools for time measurements. Atomic clocks afford a more precise definition of time, making the operation of global positioning satellite systems, such as Galileo, possible.

Grégoire RIBORDY said that we were witnessing the second quantum revolution: the growth of information transmission and processing is purely based on quantum physics. The quantum computers under development will be different from the state-of-the-art digital computers, which still require data to be encoded into binary digits (bits). Quantum computers use for the same process quantum bits (qubits), which are incomparably faster.

Since more than 50 billion connected devices exist in the world, and this number is supposed to triple in five years, safety of data and cybersecurity are of paramount importance. Mr RIBORDY presented the solutions offered by quantum cryptography. In Geneva, he said, the electoral vote counting has been secured by quantum cryptography since 2007.

In his final remarks, Professor HAROCHE argued that open and free access to research findings was needed, among other reasons, for more quality of and oversight over scientific process and discoveries. He also called for trust in and patience for science and researchers, which, he thought, was often the opposite of what policy-makers and industry needed and could afford.

More information about this event is available on the STOA website.



10. Presentations to the STOA Panel

During their meetings in Strasbourg, the members of the STOA Panel often listen to presentations of the results of ongoing STOA projects. In addition, researchers and experts from different institutions and organisations are invited to give presentations and participate in discussions on techno-scientific topics and related policy issues of interest to the Panel.

The final reports of the following STOA projects were presented to the STOA Panel during its meetings in 2015:

- *Towards Scientific Foresight in the European Parliament* (15 January);
- *Technology options for deep seabed exploitation – Tackling economic, environmental and societal challenges* (12 February);
- *Learning and teaching technology options* (12 March);
- *The collaborative economy: Impact and potential of collaborative Internet and Additive Manufacturing* (11 June);
- *ICT in the developing world* (29 October).

The following sections summarise the other presentations and discussions that took place during the Panel meetings in April, May, July, September, November and December 2015.

10.1 Exchange of views with Peter CHURCHILL, JRC

At its meeting on 30 April 2015, the STOA Panel invited Peter CHURCHILL, Advisor to the Director-General of the JRC for Scientific Development, for a discussion on the STOA study 'Impact and potential of collaborative Internet and additive manufacturing', some aspects of which were the subject of JRC research.

Mr CHURCHILL explained that additive manufacturing (AM) was the process of joining materials to make objects from 3D model data, for example in construction industry, medicine, fashion, art, aeronautics and the automotive industry. The main question was how Europe could benefit from this technology – facilitating the production of prototypes online. He explained the major challenges that confronted AM besides the ethical issues: materials, software, data management, standards, sustainability and its potential impacts on goods and services, resources, jobs etc.

During the discussion, the Panel members reflected on the readiness of Europe to innovate and of the European education systems to teach children how to use their creativity in an efficient way. The 'standardisation versus personalisation' issue and the extent to which additive manufacturing made people think about the future were also discussed.

It was concluded that Europe was not fully ready for innovation, mainly because of problems with the transfer of research outcomes from the labs onto industry. Also, all agreed that the trends were changing and people were moving towards buying a service rather than a product. In addition, it was concluded that coordinated research and innovation efforts (in materials, software and data management) were seen as important next steps, along with the development of European standards and improvement of education and skills in this technology.

10.2 Lessons learnt from the PACITA project

On 21 May 2015, the STOA Panel listened to a presentation by Lars KLÜVER, Director of the Danish Board of Technology Foundation and coordinator of the PACITA project. PACITA was a project

funded under the 7th Research Framework Programme, with the aim to increase the capacity and enhance the institutional foundations for Parliamentary Technology Assessment in Europe.

Mr KLÜVER defined Technology Assessment (TA) and 'TA-like' activities as tools in support of policy-making. TA indeed fostered debate and various models for integrating TA in political or parliamentary activity were used in different countries (e.g. Finland, Germany, Greece, Italy, the UK), depending on their traditions and cultures. Furthermore, he pointed out the three main methodological clusters in parliamentary TA – expert-based approaches, stakeholder involvement and citizen consultations. PACITA aimed at both mobilising those actors that did not have a structured or institutionalised approach to TA, and at demonstrating how a knowledge-based approach to policy-making on techno-scientific topics could make a potentially positive contribution to political activities.

After the presentation, the Panel members emphasised the importance of employing TA in policy-making, how a European research network could provide high-quality research at a lower cost, the impact of TA outcomes on policy and the criteria needed for accessing techno-scientific issues.

It was concluded that TA carried out at the European level was useful for national assessments, especially through the comparison between the two levels. In addition it was said that TA was mainly conveyed in the form of policy briefs, which seemed to be generally appreciated. Finally, early warning over possible future scenarios was considered the best service provided by TA for policy-makers to take a proactive approach and incorporate TA results into their work.

10.3 Exchange of views with Dominique RISTORI, DG Energy

For its meeting on 10 September 2015, the STOA Panel invited Dominique RISTORI, Director-General for Energy, in the European Commission, to share his thinking on STOA-related issues.

Mr RISTORI highlighted that research and scientific progress were essential for the success of the transformation of the European energy system and there was a need for a robust governance system to ensure that EU and national actions were consistent with each other and with the overall strategy. He emphasised the strong need for an Energy Union given that EU leaders had backed ambitious 2030 targets: a 40% cut in green-house gas emissions, at least 27% of energy efficiency at EU level, and at least 27% share of renewables in the energy system at EU level. By completing the internal energy market there would be savings of up to € 40 billion per year.

Furthermore, he presented the idea of a 'New Deal for Consumers', based on the premise that consumers should be able to control their own consumption and production, and to benefit from lower wholesale prices and market competition. The Commission would address these issues through a legislative proposal in 2016. Concluding, Mr RISTORI stressed that it was important to not only fund the research, but also embrace the right policy platform and culture to make sure that research can be brought into the market. During the discussion, the Panel members asked about the Commission's plan to coordinate the work of the two energy-related EU agencies - BERECA and ACER, as well as about electric mobility, alternative energy sources and energy storage, the state of play of EU's energy relationships with Algeria and Iran, and fracking and nuclear energy as alternative forms of energy that could be produced domestically.



Mr RISTORI stressed the need to strengthen the synergies between the Commission and the energy-related agencies and enhance the transparency in their operation. Regarding Algeria and Iran, there was currently a potential for EU to reach an agreement with these countries. In Mr RISTORI's view, with improved nuclear safety and security, there was a role for nuclear energy in the decarbonisation process. He referred to shale gas as a sensitive issue, with the main focus at the moment on identifying reserves in Europe. He further stated that electromobility should be limited to urban areas for the time being and it would not be wise to abandon research and technological development in the field, since European companies could benefit from that.

10.4 Exchange of views with Vladimír ŠUCHA, JRC, and Johannes KLUMPERS, SAM

At its meeting on 26 November 2015, the STOA Panel invited Vladimír ŠUCHA, Director-General of the JRC, and Johannes KLUMPERS, Head of Unit, Scientific Advice Mechanism (SAM), European Commission, to share their thinking on STOA-related issues.



Mr ŠUCHA expressed his overall satisfaction with the excellent cooperation between STOA and the JRC, also exemplified by the jointly organised 'Science Meets Parliaments' event on 15 September 2015 in the EP and the STOA visit to IPTS in Seville in October 2015. He explained how the scientific knowledge and advice provided by the JRC to the EC had broader, both direct and indirect, benefits for consumers and society as a whole. Mr ŠUCHA further outlined JRC's work in different policy areas: environment, climate change and transport; migration; monetary union and its societal impacts; and health. Talking about the JRC's

future plans, he announced that the JRC would be working closely with CERN on developing a tool for monitoring technological trends and developments, and would also launch a knowledge centre on food fraud and authenticity in 2016, on the occasion of the 10th anniversary of the start of their work on consumer protection.

Mr KLUMPERS briefly described the functioning and different structures of SAM. SAM would comprise the recently appointed High-Level Group of Scientific Advisors, who would be linked to the College of Commissioners and the EC President via Commissioner Carlos MOEDAS, in charge of Research and Innovation. Seven Advisors were appointed for a 2.5-year period, renewable once. The operational support to SAM would be provided by the unit headed by Mr KLUMPERS in the EC's DG Research and Innovation. The High Level Group would interact with the existing services (such as the JRC), specialist and advisory bodies of the Commission, European and national academies and the wider scientific community. The Group had a mandate to work on short-, medium- and long-term issues and to act proactively, identifying policy areas where advice was needed and recommending improvements, but also to be responsive to the needs of EU policy and legislation.

Panel members enquired about the resources the High-Level Group had at their disposal, the Commission's view on the provision of evidence-based information and scientific advice, and the lack of a visual identity of the Group. Mr KLUMPERS explained that the High-Level Group had at their disposal a budget of €1 million for 2016 and the operational support of 15 staff members and



3 seconded JRC scientists in the unit of Mr KLUMPERS. Agendas, minutes and opinions of the Group would be publicly available. The Group would decide autonomously on their visual identity.

10.5 Exchange of views with Hans BRUYNINCKX, EEA

The STOA Panel invited Hans BRUYNINCKX, Executive Director of the European Environment Agency (EEA), for a presentation and discussion during the Panel meeting of 17 December 2015.



Mr BRUYNINCKX first presented his agency's latest State and Outlook of the Environment report (SOER 2015), which called for working towards a better and healthier environment, and better economic opportunities for innovation and technology. Every five years EEA publishes such a report on the state of the environment for the next 20 years and the relevant policy context. On the need for ensuring better resilience for Europe, he affirmed that, even if Europe's resilience was affected by such driving forces as demographic change and acceleration of technological development, its interdependencies opened up both challenges and opportunities. Looking to the future, the success of Europe's long-term policies would depend on its ability to respond by taking a long-term view and actively anticipating and shaping a desirable future.

Reflecting on the outcomes of COP21, the speaker appreciated the fact that the objective of not surpassing the barrier of 2°C was now clearer than in previous negotiations. He said that the agreed framework involved planning for 2100 based on a climate-neutral global economy and a long-term way of thinking about these issues. The new broad framework that came out of COP21 was binding for nations, he explained, but depended on many specific commitments at national level, for which, in his view, there was a need for a more solid and transparent system for monitoring and reporting.

Panel members asked questions about the possibility of an alternative EU Emissions Trading System (ETS) based on payments and incentives, the role of policy-makers in delivering the step change needed for innovation in the renewable-energy industry and what Europe should do in terms of reforming the ETS monitoring system.

Mr BRUYNINCKX explained that he had many reasons for optimism: the political shift towards affordable sustainable technologies, more competitive than traditional ones, and the major breakthroughs in research and development. The key message with regard to a reform of the EU ETS, linked to the discussion on subsidies, was to use public money appropriately and give a clear sense of direction. For that, he noted that credible policies required four main conditions: consistency, with a long-term perspective in policy-making and legislation, overall coherence and ambition in a wide range of policies, a sense of urgency and visionary policies.

11. Networks and collaborations

11.1 STOA attendance at EPTA meetings

EPTA Directors' meeting

Zsolt PATAKI, Head of the STOA Secretariat, attended the annual Directors' meeting of the EPTA network which took place, under the 2015 French presidency, from 27 to 29 April 2015 in Pont-à-Mousson, France. Participants included the Directors and/or other officials from most EPTA full and associate members. The meeting focused on the organisation of the EPTA conference in 2015, dedicated to the topic of 'The role of innovation to answer the effects of climate change', to be at the focus of the debates at the COP 21, several institutional developments, the EPTA presidency 2016 and 2017, current studies carried out by EPTA members, horizon scanning initiatives and the basic constituents of the PACITA process.

EPTA Council meeting and Conference

STOA, represented by STOA Chair Paul RÜBIG, and STOA Panel member Mady DELVAUX-STEHRÉS, attended the EPTA Council meeting and Conference, which took place from 23 to 24 September 2015 in Paris. On this occasion OPECST also celebrated the 30th anniversary of the publication of their first TA report. The meeting was chaired by Jean-Yves LE DÉAUT, OPECST Chair and President of EPTA for 2015. Theo KARAPIPERIS, Head of the Scientific Foresight Unit (STOA), and Lieve VAN WOENSEL, Head of the Scientific Foresight Service, accompanied the Members.

On the first day, the participants had a special workshop on the topic 'How TA organisations can best detect trends'. Chris TYLER, Director of the UK's Parliamentary Office of Science and Technology (POST), led, together with some of his team members, exercises using a tool designed by POST.



The second day was devoted to a conference on 'Innovation and Climate Change', based on the OPECST 'Green Paper' on this subject, which was meant to be the EPTA input to the 2015 Paris Climate Conference – COP 21 – and comprised the contributions of EPTA Members, including STOA. The following topics were discussed: innovation for energy efficiency of buildings; innovation to feed humanity whilst reducing greenhouse gas

emissions; innovation for transportation and sustainable mobility, and citizens' involvement in the use of smart technologies. This event was an excellent occasion for networking and exchanges of experiences, views and good practices with the EPTA partners. The constructive joint work led to a pragmatic and meaningful EPTA contribution to COP 21.

11.2 STS forum

The STS *forum*, like STOA, explores science and technology's potential to tackle many of today's challenges, notably through international collaboration, and the STOA Panel members have found in these meetings a natural forum for discussing topics of strategic political interest and making authoritative contributions as speakers or session chairs, while profiting from the annual meetings of the forum to meet bilaterally a large number of world leaders in the area of S&T policy.

Paul RÜBIG, STOA Chair, attended the meeting of the STS *forum* Council, which took place on 23-24 April 2015 in Berlin. He was accompanied by Theo KARAPIPERIS, Head of the Scientific Foresight Unit (STOA). This was a preparatory meeting that gave Council members, like Mr RÜBIG, an opportunity to propose topics and speakers, and generally shape the agenda of the October meeting.

The annual meeting of the STS *forum* held in Kyoto on 4 to 6 October 2015 was the most successful in its twelve years of existence. This Davos-type meeting devoted to global trends in Science, Technology and Innovation was attended by 1000 delegates of 92 nationalities, and was opened by the Prime Ministers of Japan, France and Sri Lanka. Paul RÜBIG, Chair of the STOA Panel, attended the meeting. He was accompanied by Joe DUNNE, Acting Director for Impact Assessment and European Added Value, EPRS, whose directorate includes the Scientific Foresight Unit (STOA).

During the meeting, Mr RÜBIG chaired the session on 'Smart Cities – Urban Design and Development'. He talked about 'smart cities' as those "whose knowledge, economy, and governance is being progressively driven by innovation, creativity, and entrepreneurship, and in which regional technologies can be used to efficiently and effectively run cities and services provided by them. 'Smart cities', he said, reduce costs and resource consumption, enhance the quality and performance of services, while further engaging with citizens.



The final statement issued on 6 October highlighted: (i) the importance of COP 21; (ii) the need for a coalition of public and private sectors and academia to nurture industrial innovation driven by new manufacturing technologies, robotics, nanotechnology and new materials; (iii) the creation of 'smart cities' using ICT, with a global consensus on universal ICT rules; (iv) the need to encourage further progress in personalised and pre-emptive medicine through breakthroughs in the life sciences; (v) the pursuit of a better understanding of the oceans and resource efficiency for sustainable development; (vi) the importance of S&T cooperation; and (vii) the value of STEM education.

11.3 EXPO Milano 2015

The international exhibition, EXPO Milano 2015, took place from 1 May until 31 October 2015, with the theme 'Feeding the Planet, Energy for Life'. It was centred on the need for sufficient healthy and safe food for all, produced in a sustainable manner. The focus was expanded to include related issues, such as producing energy, preserving biodiversity, tackling climate change, conserving natural resources and protecting the environment. EXPO was intended as a platform to not only draw attention to and discuss these pressing issues, but also offer practical solutions. Participants included countries (145), international organisations (3), civil society organisations (16) and companies or corporate groups (5).



A delegation of three STOA Panel members visited EXPO: Mairead MCGUINNESS, Paul RÜBIG and Marijana PETIR. They were accompanied by Nera KULJANIC, Administrator in the STOA Secretariat. On 8 May, they attended a high-level international conference entitled 'Towards a Research Agenda for Global Food and Nutrition Security', organised by the EU Scientific Steering Committee for EXPO, and on 9 May they celebrated 'Europe Day'.

The conference featured important international actors from politics, the scientific community, industry and civil society, and served as the official launch of six-month-long discussions about the role of science, research and innovation in dealing with the challenges of feeding a growing global population sustainably with limited natural resources.

11.4 Visit to the JRC's Institute of Prospective Technological Studies

IPTS provides science-based responses to policy challenges that have both a socio-economic and a techno-scientific dimension. Paul RÜBIG, STOA Chair, and Dario TAMBURRANO, STOA Panel member, paid an official visit to the JRC IPTS on 15 and 16 October 2015 in Seville, Spain. The visit offered opportunities to meet IPTS staff in charge of research projects and provided valuable insights for ongoing and future STOA projects, as well as useful links with experts.

The visit confirmed that IPTS's key research areas are of particular interest for STOA, since they are of



a similar nature to those of STOA: knowledge for growth, agriculture and rural development, sustainable development, and the economics of climate change, energy and transport. The JRC could in fact play an eminent role in providing the STOA Panel (and possibly EP Committees) with more timely information on ongoing work, benchmarks and analysis of best practices in many policy fields. It was agreed that a new thinking was needed on how to improve the way the JRC transmits results to the European Parliament.

11.5 World Science Forum

The World Science Forum is one of the most prestigious international gatherings of scientists and in 2015 it had as main theme 'The Enabling Power of Science'. Paul RÜBIG, STOA Chair, and attended the seventh World Science Forum that took place from 4 to 7 November 2015 in Budapest. The aim of the forum was to discuss how science contributes to opening new paths for the improvement of human life, business innovation and policy-making. Scientists, politicians, decision-makers and representatives of civil society debated on burning issues affecting the scientific world and society simultaneously and the common tasks lying ahead.

Participants expressed a strong interest in pursuing mutual contacts and exchange of information on issues related to science and science policy, and to the role and responsibility of parliaments in achieving sustainable development through science, technology and innovation advice. STOA's presence at this forum contributed to maintaining the close links between the European Parliament and the international community of science and technology policy-makers.



11.6 Internet Governance Forum

The Internet Governance Forum (IGF) is a direct outcome of the World Summit on the Information Society held in Tunis on 2005 and its main purpose is to bring people together from all stakeholder groups to engage as equals in a dialogue on public policy issues related to the Internet and its governance. Eva KAILI, First STOA Vice-Chair, participated, as member of an ad hoc EP delegation composed of Members from the ITRE, JURI and CULT Committees and STOA, in the 10th Meeting of

the IGF, which took place from 10 to 12 of November 2015 in João Pessoa, Brazil, under overarching theme 'Evolution of Internet Governance: Empowering Sustainable Development'.

The following key themes provided the basic architecture of the discussions on and proposals for possible ways forward in a number of specific areas: (i) cybersecurity and trust; (ii) the Internet economy; (iii) inclusiveness and diversity; (iv) openness; (v) enhancing multi-stakeholder cooperation; (vi) the Internet and human rights; (vii) critical internet resources; and (viii) emerging issues.

11.7 ESPAS Annual Conference

The European Strategy and Policy Analysis System (ESPAS) provides a framework for cooperation and consultation at the administrative level, on a voluntary basis, between the EP, the EC, the Council of the European Union and the European External Action Service, with the Committee of the Regions and the European Economic and Social Committee as observers, to work together on medium- and long-term trends facing or relating to the EU. The mission of ESPAS is to continue the collective, strategic thinking, laying the groundwork for more permanent cooperation and dialogue as well as defining strategic options for the current EU institutional cycle up to 2019 and beyond.

The 2015 ESPAS Annual Conference, focused on 'The Global Economic and Technological Revolution', took place on 12 and 13 November 2015 and explored the challenges and opportunities that the digital revolution will bring to our economies and societies in the next 15 years. The first day, hosted at the EC, addressed the 'Future Economy and Government'. The second day, at the EP, was centred on the 'Future of Science, Society and Geopolitics' and was opened by Paul RÜBIG, STOA Chair.



The 'Future Science Panel', looking at The World in 2030, elaborated on questions such as 'How far will science have progressed by 2030 in fields such as genetics and robotics, and will societies globally and in Europe be able to shape developments and prevent possible excesses?', 'Will a scientific renaissance lead to a revitalised and more humane society?', and 'Will the negative consequences of these advances prevail, in an age when anyone might print weapons of mass destruction?'. Mady DELVAUX-STEHRRES, STOA Panel member and Rapporteur for the Working Group on Robotics and Artificial Intelligence of the JURI Committee, chaired this session and led the debate on a wide range of issues related to scientific trends and their potential impacts on society; with special guests Jean-Jacques CASSIMAN, Centre for Human Genetics of Leuven University, Geneviève FERONE CREUZET, a corporate social responsibility expert and author of the book 'Bienvenue en transhumanie', Sabine HAUERT, a Swarm Engineer at the

University of Bristol and a co-founder of Robohub, and Ana NORONHA, the Executive Director at Ciência Viva, Portugal.

Both Paul RÜBIG and Mady DELVAUX-STEHRRES look forward to further cooperation between STOA and ESPAS in the future.

12. Communication

Towards a communication strategy

Communication is very important for maximising the impact of STOA's work and showcasing its depth, scope and relevance, while reaching an ever wider audience. In his introductory statement to this Annual Report, the Chairman introduces a 'silo and pipe strategy' to identify information flows, namely which communities/institutions ('silos') information is going out from and coming into, and which channels are used for information sharing ('pipes'). In addition to disseminating its own work by various means, increasingly including new media, STOA facilitates the communication, sharing and discussion of the work of researchers from other institutions and communities ('silos'), for example through presentations to the STOA Panel (chapter 10) and the activities of the STOA network (chapter 11). STOA plans to develop a strategy by devising appropriate metrics for assessing the effectiveness of various 'pipes' in overcoming the fragmentation imposed by 'silos' and taking measures to promote the most promising ways of improving knowledge exchange.

Publications

STOA issues dealt with by the EP Committees by seeking independent expert assessment of politically relevant techno-scientific aspects of these topics. The official publications of STOA are studies and briefings related to individual projects. STOA studies report on project methodologies and findings, and assess a number of options for policy-makers to consider. Short, concise and to-the-point 'briefings' summarise the assessed policy options on 2-4 pages. A study and its findings can also be briefly summarised in 'Layman's summary' of maximum 20 pages. In addition, STOA also produces reports following its events and an Annual Report on the activities and achievements in the preceding year. All these publications are available on the STOA website and the EP Think Tank pages.

Other dissemination channels

In recent years STOA has been increasingly using new media to communicate about its activities to a wider audience. Video clips presenting outcomes of the projects are produced and uploaded on STOA's YouTube channel, summarising the work of STOA in an easily accessible way. In 2015 six video clips were published. Blog posts announce STOA events and report on news, projects and workshops. In total 36 blog posts were published in 2015. STOA events are regularly supported by live tweeting, enabling interaction with stakeholders, experts and citizens engaged on the topic. An overview of STOA's online presence is given in Table 1.

Table 1. STOA's online presence

	europarl.europa.eu/stoa	
	EPThinkTank.eu/author/stoablogger/	
	@EP_ThinkTank	
	linkedin.com/company/european-parliamentary-research-service	
	youtube.com/user/MySTOA	

13. STOA strategy for the future

A major novelty within the 'STOA strategy for the future – An Action Plan', adopted by the outgoing STOA Panel at the end of the 7th legislative period, was to explicitly embed in STOA's mission a foresight role in science and technology, firmly anchored in the agenda-setting phase of the policy cycle.

Specific objectives of the Action Plan include:

- Continuous provision of sound and relevant policy advice to Members;
- Ensuring that STOA remains proactive and its products and working methods keep pace with rapid technological and political developments;
- Achieving optimal dissemination and awareness of STOA results and activities, reaching out to all Members, relevant scientists and the wider public.

In 2015, the STOA Panel first of all discussed and approved, during their session in January 2015, a new approach for scientific foresight projects. This approach resulted to the publication of a report entitled 'Towards Scientific Foresight in the European Parliament'. This report describes a robust methodology for coming to credible and future-proof scientific advice for the Members and the committees of the European Parliament, where scientific evidence is assessed in the societal context, and checked vis-à-vis possible future scenarios (more information in chapter 3).

In 2015 the first Scientific Foresight Study was published on the subject of 'Ethics of Cyber-Physical Systems', and two other studies were prepared to start early in 2016:

- Precision Agriculture and the future of farming in Europe;
- Assistive technologies for the inclusion of people with disabilities in the society, education and jobs.

Further, STOA also started activities raising awareness about techno-scientific trends, with a focus on potential impacts and policy implications.

As 2015 was a crucial year for the creation of a new Scientific Advice Mechanism (SAM) in the European Commission, STOA Panel members and STOA team members were involved in debates with other actors in the scientific advisory community within the EU.

One of the actions which will receive special attention in 2016 is setting up criteria for the selection of workshop topics, format and content. Further emphasis will be put on timely and effective communication of the results to Members, in an accessible way.

14. Budget implementation

Following the putting in place of a multiannual framework contract in 2014 (45 contracts with 29 different contractors), six new STOA projects were launched in 2015, on the basis of the signing of specific contracts, in the areas and on the topics presented in Table 2 below.

Table 2. STOA projects launched in 2015

	Lot	Project title
3	Environment (including climate change)	Towards a circular economy - Waste management in the EU
4	ICT and Information Society	Protecting online privacy by enhancing IT security and EU IT capabilities
6	Life-sciences and human well-being	Assistive technologies for the inclusion of people with disabilities in society, education and jobs
7	Agriculture, food and biotechnology	Precision Agriculture and the future of farming in Europe
8	Science, technology and innovation policy	Ethical aspects of Cyber Physical Systems The impact of new technologies on the labour market and the social economy

In 2015, STOA committed € 647,587.03 (99.6% of its expertise budget) for conducting projects and organising project-related workshops, while € 10,000 (100% of its reception and representation budget) was committed for the organisation of other events, including notably the STOA Annual Lecture.

Out of € 2,989,988 foreseen in the budget of the multiannual framework contract, so far € 880,038 (29%) has been committed for projects, with the resources used per thematic lot shown on Figure 1 below.

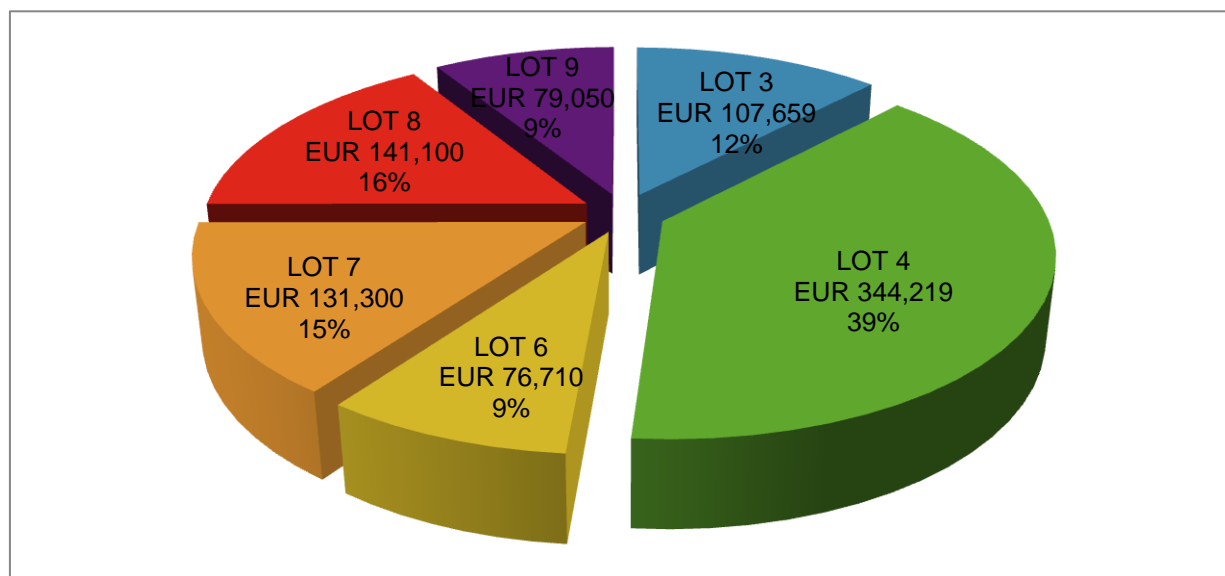


Figure 1. Budgetary resources used per thematic lot so far

15. Administration

As of 1 November 2013, the STOA Secretariat and, as of 15 September 2014, the newly-established Scientific Foresight Service are part of the Directorate-General for Parliamentary Research Services (EPRS) and constitute together the Scientific Foresight Unit (STOA). The STOA administration includes the staff members listed below at the beginning of 2016.

Scientific Foresight Unit (STOA)

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Lieve VAN WOENSEL, Head of Service

Philip BOUCHER

STOA Secretariat

Zsolt G. PATAKI, Head of Service

Mihalis KRITIKOS

Nera KULJANIĆ

Gianluca QUAGLIO (Seconded National Expert)

Assistants

Serge EVRARD

Rachel MANIRAMBONA

Damir PLEŠE

Anne VILLERS

STOA trainees

STOA actively uses the Schuman scholarship scheme to offer vocational training to several high-potential recent university graduates. In addition, the unit accepts those who seek a traineeship as part of their studies or for the advancement of their careers. Each trainee works closely with an administrator and so becomes involved in most of the tasks and challenges they face: participating in meetings with MEPs and other stakeholders, and organising workshops and studies on science and technology topics. They are also able to go on a mission to the EP in Strasbourg and attend the monthly plenary session. Trainees thus become acquainted with the whole EU policy-making process.

During 2015, the following trainees worked with STOA:

Geoffrey ARCHER (UK, October 2014 - February 2015);

Darja VRŠČAJ (SL, October 2014 - February 2015);

Sara CAGOL (IT, March 2015 - July 2015);

Guillermo GARRIDO-LESTACHE (ES, March 2015 - July 2015);

Liliana Filipa MENDES CUNHA (PT, October 2015 - February 2016).

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