

Legal and ethical reflections concerning robotics

Introduction

As the world we live in rapidly becomes crowded with a multitude of different cyber-physical systems—machines or mechanisms controlled by increasingly intelligent, computer-based algorithms, a wide range of legal issues will need to be re-examined and adapted to new realities.

Technological changes have nowadays accelerated to such a speed that increasingly law-making has difficulty catching up. STOA therefore recently conducted a foresight study in order to draw up possible scenarios to illustrate where developments in the area of cyber-physical systems might take us. Using these scenarios it was then possible to identify the areas of jurisdiction that should be addressed pro-actively, in order to reap the greatest possible benefits from the technical developments while avoiding, as far as possible, the negative consequences.

This briefing presents legal reflections for seven areas of concern¹ that are of relevance to the work of the European Parliament, listing the issues that might have to be dealt with, the EP committees concerned, and the legislative acts that might need to be revisited. It is hoped that the briefing will give Members of the European Parliament a better overview of the various questions they will likely be confronted with in the coming years, and a forward looking instrument to allow the EP to plan actions pro-actively rather than later having to react to some unforeseen event, accident or disaster.

The analysis looks at the different ways in which the current EU legislative framework may be affected by advances in robotics and by the respective technological trends. To do so, a scanning of the current state-of-the-art of legislation pertaining to robotics was performed pointing towards mostly areas of EU law that are in need of adjustment or revision due to the deployment of emerging robotics technologies. The focus has primarily been on whether robots raise particular legal concerns or challenges and whether these can be addressed within the existing EU legal framework, rather than on how human behaviour might be affected through robotics.

The focus on the existing EU legal framework does not necessarily imply that all robotic applications by and large can be accommodated within the current boundaries of EU law or that the adoption of a uniform body of law or of a single legal approach towards CPS as a whole (a form of *lex robotica*) should be excluded given the transnational character of some of these challenges.

Although the regulatory implications of robotics can be approached from a variety of legal perspectives, the legal analysis does not attempt to prejudge what will eventually be the most appropriate instrument in each case. For some types of applications, a review is recommended while for some others, robotics can possibly be regulated by modifying existing directives or regulations, international conventions, soft law instruments or standards drawn up by professional associations or technical standardisation organisations.

¹ Transport, trade, civil liberties, safety, health, energy and environment, and horizontal issues

A. Legislative aspects of cyber-physical systems in selected policy areas

1. Cyber-physical systems and transport

**Committees concerned: LIBE – Civil Liberties, Justice and Home Affairs
TRAN – Transport and Tourism**

Areas of interest or concern and possible issues and challenges

- Privacy, data protection, cyber-security and human dignity issues arising from the growing use of surveillance systems and monitoring procedures in the fields of transport and logistics
- Assessment procedures to ascertain the functionality and safety of automated systems – including standardised test procedures for pilot tests, recording of data, infrastructure requirements, cross-border testing, etc.
- Safety aspects of operating CPS in public spaces, and in particular safety and liability issues of self-driving vehicles and rules governing the testing, licencing and operation of this technology on public roads
- Risk that increased connectivity and integration of vehicles and complex logistics networks may lead to exposure to potential criminal or malicious attacks or misuse, which could result in significant financial loss, gridlock across Europe and, in the worst case scenario, injury and fatalities
- Review of the rules for truck and bus drivers on driving and resting times and digital tachygraphy in the age of increasingly autonomous transport systems

Legal instruments and provisions that might need to be reviewed or updated (indicative list)

EU legislative acts

- Regulation (EC) 561/2006 and Regulation (EEC) 3821/85 regarding driving and resting times and digital tachygraphy (for truck platooning)
- Directive 2014/45/EU on Roadworthiness
- Directive 2010/40/EU on Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport
- Directive 2009/103/EC on motor vehicle insurance
- Directive 2007/46/EC on vehicle approval
- Directive 2006/126/EC on requirements for driving licences
- Directive 2003/59/EC on training and initial qualifications of professional drivers
- Directive 85/374/EEC on product liability

Relevant international legal acts and documents

- United Nations Convention on Road Traffic, 19.9.1949
- United Nations Vienna Convention on Road Traffic, 8.11.1968
- United Nations Economic Commission for Europe (UNECE) acts, in particular:
 - UNECE regulation R13 on braking systems, to take account of automatically commanded braking
 - UNECE regulation R79 on steering equipment for automatically commanded steering functions beyond the threshold of 10 km per hour
- United Nations Economic Commission for Europe (UNECE) – Inland Transport Committee–documents:
 - Report of the 68th session of the Working Party on Road Traffic Safety, Geneva, 24-26.3.2014
 - Status of the implementation of the Road Map on Intelligent Transport Systems, Geneva, 15.12.2015
 - UNECE and automated vehicles – Informal document WP.29-167-04, November 2015

2. Trade of dual-use technology

Committees concerned: INTA – International Trade
ITRE – Industry, Research and Energy
JURI – Legal Affairs

Areas of interest or concern and possible issues and challenges

- How to implement fail-safe cyber security measures in the context of CPS for the protection of European Citizens
- The legal concerns raised by the availability and constantly improving sophistication of CPS for criminal or terrorist purposes
- Asymmetric risks from dual-use, mission creep and misuse of security related research
- Opening up of new vulnerabilities that may be exploited by hackers either to corrupt the operation of systems, or to extract commercial or other sensitive data
- Potential misuse of robotics and artificial intelligence should be considered; need to consider the introduction of additional safeguards (e.g. access restrictions, use of less dangerous substances, training, safe disposal, ethics management, an ethics advisory body)

Legal instruments and provisions that might need to be reviewed or updated (indicative list)

- Council Regulation 428/2009 setting up a Community regime for the control of exports, transfer, brokering and transit of dual-use items
- EU explanatory note on the potential misuse of research²
- EU guidance note – Research involving dual-use items³

3. Civil liberties (data protection, privacy, etc.)

The protection of privacy and of personal data is a major ethical and legal concern in the field of robotics given that CPS extract, collect and share information of a particularly sensitive nature with a wide range of stakeholders, especially in the fields of homecare and health.

Committees concerned: IMCO – Internal Market and Consumer Protection
ITRE – Industry, Research and Energy
JURI – Legal Affairs
LIBE – Civil Liberties, Justice and Home Affairs

Areas of interest or concern and possible issues and challenges

- Data practices in relation to homecare robots, such as obtaining and ensuring informed consent especially by disabled and/or vulnerable people when using or interacting with service, homecare or healthcare robots
- Ensuring transparency of the process by which domestic robots collect, process, and make use of personal data, including the terms of use of algorithms
- Privacy and integrity risks associated with the emergence of new forms of access to domestic sphere
- Concept of privacy beyond a data protection perspective
- Concept of privacy by design and by default in robotics applications

² http://ec.europa.eu/research/participants/portal/doc/call/h2020/fct-16-2015/1645168-explanatory_note_on_potential_misuse_of_research_en.pdf

³ http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/guide_research-dual-use_en.pdf

- Concepts of sensitiveness and vulnerability – the collection of sensitive personal data, especially from vulnerable patients and/or under constant direct observation or surveillance
- Data ownership, control, storage and security issues, especially regarding interconnected robots
- Sharing of private patient information collected by robots with other systems, medical personnel, caregivers and the disabled person and preventing the potential misuse of data
- Division between data processors and data controllers and the terms under which third parties' information is processed
- Data collection during the research, development and testing of CPS
- Accessibility of robots especially for elderly people and people with disabilities
- Possible need for compulsory insurance covering pecuniary and non-pecuniary damages which can be caused by the illicit treatment of personal data

Legal instruments and provisions that might need to be reviewed or updated (indicative list)

- Regulation (EU) 2016/679 of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data
- Directive 2009/136/EC amending Directive 2002/22/EC on universal service and users' rights relating to electronic communications networks and services, Directive 2002/58/EC concerning the processing of personal data and the protection of privacy in the electronic communications sector and Regulation 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws
- Directive 2002/58/ of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector
- Council Framework Decision 2008/977/JHA of 27 November 2008 on the protection of personal data processed in the framework of police and judicial cooperation in criminal matters

4. Safety (including risk assessment, product safety, etc.)

Committees concerned: 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

Areas of interest or concern and possible issues and challenges

- The need to address the safety aspects of the operation of CPS, as they will operate in public settings with potential harmful impacts
- The need to introduce multiple safeguards to ensure that the robot itself is safe for users and does not infringe on their right to physical integrity
- Certification and approval of individualised (or custom) products
- Certification (e.g. ISO safety standards)
- Certification amidst increasing complexity and interconnectivity of devices including component upgrades
- The need to build effective verification and certification in at the design stage of CPS
- The need for an overall assessment of the safety and effectiveness of CPS
- The liability of manufacturers and designers should customised products not comply with safety standards
- Feasibility studies and the development of solutions for the safe implementation of planned mobile robot applications
- Individual risk assessment during the development of a new robot solution and assistance with CE label certification

- Research into and identification of safety requirements for new and emerging application fields in robotics
- The overall application may also need to be considered (process, fixtures, gripper technology, robot), i.e. not only the robot itself
- Ensuring transparency in the operation of a tele-presence robot in terms of its control functions and safeguards
- Distribution of tasks, roles and responsibilities among robots and operators
- Varying degree of automation and varying degree of development of the various application areas
- High variety of types of user interface, handover, conveying, etc.
- Frequency of changeover, typical lot sizes
- Identification of keys for acceptance of partial automation or a mixed human-robot environment
- The need for new tests for application design and ergonomics, accompanied by tailored training programmes for designers and users
- Considering making ex-ante risk assessment compulsory for all kinds of human-robot collaboration
- The potential need to introduce special safety safeguards and testing protocols for the research into and development of the new generation of robots
- Possible need for risk assessment procedures to take non-technical parameters (i.e. psychosocial factors) into account, i.e. indirect impacts of machine-machine communication
- The need to implement safety functions using suitable components in accordance with pre-determined requirements
- Lack of specific international safety standards for robotic prostheses including risky and unsafe activities of autonomous robotics
- Possibility for long-term care insurance contracts for assistive robots
- Need to update security measures on a constant basis
- Robot-specific safety clauses for autonomous industrial robotics
- Safety concerns stemming from possible data security threats
- The need to ensuring and manage systems' predictability, and increase human understanding of the increasing complexity of automated safety

Legal instruments and provisions that might need to be reviewed or updated (indicative list)

- Directive 2009/104/EC concerning minimum safety and health requirements for the use of work equipment by workers at work
- Directive 2006/95/EC (Low Voltage Directive (LVD))
- Directive 2006/42/EC on machinery (henceforth Machinery Directive (MD))
- Directive 2004/108/EC (Electromagnetic compatibility Directive (EMC))
- Directive 2001/95 on general product safety (GPS)
- Directive 99/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres
- Directive 92/58/EEC on minimum requirements for the provision of safety and/or health signs at work
- Directive 89/656/EEC on minimum health and safety requirements for the use by workers of personal protective equipment at the workplace
- Directive 89/654/EEC concerning minimum safety and health requirements for the workplace
- Directive 89/391 - OSH Framework Directive on the introduction of measures to encourage improvements in the safety and health of workers at work
- The United Nations Convention on the Rights of Persons with Disabilities. *Treaty Series, 2515, 3, (2006)*

ISO standards

- ISO 10218-1 Robots and robotic devices – Safety requirements for industrial robots – Part 1: Robots;
- ISO 10218-2 Robots and robotic devices – Safety requirements for industrial robots – Part 2: Robot systems and integration;

- ISO/TS 15066 Robots and robotic devices – Collaborative robots;
- ISO 12100 Safety of machinery – General principles for design – Risk assessment and risk reduction;
- ISO 13849-1 Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design;
- ISO 13849-2 Safety of machinery – Safety-related parts of control systems – Part 2: Validation;
- ISO 60204-1 Safety of machinery – Electrical equipment of machines – Part 1: General requirements.

5. Health (Clinical Trials/Medical Devices/E-health devices)

Committees concerned: ENVI – Environment, Public Health and Food Safety
ITRE – Industry, Research and Energy

Areas of interest or concern and possible issues and challenges

- Certification and approval (e.g. ISO safety standards), in particular a possible adaptation of current trial procedures – designed mainly for testing medicines – to the purpose of testing new medical robotic devices
- Certification for individualised (or custom) products
- Certification and setting of standards amidst increasing complexity and interconnectivity of devices including component upgrades, also taking into account the added vulnerability of patients
- The need to incorporate effective verification and certification at the design stage of CPS
- Review of codes of conduct on medical professional secrecy, including an examination of the challenges associated with the use of a robot as an 'electronic health record'
- The use of e-health devices and surgical robots needs to be discussed first within the framework of medical devices legislation, along with the respective implementing measures
- Clinical certification and approval procedures for robotics and suitability review of the current framework for healthcare robots, with special attention to their use by impaired users or in emergency situations
- Randomisation, inclusion of a control group, power calculation based on a clinically meaningful outcome, and reproducible descriptions of the intervention being tested

Legal instruments and provisions that might need to be reviewed or updated (indicative list)

- Directive 2001/20/EC on the approximation of the laws, regulations and administrative provisions of the Member States relating to the implementation of good clinical practice in the conduct of clinical trials on medicinal products for human use
- Directive 98/79/EC on in vitro diagnostic medical devices (IVDMD)
- Directive 93/42/EEC concerning medical devices modified by Directive 2000/70/EC (MDD)
- Directive 90/385/EEC on active implantable medical devices (AIMDD)

6. Energy and environment

Committees concerned: AGRI - Agriculture and Rural Development
ENVI - Environment, Public Health and Food Safety

Areas of interest or concern and possible issues and challenges

- Possible review of labelling, energy efficiency, eco-design and standard product information rules
- Clarification of whether CPS for disabled people should be defined as home appliances and/or electric motors for the purposes of energy efficiency legislation
- Applicability review of the EU rules on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances

- Minimisation of the possible environmental or ecological footprint of (mostly industrial) robotics (improving energy efficiency, reducing waste, and adopting new environmental friendly technology)
- Examination of the conformity of the use of rare, and precious materials against EU's methodological approach and criticality assessment
- Applicability review of the REACH framework in relation to microscopic chemical robots
- The possible use of rare and precious materials may trigger the need to be evaluated against the methodological approach and criticality assessment of the European Commission (Raw Materials Initiative, etc.)
- Data-management and storage concerns and level of legal control of critical system operations including security of supply, safety, etc.
- Need to identify legal solutions for facilitating the production and transport of excess energy production to the grid
- Potential misuse or capture of the robotics infrastructure established for energy transmission or as power or energy grids
- Possible review of the European Convention for the Protection of Animals kept for Farming Purposes and of the EU acquis on farm animals and animal experimentation regarding the use and treatment of animals when testing farm robots and/or cyborgs and the terms of interaction among robots, humans and animals

Legal instruments and provisions that might need to be reviewed or updated (indicative list)

- Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC
- Directive 2010/63/EU of the European Parliament and of the Council of 22 September 2010 on the protection of animals used for scientific purposes
- Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products
- Regulation 2006/1907 on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
- Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes

7. Horizontal legal issues (cross-committee considerations)

Committees concerned: AGRI - Agriculture and Rural Development

EMPL - Employment and Social Affairs

IMCO - Internal Market and Consumer Protection

ITRE - Industry, Research and Energy

JURI - Legal Affairs

LIBE - Civil Liberties

TRAN - Transport and Tourism

Areas of interest or concern and possible issues and challenges

- Issues raised by these systems' integration with communication technologies in terms of control and monitoring but also in terms of the reversibility of their functions or decisions
- Legal concerns regarding access and equal opportunities for all people in need of assistance given the national character of social and healthcare policies; the need to consider the affordability/accessibility of robotics technologies/products and to coordinate national legal systems so as to reinforce the principle of equality;
- Legislative measures to boost long-term care contracts, such as tax relief or similar incentives, and applying such incentives for the use of assistive robotics for elderly and disabled people

- Legal control and power over the CPS and the respective algorithms
- Intellectual property rights
- Strict liability and insurance instruments for products/users
- Consideration of the possibility of creating a new legal category under the title e-person (electronic person) for smart robots by analogy with the category legal subjects
- Development of bounded control rules that guarantee and preserve connectivity of the overall network in applications involving mobile sensor networks and multi-robot systems
- Legal and regulatory standards for anthropomorphic projection that enhances the acceptance and use of robots and/or directly supports the main function of the robot (social robot technology)
- Laws as algorithms during the design and deployment process

Legal instruments/provisions that might need to be reviewed/updated (indicative list)

- European Charter of Fundamental Rights and the UN Convention on Disability Rights;
- Directive 2011/24/EU of the European Parliament and of the Council of 9 March 2011 on the application of patients' rights in cross-border healthcare, OJ L 88, 4.4.2011, p. 45-65;
- Communication of the European Commission, Taking forward the Strategic Implementation Plan of the European Innovation Partnership on Active and Healthy Ageing, COM(2012) 83 final;
- Council Declaration on the European Year for Active Ageing and Solidarity between Generations (2012): The Way Forward, Guiding Principles for Active Ageing and Solidarity between Generations, Brussels, 7 December 2012.

B. Ethical considerations regarding of cyber-physical systems

The introduction of cyber-physical systems into our daily lives will pose not only a challenge in legislative terms but, as illustrated by the ongoing discussion about electronic personhood and the learning abilities of autonomous robots, it will pose ethical challenges as well. In fact, recent years have witnessed a wave of innovation in robotics driven by the need to move out of the industrial context and start introducing robots into unstructured environments where ethical challenges for policymakers, practitioners and participants will become much more nuanced in their nature and will effectively affect the way we approach and interpret legal concepts, human safety, privacy, integrity, dignity, intimacy, autonomy and data ownership, and intimacy.

In view of the future human-centred challenges, a governing or guiding framework for the design, production and use of robots is needed to guide and/or complement the various legal recommendations or the existing national or EU acquis. Such a framework should take the form of a code of conduct for researchers/designers and users and should be based on the principles enshrined in the EU Charter of Fundamental Rights (such as human dignity and human rights, equality, justice and equity, benefit and harm, dignity, non-discrimination and non-stigmatisation, autonomy and individual responsibility, informed consent, privacy and social responsibility as well as the rights of the elderly, the integration of persons with disabilities, the right to healthcare, and the right to consumer protection) and on existing ethical practices and codes.

The values enshrined in the EU Charter of Fundamental Rights represent the normative framework on which a common understanding of the ethical risks associated with the operation of robots could be built. Still, judgements about the ethical soundness of robotics applications depend significantly on the specific context of application and the findings of the respective risk assessment process.

Thus, it is important to highlight that in view of the value-laden nature of the majority of the legal challenges and concerns associated with robotics and the social intensity of the latter, law and ethics should go hand in hand when designing anticipatory legal solutions and regulatory instruments.

C. Final reflections

As technology increases its impact on human activity, the potential for empowerment through the use of robotics is nuanced by a set of tensions and risks to human safety, privacy, integrity, dignity, autonomy and data ownership. While much of the promise held in these technological innovations remains to be fully realised, the expansion of robotics into new areas of human interaction and activity is expected to be followed by a profound set of shifts in the way individuals perceive some fundamental concepts such as companionship and intimacy. The human-centred turn in robotics technologies raises complicated legal questions that need to be addressed directly at the design phase. These questions involve the gathering and volunteering of data, and the involvement of lay people in experimentation with robotics for the programming of the necessary algorithms.

The path from the laboratory to the actual use of robots in real environments necessitates a broader look into these technologies, as robots and artificial intelligence will increase interaction with humans across very diverse fields. Robots have quickly become not only one of the most prominent technological trends of our century but also a dynamic object of legal concern. The accelerating pace of the design, creation, production, programming and use of robots is continually raising new and difficult legal questions.

The preceding legal analysis, based on a consideration of the study's scenarios, points primarily to the need to adjust the current EU legal framework on privacy, data protection and data ownership, to the dynamic flow of data that may arise when robots become more autonomous. In the near future, many risks may also be faced by consumers in terms of safety and security, requiring further legal action. Specific provisions will need to take into consideration all the social aspects, including human and moral values, education, employment and social security.

Given the wide range of application of robotics technology, the question arises as to whether existing EU legislation can cope well with the respective legal challenges in an efficient manner and also as to the need for legal categorisation. Among these challenges, one should highlight structural differences in the way robots are approached from a legal perspective at national level and the lack of coordination, classification, sharing and validation of any information concerning the assessment and market use of robotics applications. How can EU law ensure that care robots are easily accessible to vulnerable people given the complexity of the healthcare and social systems that organise and regulate the provision of care? Can our legal system pave the way for a one-stop shop for safety and insurance purposes while remaining compatible with the various national systems for example? How can regulatory bodies and authorities secure transparent acceptance procedures for autonomous robots or even introduce standards on quality levels that could apply across all EU Member States?

Given the wide range of concerns with regard not least to setting high standards of quality and safety for robots, one might also ask whether it is feasible, in legal terms, to have uniform testing procedures for assistive technology products. Alternatively, should policy-makers move forward through softer approaches that are based on an exchange of best practice, data and experience or even through the compilation of regulatory EU-wide databases and catalogues? A further challenge stems from the absence of a horizontally accepted definition of robots and the varying autonomy of cyber-physical systems. Will the definitions provided in various technical contexts suffice also for legal contexts where robots are gradually introduced? Similarly, rapid technological developments in the field of robotics raise multiple questions regarding the shaping, application and interpretation of concepts such as autonomy, integrity and privacy.

The myriad ethical, legal and social effects of the commercial development and use of these technologies may signify a paradigm shift in tort law and insurance law or may even affect the terms of interaction between science, ethics and law. Last but not least, given the dynamic interface between market innovation and ethical considerations, EU legislators need to perform a social fitness test of the current framework. Accessibility should be a key consideration in all ongoing and future efforts to enhance standardisation and the formulation of specific standards for the improvement of the proper functioning of the internal market for robotics products and services.

Beyond the identification of the main areas of potential legal concern and the associated challenges as well as the respective pieces of EU legislation that may need to be reviewed or considered, the analysis leads to several, rather conceptual conclusions of a structural nature. The first is that every attempt to conceive and tackle the legal challenges associated with such a multifaceted technology needs to be designed in a reflective manner in order to help making individual adjustments on a case-by-case basis. Moreover, special emphasis should be placed on the need for a clear definition of CPS and, more specifically, of smart autonomous robots, for reasons of legal certainty at least at EU level.

Such a definition should be subject to future modifications, possibly by means of delegated acts. Apart from the identified points of legal reflection, a risk analysis strategy should be devised in order to provide a plausible instrument of regulatory importance that will have a horizontal and technology-driven perspective. The attempt to regulate emerging technology of this kind should be accompanied by ethical standards and with procedures that will address the needs and ethical dilemmas of researchers, practitioners, users and designers alike. This ethical framework would not need to take a legally binding form but could take the form of an EU code of conduct. Such multidisciplinary exercises can in fact facilitate the technological embodiment of law and help to shape a pluralist conception of law, ethics and technology.

Finally, it should be emphasised that not all the concerns identified in the previous steps can be translated into legislative terms. These are the affordability of CPS services, the control boundaries for the enhancement of the likely digital divide between those using CPS and those not, potential effects upon the labour market, the terms of interface between the authority of the doctor and of the patient with the AI-authority, the expected data concentration, the shortage of skills required for working with robots (e.g. as a person with a disability, as a user of an autonomous vehicle or as a farmer), the terms of emotional attachment with robots and the control of super smart, quick, strong cyborgs. Last but not least, our analysis indicates the regulatory and protective limits of law in its protective and even precautionary functions, and the fragility of traditional legal instruments.

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The study can be found at <http://www.europarl.europa.eu/stoa/>. A summarizing video clip is available on [You tube](#).

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