



The Collaborative Economy

Impact and Potential of
Collaborative Internet and
Additive Manufacturing

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The Collaborative Economy

Impact and Potential of Collaborative Internet and Additive Manufacturing

Study

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Abstract

The Collaborative Economy is approaching thanks to advances in technologies related to Collaborative Internet, Big/Open Data, Crypto Currency and Additive Manufacturing. Policy makers wish to be prepared and understand their options in order that effective policies can be put in place in time to nurture the positive impacts and negate the negative impacts associated within range of potential afforded by this advance.

The results of a short Delphi-inspired study reveal a wide range of opportunities and threats associated with the technologies supporting the Collaborative Economy. In the wider context, attention is drawn to a number of social, political, economic, moral and ethical issues also associated with the migration into this new way of working. Importantly, the impacts of the Collaborative Economy are not restricted to the conventional workplace, where economic activity currently takes place. In the Collaborative Economy, impacts are felt not only at home but also on the person, indeed the effects are felt everywhere.

In conclusion, a number of policy options are presented for the consideration of policy makers.

The STOA project "The Collaborative Economy - Impact and Potential of Collaborative Internet and Additive Manufacturing" was carried out by AcrossLimits Ltd (Malta) at the request of the Science and Technology Options Assessment Panel and managed by the Scientific Foresight Unit (STOA) within the Directorate-General for Parliamentary Research Services (DG EPRS) of the European Parliament.

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Executive Summary

This publication is an outcome of the STOA funded Study on '*The Collaborative Economy: Impact and Potential of Collaborative Internet and Additive Manufacturing*'. The work is funded under contract IP/G/STOA/FWC/2013-001/Lot4/C1/SC1.

Study objectives

The objective of this study is to analyse what is the combined potential and long-term impacts of new Internet and manufacturing technologies, and what could be their macroeconomic and societal effects. The technologies are: Collaborative Internet Technologies, Big/Open Data, Crypto Currency, and Additive Manufacturing.

Study context

The study is designed to review the latest developments for each of the technologies listed above and to forecast the likely break-throughs in the next 10 years. The potential impact of these technologies on service and manufacturing industries is also assessed, as is the global macroeconomic impact. Key stakeholders are identified and policy options are proposed.

Brief description of methodology

Initially a team of experts carried out desk research, and scenarios were developed. A modified Delphi study was then conducted to test the scenarios and to identify future trends and impacts. Results were analysed and areas where policy issues appeared were identified. The findings are contained in this report and summarised in an [accompanying video](#).

Main policy options

1. Stimulate the free flow of co-created ideas

Co-created ideas are increasingly important for creating new products that satisfy a fast-changing market; supporting those who work across borders to work effectively will help grow the European economy; model future legislative proposals in relation to the updating of [Directive 2001/29/EC](#)¹ (on the harmonisation of copyright and related rights in the information society) on the approach taken with [Directive 2014/26/EU](#)² (on collective management of copyright), which introduces the possibility of EU-wide multi-territorial licencing for online musical works. Tensions between [Directive 2001/84/EC](#)³ (resale right) and the legislative measures which are expected to adapt the [2001/29/EC](#) Directive to technological developments in the digital age will most probably also need to be resolved.

2. Reforming EU IP rules, fair use and consumer protection policies to enable emerging capabilities

To increase EU competitiveness in a collaborative economy, rules relating to copyright and Intellectual Property Rights need to be based on the same principles across the EU given the variety of national legal approaches. From the perspective of the existing EU acquis on product liability and

¹ Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the harmonisation of certain aspects of copyright and related rights in the information society

² Directive 2014/26/EU of the European Parliament and of the Council of 26 February 2014 on collective management of copyright and related rights and multi-territorial licensing of rights in musical works for online use in the internal market

³ Directive 2001/84/EC of the European Parliament and of the Council of 27 September 2001 on the resale right for the benefit of the author of an original work of art

consumer protection the emergence of the collaborative economy raises the need, among others, for the delineation and, in fact, extension of the existing limitations on fair use. For example, it is possible that current IP rules will have to be reconsidered in light of the need for collaboratively developed open data for the 3D printing of products. It is important for IPR rules to be applied as a balanced incentive system that on the one hand encourages inventors and compensates them for their creativity, and on the other, promotes benefit-sharing, fair use and further creativity. In fact, the concepts of 'intellectual property', 'access' and 'sharing' need to be redefined in the context of the collaborative economy as the latter may reshape the traditional defences to copyright infringement. The collaborative economy is likely to heighten the tensions between traditional legal approaches of ownership and the introduction of modern practices that focus on fair use, open access creative licences and flexible licensing structures. . In this regard, the [recently adopted resolution](#) of the European Parliament concerning the modernization of the EU copyright system clarifies the scope of certain fair use exceptions, such as for Text and Data Mining (TDM). These reforms are expected to contribute to enabling the development of such "welfare-enhancing" technologies⁴.

3. Create new enforceable regulations capable of supporting and protecting all stakeholders in the Collaborative Economy

Steps could be taken to eliminate the legal uncertainties that follow from the usually transnational nature of collaborative technologies ([Directives 2004/48/EC](#)⁵ (on enforcement of IPR) and [98/44/EC](#)⁶ (on biotechnological inventions) apply to producers, [Directive 1999/44/EC](#)⁷ (on aspects of sale of consumer goods) and [Regulation 178/2002](#)⁸ (on general principles and requirements of food law) apply to consumers and [Directive 2001/29/EC](#) applies to both. Getting this right gives the EU a leading opportunity to increase the rate at which innovations can be transferred into commercial reality and to reduce the potential for fraud. Similar policies against tax evasion and money laundering are also required and should be addressed through revisiting the 4th Anti Money Laundering (AML) Directive. This will require a global transparency agreement, to ensure monitoring and accountability of fraudulent activity.

4. Create new enforceable regulations capable of supporting and protecting users of derivative services growing out of the Collaborative Economy

Decentralized stock exchanges and insurance companies will very likely emerge and, again, it is possible that within these aspects of a collaborative cyber currency market, authorities will not be able to regulate the activities taking place within them using current approaches. Again, revisiting the 4th AML Directive is advisable.

5. Re-consider laws that currently limit what someone can do with their own data

"Personal" and "Private" need new definitions in a world where data are universal and even personal data sets are a tradable good (legal if the subject/owner is doing the trading). There needs to be a

⁴ For further information see: "Review of the EU Copyright Framework - European Implementation Assessment", EPRS October 2015 at:

[http://www.europarl.europa.eu/RegData/etudes/STUD/2015/558762/EPRS_STU\(2015\)558762_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2015/558762/EPRS_STU(2015)558762_EN.pdf)

⁵ Directive 2004/48/EC of the European Parliament and of the Council of 29 April 2004 on the enforcement of intellectual property rights

⁶ Directive 98/44/EC of the European Parliament and of the Council of 6 July 1998 on the legal protection of biotechnological inventions

⁷ Directive 1999/44/EC of the European Parliament and of the Council of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees

⁸ Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety

distinction between data subject, data owner, data collector and data user in future versions of the Data Protection [Directive 95/46/EC](#)⁹ (on the processing of personal data) and The EU General Data Protection Regulation, as a 'data owner' is not the same entity as a 'data subject'. All terms used should be explicitly defined. Personal data sets are now like appearance - models make a living by trading on their looks: now everyone has something to trade. Reconsider laws that currently limit what someone can do with their own data. Individuals need to be able to protect or use their own data in whichever way they choose. However, data protection issues will be impossible to enforce from central locations and the new empowered owners will need the support of specially designed enforcement tools, which will work in a decentralised environment. It is also necessary to establish a mechanism to determine the relative values of public good vs individual good especially in the clinical trials context. Many important (medical/clinical) advances depend upon access to personal data and are suffering from lack of clarity around terms used in current policies.

6. Establish a recognition process for crypto currencies

Driving the communities using crypto currencies underground will complicate matters in the future. It is better to proactively legislate, perhaps through a revision of the 4th AML Directive, to incorporate crypto currencies into the wider economy. View a crypto currency as just another currency which should not be feared but rather recognise that the sociological part of the system needs careful handling.

7. Engage with a wider set of consultative bodies in the Additive Manufacturing policy debate

Current approaches to the development of industrial, innovation and research policies at the EU level neglect how Additive Manufacturing and 3D printing technologies go far beyond traditional manufacturing and are relevant for areas including healthcare, medicine, chemistry and construction. Current stakeholder groups may be too restricted, not just in the sense of mainly representing traditional manufacturing industries, but also because they represent large established companies with their embodied need to preserve or increase competitiveness, often to the exclusion of most new entrepreneurial possibilities.

8. Modify education policies to ensure that relevant skills are in place when they are needed

In the light of experience in the area of 3D printing in education, two issues that seem to arise in the wider Collaborative Economy context include the need for training teachers in the use of 3D printing and related technologies, and the need to develop suitable curricula that go beyond the mere use of 3D printers as “demonstrators”. In the broader context, a new techno-centric and multidisciplinary approach to education will have to be designed and deployed. Knowledge transfer is critical in all aspects of the Collaborative Economy. For those who are engaged in this kind of society, the rapid change in all aspects of life implies that education will become a continuing function in everyone's lives. The EC ‘Opening up Education’ initiative¹⁰ should recognise these strategic issues in its plans.

9. Implement policies at the global level

In the Collaborative Economy, everything is data. All aspects of life are to some extent conducted in the digital domain. Data will become the main source of desire, the preeminent medium of exchange and the main source of tension. Global policy formulations are required in the Collaborative Economy because it operates on a global scale, regardless of national or regional borders. The creation of global policies that can be implemented, regulated and enforced will be crucial to the success of the Collaborative Economy. National or regional policies will be meaningless. Follow the lead set by those

⁹ Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data

¹⁰ <http://openeducationeuropa.eu/>

involved in developing the General Data Protection Regulation in its approach to extra-regional policy-making.

10. Stay ahead with policy

Policy makers should not try to make policy for current digital technologies and capabilities. Digital technology evolves so fast that policy implementation may lag behind and, generally, harms the prospects of what follows. Instead, policy makers should look ahead and devise policy in a manner that regulations are in place as technology arrives. A catch up approach might be problematic when chasing increasingly short technology innovation cycles.

11. Disintermediation and decentralisation will have profound effects upon society and market structures. Radically new ways of policy making, deployment and regulating will need to be developed.

Disintermediation is a key concept to emerge in this study. The technologies embraced in the Collaborative Economy will ultimately eliminate conventional professional people from the workplace and destroy large hierarchical corporations. Once services are decentralised, new means of enforcing policy measures and regulations should be constructed, perhaps in a revised [Directive 1999/44/EC](#).

12. Protecting and regulating for the notion of individual identity

The morals and ethics of Identity and individual identity are concepts that will eventually need to be regulated in the Collaborative Economy; possibly in the same way as IP, and protected in the same way; through revisions of [Directive 2014/26/EU](#), and [Regulation No. 608/2013](#)¹¹ (on customs enforcement of IPR). Ideas of individual identity need revision in the data-is-everything world. Not only is it possible to collect and store data about our activities and other aspects of our lives, now it is possible to capture appearance data. The ability to synthesise (parts of) people is a real consideration. New codes of morals and ethics need to be considered. When a printed everything is possible, what will “real” or “individual identity” mean?

13. Objectively consider the fears of criminal use

It is true that all of the technologies covered in the study might be used for illegal purposes but so may any other technology. Cars can be used in burglaries and bank robberies; the proliferation of guns does not depend upon new forms of printing; big data is not the only repository of information useful to extortionists; terrorists have many means of collaborating and spreading their message outside of Internet collaboration technologies. It is also true that the technologies under investigation bring with them new and unusual problems that must be overcome before they can become mainstream.

14. Foundational issues associated with Access and Availability need to be addressed

In the Collaborative Economy, all data will be digital. Digital data are stored and processed in an electronic network environment. The services supported on the network will become a fundamental and essential part of most people’s lives. Fair access to the digital environment will be essential. Fixed and mobile devices need reliable network connectivity. In many parts of Europe this is still not available even in the wealthiest member states. These gaps must be filled. Furthermore, the electricity supply that all electronic devices rely upon must be secured. Directives on electronic communications networks and services, namely [2002/21/EC](#)¹², [2009/140/EC](#)¹³, [2002/19/EC](#)¹⁴, [2002/20/EC](#)¹⁵,

¹¹ Regulation (EU) No 608/2013 of the European Parliament and of the Council of 12 June 2013 concerning customs enforcement of intellectual property rights and repealing Council Regulation (EC) No 1383/2003

¹² Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services

[2002/22/EC](#)¹⁶, [2009/136/EC](#)¹⁷ and [2002/58/EC](#)¹⁸ (as well as its amending [Directive 2006/24/EC](#)¹⁹) and Regulations [No 1211/2009](#)²⁰ and [No 531/2012](#)²¹ (on roaming) all apply here. The education system is very wide and no technology will be adequate to solve all problems. Moreover there are many and fast evolving technologies while every region and country face specific challenges and have specific contextual factors. Therefore the policy options are intended as strategic approaches that provide a framework for decision-makers to define more concrete policies.

Conclusions

The study explored all aspects of technical and macroeconomic impact. Fundamental changes in the way work is done and work's place in an economy are on the way. The effects will be profound and those with an interest in maintaining the status quo will resist the anticipated changes. However, these efforts should be strenuously resisted, as the potential long-term benefits are significant, especially for those regions able to lead the change: however painful it might be in the short term.

Recommendations

The subject of the study is very complex and the study period was relatively short. We (*the experts who carried out the study*) recommend that further, more detailed studies into various aspects of the study area be carried out.

The policy options developed in the report should be used to begin an open conversation with the widest possible range of stakeholders, in order to develop more detailed information about potential opportunities and risks.

¹³ Directive 2009/140/EC of the European Parliament and of the Council of 25 November 2009 amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services, 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities, and 2002/20/EC on the authorisation of electronic communications networks and services

¹⁴ Directive 2002/19/EC of the European Parliament and of the Council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities

¹⁵ Directive 2002/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services

¹⁶ Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services

¹⁷ Directive 2009/136/EC of the European Parliament and of the Council of 25 November 2009 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 (EC) No 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws

¹⁸ Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector

¹⁹ Directive 2006/24/EC of the European Parliament and of the Council of 15 March 2006 on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending Directive 2002/58/EC

²⁰ Regulation (EC) No 1211/2009 of the European Parliament and of the Council of 25 November 2009 establishing the Body of European Regulators for Electronic Communications (BEREC) and the Office

²¹ Regulation (EU) No 531/2012 of the European Parliament and of the Council of 13 June 2012 on roaming on public mobile communications networks within the Union

1 Introduction

Context

This study was conducted on the request of the Science and Technology Options Assessment (STOA) Panel in the European Parliament. The title is 'The Collaborative Economy: Impact and Potential of Collaborative Internet and Additive Manufacturing'. The work is funded under contract IP/G/STOA/FWC/2013-001/Lot4/C1/SC1.

Background

The European Parliament recognises that a “perfect storm” of technologies is emerging. The technologies are anticipated to have impacts in the way industry operates and, therefore, upon the functioning of the European economy. The technologies are currently at different levels of maturity, and are growing at different velocities. However, it is almost certain that they will eventually unite, with other related technologies, and present a significant shift in a wide range of social, technical, economic and industrial norms.

The Purpose of the Report

The contract calls for a short foresight-like exercise, based on the Delphi approach, to investigate policy options in order to help policy makers consider their options before regulating in the new market places that are expected to emerge.

The report begins with a sketch of the methodology employed in the study. Following this, the four technology areas which are covered are introduced. Subsequently the scenarios used in the study are introduced before the interview designs are enumerated. The expert responses are summarised before an analysis of them is revealed. Highlights of the study context are discussed before the main policy recommendations are summarised. The body of the report is composed of summarised information and discussion around the salient points. All of the associated detailed and supporting information is enclosed in Annexes 1 to 6.

The structure of the report is organised around the main outcomes of the study (not around the methodology).

Scope and Constraints

Four specific technologies form the scope of this study:

- Collaborative Internet Technologies,
- Big Data and Open Data,
- Crypto Currencies and
- Additive Manufacturing Technologies.

Within the time constraints of the study contract, the study is Delphi-inspired, however not an in-depth Delphi study. The methodology description gives explanations where appropriate.

2 Study Methodology

The methodology adopted in this report is based on the Delphi method²² but has been adapted to meet the constraints of the study. We incorporated techniques from Ackoff²³, Kolb²⁴, Tuckman²⁵ and Ansoff²⁶ to compensate for the difficulty we anticipated in obtaining the voluntary cooperation of leading experts within the time period we conducted the study. We began with a literature review and used this to develop a benchmark for current activities, identify experts and initiate scenario development in the four areas covered in the study. Then the modified Delphi study began and the questions were set in the context of a set of preliminary scenarios. Because we closely involved our own internal experts in the study (e.g. leading expert interviews) we applied measures to remove domain bias in the analysis of the results. The results of the Delphi analysis and the results of the literature review were then combined with internal expertise to develop a modified final set of scenarios from those used in the interviews. These scenarios were then used to conduct internal systematic inventive thinking activities, where a closed world model of the future was imagined and this was then used to identify policy options. A detailed study structure follows.

Methodology Outline

1. Literature Review
2. Delphi-inspired Interview-based Qualitative Study
3. Analysis of the Delphi-inspired Study
4. Development of a "backstory" as a broad spectrum foundation of the current situation and its origins
5. Development of future scenarios and identification of policy options based on projections of important backstory elements
6. Report of the study findings

Further, a 4 minutes [video clip](#) presents the conclusions of the study. A short scientific/technology paper, summarising the conclusions and findings of the study, will be prepared for publication in a peer-reviewed journal.

²² A means of reducing the variance around possible futures.

²³ Decision Theory

²⁴ Experiential Learning Theory (ELT)

²⁵ Forming, Storming, Norming, Performing Model (FSNP), similar to Situational Leadership

²⁶ Strategic Early Warning Systems (SEWS), contains Weak Signal Analysis.

3 Subject Area Introductions

3.1 Collaborative Internet Technologies

The Internet has existed for 45 years, although in the minds of most people it emerged around 1995 when the World Wide Web made its significant breakthrough. The growth of Internet use has been staggering, and the number of Internet users will surpass 3 billion in 2015. The EU Digital Agenda aims for broadband access to all citizens by 2020. The European Commission has identified the completion of the Digital Single Market (DSM) as one of its ten political priorities²⁷.

An essential aspect of Internet was always that it facilitated new ways for collaborating with other people remotely. In a first wave in the 80's, email was the collaboration breakthrough that enabled effortless exchange of digital materials. In the 90's, the World Wide Web was the second wave, enabling shared focuses for collaboration on web sites. In the first years after 2000, a third collaboration wave saw the emergence of social media and e-meeting technologies that enabled face-to-face interaction with others via the Internet. In later years, new modes of collaboration have been explored that are now reaching mainstream use. In the following paragraphs, each of these new technologies is introduced.

E-meetings will evolve further, and the new Web Real-Time Communication (WebRTC) technology will make e-meetings a standard feature of every web server. Already global social media actors like Facebook and Google are moving in this direction. This technology enables to run e-meetings directly in any web browser, with powerful abilities to give an illusion of being in the same place and also enabling automatic adjustments for better eye-contact and awareness of each other. These more natural e-meeting systems will be used by people who nowadays feel uncomfortable or constrained while meeting remotely. The main policy concern is if current regulations for telecom operators such as the Data Retention Directive²⁸ should apply to web sites offering e-meeting facilities and whether such regulation is even feasible when any web site owner can become - in essence - a personal communications service operator.

Crowd Sourcing is the practice of obtaining needed services, ideas or content, by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers (Merriam-Webster). This technique is heavily exploited by Internet giants like Google, Facebook and Apple, who harvest data about individuals - with their consent - and aggregate information about them to analyse patterns and trends in society that form the basis for valuable services. There is growing concern that this massive body of data might be used to invade the privacy of individuals and that the consents for using this data are not accompanied with enough information about how they might be used. Even public policy can now be crowd-sourced, supporting a kind of direct democracy ruled by the power-of-the-crowds. A different trend is towards *crowd working* which is a form of crowd-sourcing where contributors receive tangible benefits, sometimes even payment. Emerging self-organisation among crowd-workers is beginning to improve the compensation offered to them.

Crowd Funding is the practice of funding a project or venture by raising many small amounts of money from a large number of people, typically via the Internet (Oxford Dictionary). This has proven to be a powerful source of early funding for innovative start-ups, but a number of scams have also been funded. In 2014, the Commission released Communications on long-term financing and on

²⁷ A Digital Single Market Strategy for Europe, Communication COM(2015) 192, European Commission May 2015

²⁸ Communication on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending Directive 2002/58/EC 2006/24/EC, European Commission March 2006

crowd-funding, that highlight the need for better access to finance for SMEs²⁹ and demonstrates that crowd-funding has already surpassed traditional business angel investments³⁰. Another growing concern is the non-accountability of crowdfunded projects, especially for common delays and in particular for over-funded projects³¹.

Co-creation is a means for companies to enlarge their base of information about needs, applications and solution technologies (Piller and Ihl 2013) by engaging and involving their customers in design and innovation processes. Some manufacturers already host platforms for capturing and transferring external ideas and concepts into products and services. Applying co-creation techniques will be a matter of survival for many businesses in future fast-changing markets for goods and services, and therefore "ideas" may become an additional essential production factor that needs to enjoy ensured free movement in the EU common market.

Open Design is the development of physical products, machines and systems through use of publicly shared design information (Wikipedia). It is sometimes a means to stimulate co-creation, while in other cases it is a way to increase the value of a product by enabling third-party extensions to be developed. By its very nature, open designs need no regulations to protect their confidentiality, but intangible ownership regulations need to continue to apply uniformly within the EU.

Open Source Software is computer software with its source code made available with a license in which the copyright holder provides the rights to study, change and distribute the software to anyone and for any purpose (Wikipedia). The policy aspects are similar to those for open designs (see above).

Commons-based Peer Production describes a new model of socio-economic production in which the labour of large numbers of people is coordinated (usually with the aid of the Internet) mostly without traditional hierarchical organization. The term is often used interchangeably with the term **social production** (Wikipedia). Free digital resources like open designs, open source software and open data (described below) are used by groups of people for creating new products and services, often contributing their results back to the commons area. Finding a suitable balance between funding this type of activity versus funding activities that stimulate commercial innovation where ownership of successful results are protected, ensures sustainability.

To conclude this introduction, Collaborative Internet has always been with us, but emerging new collaboration technologies challenge current policies on telecom services, and may require new regulations for protecting the privacy of citizens and stimulating digital innovations. Ensuring free movement of ideas may become an additional component of the common market. The new technologies for collaboration on the Internet also give significant competitive advantages to voluntary contributions of freely available digital resources, potentially changing what is the optimal balance between stimulating commercial innovations versus making digital innovations freely available for anyone to use.

3.2 Big Data and Open Data

3.2.1 Open Data

Open data are data that can be freely used, reused and redistributed by anyone - subject only, at most, to the requirement to attribute and share-alike³². Open Data are typically available through the

²⁹ Communication on Long-Term Financing of the European Economy, COM(2014) 168, European Commission, March 2014.

³⁰ Unleashing the potential of Crowd funding in the European Union, COM(2014) 172, European Commission, March 2014.

³¹ *The dynamics of crowdfunding*, E. Mollick, J. Business Venturing, Elsevier 2014, doi:10.1016/j.jbusvent.2013.06.005

³² <http://opendatahandbook.org/en/what-is-open-data/>

Internet in a convenient and modifiable form. They are provided under terms that permit their reuse and redistribution, but also their combination with other datasets. Furthermore, they enable universal participation without discrimination against specific groups, persons or applications. Open data are already the foundation for a wide range of products and services, including decision support systems, location based services, mobile apps and services, business services, community services and more.

Both governments and businesses already use Open Data sets in order to drive social change. Government agencies are increasingly collecting, structuring and making publicly available vast amounts of data including weather information, maps and geographical information, legal filings, financial statements, health indicators, as well as metrics associated with education, research and innovation (R&I). Public organizations (e.g., central governments, regional governments and smart communities) are already taking advantage of such data sets in order to implement applications that boost transparent connected government, improve accountability and offer high-quality services to citizens. Furthermore, they analyze the data in order to create evidence-based policies in critical areas such as education, innovation and healthcare. Additionally, these data sets are also exploited by individuals and private organizations in order to implement novel services in areas such as public safety, management of emergency incidents and producing healthcare products.

In general the proper processing of open data sets can enable the deployment of applications with significant societal impact. Prominent examples include:

- a) Researching and providing effective personalized medicines and/or treatments for dominant and potentially fatal diseases (e.g., cancer, cardiovascular diseases, neurodegenerative diseases and more);
- b) Using open data to enhance the sustainability of national health care systems, through offering insights into healthcare costs and outcomes³³;
- c) Tackling environmental challenges and boosting sustainability, through analysis of energy consumption or air pollution datasets;
- d) Enabling progress in scientific research and collaboration towards producing novel outcomes.

The evolution of the Open Data approach is propelled by the latest technological advances in areas such as the handling and analysis of large data volumes (including Big Data), semantic computing and the semantic web, linked data and more. These advances empower the structuring, linking and intelligent processing of open datasets, as well as the development of novel applications and tools. Advances made at the policy level complement technological advances; with respect to Open Data, these include the legislative framework that regulates the use of Open Data. The general directive on the re-use of public sector information (OJ L 345/90, 31.12.2003) sets the legal framework for public data in the EU. More specific directives and policy initiatives have also been developed about specific types of Open Data sets, including the INSPIRE Directives³⁴ for access to Environmental Information, the European Commission's policy on open access to scientific information and policies associated with the digitization of cultural heritage as part of the Europeana Digital Library³⁵. Despite the availability of a number of open data repositories and associated policies, there are still many things to be done at both the technical and political levels (among others) towards harmonizing the legal framework, engaging stakeholders (notably public authorities), and overcoming language barriers.

3.2.2 Big Data

Big Data sets are typically those that exceed the capacity of existing database systems and tools due to one or more of their «3V» properties including Volume (i.e. amount), Variety (i.e. range of

³³ 'Big Data, The next frontier for innovation, competition and productivity', Mc Kinsey Report, May 2011

³⁴ Directives 2003/4/EC, OJ L 41/26, 14.2.03 and 2007/2/EC, OJ L108/1, 14.3.2007

³⁵ www.europeana.eu

heterogeneous data types and data sources) and Velocity (in/out speed and ingestion rate of data streams)³⁶. The interest in Big Data, as an area of study, is propelled by the explosion of information generating resources, which currently generate data at rates of many Exabytes per annum³⁷. However, there are also a number of technological advances that propel this growth, such as the very high penetration of mobile phones, as well as the proliferation of low-cost multi-sensor devices and the related advent of the Internet-of-Everything³⁸.

Big Data processing/analysis is currently a cornerstone of a wide range of business applications (e.g., retail, retail banking, real-estate, manufacturing), as well as for several government applications (e.g., towards more efficient public finances and healthcare). Several Big Data applications are likely to leverage vast amounts of open data sets. Likewise, Big Data technologies are expected to have a significant socio-economic impact in the coming years, through playing a decisive role in next generation applications such as personalized drugs and healthcare, customer focused retailing, public safety, urban mobility, energy management, management of natural resources, as well as a variety of applications that hold the promise to improve the sustainability of our society.

The evolution of Big Data technologies is empowering the realization of the above-listed benefits. Technological advances are taking place in the area of distributed computing and efficient storage technologies for very large data sets, advanced and effective data analytics algorithms, efficient search and indexing of large data sets, as well as a wide range of advances concerning specific application domains (e.g., e-science, financial services, healthcare). At the policy level, efforts towards fostering Big Data awareness and education, security compliance and data protection directives (e.g., EU Data Protection Directive (95/46/EC)) and the development of business-friendly environment where businesses (including start-ups) will be able to develop innovative products and services based on high-tech start-ups is required. Open Data policies (outlined above) are also closely linked to Big Data, since Big Data applications and services are very likely to leverage open freely available data sets.

3.3 Crypto-currency

Crypto Currencies represent a technological trend that might have the capacity to change several aspects of the financial services value chain. As a digital currency, in which encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds, it operates independently of a central bank. Its effectiveness, not referring to technical aspects, is based on an innovative consensus technique, realized through what is called a “block-chain”. The most famous crypto-currency right now is Bitcoin. Bitcoin is both a network protocol and a new scarce asset that can be “owned” (the software is also called Bitcoin).

Crypto-currency transactions are anonymous and untraceable. The ‘owner’ of a Bitcoin is whoever is referenced, by a pseudonym, in the most recent digital signature in a chain of signatures. Information on accounts and transactions are held in a public ledger and the “Bitcoin” is a chain of digital signatures stored in this public ledger. The block-chain is the public ledger.

The referenced owner is the only person who can sign his/her Bitcoin over to someone else, transferring ownership. The network would reject any other signature because it would violate the software’s consensus rules. There are no physical Bitcoins, nor are Bitcoins software files. The final digital signature in a given chain will be that of the current holder of a Bitcoin amount and he/she

³⁶ PwC Australia, 2012, Big Data - The next frontier for innovation, available at: <http://www.pwc.com.au/consulting/assets/publications/Big-Data-Oct12.pdf>

³⁷ Matthew Wall, «Big Data: Are you ready for blast-off?», BBC May 4th, 2014, available at: <http://www.bbc.com/news/business-26383058>

³⁸ Tim Bajarin, «The Next Big Thing for Tech: The Internet of Everything», Time, Jan. 13, 2014, available at: <http://time.com/539/the-next-big-thing-for-tech-the-internet-of-everything>

will be recognized by the network by a random but unique string of characters, the user's public address. Possession and control over a particular Bitcoin holding is synonymous with having knowledge of one or more private keys that are mathematically linked to one or more public addresses. If those addresses have been sent some quantity of Bitcoin in the past, as noted by the public record, the user holding the private keys is the only person capable of sending them on to another address.

Bitcoin as the primary, or best known, crypto-currency has been referred to in an increasing number of academic publications that discuss the technological issues, the financial impact and in some rarer cases the social impact, but also ephemera publications, dedicated financial news sites, or websites focused solely on Bitcoin. Basic truths about Bitcoin can be hard to discern amid the hype, but several publications provide key background information as well as an overview of major issues. It is notable that institutions related to the banking sector take a more cautious position.

Many legal aspects associated with crypto-currency were investigated in the US Congressional Service's report "Bitcoin: Questions, Answers and Analysis of Legal Issues"³⁹. Here the authors point out the currency's low transaction costs and increased privacy but also point out its lack of widespread legal standing as tender and vulnerability to fraud, including counterfeiting. They also mention issues in relation to taxation and specific terrorism-related money laundering.

The report also notes that, given the powers articulated in the U.S. Constitution, specifically the authority "to coin money" and "regulate the value thereof," the responsibility to oversee digital currency falls upon Congress. As of now, Congressional actions remain in the exploratory phase, with the Senate Finance Committee having only recently asked the Government Accountability Office to review tax requirements and compliance risks. Federal banking regulators have yet to issue guidance or regulations governing how banks are to deal with Bitcoins. In a February 2014 statement, Federal Reserve chair Janet Yellen said: "Bitcoin is a payment innovation that's taking place outside the banking industry.... There's no intersection at all, in any way, between Bitcoin and banks that the Federal Reserve has the ability to supervise and regulate."

The European Central Bank (ECB) has also taken a position in relation to Bitcoin, in its analysis papers: "Virtual Currency Schemes (VCS) - A Further Analysis"⁴⁰ and "Virtual Currency Schemes"⁴¹. The ECB views Bitcoin as inherently unstable but potentially transformative, recognizing its threat to the ECB's ability to function meaningfully as the central bank of the Eurozone. Only the lack of Bitcoin's widespread adoption reduces the threat level. The authors note in particular that "Although VCS units are not denominated in euro, they do have the potential to have an impact on monetary policy and price stability, financial stability and the smooth operation of payment systems in the euro area." Fundamentally, crypto currencies were seen as mechanisms that might "severely impair" the ability of a central bank to govern a monetary system⁴².

According to a Bank of England (BoE) research report published in February 2015, "The One Bank Research Agenda"⁴³ (which investigates issues beyond the UK central bank's traditional scope to decipher how monetary policy interacts with developments such as climate change and increasing life spans), a combination of digital currencies and mobile technology may reshape the payments landscape. The views offered on Bitcoin in the agenda mark a stark contrast to the Bank of England's

³⁹ Craig K. Elwell; M. Maureen Murphy; Michael V. Seitzinger. "Bitcoin: Questions, Answers and Analysis of Legal Issues," Congressional Research Service, January 2015

⁴⁰ <https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemesen.pdf>

⁴¹ <https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemes201210en.pdf>

⁴² <http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q3digitalcurrenciesbitcoin2.pdf>

⁴³ <http://www.bankofengland.co.uk/research/Documents/onebank/discussion.pdf>

previous dismissal of Bitcoin's ability to function on a wider scale. The ability of Bitcoin to serve as money is analysed and questioned; however, this is heavily caveated in relation to uptake. Like the ECB, the BoE also regards Bitcoin as a destabilizing influence on market places, especially in relation to price volatility. Despite this, the report concludes cautiously that it is likely that, because of the decentralized ledger (the block-chain), Bitcoin's influence will expand in future and questions the feasibility of central banks adopting the decentralized ledger concept themselves.

Additionally, in a report published by the Virtual Currencies Working Group of the French Ministry of Finances⁴⁴, titled "Recommendations to prevent virtual currencies from being used for fraudulent purposes and money laundering", published in June 2014, recommendations for regulating virtual currencies to prevent them from being used for fraudulent purposes and money laundering are issued. The report states that the nature and multi-functionality of virtual currencies means that there is a risk of them being used for fraudulent purposes. Due to the upswing in new criminal activities in connection with virtual currencies, legislative and regulatory frameworks need to be updated and adapted in response to these new challenges, particularly with respect to the fight against money laundering and terrorist financing. One possible strategy, the report proposes, would include three complementary components:

- a) Limiting the use of virtual currencies, by limiting the anonymity of users of virtual currencies, particularly by introducing mandatory proof of identity, by strictly capping the sums that can be paid with virtual currencies, and limit cash/virtual currency flows, particularly when it comes to using Bitcoin ATMs,
- b) Regulation and cooperation, by harmonizing regulations concerning virtual currency exchanges at EU and international level and preventing virtual exchanges located abroad from circumventing French law and
- c) Knowledge and investigation, by which risks and opportunities associated with virtual currencies should be monitored

3.4 Additive manufacturing

Within the context of additive manufacturing we include the techniques of contour crafting and 3D printing and scanning, the main difference being the scale of the manufacturing processes. Large-scale industrial processes employ contour crafting fabricators, while local FabLabs⁴⁵ and domestic devices will employ the more manageable 3D printer or scanner to manufacture smaller components. Robotic techniques are built into both scales of manufacture.

It is now 30 years since the very first 3D printers were invented. The earliest versions were very expensive and were bought by large manufacturing companies to help with rapid prototyping.

Many reports explain in detail how the market for 3D printers is growing, the annual Wohler Associates Report⁴⁶ being one of the most comprehensive. The recent and rapid burgeoning is due in no small part to the expiry of large numbers of early patents in the domain that can now more easily be copied or adapted by new entrants anxious to get a quick start in the business. This has resulted in a large number of hi-tech start-ups entering the area, which have subsequently garnered a lot of interest from venture capitalists. TECH.EU - a European trade magazine - recently published a list of the top 10 EU printing start-ups⁴⁷ to watch. Enabled by other developments in ICT and software and design, the latest machines include a range that is affordable by schools, families and hobbyists costing from €300 to €1000. Midrange versions are affordable by professionals in various healthcare

⁴⁴ <http://www.economie.gouv.fr/tracfin/rapport-lencadrement-des-monnaies-virtuelles>

⁴⁵ http://en.wikipedia.org/wiki/Fab_lab

⁴⁶ <http://wohlersassociates.com/2015report.htm>

⁴⁷ tech.eu/features/4319/can-make-10-european-3d-printing-startups-watch

industries where they are used to produce personalised items such as hearing aids and orthodontic braces. At the high end, printers that are 100 times faster and far more reliable are now available, not only for rapid prototyping but also for the advanced manufacturing of high performance aircraft and engine parts.

Consumer adoption of 3D printing, though still in its infancy, is evolving very rapidly. Industry observers such as Gartner Research remark that while the mass adoption of this technology by consumers is at least 10 years away, growth has entered a new phase and shipments of 3D printers intended for the mass consumer market is expected to double every year until 2018: the total number of printers shipped in 2014 was just over 100 thousand. This is expected to exceed 200 thousand by the end of 2015 and more than 400,000 before the end of 2016 and 2.3 million units by end of 2018.

Many of the new users will be students and teachers, spurred on by public policies to boost adoption of the technology as well as by aggressive campaigns by companies in the domain to help educators adopt the use of 3D printers in the teaching of new and traditional curricula.

In its 2014 report⁴⁸ the European Commission emphasises the extent to which the EU industry will rely on AM as a source of future competitiveness in manufacturing. Underlining the importance of removing barriers to the development of the sector, it remarks that based on current trends it is expected to generate \$11B of revenues in 2020, these could be as high as \$105B if the barriers to growth can be removed.

What has started as a quiet revolution in industry has started to draw the attention of public administration on a number of levels. We briefly review the impact of 3D printing on policies in industry, innovation, research and education, intellectual property and consumer law, highlighting important issues that arise and that will need sustained attention in the future. This review is not exhaustive but serves to illustrate the role that public policy might play in the future, so that these opportunities are fully harnessed to help reduce costs and create jobs, while boosting the competitiveness of European industry and the efficiency of public sector investments.

⁴⁸ <http://www.rm-platform.com/linkdoc/EC%20AM%20Workshop%20Report%202014.pdf>

4 Scenario Development and Sample Scenarios

The team of experts involved in the study developed several scenarios. They started from the backstory developed earlier in the study and developed a number of conceptual themes with a view to exploring the limits of technical potential. No particular epoch was imagined as being associated with exploring these potentialities; however, some context was given. The crosscutting scenarios were imagined from the perspective of someone looking back from the far future on a time that once existed. This was done to explore the potential of manipulating what-if scenarios about events that have not happened yet.

Only the technical scenarios were condensed and used to provoke conversation during the questionnaire and interview sessions. The crosscutting scenarios were used in conjunction with the interview analyses in the development of policy recommendations.

The full set of the developed scenarios can be found at Annex 2.

Two sample scenarios can be found directly below.

Emergency Aid Scenario

- Sharon is on her way into the office. She is a collaborative worker in the future and hears about a terrible natural disaster that has just occurred in a remote part of the world.
- When she arrives at the office she gets online and immediately sets up an ad hoc community to help.
- Member skills and credentials are verified through their block-chain (crypto-currency) trust/ID tokens.
- They search through the EC appeals response database and collectively choose to work on modifying the printer design files for: shelters, earth moving equipment and regionally adapted food.
 - While conducting the search they notice that other ad hoc teams are working with live satellite data to revise the local topological and land transport maps so they reflect the new ground reality and that a medical team is getting ready to deploy.
- The data source is accessed and relevant data sets are processed in the cloud by the ad hoc team and within two hours they have all finished enhancing the terabytes of design data lodged there, so that they can actually help the survivors in the disaster area.
- Sharon contacts the aid coordination centre and the files are uploaded via data link into the printers that are already on board planes *en route* to the disaster area.
- Four hours after Sharon and her ad hoc team started work, the printers are parachuted into all parts of the disaster zone, even the remotest. Some of them drop with the medics who also have specialist printers able to print individually personalised body parts to help them perfectly replace limbs and organs lost or damaged when the disaster struck the region, safe on the knowledge that these replacements will not be rejected by the recovering patient's body. All the doctors do is collect a gene sample from their patient and the printer creates the required replacement or therapeutic material from its organic feed tank, which is easily replaced in the field with other feed tanks to be parachuted in on the next supply run.
- The printers running on Sharon's datasets and programs, however, are much simpler. The able bodied survivors use material they scavenge from the rubble around them to feed the printers, select the output they require and the printer modifies its configuration to print out earth movers to clear the rubble, speeding up the search for further survivors. When the search team gets hungry they fire up the printer optimised for meal printing and enjoy a familiar meal sourced from the organic material they scavenged earlier. Other groups are printing out perfectly adapted structures to sleep and shelter in. These shelter-configured printers are also fed from the piles of rubble surrounding them.

- Knowing that she had done your bit, Sharon thanked everyone in the ad hoc team and disbanded it, then she got back to work while the trust mechanism behind her personal crypto-currency/ID process is updated to increase her social concern and responsiveness parameters. At the same time it reduces her productive hours worked that day. Fortunately her employer has a social responsibility policy that rewards staff members for their involvement in community activities. It's great that the notion of community now has a global dimension to it, Sharon thinks to herself, when she checks her account credits later the same day and notices that her balance has been restored with a full salary paid in for the day.

Enhanced Digital Caveman Scenario

- Consider that synthetic meat has already been created and biological / organic tissue can already be printed. It is easy to imagine a time when it will be possible to print a meal on demand. Food can be printed from our own recycled organic waste and from fresh insect, krill and algae protein.
- Jeremy works collaboratively online and is paid a good salary, in a crypto-currency. He finds that he no longer needs to venture outside to go shopping or even cook his own food. The content of the protein bars that feed his food printer are heavily regulated but he has access to black market fat supplements. Consequently he has terrible weight and health problems.
- Like a very many other people, Jeremy is a burden on the social and health systems. He is currently trying to crowdsource and crowdfund a distributed remote medical intervention to graft in new personalized bio-printed organs and sculpted bio-printed body parts to replace those that have deteriorated though lack of use and abuse.
- Because of his size, Jeremy prefers not to have real personal relationships. He has joined the millions of others who conduct their personal affairs online. New distributed intermediation technologies facilitate a full range of relationship experiences⁴⁹. It is rapidly becoming the case that the majority of people no longer have real to have relationships with each other. Family life as it was once understood is long gone.
- The notion of community is also suffering, with the majority of people now interacting and collaborating through virtual means instead of meeting for a chat in the street. Now that everything about life has moved into the digital domain people are questioning what it means to be human. The greatest existential threat that people now fear is no longer a nuclear holocaust but power cuts that affect the compute infrastructure supporting their virtualized lives.
- There are some Luddite-like movements resisting this change. They are generally by farmers made redundant by synthetic printed food causing the closure of their farms and by central and investment bankers made redundant by decentralized crypto currencies. Governments are hurriedly seeking alternative means of income now that large chunks of major secondary and tertiary economic activities have been undermined. Financial growth is stagnating but the new models of regulating the collaborative economy are now kicking in and the word is that things will be stable again... soon.
- With the decentralisation of power, decentralisation of industry and flattening of hierarchies because of the disintermediation of most of life (and the intermediation of other parts of life)

⁴⁹ WARNING Adult material

<https://www.born.com/view/631/crescendo-the-worlds-first-truly-personal-adult-toy>

<https://www.indiegogo.com/projects/eva-the-first-truly-wearable-couples-vibrator>

<http://myfreeimplants.com/about-us>

<http://www.vice.com/read/online-glory-holes-and-virtual-infidelity-frixion-969>

<http://www.vice.com/video/love-industries-digital-sex-669>

<https://medium.com/@brandonronk/virtual-reality-and-sex-an-inevitable-partnership-20bce6c6994a>

through the use of decentralised collaborative technologies, everything is much harder to regulate. The emergence of digital fiefdoms ruled over by cyber barons has prevented a form of anarchy developing online. The social model behind the online component of people's lives has receded further and returned to the dark ages in terms of social cohesiveness.

- People never were very nice to each other online.

5 Delphi analysis

5.1 Questions, Interviews and Responses

Questions

After the scenarios had been developed we derived a set of questions (see Annex 3). The questions were designed to broaden the discussion around what the future may hold by engaging various stakeholders in the technology areas we are exploring.

The questions were structured to:

- Introduce a theme and to then delve a little deeper into that theme.
- Aggregate a number of small questions into a larger question with a view to establishing dialogue around them.

The questions were designed to provoke discussion rather than to be easy to understand and answer in a few words. We were interested in gathering feelings, opinions and biases as well as facts.

In the first capture phase we published a set of very open survey questions. The information collected was then processed to create a background context for the second phase. In the second phase, the same questions were used but the interviewee was invited to respond to background information that may conflict with their original answer to the question. The rationale for this process was threefold:

- It tests the conviction of the views held by the interviewee.
- It provides the interviewee with an opportunity to consider a conflicting view and possibly modify their own view.
- It enlarges the debate and leads to the exposure of interesting views related to unasked questions.

Responses

A typology classification was developed with which to compare the wide-ranging qualitative, opinion-led answers and to the questions. After profiling the type of person contributing to the process, the typology we chose was based on reach and range, this approach was chosen in order to test the collective mood for various aspects of future possibilities.

Experts themselves were anonymously profiled in order to determine if certain groups hold different or stronger views than other groups.

In order to eliminate potential subjectivity in classifying the expert responses the compound questions were atomised and normalised into a group of 31 atomic questions. Where a question had comparative facets, the responses were linked and a weighting was created.

The classification schema can also be found in Annex 3.

5.2 Summary of Response Analysis

Respondent Profiles

In all, the views of thirty eight individuals were obtained. Twenty six completed an online questionnaire and another twelve were interviewed.

The majority of respondents were experts in one or more of the technology areas under investigation. This group of respondents was split between roughly equal numbers of scientists working in the areas of interest for the study and industrial technologists & strategists; however, there were a few respondents from application and end user domains where there is clear interest in the various potential impact aspects of the technologies in their own area. This second smaller group tended to focus on longer-term issues, highlighting the negative aspects of policy that might harm the potential opportunities they saw in their own domains. In the main group, the scientific respondents answered the questions with some bias towards their own expertise and tended to focus on the shorter-term opportunities associated with the work they were undertaking; however, they did expand the answers where possible into all of the related areas under investigation here. Industrial respondents tended to have a more negative experience with current policy than academics, this is probably because of their exposure to marketplace regulations and data regulations that do not apply to laboratory experiments.

Many respondents have a global profile and most of the rest are notable in the EU.

The overall mood of respondents is overwhelmingly positive in relation to the likely benefits of the potential these technologies embody.

Emerging Themes

The public sector policy-makers must resist the selfish conservative industrial lobbying that the big players in established markets will make. It is felt that the potential of the collaborative economy will be seen by these actors as a threat to be eradicated rather than an opportunity to be grasped. It is a natural feature of human nature to resist change and there is much evidence that the powerful will use all tools at their disposal in an attempt to stifle changes that may undermine their dominance in the market. An interesting comparative case study is presented in the next section.

Policy cannot stay ahead of the technology development curve. Policy makers will need to become more closely involved the technology domain in order to be able to make good policy quickly. Both are currently possible but only on a one-or-the-other basis. There are calls that policy makers should make sure that no regulatory obstacles remain or are put in place, which might stifle the potential of the collaborative economy. In some subject areas, there are calls for no regulation at all. It is interesting that the community calling most stridently for zero regulation is that which has been most in need of regulation in the recent past and is, arguably, currently the most heavily regulated industry (finance). Of course, others argue strongly for rapid regulation deployment in this same area to protect cyber-currency users in the same way that conventional currency consumers are currently protected. This dichotomy can be resolved when one thinks of the different perspectives involved here: those of the producer and those of the consumer.

Since the development of social media and before that, similar off-line opinion gathering tools, policy makers have sought the comfort of testing policy options on the general public. This model is being heavily criticised, with contributors arguing that bottom up policy development may be popular but it does not work at the strategic level. The argument is that members of the public react emotively to reports published in the media (the popular media was most heavily criticised) and do not, therefore, have correct information or all necessary information to hand when expressing opinion. Politicians must lead in the area of strategic policy and a strategic view is argued for very strongly.

All of the technologies within the scope of this study embody the concept of disintermediation. We investigate this concept in more detail in the next section.

Detailed Aspects

A largely pragmatic view was taken in relation to the current state of the art. Academics commenting out of their domain tend to be hostile towards the potential of other technologies and those with commercial backgrounds tend to be a little more idealistic.

Anticipated breakthroughs are ambitious in the main, with out of domain academics tending towards the mundane.

Longer-term predictions anticipate ambitious breakthroughs, once again with out of domain academics tending towards the mundane.

Current public policies that both support and hinder progress were revealed, with a slight weighting to an overall negative effect on the work and ambitions of the respondents.

Overwhelmingly, it was felt that the technologies under investigation would revolutionise industry and have a positive macro-economic effect at the global scale and in the long term.

The technologies were felt to mainly positively affect the distribution side of future markets, with performance and organisational improvements also featuring, resulting in globally positive macro-economic effects.

Overall, it was felt that business models will probably not change much as a result of the collaborative economy becoming a reality but there is a clear tension between tendencies that imply complication in some areas and simplification in others. Notably, those respondents from the commercial sector were those who strongly disagreed with the opinions of the academic majority. This area represents a powerful argument for further investigation, as the weak signal analysis here reveals a significantly prominent spike in terms of the quality and strength of opinion.

In support of the minority opinion noted above, there is overwhelming opinion that a significant paradigm shift will take place as these technologies mature. The corresponding view, that such a shift will not take place, is very weak. Interestingly the optimistic views regarding a significant paradigm shift tended to be expressed by those who seemed to be unconstrained by the focus of the technology domain, while the pessimistic views were all expressed by those focussing mainly on a single technology domain. The optimistic and realistic technology deployment and usage scenarios significantly outweigh the pessimistic deployment scenarios.

Many key players and stakeholders were revealed. They mainly come from the academic, governmental, industrial contexts.

The general risks and opportunities associated within these technology domains under consideration were not well addressed. It is clearly too difficult for those intimately involved in the development of new technology to imagine the different attitudes of those outside of a domain of experience. However, by focussing on specific stakeholder examples, we helped to draw out additional detail but this was still poorly developed, especially in relation to commercial landscapes and supportive policy development. This is probably a reflection of the academic dominance in the respondent population.

At the highest level, there was significant support for policy development to focus on maximising social benefit rather than macro-economic benefit. Again this view is probably distorted by the mainly academic response.

5.2.1 The Long-term Potential of Technologies and Macroeconomic Impact

Foundational Issues

If we are heading to a time where everything is data and those data are held in electronic systems and accessed via the Internet, then there are two important foundational issues to consider.

- We will be utterly reliant upon the provision of resilient and dependable electrical power supplies. European energy security issues will have to be resolved.
- We will be utterly dependent upon the provision of comprehensive and affordable Internet access services available to all devices in all locations. Fixed and mobile devices will be used as data access end-points. In several parts of Europe there is still no Internet access of any kind, fixed or mobile. Minimum access speeds are required in all areas of the EU.

Consumption

The personalisation of products is already with us on a small scale. The personalisation of medicines and medical therapies is gathering momentum and will continue, potentially delivering massive social benefit.

It is anticipated that service-oriented consumption will replace the concepts of buying and selling, which will eventually die out. Leasing and service consumption will take over, once sufficiently dependable fine grained logistics can be deployed, reducing waste and embodied energy.

Education

A new techno-centric and multidisciplinary approach to education will have to be designed and deployed. The new techno-centric subjects need to break down traditional structures and permeate through society.

Knowledge transfer is critical in all aspects of the economy. For those functionally engaged in this society, the rapid change in all aspects of life implies that education will become a continuing function in everyone's lives. Remotely accessed education services will deliver courses adapted with gamification concepts to improve the learning experience.

However, with the corresponding increased level of automation, the levels of disengagement may increase for those who are merely consumers, and there may be some “dumbing down” in society at large.

Citizen Power

The empowered citizen will become part of the system: people are still better at very many things. A well-designed and managed socio-technical system is, in many ways, superior to purely technical or social systems.

Sensors will be embedded in everything. Data can be collected and exchanged in return for free goods and services. The choice to do this is the individual's. Concepts of data privacy and personal data need to be handed back to the individual.

People could choose to act as sensor platforms, e.g. with their mobile phone reporting holes in roads to their local council.

Intellectual Property

The continued protection of Intellectual Property (IP) through copyright and patents, etc. will have a negative effect on the collaborative economy, especially 3D print technologies.

Many conventional business models use IPR as a tool to block competition. In the world of highly distributed, open and collaborative additive manufacturing, this approach is untenable.

IP hoarding should be prevented with the introduction and enforcement of a 5-year use-or-loose obligation on all IP.

Trust, Privacy and Security

There are, and will continue to be many issues around personal protection. Citizens need to be able to trust in their service providers, regardless of the service provided, to at least respect their wishes around the management of identity and privacy issues.

New models of privacy and identity protection and maintenance are required. The centralised and highly regulated approach will not work in a decentralised and ephemeral collaborative economy because traditional enforcement cannot work there.

Data privacy issues are already preventing a lot of societal benefit being generated: clinical research is already being hampered. A position needs to be taken on the correspondence of social benefit versus individual benefit. In any case there is a great deal of evidence that the data subject will increasingly see personal data as tradable assets. Therefore, individuals need to be made responsible for maintaining their own personal data security. They should be supported by public enforcement tools that are effective in the new decentralised structures.

Data privacy is now the responsibility of the owner, who is now a prosumer, free to trade their data and consume data traded by others. This situation spells the end of free data and heralds a period of commodity data.

Data

Related to the data security and privacy issues: it is considered that there is still too much bureaucracy around some data access. Some argue that all levels of government and NGOs should be required to open their data and to publish it digitally. Others argue that enforcing open access to all data could have a detrimental effect. Some data has high commercial value and production will stop if this is opened as all commercial value will be lost. Moreover, not all originators want to be identified.

Data standardisation efforts should be strengthened. Data structures, scope, subject and thesauri need agreement at high levels. Data interoperability is key to bootstrapping the data-driven economy. Establish a reward model for data reuse.

Real time Big Fast Open Data (BFOD) analysis is nearby and Microsoft has demonstrated limited forecasting⁵⁰ using BFOD at the 2014 Research Data Alliance meeting, held in Dublin. Big data could eventually be used as a sixth sense in online communication, to provide a user with important context, background and forecasts of any situation.

We are moving towards data driven industry already. The digital transformation is taking place. It cannot be stopped. Important next steps are missing if we are to quickly achieve a data driven economy: policy makers need to put in place the necessary measures to create (or adopt existing) digital markets.

Measures need to be put in place to prevent open data being captured by big industry in order to protect its conventional position in a conventional market

The free movement of data (and ideas) is as important in the future economy as the free movement of people is now.

⁵⁰ <https://media.heanet.ie/page/41aa54c58c78489cb5eed55183cafcf0>

Policy

The policy change process is slow. Current policies are formatted around old manufacturing structures producing goods the old way. Legislation for current technology is implemented after that technology has been superseded. It then gets in the way of the new technology's ability to generate benefit. Instead monitor markets and stimulate self-regulation. Policy change cannot keep pace with technology change. Policy makers should not try, they should predict and anticipate policy requirements in order to jump ahead: aim to act decisively when breeches of promise occur and consumer trust is damaged.

In a digitised global economy, EU, national and regional policy is meaningless in terms of enforcement. Collaborate with other world regions to create global policy that can be enforced globally.

Politicians should prepare for lots of resistance and criticism from established actors, as change is encouraged. Large companies will not want to change and will fight to ensure the market remains the same.

Policy makers should aim to fill the gap between policy and practice as well as the gap between regulation and enforcement

There are green incentives for using these technologies and significant beneficial environmental impact will be derived from its deployment. However, many established consumer incentives are structured around current market models and encourage behaviour that is detrimental to the environment. For example, airmiles and other non-green incentives should be outlawed.

Commerce

The macroeconomic impact will be huge and felt around the world regardless of whether it is enabled around the world. The Collaborative Economy is not just about new technology, it is about new processes as well. Data as well as goods and services will have intrinsic value again. Money of any variety, crypto- or real, will not be the only unit of currency in many transactions. Taxation will be more difficult but new models are possible. Government must continue to function.

Another industrial revolution is about to take place. New processes and new jobs will be created and less pollution will be produced. Initially, the efficiency of conventional manufacturing will improve, and then manufactures will evolve into service providers. Finally, everything will become a (an automated) service. The current professional class will decline and disappear or change radically.

Crowd funding is not just about raising finance it is about creativity and innovation.

Crowd working on a global scale would enable 24hr operations without requiring abnormal hours working.

6 Policy considerations and discussions

Here we elaborate policy considerations on the four main areas of the study. In the next chapter we will discuss the policy issues arising out of these considerations.

6.1 Collaboration Technologies

The Internet has always been the scene for collaboration, and it was once its main *raison d'être*. Today, internet collaboration is mixed with many other uses, for example e-commerce, e-health, e-government, online games and gambling, web publications, internet radio, IP-TV, and the emerging Internet-of-Things. There are therefore many possible motivations for Internet-related policy, sometimes in conflict with its anti-regulatory roots. The diversity of this field prompts us to give an overview of the academic and public debate on related policy topics, while more in-depth studies will be needed for each new policy option.

Our study on Collaborative Internet has considered existing literature in a number of policy areas and related topics; Impact on the division of labour; Impact of the dis-intermediation of some central players; Intellectual Property Rights and copyright protection; Consumer protection; Productivity gains; Economic growth; Benefits for SMEs; Impact of the de-materialisation of services; and Technological challenges and opportunities. In addition, public debate in the media and online has been monitored on Co-creation, Crowd-sourcing and Crowd-funding, to capture what policies are currently discussed within and outside the Commission and Parliament. This material has then been vetted against feedback in interviews with leading researchers and industrialists.

New policies for Collaborative Internet should relate to the Digital Agenda for Europe⁵¹. The Digital Agenda has seven action areas, the most directly related to the Internet being: a vibrant digital single market; interoperability and standards; trust and security; fast internet access; research and innovation. The discourse presented here has been structured according to these areas.

6.1.1 Single Digital Market issues

Looking into the debate on shifts in division-of-labour, it is noted that information is the main resource for much of the work that goes on in the global economy, and increased use of collaborative technologies on the Internet is going to increase its importance while strengthening the power of the first-world economies⁵². With only a small stretch of imagination, the same can be expected within the EU - the currently strong knowledge economies will remain so, while the less developed member states will struggle trying to catch up.

In the context of this study, the most relevant information types to consider are *ideas within co-creation*, *crowd-sourced data* and *open data*. The first is further discussed below, while the second is addressed in the Trust section. The third is discussed in the Open Data section later on.

The European Commission has identified the completion of the Digital Single Market (DSM) as one of its ten political priorities and recently published a strategy for achieving this political goal⁵³. It represents a significant step towards full implementation of the Digital Agenda. A key observation is that future collaboration will build strongly upon new ideas co-created by customers and peers⁵⁴, and

⁵¹ *Digital Agenda for Europe*, Communication COM(2010) 245, European Commission, May 2010

⁵² Graham, M., *The Knowledge Based Economy and Digital Divisions of Labour*. 2014. In *Companion to Development Studies*, 3rd edition, eds v. Desai, and R. Potter. Hodder. 189-195.

⁵³ *A Digital Single Market Strategy for Europe*, Communication COM(2015) 192, European Commission May 2015

⁵⁴ *Co-creation with Customers*, F. Piller, C. et al, Chapter 9 in *Leading Open Innovation*, MIT Press 2013, ISBN: 9780262018494

using massive data collections as a resource for them. So, how can it be ensured that this can happen with minimal friction? For Open Data, there is already the directive on re-use of public sector information (PSI)⁵⁵.

In a case study funded by the European Commission⁵⁶, it is noted that important building blocks for customer interaction (with a purpose to co-create) are Dialogue; Access; Risk/benefits; Transparency. The new technologies analysed in this report enable new ways to facilitate co-creation based on a free flow of ideas, some of which should be given a stronger legal basis - for example, leading researchers and crypto-currency industrialists interviewed by us, suggest that the so called "block-chain" technology can be used for transparent legal agreements between previously unrelated parties.

Turning our attention to dis-intermediation of some central players, we find that most of the general academic debate on this topic focuses on single sectors related to travel, which corresponds well with recent global successes of internet-based booking of flights, trains, hotels, apartments, taxis). However, most publications have a narrow geographic focus (countries) and a well-cited body-of-literature has not emerged yet. Specifically within additive manufacturing, there are sometimes claims that additive manufacturing will disintermediate the entire supply chain, but a comprehensive literature study exists that finds otherwise, the key observation being "that e-commerce channels can lead to both disintermediation but also re-intermediation of the supply chain; cost reductions and increased efficiency may not automatically follow"⁵⁷. This suggests that current manufacturing stakeholders might survive and that some of them will be able to exploit this change. The importance of the anti-thesis "maker movement" might well be to spread enthusiasm about all sorts of do-it-yourself activities that are not limited to 3D-printing but also comprises diverse activities such as textile craft, robotics, cooking, woodcrafts, electronics, digital fabrication, mechanical repair, etc⁵⁸.

For facilitating a free flow of ideas (and information in general), there appears to exist a policy gap, which could be filled in the first instance by assigning it due importance as a key production factor in the future collaborative economy.

6.1.2 Intellectual Property issues

Co-created ideas are increasingly important for creating new products that satisfy a fast-changing market. To ensure EU competitiveness, copyright and IP rules need to become uniform across the EU. This will also stimulate creation and distribution of Open Source Software, Open Designs and Open Data, benefiting businesses that can build growth-driving new products on top of such open assets.

While the Digital Agenda identifies the need for "appropriate rules for intellectual property", this remains a highly contentious policy area. The extreme ease of copying digital materials has led to suggestions that relaxing copyright rules might be beneficial for society, but on the other hand other incentives for creating valuable materials must then be found. Indeed some of our academic respondents made suggestions for relaxed patenting and copyright regulations. New collaborative Internet technologies will not fundamentally change the conflict between the desirability of reusing what exists and ensuring fair remuneration to original creators.

⁵⁵ *Directive on the re-use of public sector information*, Directive 2003/98/EC, known as the 'PSI Directive', European Commission 2003 (amended by Directive 2013/37/EU)

⁵⁶ *Co-creation design as a new way of value creation*, Contract No 190/PP/ENT/CIP/12/C/N03C01, February 2014

⁵⁷ *E-commerce channels for additive manufacturing: an exploratory study*, Daniel R Eyers , Andrew T Potter , (2015), *Journal of Manufacturing Technology Management*, Vol. 26 Iss: 3, pp.390 - 411

⁵⁸ *Maker movement spreads innovation one project at a time*, kappamagazine.org, 2013

In the specific area of additive manufacturing, a recent study commissioned by the UK Patent Office comes to the conclusion that there is no urgency to legislate on 3D printing at present⁵⁹. While this is a strong statement, the overarching debate on Intellectual Property regulations and their uniformity across EU should not be forgotten.

6.1.3 Trust issues

Trust is absolutely essential for citizens to voluntarily allow service providers to use personal data provided by them for valuable services, for example for resource sharing or for services based on "Big Data" analysis. Already it can be seen that dominating actors like Google and Facebook require their users to give far-reaching rights for them to analyse personal data and re-use the results, even with third parties. The Digital Agenda however correctly identifies that "we expect control over our personal data".

Sharing of resources has changed how many people in the western world commute, shop, go on vacation and borrow money, in the so called "sharing economy". A key observation is that the sharing economy has overcome some market imperfections, which otherwise would be subject to regulation⁶⁰.

In the US, there is on-going debate on how to best ensure privacy in the face of complex service offerings to consumers. In particular the principle of "notice and choice" has been used extensively in the past, as opposed to statutory and administrative regulation⁶¹. This study claims that the Notice-and-Choice principle is suitable for avoiding unauthorised disclosure of personal data, but only if the non-disclosure commitment is accurate, for example "we will only share with our affiliates" is not accurate enough. It also suggests that statutory regulation is needed regarding what are reasonable "business needs" to retain data, and the consequences of data breaches.

It is well-known that most people do not read long-winded online agreements for giving consent, and there is therefore a strong need for minimum citizen protection against unfair or privacy-invading use of data about them. Possible options include ensuring that personal data remains owned by the individual and prohibiting agreements that allow sharing personal data with third parties without *accurate consent* from the individual.

European innovative enterprises are chronically under-financed, and crowd-funding is a chance for EU to strongly increase the transfer of innovations into commercial reality. In 2014, the Commission released its Communications on long-term financing and on crowdfunding, that highlight the need for better access to finance for SMEs⁶² and demonstrates that crowdfunding has already surpassed traditional business angel investments⁶³. Crowdfunding may disintermediate traditional banking actors in Europe that currently price risks too high and that therefore miss opportunities for profitably funding digital innovations⁶⁴. This may be part of a wider policy initiative, towards the proposed Capital Markets Union⁶⁵.

⁵⁹ *A Legal and Empirical Study into the Intellectual Property Implications of 3D Printing*, Dinusha Mendis, Davide Secchi and Phil Reeves, Bournemouth University, commissioned by the Intellectual Property Office, March 2015.

⁶⁰ *The Sharing Economy and Consumer Protection Regulation: The Case for Policy Change*, C. Koopman et al, George Mason University, December 2014

⁶¹ *Privacy Harms and the Effectiveness of the Notice and Choice Framework*, J. R. Reidenberg, Fordham Center on Law and Information Policy, 2014.

⁶² *Communication on Long-Term Financing of the European Economy*, COM(2014) 168, European Commission, March 2014.

⁶³ *Unleashing the potential of Crowdfunding in the European Union*, COM(2014) 172, European Commission, March 2014.

⁶⁴ *The Need for an Innovation Principle in Regulatory Impact Assessment: The Case of Finance and Innovation in Europe*, P. Zilgalvis, Policy & Internet Volume 6, Issue 4, pp377-392, December 2014, DOI: 10.1002/1944-2866.POI374

Another growing concern is the non-accountability of crowdfunded projects, especially for common delays in particular for over-funded projects⁶⁶. While current law already prohibits publishing false or misleading prospects for funding, stronger restrictions and enforcement mechanisms may be needed in the face of transnational crowdfunding schemes. Similar to policies against tax evasion and money laundering, this will require international transparency agreements beyond EU, to ensure monitoring and accountability of fraudulent crowdfunding offers.

6.1.4 Internet Access issues

For remote collaboration, fast Internet access is a necessity to meet citizens' expectations on being able to communicate with video when desired, and viewing video materials together. The Digital Agenda calls for download rates of at least 30 Mbps for all its citizens which is more than enough for today's e-meeting services, but which might be challenged by emerging advanced e-meeting systems that give a much stronger feeling of presence, so called "immersion".

The Data Retention Directive (2006/24/EC)⁶⁷ for saving usage data for 6-24 months is contentious after having been declared invalid in court. Here we only reflect upon what are the possible consequences of the directive in relation to new Internet collaboration technologies, separate from the main issue of its justifiability in relation to privacy. Platforms for e-meetings, crowd-sourcing, crowd-funding, co-creation and social production all have features for communicating between people and are usually publicly available. As such, they would probably fall under the invalid 2006/24/EC directive. The diversity of such services and the likely emergence of new collaboration technologies however makes it infeasible to maintain a list of specific technologies in this type of directive, so any new regulation in this area has to have a wide but accurately described scope in order to be enforceable and legally acceptable.

Our industrial respondents strongly emphasized the need for *mobile* Internet access as a key intervention area to ensure that collaborative technologies are adopted widely and contribute to the competitiveness of EU as a whole. They expressed strong support for roaming fees more similar to home country pricing as is currently being considered at the EU level⁶⁸, and confirmed that technical solutions for roaming Internet access can reduce the additional cost to almost zero. An overview of the pros and cons of above (or below) cost roaming charges was published in 2012⁶⁹. There is on-going public debate strongly driven by former Commissioner Viviane Reding to proceed quickly and implement "Roaming Like At Home" retail pricing regulations, while addressing wholesale pricing caps separately.

6.1.5 Research and Innovation issues

Research and innovation has been driven by the Framework programmes that have now been succeeded by the Horizon 2020 programme. There was always the inherent tension between the wish to maximise use of research results by making them public, and on the other hand the desire to

⁶⁵ *Joint Declaration on the Capital Markets Union*, AFME/EBF/BAE/EBAN/EBN/ECN/EUROCHAMBERS and European Issuers, May 2015

⁶⁶ *The dynamics of crowdfunding*, E. Mollick, J. Business Venturing, Elsevier 2014, doi:10.1016/j.jbusvent.2013.06.005

⁶⁷ Communication on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending Directive 2002/58/EC 2006/24/EC, European Commission March 2006,

⁶⁸ Proposal for a Regulation of the European Parliament and of the Council laying down measures concerning the European single market for electronic communications and to achieve a Connected Continent, 2013/0309 (COD), Council of the European Union, January 2015

⁶⁹ *Roaming and investments in the mobile internet market*, T. Stühmeier, Telecommunication Policy, Volume 36, Issue 8, September 2012, pp595-607

increase the competitiveness of EU industry by ensuring that immaterial properties are identified, protected and commercialised.

Maybe there is another way. Contributing improved or new assets to commons libraries maximises their utility. The "Power of crowds" can be expected to enable some of the commons-based initiatives to surpass existing commercial products. Already there are examples where commons-based approaches exceed the capabilities of commercial or governmental organisations, both in quantity and quality (e.g., Wikipedia).

In addition, if benefits from synergies between the activities of formal science and loosely connected online groups are to be increased, it will be necessary to create specific incentives for it, for example targeted research initiatives in this direction⁷⁰.

6.1.6 Policy Creation issues

There are claims on beneficial interlinks between crowdsourcing and urban development, but crowdsourcing is still underused in regional development⁷¹. Regional development strategies tend to be created in a top-down manner, often resulting in too little direct involvement of citizens, and thereby low awareness of the resulting strategies. We have seen this happen in recent development of the regional Digital Agendas.

Different models for crowdsourcing methods have been proposed for setting policy agendas, problem definition and policy design, mainly Open Collaboration and Tournament-Based Collaborations methods⁷².

6.1.7 Conclusion

Creating policies for the use of collaborative Internet technologies is an area fraught with peril. On the one hand, Internet has markedly anti-regulatory roots and a loud minority of vigilante groups opposing anything that would "threaten freedom on the Internet". On the other hand, the majority of citizens would be content with fast and secure Internet access and accept a certain amount of regulation and even monitoring.

In this study we have found that there are options for good policies to facilitate increased uptake of collaborative technologies, so that they may contribute to economic growth by supporting additive manufacturing, and on its own for creating innovations and products for the future fast-changing consumer market. Big Data analysis and Crypto-Currencies will sometimes be used for producing and distributing digital services, including designs for additive manufacturing.

6.2 Big Data and Open Data

Our policy discussions on the Open Data and Big Data topics have considered a critical analysis of policies in USA and UK after several years from their establishment, relevant policy developments in the EU, as well as feedback received through interviews and questionnaires. These discussions have taken place under the prism that (open/big) data represents a resources and is an enablers for a wide range of innovative products and services, including services that boost transparency in government, improve citizen services, facilitate citizen engagement and in several cases address societal challenges.

⁷⁰ *Employing digital crowdsourced information resources: Managing the emerging information commons*, Int. Journal of the Commons, Vol. 7, no2, August 2013, pp255-277, Igitur Publishing 2012, ISBN 1875-0281

⁷¹ *Smart Regions: two cases of crowd sourcing for regional development*, S. Roth et al, Int. J. Entrepreneurship and Business, Vol 20, No. 3, pp272-285, Inderscience 2013

⁷² *Crowdsourcing the Policy Cycle*, J Prpic et al, Proceedings of Collective Intelligence 2014

The evaluation of open data initiatives in the UK⁷³ reveals success and failures, which should be taken into account for policy development at both EU and national scale. In the UK an institutional approach has been followed⁷⁴ to the release of open data sets, which on the one hand facilitate awareness, but on the other gave a political nuance to open data that distracted the public from the main objectives of Open Data. Furthermore, despite the emergence of applications that improved citizen service and government efficiency, the expectations regarding the social impact of Open Data seem to be overly optimistic. Also, the assessment reveals some mistakes in the process of establishing and promoting open data infrastructure, such as the prioritization of specific data sets in vertical areas (e.g., expenditure and finance data). In retrospect, an attempt to release as many datasets as possible would have been more effective. Likewise, policies that engage existing communities and gradually expand to others are deemed more efficient for bootstrapping open data infrastructures and applications. Moreover, the importance of citizen engagement as an element of success for the collaborative economy in general and open transparent governance in particular is highlighted⁷⁵. Overall, the UK experience shows that policies facilitating the release of many datasets, along with motivation for subsequent citizen engagement should be provided. The steps to successful establishment and uptake of open data resources/assets, including raising awareness in the society, engage people already empowered and gradually expand towards third party communities.

Policies should be developed in-line with the EU policy landscape and relevant experiences from the effects of these policies. One of the first policy initiatives has been the INSPIRE directive⁷⁶, which has been a catalyst for the EU wide dissemination of environmental and spatial information, yet for several years quality, consistency and EU-wide availability of data issues had to be confronted. These issues have been unveiled in the scope of assessments and public consultations on the use of the INSPIRE directive, along with the need to provide consistent functionalities about finding, accessing and using spatial data. Also, the issue of the compatibility across different data sets has been raised, which is a wider issue associated with the release of open data sets. In this context, the European Interoperability Framework for e-Government services⁷⁷ should be considered as a policy initiative. The use of INSPIRE has proven to be more effective when implemented/combined with relevant directives such as the Public Sector Information (PSI) directive⁷⁸, including its revision to address foster open data adoption through regulating licensing and promoting unrestrictive use^{79,80}. Similar to the INSPIRE initiative, other policy initiatives have enabled the establishment and EU wide use of datasets such as policies for open access to scientific information⁸¹, policies for the development of the

⁷³ Antti Halonen, "Being open about data", Analysis of the UK open data policies and applicability of data, The Finnish Institute in London, 2012.

⁷⁴ Cabinet Office: Making Open Data Real: A Public Consultation, <http://www.cabinetoffice.gov.uk/resource-library/making-open-data-real-publicconsultation>

⁷⁵ Open Government Partnership, "The UK's First Open Government Partnership National Action Plan: Civil Society Perspectives 2011-2013", <http://www.ogphub.org/wp-content/uploads/2014/06/UK-2011-2013-Civil-Society-Perspectives.pdf>

⁷⁶ Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) 14.03.2007

⁷⁷ EUROPEAN INTEROPERABILITY FRAMEWORK FOR PAN-EUROPEAN eGOVERNMENT SERVICES, November 2004, ISBN 92-894-8389-X, © European Communities, 2004

⁷⁸ European Public Sector Information Platform Topic Report No. 2012 / 3, "The amendment of the PSI directive: where are we heading?", April 2012

⁷⁹ Revised PSI Directive (Directive 2013/37/EU)

⁸⁰ Janssen, K. and Hugelier S., "Open data as the standard for Europe? A critical analysis of the European Commission's proposal to amend the PSI Directive", European Journal of Law and Technology, Vol. 4, No. 3, 2013.

⁸¹ Communication on scientific information in the digital age, COM(2007) 56, Communication on ICT infrastructures for e-Science COM(2009) 108 and related Council Conclusions.

Europeana⁸² digital library for cultural heritage and more⁸³. Experiences from the application of these policy initiatives converge to the importance of complying with privacy legislation, while at the same time resolving IPR issues. Therefore, policies that facilitate the resolution of these issues are essential.

Recently, the EC has given attention to the development of Open Data portals, as a means of fostering the creation and structuring of Open Data sets. Several open data portals have been created in the members states. In 2012 the EU launch the European Union Open Data Portal⁸⁴, which is the single point of access to a growing range of data from the institutions and other bodies of the EU. Open data portals and platforms facilitate discovery and access to datasets and seem to have a growing momentum, given that we are witnessing a proliferation of the number of data portals and of their datasets. It has been proven that portals facilitate the engagement of innovative developer communities. However, the “Pricing Of Public Sector Information Study”⁸⁵ report has concluded that their short term impact has been quite limited. Nevertheless, their longer-term impact is expected to be higher, provided that technological innovations are combines with organizational ones. Policy development should therefore foster such innovations, while at the same time boosting the engagement of citizens, beyond developers, policy-makers and open data communities. To this end, open data applications should extend beyond government transparency i.e. through addressing real-world challenges and problems (e.g., as in the cases of the challenges.gov⁸⁶ in the USA where competitions are organized towards solving practical government-related cases).

Our interviews with experts have confirmed the main open data issues that should be addressed during policy development, such as: (i) The need to create a trustful environment for the exploitation of open data, including the safeguarding of security, privacy and data protection; (ii) Challenges relating to interoperability, including the need to combine different data sets and challenges relating to multi-lingual and cross-border datasets; (iii) The importance of raising awareness and boosting engagement of innovators and citizens at large; (iv) The need to ensure availability without restrictions. These issues are in-line with current policy development initiatives in the EU (such as those outlined earlier) and extension to the scope and applicability of these policies has been also discussed. However, there were also concerns about possible over-regulation and the need to balance between a regulated environment that creates confidence and an over-regulated environment that provides barriers and set-backs to wider adoption. In this context, policies should not pose any restrictions to the use of data, so that people can freely and openly engage in the development and use of applications. Policy initiatives should therefore cater for the education and awareness of the society on BigData and OpenData technologies and issues, which will enable innovators and citizens’ engagement in the development of novel products and services. Especially for BigData applications, policy initiatives should create a positive business climate that will boost the ability of high-tech companies to create products and services including products that address societal goals and enterprise products that will improve quality of life and facilitate economic growth. Several experts underlined the importance of supporting BigData startups in the development of novel products/services. This is particularly important due to the proliferation of data sets, which creates unprecedented opportunities for novel (BigData) products and services, notably products/services that were (until recently) not possible.

⁸² <http://www.europeana.eu/portal>

⁸³ European Commission, “Open data: An engine for innovation, growth and transparent governance”, COM(2011) 882 final, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, December 2011.

⁸⁴ <http://open-data.europa.eu>

⁸⁵ European Commission Information Society and Media Directorate-General, “Pricing Of Public Sector Information Study” (POPSIS), Open Data Portals (E), Final Report, October 2011.

⁸⁶ <https://www.challenge.gov>

6.3 Crypto-currency

6.3.1 Discussion

Bitcoin as the primary, or best known, crypto-currency has been referred to in an increasing number of academic publications that discuss the technological issues, the financial impact and in some rarer cases the social impact, but also ephemera publications, dedicated financial news sites, or websites focused solely on Bitcoin.

Basic truths about Bitcoin can be hard to discern amid the hype, but several publications provide key background information as well as an overview of major issues.

Of those we recognize, that institutions related to the banking sector keep a more cautious position.

Among the publications we place emphasis on:

The 2015 US Congressional Research Service (CRS) report, "Bitcoin: Questions, Answers and Analysis of Legal Issues"⁸⁷

The number of Bitcoins in circulation as of January 2015 was approximately 13.7 million, with the maximum set at 21 million. As of April 2015, their total value was \$3 to \$4 billion. This relatively small figure, according to CRS, prevents Bitcoins from having a significant effect on the Federal Reserve's monetary policy (an argument that is frequently brought up as one of the dangers of Bitcoin).

The CRS report explores the following technical, functional and legal issues:

- Bitcoin advantages:
 - **Lower transaction costs:** Because Bitcoin operates without a third-party intermediary, merchants are able to avoid the fees traditionally charged by payment systems such as credit cards.
 - **The possibility of increased privacy:** Bitcoin provides a heightened degree of privacy for purchases and transactions, though by the system's nature, a complete list of all transactions is forever recorded to each user's encrypted identity.
 - **Protection from inflation:** Since Bitcoin's circulation is not linked to currency or government regulation, it is not subject to standard inflation. However, it more than makes up for this in volatility.
- Bitcoin disadvantages:
 - **Severe price volatility:** The value of a Bitcoin is determined by supply and demand, and as a result, can fluctuate rapidly. The value was as high as \$1,100 in December 2013, then hit a low of \$177 in January 2015. This extreme fluctuation is more characteristic of a commodity than a currency.
 - **Not legal tender:** Debtors are not required to accept it, and without any formal backing other than the computer program to which it is linked, Bitcoin can be seen as an "unattractive vehicle" for holding and accumulating wealth.
 - **Uncertain security from theft and fraud:** While the counterfeiting of Bitcoins is allegedly impossible, the system has at times found itself vulnerable to large security breaches and cyber-attacks. Most recently, Bitstamp, a large European Bitcoin exchange, lost 19,000 Bitcoins (valued at about \$5 million) in a digital security breach. This follows the massive problems with Mt. Gox in 2014 and the collapse of other exchanges in 2011.

⁸⁷ Citation: Craig K. Elwell; M. Maureen Murphy; Michael V. Seitzinger. "Bitcoin: Questions, Answers and Analysis of Legal Issues," Congressional Research Service, January 2015. - See more at: <https://fas.org/sgp/crs/misc/R43339.pdf>

- **Vulnerability of Bitcoin “wallets”:** Purchased or mined Bitcoins are stored in a digital wallet on the user’s computer or mobile device, and digital keys can be lost, damaged or stolen. Paper or offline storage is an option, but not always practiced.

The CRS report notes that, given the powers articulated in the U.S. Constitution, specifically the authority “to coin money” and “regulate the value thereof,” the responsibility to oversee digital currency falls upon Congress. As of now, Congressional actions remain in the exploratory phase, with the Senate Finance Committee having only recently asked the Government Accountability Office (GAO) to review tax requirements and compliance risks. The tax code lacks clarity on how such currency should be treated: Is it digital currency, property, barter or foreign currency? Early concerns have focused more on tackling consumer protection issues than tax ambiguities, and as a result, the GAO recommended increased inclusion of the Consumer Financial Protection Bureau in questions related to Bitcoin.

Federal banking regulators have yet to issue guidance or regulations governing how banks are to deal with Bitcoins. In a February 2014 statement, Federal Reserve chair Janet Yellen said: “Bitcoin is a payment innovation that’s taking place outside the banking industry.... There’s no intersection at all, in any way, between Bitcoin and banks that the Federal Reserve has the ability to supervise and regulate.” (See a 2014 paper from the Federal Reserve on technical background and data analysis.) Some state financial authorities have taken steps to devise regulations, with New York’s Department of Financial Services (NYDFS) in the lead.

According to the CRS report, other legal issues with Bitcoin include:

Counterfeiting criminal statutes: It is illegal to counterfeit both U.S. and foreign currency, but current monetary laws do not mention digital currency. Given that Bitcoin is a peer-to-peer transaction without any formal involvement by a regulatory body or a government, it is unclear if there is a role or responsibility for the U.S. legal system to intervene if counterfeiting occurred in such a situation.

Federal tax laws: To date, the IRS has done little to address the tax implications of virtual currencies. Instead, the IRS has focused on public education by issuing guidelines indicating that for now, virtual currency will be treated as property for tax purposes, and within that framework, all corresponding tax laws apply.

Federal anti-money laundering laws: To fight illegal and terrorist-related financial transactions, the Bank Secrecy Act (BSA) requires financial institutions to keep records. This allows suspicious withdrawals and transactions to be tracked. These requirements would conceivably be placed on any business that engages in the exchange of Bitcoins for U.S. or foreign currency.

The European Central Bank. In its reports: “Virtual Currency Schemes - A Further Analysis⁸⁸” (February 2015) and “Virtual Currency Schemes⁸⁹”, October 2012⁹⁰, the European Central Bank has released a new report on digital currency, describing it as “inherently unstable” but potentially transformative in the realm of payments. The ECB study builds off an earlier study published in 2012, offering both a general overview of digital currencies as well as follow-up analysis on the potential benefits and risk of using so-called virtual currency schemes (VCS).

The European Central Bank, which oversees national-level central banks in the Eurozone, suggested in the report that digital currencies could impact the ECB’s ability to function. However, it stopped short of calling digital currencies a threat to its operations **because of its lack of widespread adoption among consumers and businesses.**

⁸⁸ <https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemesen.pdf>

⁸⁹ <https://www.ecb.europa.eu/pub/pdf/other/virtualcurrencyschemes201210en.pdf>

The report's authors note: *"Although VCS units are not denominated in euro, they do have the potential to have an impact on monetary policy and price stability, financial stability and the smooth operation of payment systems in the euro area."*

The viewpoint echoes a report released last year by the Bank of England⁹¹, which in September 2014 acknowledged that, if widely adopted, Bitcoin could "severely impair" its ability to govern the UK monetary system. However, several months later The Bank of England said in an updated study in Feb 2015 (see next entry), that the technology could fundamentally change the way that central banks function.

The ECB outlined a number of areas in which digital currency development could broadly impact the traditional payments space (Cross-border payments disruption), noting that defects in the remittance ecosystem could provide an opportunity for the technology to flourish in the long term.

The report's authors state that digital currencies like Bitcoin, given their cost structures, make the technology a potentially attractive option for both domestic and international remittances. While acknowledging the technological resources required to build such a network, the ECB notes: *"...there is major room for improvement, especially in [the remittance] field, and hence a VCS could have the potential to offer a better service than traditional providers (banks, money remitters and informal remittance systems)."*

The ECB goes on to say that a significant barrier to broader adoption for remittance is the lack of centralized protections for those who opt to use digital currencies.

As well as including refrains of central bank warnings about digital currencies, such as a perceived lack of transparency and market volatility, the ECB also touched on the growth of altcoins. The report suggested that altcoins may one day serve as future payment networks that, in the eyes of the ECB, could compete with Bitcoin given the differences in design, distribution and implementation. At the same time, the report highlighted how altcoins pose added risks for investors because of the nebulous nature of some projects, noting: *"It is too early to tell what the future of these altcoins will be. A great many of them could be nothing more than "scamcoins", ie VCSs that are created with the main objective of swindling naive buyers, either as consumers and payers or as investors."*

Specific risks named in the report include a lack of specific information about an altcoin network's management, pre-mining and market illiquidity.

The Bank of England. According to a Bank of England research report published in February 2015, "The One Bank Research Agenda"⁹² (which investigates issues beyond the UK central bank's traditional scope to decipher how monetary policy interacts with developments such as climate change and increasing life spans), a combination of digital currencies and mobile technology may reshape the payments landscape. The views offered on Bitcoin in the agenda mark a stark contrast to the Bank of England's previous dismissal of Bitcoin's ability to function on a wider scale.

One of the major questions explored in the Bank of England's report is whether or not Bitcoin is a form of money. The study relies on a common, three-part definition of money that involves three use cases: as a store of value, a medium of exchange and a unit of account. The Bank of England explains that, under current conditions: "Digital currencies could serve as money for anybody with an internet-enabled computer or device. At present, however, digital currencies fulfill the roles of money only to some extent and only for a small number of people. They are likely at present to regularly serve all three purposes for perhaps only a few thousand people worldwide, and even then only in parallel

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<http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q3digitalcurrenciesbitcoin2.pdf>

⁹² <http://www.bankofengland.co.uk/research/Documents/onebank/discussion.pdf>

with users' traditional currencies." However, this could be subject to change. The report highlights that, long-term, growing confidence in digital currencies could lead to broader use as a store of value and a medium of exchange. For accounting purposes, the Bank of England acknowledges that few businesses, if any, denominate their records in Bitcoin. Should this practice emerge, that element of the definition of money could become more relevant for digital currencies.

According to the Bank of England, Bitcoin and digital currencies do not – at present – pose a threat to the broader financial system. Yet it does suggest that, should broader adoption take place, the integration of Bitcoin with complex financial instruments and global marketplaces could deepen the impact of any price volatility on the broader economy.

The 2ND report notes that there is "little incentive" currently for a major shift from fiat to digital currencies. However, the technology's use as a form of money – and the broader applications of the decentralized ledger – could expand in the future.

The report noted that "while existing private digital currencies have economic flaws which make them volatile, the distributed ledger technology that their payment systems rely on may have considerable promise". With this in mind, the Bank of England raised the question of whether central banks should make use of such technology to issue digital currencies. In doing so, the financial authority also addressed the economic, technological and regulatory challenges it would face if it did so.

The report outlined the costs and benefits of creating a new form of central bank money and making it widely accessible. The research also looked into how this development may impact existing payment and settlement systems, while analysing the implications for government-backed deposit insurance if central bank money was made widely accessible to both households and businesses.

The report questioned whether digital currencies issued by the central bank should be remunerated and whether this should be linked to the country's official interest rate.

Other aspects of the research included the implications for the availability of credit, the costs and benefits of different central banks using a common platform for issuing digital currencies, and how could institutions offering access to central bank issued digital currencies be regulated.

Goldman Sachs. In its report "The Future of Finance: Redefining The Way We Pay in the Next Decade". (March 2015), written by James Schneider and SK Prasad Borra⁹³, payments analysts at the bank's research division, Goldman Sachs' equity research analysts say that Bitcoin and similar cryptocurrencies could be the "future of finance" as the demand for a new way to move money continues to rise. In the report titled The Future of Finance: Redefining The Way We Pay in the Next Decade, the authors say merchants will be the largest companies to benefit from the shift toward cryptocurrencies and highlight three existing Bitcoin-based businesses as the leading firms in the cryptocurrency space: Coinbase, BitPay and Ripple Labs.

Bitcoin, along with improved payment security, 'big data' analytics and faster payment networks are the components of a technology trend that will disrupt the payments ecosystem, the report says. The disruption of the \$1.2tn global payments industry will be also be driven by converging trends in regulation, global demographics and the rise of markets outside the United States.

The report says: "Innovations in network technology and cryptography could change the speed and mechanics of moving money."

According to Schneider and Borra, Bitcoin's major impact will be enabling the transfer of assets without a central clearing authority. The large public companies that will benefit will be merchants, who will reap savings on payment costs. Firms who might lose out are traditional money-transfer firms like Western Union, Moneygram and Xoom.

⁹³ Joon Ian Wong, <http://www.coindesk.com/goldman-sachs-report-says-bitcoin-could-shape-future-of-finance>

Bitcoin's impact will be felt in the field of consumer-to-consumer payments, the report says. This market includes all payments made between consumers, with examples of leading vendors being mobile wallets like Venmo and Square Cash.

Disruptive entrants to the consumer payments space are limited to earning revenue from international money transfers, according to the report, a market that's worth \$580bn. These entrants include Bitcoin exchanges and the peer-to-peer platform for foreign currency exchange TransferWise. Exchanges named in the report include Coinbase, itBit, Circle, Trucoin and CoinCorner.

Bitcoin could also play a significant role in global remittances for customers who want to use cash to begin the transfer process. The report points to Bitspark as an example of a firm that lets customers remit funds by depositing cash, bypassing the need for a bank account. Bitspark then performs the transfer by exchanging it into Bitcoin. New players could take 20% of the current \$30bn consumer-to-consumer market from incumbents over the next 10 years, the analysts estimate. Newcomers will also drive fees down from a current average of 6% of the principal to 2.5%.

"Distributed networks are, in principle, more secure and reliable due to their open source nature, and there is no single point of failure," the report notes.

"Given the low transaction fees associated with ... virtual currencies, there is potential for significant dislocation in the profit pools associated with money transfer."

Merchant adoption of Bitcoin could rise in coming years, the report found. The analysts conducted a survey with the Electronic Transactions Association that found 23% of merchants planned to accept Bitcoin within the next 24 months.

The report estimates that more than 100,000 merchants currently take Bitcoin payments globally.

The analysts stress that merchant adoption of Bitcoin is in its "infancy" and that results so far have been inconclusive. It cites Overstock.com falling well short of its Bitcoin sales target last year as an example of a merchant who is not enjoying significant benefits from Bitcoin payments. But the authors also stress that it's too early to write Bitcoin off, and that they will "closely monitor" merchant Bitcoin-use in the coming months.

The report also noted that nearly 80% of trading volume on Bitcoin exchanges is driven by trade in the yuan-Bitcoin currency pair, although it did not point out that Chinese exchanges often don't charge fees for trading, leading to higher trading volumes.

The opportunity for Bitcoin-linked companies is tiny compared to the potential gains available in other sectors identified in the report. While \$6bn could accrue to firms like Bitcoin exchanges operating in the consumer-to-consumer payments space, some \$17bn is up for grabs in the business-to-business payments sector.

In the field of payments between businesses and consumers, \$84bn could be taken by newcomers.

In May 2015, Goldman Sachs struck a partnership with a major Chinese investment firm, IDG Capital Partners, to lead a \$50 million investment into Circle Internet Financial, a start-up that aims to use the technology underlying Bitcoin to improve consumer payments.⁹⁴ The founders of Circle are aiming to use Bitcoin to move into the burgeoning industry of peer-to-peer payments. The industry is currently led by companies like Venmo, a PayPal-owned application that allows friends to quickly send one another money rather than using a check or a bank transfer, which can take days to go through.

⁹⁴ <http://www.nytimes.com/2015/04/30/business/dealbook/goldman-and-idg-put-50-million-to-work-in-a-bitcoin-company.html? r=1>
<http://www.businessinsider.com/goldman-sachs-gets-into-bitcoin-2015-4#ixzz3aDHv2IEQ>

Circle is focused on providing the benefits of block-chain technology to enhance global payments, while absorbing the risk that volatility poses to consumers using Bitcoin⁹⁵.

Martin Tillier at Nasdaq.com writes (sic): Big business usually deals with challenges to the status quo in a certain way: First they attempt to ignore them, then they ridicule and attempt to destroy them, and finally, if they still refuse to go away, they simply buy them. Goldman, it seems has rushed through all of these stages with reference to Bitcoin. Just over a year ago, they stopped ignoring digital currency and moved into ridicule and attack mode, publishing a report⁹⁶ that recognized the potential of the underlying technology, but concluded that Bitcoin was "...not a currency..."

Bitcoin. In its report: A Primer for Policymakers by Jerry Brito & Andrea Castillo⁹⁷ describe that as the world's first decentralized digital currency, Bitcoin has the potential to revolutionize online payments systems in a way that benefits consumers and businesses. Instead of using an intermediary such as PayPal or submitting credit card information to a third party for verification –both of which often include transaction fees and other restrictions –Bitcoin allows individuals to pay each other directly for goods or services.

The characteristics that make Bitcoin so innovative have also made it a target for regulators, who fear that the cryptocurrency will aid tax evasion, money laundering, and other crimes. While it is true that it can be used for nefarious purposes, the same can be said of cash. But, unlike cash, Bitcoin transactions are recorded in an online ledger.

In this primer, Jerry Brito and Andrea Castillo describe how the digital currency works and address many of the common misconceptions about it. They also analyze current laws and regulations that may already cover digital currencies and warn against preemptively placing regulatory restrictions on Bitcoin that could stifle the new technology before it has a chance to evolve. In addition, they give several recommendations about how to treat Bitcoin going forward. At the forefront of the debate, Brito and Castillo both support innovation and provide much-needed clarity for policymakers and law enforcement

In their summary the authors conclude that: Bitcoin is an exciting innovation that has the potential to greatly improve human welfare and jump-start beneficial and potentially revolutionary developments in payments, communications, and business. Bitcoin's clever use of public-key encryption and peer-to-peer networking solves the double-spending problem that had previously made decentralized digital currencies impossible. These properties combine to create a payment system that could lower transactions costs in business and remittances, alleviate poverty, provide an escape from capital controls and monetary mismanagement, allow for legitimate financial privacy online, and spur new financial innovations. On the other hand, as "digital cash," Bitcoin can be used for money laundering and illicit trade. Banning Bitcoin is not the solution to ending money laundering and illicit trade, just as banning cash is not a solution to these same ills.

Bitcoin could ultimately fail as an experimental digital currency and payment system. An unanticipated problem could arise and undermine the Bitcoin economy. A superior cryptocurrency could outcompete and replace Bitcoin. It could simply fizzle out as a fad.

The possibilities for failure are endless, but one reason for failure should not be that policymakers did not understand its workings and potential. We are ultimately advocating not for Bitcoin, but for innovation. It is important that policymakers allow this experimentation to continue. Policymakers should work to clarify how Bitcoin is regulated and to normalize its regulation so that we have the opportunity to learn just how innovative Bitcoin can be.

⁹⁵ <http://www.nasdaq.com/article/goldman-sachs-investment-in-bitcoin-is-newsworthy-but-not-significant-cm473061#ixzz3aDIsoGE>

⁹⁶ <http://www.paymentlawadvisor.com/files/2014/01/GoldmanSachs-Bit-Coin.pdf>

⁹⁷ http://coincenter.org/wp-content/uploads/2013/08/Brito_BitcoinPrimer_v1.3.pdf

In an additional report titled **“Bitcoin Financial Regulation: Securities, Derivatives, Prediction Markets, and Gambling”**⁹⁸, authors Jerry Brito, Houman Shadab & Andrea Castillo, argue that the next major wave of Bitcoin regulation will likely be aimed at financial instruments, including securities and derivatives, as well as prediction markets and even gambling. While there are many easily regulated intermediaries when it comes to traditional securities and derivatives, emerging Bitcoin-denominated instruments rely much less on traditional intermediaries such as banks and securities exchanges. Additionally, the blockchain technology that Bitcoin introduced for the first time makes completely decentralized markets and exchanges possible, thus eliminating the need for intermediaries in complex financial transactions.

The Euro Banking Association. The Euro Banking Association (EBA) has published two reports on Digital Customer Service Interfaces (DCSI) and crypto-technologies, with the intention of detailing the electronic payments landscape of the future.⁹⁹

The reports, produced by the EBA’s Working Group on Electronic Alternative Payments (e-AP WG), are intended to help financial institutions (FIs) navigate the changing payments landscape. The publication of the EBA reports follows closely the EU Commission’s “Block-chain and Digital Currencies Workshop” on April 27 2015.

According to the EBA, digital currencies such as Bitcoin or ripple have the ability to disrupt the payment and banking landscape and assist in the fight against cyber-criminals.

The crypto-technologies paper, titled “Cryptotechnologies, a major IT innovation and catalyst for change,” is an information paper for transaction banking and payments professionals. It details four categories (currencies, asset registry, application stack, asset centric), applications such as remittances and real-time payments and scenarios, and describes the respective potential for these different categories of applications to have a major short-term impact on the architecture of systems and processes in a number of digital transaction-based industries. It also details four use cases for the most promising category. It concludes by setting forth four different scenarios of how organizations in transaction banking and payments could position themselves with regard to these new technologies.

“Cryptotechnologies are a key subject for further study for transaction banking and payment professionals, especially against the background of evolving financial infrastructures,” said Vincent Brennan, deputy chairman of the Euro Banking Association and chair of the EBA e-AP WG. “The information paper put together by the e-AP Working Group provides a hands-on introduction to this topic, which specifically focuses on the practical potential and related implications of cryptotechnologies for the transaction banking and payments area in the short to medium term.”

The four scenarios analyzed by the paper reflect different degrees (high and low) of cooperation between banks and the crypto-community, and crypto-adoption by banks. The four scenarios are dubbed:

- “Out in the cold” – the creation of a separate cryptoeconomy.
- “First amongst equals” – an approach where individual payment service providers (PSPs) strive to position themselves as developers of crypto-technology applications.
- “Awake and aware” – a collaborative approach based on constant dialogue and possible partnerships in selective areas.
- “United we stand” – a collaborative approach based on partnerships between PSPs and the cryptotechnology community embracing a successful integration of processes.

⁹⁸ <http://coincenter.org/wp-content/uploads/2015/01/BritoShadabCastillo.pdf>

⁹⁹ https://www.abe-eba.eu/downloads/knowledge-and-research/EBA_20150511_EBA_Cryptotechnologies_a_major_IT_innovation_v1.0.pdf

The report concludes that all are distinct manifestations of cryptotechnology with unique merits and differing levels of current applicability to the transaction banking and payments sector.

Currently, asset-centric developments are potentially the most interesting cryptotechnology-related category for transaction banking and the payments industry. This conclusion has been drawn based on the fact that developments in other areas are still impeded by technological and regulatory challenges, even though these other categories also hold considerable future promise. The industry is therefore advised to stay aware of developments in:

- 1) reach, conversion and cost advantages of currencies and
- 2) reductions in auditing and governance expenditures from asset-centric as well as
- 3) radical innovation from application stack cryptotechnologies.

Asset-centric developments have potential and current applicability regarding today's activities of financial service and payment organisations, because they can operate in an integrated fashion with legacy IT, legal frameworks and existing assets (currencies, stock, bonds etc). The use cases (foreign exchange/remittance, real-time payments, documentary trade and asset servicing) presented in this paper have showcased cryptotechnologies in a more practical context. The categorisation, in combination with the use cases, should benefit the readers of this paper by providing an explanatory structure geared at increasing understanding of ongoing developments in this area.

Technology does not exist nor does it develop in a vacuum. It is subject to institutional norms and dynamics. Comparably, in history few things happen without precedent. By drawing on these insights it has been possible to create potential cryptoscenarios for the transaction banking and payments industry by identifying drivers that were also relevant to voice over internet protocol (VoIP) around the year 2005.

Two drivers, namely cooperation (between organisations in the transaction banking and payments industry themselves and between these organisations and the cryptocommunity) as well as adoption of cryptotechnologies, were identified. The combined outcomes of differing degrees of cooperation and adoption led to four broad and plausible scenarios, which have been detailed in this paper.

Cryptotechnologies are still a nascent area of innovation. Together with emerging and future technical developments in this area, the impact (and speed of impact) of cryptotechnologies on the transaction and payments industry will very much depend on the future cooperation models as well as the adoption of cryptotechnology-fuelled applications by existing or new market players. What can be safely said at this point in time is that cryptotechnologies are an area to be closely monitored and revisited for further analysis.

Commonwealth of Massachusetts Division of Banks: Consumer Attitudes on Bitcoin and Other Virtual Currencies¹⁰⁰ A national survey was conducted to study US consumers' awareness and use of virtual currencies, as well as the drivers of consumers' decisions on whether or not to use Bitcoin or any other virtual currencies. The study was commissioned by the Massachusetts Division of Banks, as a consumer-research initiative coordinated in conjunction with the Conference of State Bank Supervisors (CSBS) recently formed Emerging Payments Task Force (Task Force).

Key findings include:

- **On Sources of Financial Information:** Respondents indicated they learned about banking or financial products from their bank or credit union, or from the Internet. Fewer received this information from friends or family, television or "other" including financial planners or the newspaper

¹⁰⁰ <http://www.csbs.org/regulatory/ep/Documents/Final%20Report-VirtualCurrencySurvey2014.pdf>

- Awareness of Bitcoin and Other Virtual Currencies: Over half of respondents (51 percent) said they had heard of Bitcoin or another virtual currency. Among those who heard of virtual currency, the most common sources of information were the Internet (54 percent) followed by television (25 percent).
 - Men (64 percent) were more likely than women (38 percent) to be aware of virtual currency; More individuals residing in households with income over \$100,000 (70 percent) have heard of virtual currencies than those in lower-income households (43 percent)
 - A higher percent of college graduates (67 percent) are more aware of Bitcoin or another form of virtual currency, with remaining respondents having a high school diploma or less (37 percent).
- Likelihood of use of Bitcoins or other virtual currencies:
 - The likelihood of purchasing Bitcoins varied dramatically by population subgroup:
 - Younger respondents reported much greater willingness to purchasing Bitcoins than older respondents. Among 18-24 year olds, 43 percent said they were “very likely” or “somewhat likely” to purchase Bitcoins, compared with only 8 percent of those older than 55. Among those 65 or older, 75 percent said they were “very unlikely” to purchase Bitcoins.
 - A greater proportion of Hispanics (30 percent) and African Americans (24 percent) than whites (14 percent) said they were at least somewhat likely to purchase Bitcoins.
 - Respondents with high household income were least likely to say they may purchase Bitcoins in the future (11 percent of those with at least \$100K in household income, vs. Nineteen percent of those with less than \$100K).
- Concerns Related to Virtual Currency: Of the respondents who answered the question concerning relevant information needed before using Bitcoins or virtual currency, additional open-ended comments were provided:
 - 25 % said they would never use Bitcoins;
 - 7 % said they would want to know whether Bitcoins were safe before purchasing them;
 - 14 % said they did not understand the purpose of virtual currency;
 - 13 % said they would want to know whether Bitcoins will hold their value.

The **French Ministry of Finance**, in a report published by the Virtual Currencies Working Group, titled “Recommendations to prevent virtual currencies from being used for fraudulent purposes and money laundering”¹⁰¹, in June 2014, identifies three aspects of virtual currencies that are sources of risks: the presence of unregulated participants, the lack of transparency and extraterritoriality. The risks connected to the three main uses for virtual currencies include:

- a) Settling a transaction in a virtual currency, especially noting that there are no consumer protection measures applicable to virtual currencies and they do not fall within the scope of the EU Directive on Payment Services (PSD), and thus, unlike traditional payment methods, offer no protection against fraud.
- b) Transferring money. The virtual currency infrastructure may be used to transfer money at lower rates than those charged by the banking network and international money transfer services, which may undermine the banking system.
- c) Virtual-currency-linked investments. The report considers a risk that virtual currency loans are just beginning to emerge, based largely on trust, particularly via social networks and on

¹⁰¹ http://www.economie.gouv.fr/files/rapport_monnaiesvirtuelles_web.pdf

crowdfunding sites, the use of virtual currencies could allow payment in return for fulfillment of certain conditions.

Finally the report states that given their nature (specifically their extraterritoriality and the lack of a regulatory body) and how they operate, virtual currencies are inherently risky, and can be used to finance criminal activities and facilitate the laundering of proceeds from those activities.

The report proposes recommendations for regulating virtual currencies to prevent them from being used for fraudulent purposes and money laundering, but stating that these recommendations do not address the issue of the legal characterisation of virtual currencies, nor issues of preventing risks in terms of protecting and informing users, and that these recommendations should be rolled out slowly and in stages, based on appropriate circumstances for implementing them.

The Academic Paper, *Of Two Minds, Multiple Addresses, and One History: Characterizing Opinions, Knowledge, and Perceptions of Bitcoin Across Groups*¹⁰² draws attention to the surge of attention around Bitcoin and the authors became interested in finding out how people both inside and outside the Bitcoin community perceive Bitcoin, what they think of it, how they feel about it, and how knowledgeable they are about it.

Towards this end, they conducted the first interview study (N = 20) with participants to discuss Bitcoin and other related financial topics. Some of their major findings include: not understanding how Bitcoin works is not a barrier for entry, although non-user participants claim it would be for them and that user participants are in a state of cognitive dissonance concerning the role of governments in the system.

The participants spanned more than seven different states across the US and vary widely in demographic terms. They recruited 20 participants aged 18 years or older across the United States, of which 10 were Bitcoin users and 10 were non-users. Bitcoin users were recruited online from Bitcointalk and Reddit and non-users were recruited on our university campus via flyers and online using Craigslist.

Their findings, overall, contribute to knowledge concerning Bitcoin and attitudes towards digital currencies in general. Major findings of the study:

- 1) Non-user participants did not understand Bitcoin, but neither did most user participants;
- 2) Most user participants thought Bitcoin had good security and privacy controls despite evidence to the contrary;
- 3) Participants highly disapproved of government regulation but still want governments to insure deposits;
- 4) Participants' opinions about attributes of an ideal payment system map directly to properties that Bitcoin has; and
- 5) Bitcoin has barriers to overcome that make it difficult to be used for mainstream adoption.

A majority of our user participants held various misconceptions about how Bitcoin actually works. Non-user participants bemoaned that they could not use Bitcoin since they do not know how it works; this is clearly not a barrier for the user participants so the real reason must lie elsewhere. User participants staunchly oppose government regulation but still desire them to insure any deposits.

According to the participants, the major advantages of Bitcoin include fast transaction speeds, low transaction fees, security, and no third-party regulation. Perceived disadvantages of Bitcoin included that it is not widely accepted, its price keeps changing, and it has no mechanism for reversing payments. Interestingly, the properties that participants (e.g. including non-users of Bitcoin) ascribed to an ideal payment system are ones that Bitcoin has.

¹⁰² http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2575796

The authors conclude that the Bitcoin user demographic pools are a highly fragmented collection of people that merit further examination while the non-user demographic pool could be surveyed in more detail about the barriers to entry necessary for them to use Bitcoin.

Statistics on Bitcoin

Several online services depict statistics on virtual currencies. In the case of Bitcoin we should mention:

<https://blockchain.info>

<http://www.coindesk.com/data/Bitcoin>

<http://realtimeBitcoin.info>

6.4 Additive Manufacturing, 3D Printing and Scanning

6.4.1 Impact on Policies for Industry, Innovation and Research

Among the many advantages afforded by the application of 3D Printing or Additive Manufacturing (AM) in industry are:

- Reductions in the time and cost required for design, prototyping and testing
- Reductions in the amount of waste generated in production
- Reductions in the number of components required to construct a device
- Reductions the number of steps and time required to assemble the device
- Reductions in the length or complexity of supply chains
- Improved designs that would otherwise have been too complex or costly to produce

The expected improvements are not mere increments, but radical reductions: often in the order of 90% compared to previous approaches. Experience already shows that up to 90% savings can be made in the production of waste alone. The US DOE sees in AM the potential for 50% savings in energy consumption. The cumulative impact of these savings is therefore expected to be profound, both in qualitative and quantitative terms. It is considered that the large scale adoption of AM by existing enterprise will be essential for its future survival. It is expected that the large scale adoption of AM will provide other benefits as well, creating jobs for example by enabling the re-shoring or on-shoring of manufacturing carried out elsewhere.

Most governments recognise that AM has an important role to play in future job creation, and that efforts are needed to help existing manufacturing companies to develop relevant competencies and increase their productivity and competitiveness. Many governments have put in place explicit policies intended to do this, policies that include not only research but also education, training and public procurement.

In June 2014 the European Commission DG for Research and Innovation, Directorate for Key Enabling Technologies published the proceedings¹⁰³ of a conference it hosted on AM in FP7 and H2020 entitled "AM in FP7 and H2020" which emphasised the competitive threat to the EU of major investments being made not only by the US and China but also by Singapore, Israel, Korea, Japan and South Africa. The EC has funded research in this domain since the very first Framework Programme in 1984. FP7 alone contributed €160M towards 60 projects worth over €225M. The report notes that in a few small years the US and China have committed more to research into AM technology than the total cumulated investment of the European Commission since the first Framework Programme launched in 1984. Ultimately this report serves as a red flag to all involved, indicating a need for further investments at EU and member state levels, to ensure that the promise inherent in AM should not be lost due to a very large late spurt of investments by the economies of Asia, Africa and the US. The current PPP approach of the Factory of the Future, in the end may prove to be too narrow and too old

¹⁰³ <http://www.rm-platform.com/linkdoc/EC%20AM%20Workshop%20Report%202014.pdf>

school to do all of what is needed to fully benefit from the new and emerging industrial order. We justify this comment in the following bulleted list:

1. This new industrial order will be based on a combination of the following processes:
 - a. The gradual restructuring of existing industrial systems in domains such as traditional manufacturing, textiles, fashion accessories, consumer goods, aerospace and automobile. These have already started and will continue to use 3D printing technologies to accelerate design and development cycles, to improve the functionality and performance of their goods, to eliminate waste, to eliminate or simplify traditional steps such as the creation of prototypes and the construction of moulds, to simplify and speed up tooling, to enable the fabrication of goods that were previously difficult to create and enable new forms of interaction between OEMs and their clients.
 - b. The emergence of new industrial eco-systems in manufacturing, based on structures that no longer require the presence of the powerful central players or intermediaries that characterize the old order. These were necessary in the past because they guaranteed access to capital, raw materials or distribution channels. They “assembled” and coordinated or orchestrated the activity’s complex supply chains and distribution channels and built up barriers to entry in terms of capabilities in plant-management and intellectual property. These actors may no longer be needed. In domains such as the production of electric vehicles where current markets are still small, but which could over time come to dominate transport and realize the dream of mass customization, it is possible to build modern high performance electric cars, using a distributed micro-factory model based on innovative organizational and business model paradigms, using 3D printed parts, open-source co-design, crowd funding for both plant and buyer finance, all supported by relatively low cost training and mentorship from global gurus working through MOOCs and online collaboration software.
 - c. The transformation of important aspects of the healthcare, medical and pharmaceutical industries via:
 - i. Adoption of 3D bio-printing technologies to create lab-on-a-chip or organ-on-a-chip technologies to accelerate clinical trials and reduce the cost of regulatory research for new drugs and therapies. Examples already exist and the global leader right now is perhaps US based Organovo.
 - ii. The development of viable replacement organs using 3D bio-printing technologies capable of printing personalized complex organs with highly differentiated cell-types, complete with vascularization, as is currently being pursued by many research groups in Europe, the US and other parts of the globe.
 - iii. The use of 3D printing to accelerate the adoption of “precision medicine” where those undergoing treatment receive medication that is customized in terms of the shape of the pill and the volume of the dose, in accordance with precise patient needs.
 - iv. In these cases there seem to be important opportunities for savings in public healthcare expenditure, based on the use of big data to rationalize the prescription of medication.
 - d. The possible transformation of industries that depend on the synthesis of organic molecules, based on a combination of “reactor-ware” where chemical reaction systems are “printed” using 3D printing technologies. These technologies print not only the highly customized and now context-specific reactor, but simultaneously integrate reagents into the system as part of the print process. The print medium used here is based on the use of organic chemical component “inks”. This idea has already been prototyped and the entrepreneurs see it as a disruptive force that will enable new kinds of collaborative research and entrepreneurial activity.

- e. The transformation of food related industries by the emergence of an entire new category of “3D printed food”. Applications that have already been identified include easily edible food for elderly people, patients and anyone with difficulty swallowing. What is exciting about this technology is the possibility of working with entirely fresh or seasonal ingredients. In this sense it can be just as healthy and nutritious as a smoothie or vegetable drink made using a blender. This technology provides a platform for collaboration between food designers, nutritionists and service providers that could transform an important part of our daily lives, via an entirely new way to prepare food for immediate or delayed consumption. It could spell the end of the microwave in the kitchen!
 - f. The transformation of important parts of the construction industry by the application of 3D printing technologies. This is not so much applicable to the printing of whole buildings, but to the printing of building structures and components, using specially designed “concrete”, “insulation” or other product, perhaps integrating carbon fiber, graphene or other high performance materials. What is most exciting in this area, is the possible convergence of robotics and 3D-printing and scanning technologies to create a new generation of robotic tools, to assist construction workers carrying out complex one-of-a-kind tasks either for new-build or retrofitting, repair and maintenance work, based on design goals determined in collaboration with the occupier or relevant stakeholder community.
2. New Industrial Order Inception and Support Mechanisms
- a. The first mechanism cited above is already anticipated by programmes such as H2020 and the PPP initiatives that bring the big players around the table to develop strategic roadmaps and implement joint programmes. These activities are a natural extension of efforts by the European Commission that go back to the very first Framework Programme. However they focus on the role of existing big-industry players catering to a need to preserve employment and tax revenues by helping them to improve their productivity and overall competitiveness in the face of fierce global competition.
 - b. The other 5 mechanisms however are less well catered for. They open up a whole new word of entrepreneurial opportunity that is at best indirectly addressed by existing instruments in Europe. One positive example is the EU SME programme, which limits its support to disruptive and innovative entrepreneurial activities most often found within SMEs. The FTI Pilot supports pure bottom up innovations emerging from within larger industrial entities but, as a pilot, it is not nearly so well funded as the SME instrument.
3. In our view it is worth considering a much more comprehensive approach that addresses not only research, but all other activities necessary to prepare for a possible flourishing of entrepreneurial activity based on new organizational paradigms which are faster, lighter and more flexible than those that underpin the prevailing industrial order. These activities can draw inspiration from the logic of support for total-innovation, as well as from efforts in the US and Asia to develop the new skills and competences required by an entrepreneurial workforce of the future, which will rise to seize these opportunities.

In April 2013, TNO of the Netherlands launched an AM joint research programme¹⁰⁴ with ITRI a non-profit research organisation from Taiwan.

¹⁰⁴ <http://www.3ders.org/articles/20130411-tno-itri-launched-penrose-shared-research-program-for-additive-manufacturing.html>

The Japanese ministry of the economy considers 3D printing as a key technology in manufacturing worldwide. It now funds a programme¹⁰⁵ to encourage interest in 3D printing at universities and to encourage the adoption of 3D printing in selected high schools from 2015. Japan considers that it lags the US and Europe in 3D printing capabilities and included \$44M in its 2014 budget to support in R+D related to the manufacture of metal products.

In 2014 the South Korean government announced plans to develop a 10 year roadmap¹⁰⁶ for 3D printing. This is part of an overall effort by the South Korean government to create jobs based on the convergence of ICT with other industries. They want to catch up on what they see as a shortfall in Korean AM capabilities compared to other countries. At the time of the announcement Korean output in 3D printing represented only 2.3% of the global market. It is expected that the roadmap will help boost this to 15% of global output by 2020. The plan involves the installation of 3D printers at 227 libraries and 5,885 schools by 2017 as well as the training of 10 million South Koreans, including students and entrepreneurs, on 3D printing by 2020. At the same time the Korean government announced a \$2.3M programme¹⁰⁷ to set up 3D printing centres that will encourage the adoption of 3D printing technology by South Korean companies. Currently South Korean firms have only a small role in the global market for printers and 3D print technology. The Korean government hopes that these measures will help Korea have at least 5 globally competitive companies operating in the sector.

In September 2014 the United States Trade Commission published a report on Additive manufacturing Technology: The Potential Implications for U.S. Manufacturing Competitiveness¹⁰⁸. It underlined the need for the US to continue to invest in the domain and identified key areas for future research. This is one of several reports published by the US government. A previous report published by the National Institute for Standards and Technology focused on needs in metrology and provides a roadmap for measurement science applied to metal-based AM¹⁰⁹.

In 2012 the US created The National Additive Manufacturing Innovation Institute. At the time the US already had about 40% of the world's 3D printers. The goal of the institute was to make sure that the U.S. was more competitive in 3D printing and additive manufacturing. Since then it has rebranded the institute as America Makes¹¹⁰ using the catch phrase "When America Makes, America Works". This is clearly a reference to the need to make up perceived lost ground in manufacturing. It is structured as a PPP with an integrated approach to fostering collaboration on 3D printing related technologies, materials and design as well as the training and development of a modern workforce that will respond to the needs of domestic companies using this technology. Programs supported by America Makes help community colleges create certificate, and 2-year degree, programs to ensure that employers can find enough qualified workers to hire.

The PPP involves more than 100 companies, non-profit organizations, academic institutions and government agencies from all over the U.S. America. It is part of the National Network for Manufacturing Innovation¹¹¹ institutes and is driven by the National Center for Defense Manufacturing and Machining or NCDMM¹¹².

The US DOE invests in the activities of America Makes, because it sees in AM the potential for delivering energy-use benefits of up to 50%. The link with the defence industry is no accident either. The defence sector is a large customer for the manufacturing sector in general and is under fierce

¹⁰⁵ <http://www.3ders.org/articles/20140203-japanese-government-to-fund-3d-printing-in-education.html>

¹⁰⁶ <http://www.3ders.org/articles/20140716-south-korea-drawing-up-a-10-year-plan-for-3d-printing.html>

¹⁰⁷ <http://www.3ders.org/articles/20140423-korean-government-invests-in-3d-printing-centers.html>

¹⁰⁸ http://www.usitc.gov/journals/Vol_VI_Article4_Additive_Manufacturing_Technology.pdf

¹⁰⁹ <http://nextbigfuture.com/2009/10/roadmap-for-additive-manufacturing.html>

¹¹⁰ <https://americamakes.us>

¹¹¹ <http://manufacturing.gov/nmmi.html>

¹¹² <http://ncdmm.org>

pressure to reduce costs. The NCDMM was created in 2003 to help the military manage its supply chain by lowering the cost and raising the quality of the billions of dollars of parts and systems it purchases every year. AM is seen as an important way to do this. In particular, the DOD has a vision for "fast fabrication in units of one", in that they want to develop a capability to make equipment and parts on the battlefield that are tailored to the unique conditions facing its soldiers. This is a capability that is of immediate interest to the military but which could have important applications as a dual use technology further down the line. The intention is that future contract manufacturing for the US defense system may include specifications for price and performance that can only be met by using the most recent advances in AM.

This cursory look at AM or 3D printing related policies around the world reveals that the overall focus is very much on manufacturing and the on the competitiveness of established manufacturing companies. Our feeling is that there is a need to look at the bigger picture. This includes potential for growth created by AM or 3D printing in other domains such as healthcare, construction and chemistry, as well as greater prominence given to the role of design and to the possibility of AM enabling new entrepreneurial ventures. AM may need to be reinvented so that it moves beyond the important yet relatively limited view of improvements to traditional manufacturing, towards the enabler of entirely new areas of activity and ultimately as the catalysts for a radical changes in the structure of global industry.

6.4.2 Impact on Intellectual Property, Liability and Consumer Law

The sudden increase of interest in 3D printing in the USA, associated in particular with the rise of the maker movement, but also with increasing interest from teachers in the use of 3D printing in schools, has led libraries to consider the provision of access to 3D printers as part of their overall service to the public. This has led a great many libraries to buy printers and make them available to library users. It has also led to a great level of interest in the possibility of liability due to infringement of copyright or patent law.

The popular press often uses the possibility of 3D printed usable guns to stoke up fear and resentment about the use of the technology. Although it is hard to imagine a measurable increase in gun-related deaths due to the simple fact that a functioning gun could be printed using 3D printing technology, this example may raise issues worthy of debate, arguably as much about the need to use a gun as about its means of manufacture. A much more urgent or widely applicable issue is illustrated by the case of the Coke Bottle. The original Coke Bottle benefits from protection under laws related to copyright, trade-marks and trade-dress. Functional aspects of the design of the coke bottle have also lead to its protection under patent law.

If someone innocently or otherwise were to copy and reproduce the bottle, perhaps using modern scanning equipment, they may in principle violate any or all of such applicable laws. Readily available low cost hand held scanners are very useful tools for the reverse engineering of objects. Libraries are starting to worry about the kinds of things that may be copied or reproduced using a combination of scanning technologies, distribution by email or other means of the corresponding digital files, as well as their reproduction using printers based on their premises. The main concern for libraries is of course their liability in these cases and because of widespread uncertainty, for the moment the American Library Association advises its members¹¹³ to post a notice on the printers they provide for use by clients, intended to absolve them of responsibility in case the machine is used in some way for illegal purposes, for anything ranging from copying a coke bottle to printing a gun.

¹¹³ http://www.ala.org/offices/sites/ala.org.offices/files/content/3D%20Printer%20Warning%20Notice%20for%20Libraries_TLEDITED.pdf

We are not yet aware of similar debates in Europe, but there is certainly a broader set of questions that require examination. These go beyond the liability of a library or other service provider and touches upon the liability of the individual who reproduces the object, as well as a much broader issue of managing extended objects, objects that are reproducible, that are embodied in design files of some kind, and properties that are not obviously a part of the original object being reproduced. For example what if the coke bottle was reproduced as a solid object incapable of holding a liquid intended for consumption, or in wood and not glass, or with a hole in the bottom so that it always leaked.

This discussion is not academic. One of the oft-touted advantages of 3D printing is the ability to print discrete components such as handles, knobs or other pieces of a device that have been lost or broken, and which are no longer supplied by the original maker, these are often very difficult or even impossible to replace. These components may have been designed to fall-off or break, as built-in obsolescence intended to force the user to upgrade. How is this case different from the case of the coke bottle and how is the user protected if the maker decides to prosecute for violation of intellectual property, or violation of other “small print” requirements, of which the user may be utterly unaware?

In a sense these debates are a case of history repeating itself. We had them back then when the music industry systematically blocked any move that gave freedom to consumers and which deprived them of the rents to which they felt they had a right. The development of new businesses and new entrepreneurial activity will benefit from clarity on this area. But maybe it is too early to regulate, perhaps it is best to see what happens so as to focus later on real issues rather than too early on imagined ones. At least we should decide.

Further issues to clarify related to “product liability” in the case of products printed by a user, using a 3D printing technology either home-based or provided by a nearby 3D printing service.

Traditional product liability or consumer protection law applies to a situation where an Original Equipment Manufacturer (OEM) produces a good and sells it to a consumer, who then has a legitimate right to expect that the product will do whatever it is intended to do. One of the key issues here is that the product is made by the OEM, who controls all parts of the process. If the commercial agent provides only the design, and the product is made by the user, this changes things somewhat. In this case if the product proves defective, is the user entitled to their money back? Maybe the defect is due to inaccuracies inherent in the printer. If so, does this make the printer or print-service provide liable? And, how is it possible to prove that the problem was not inherent in the design? Or, that the design was not tampered with? All of these things are possible in a consumer paradigm based on mass customisation. These issues are discussed in some detail in an essay entitled “3D printing and Product Liability: Identifying the obstacles”¹¹⁴ published in Penn Law review in 2013. To put it mildly the author argues that 3D printing “unsettles product liability law’s traditional theoretical foundation”. Although this essay is based on US law, it serves to open up a discussion and illustrate the range of issues that may need to be addressed. Other essays include “The Effects of In-home 3D Printing on Product Liability Law”¹¹⁵ in the journal of Science policy and Governance.

It might be helpful for European legal experts to examine this in more detail. Although we are a less litigious society than the US, consumers may need protection and clarity on issue such as these could help create better more viable business models on which to base future entrepreneurial ventures. It would reassure would-be entrepreneurs as well as their clients and improve their prospects of developing a thriving business and realising the potential that these technologies represent.

¹¹⁴ <http://www.pennlawreview.com/online/162-U-Pa-L-Rev-Online-35.pdf>

¹¹⁵ http://www.sciencepolicyjournal.org/uploads/5/4/3/4/5434385/harris_new_ta1_1.2.2015_lb_mg.pdf

6.4.3 Impact on Policies in Education

Schools all over Europe, and all over the world, in the US, Australia, China and South Korea, have recently started to integrate the use of 3D printers in the teaching of both traditional and new curricula.

In the case of the UK this started seriously in 2012 when the Department for Education funded 21 secondary schools in a pilot project to explore new and innovative ways of teaching STEM and design subjects in UK schools that realise the full potential of 3D printers. A summary of findings was published in October 2013¹¹⁶. Teachers felt that their students were highly motivated because 3D printers helped them move quickly through stages from design to manufacture. They felt it was best suited to project work and saw it as a vehicle for stimulating and motivating interest in a wide range of domains not just STEM subjects and design but other areas such as physics, biology and geography and history. The main issues arising include the need to provide teachers with adequate training and help them develop curricula that made full use of the pedagogical potential of the technology. Since then the Department of Education has announced a £500,000 fund to enable 60 schools to purchase equipment and train teachers how to use it effectively, with a view to eventually rolling this out into the whole of the UK educational system. Although the main reason for the programme is to enhance and improve education in STEM subjects, it is also being driven by a realisation that 3D printers were “revolutionizing manufacturing and it is vital that we start teaching the theory and practice in our schools” (quote from the UK education secretary Michael Grove.)

President Obama referred to 3D printing in his state of the union address in February 2013. He laid out a vision for the future of 3D printing in the US noting that “a once-shuttered warehouse is now a state-of-the-art lab where new workers are mastering the 3D printing that has the potential to revolutionize the way we make almost everything. There's no reason this can't happen in other towns.” Initiatives such as America Makes ensure the availability of training and education programmes at community colleges and providers of 2 year degrees. At lower levels it mainly relies on the initiatives of teachers to integrate 3D printing into the normal teaching activities as a natural part of their pedagogical innovation process. 3D printing companies consider schools as an early market that will help boost awareness of and stimulate interest in the development of the sector. They create packages priced for affordability by parents and teachers. They provide software adapted to their needs and the capabilities of students, as well as material for courseware development. For example:

- Printrbot has an Educational Ambassador Bot program¹¹⁷ and has promised to provide one printer for every classroom in the US at a discounted price of \$399 per school.
- The MakerBot Academy¹¹⁸ is an initiative to improve STEM literacy by putting a MakerBot desktop 3D Printer in every school in America.
- MIT-Founded NVBots has set aside \$2M to Spread 3D Printing in Schools¹¹⁹.
- Stratasys¹²⁰ a provider of industrial grade additive manufacturing machines provides a rental programme aimed at educators since 2011. The idea is that the printer is provided initially at very low cost, so that the teacher can use it to demonstrate its capabilities and help raise money needed to pay for the machine, maintain it and buy supplies. Nowadays they can use crowd funding as one of the possible approaches.

¹¹⁶ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/251439/3D_printers_in_schools.pdf

¹¹⁷ <http://printrbot.com/education/printrbot-educational-ambassador-bot-program>

¹¹⁸ <http://www.makerbot.com/academy>

¹¹⁹ <http://bostinno.streetwise.co/2015/02/10/3d-printing-nvbots-raises-2m-funding-for-school-3d-printer>

¹²⁰ <http://www.stratasys.com>

In addition to these kinds of initiative, the Robert C Byrd Institute for Advanced Flexible Manufacturing¹²¹, based in Western Virginia USA (which normally serves local industry, national contractors such as NASA, and Fortune 500 companies) has now started to work with students, teachers and makers to introduce 3D printing in the classroom. Their goal is to prepare educators to use this innovative technology. They have developed courses during which teachers will design and fabricate 3D objects using computer-aided design (CAD) software and 3D printers. The idea is to explore new ways of thinking and creating and to help prepare educators to use the innovative technology in teaching.

Australia has also been quick to encourage the uptake of 3D printing in schools. One of the programs of Quantum Victoria¹²², a science and maths innovation centre funded by the Victorian Government, is training teachers how to build and use 3D printers and incorporate them into school curriculum. Makers Empire¹²³, an Australian developer of 3D printing software, has developed software specifically targeted at primary and secondary school users. They claim that with this software, a group of five-year-olds can learn to design and print in 3D, within one hour. Although originally trialled in Australia, the software has garnered interest from primary and secondary school teachers in Hong Kong, South Korea, Malaysia, Singapore, the Philippines and the USA.

Earlier on we mentioned the Korean initiative to install 3D printers at 227 libraries and 5,885 schools by 2017, and to the training of 10 million South Koreans, including students and entrepreneurs, on 3D printing by 2020. 3DPrint an online newsletter recently reported that the Chinese government¹²⁴ has a plan to put 3D Printers in all 400,000 Elementary Schools over the next 2 years. NB There may have been mistakes in translation in both of those messages. Perhaps the 10 million Koreans should have been 1 million or even 100,000. Perhaps this was 400,000 printers, not 400,000 schools. It seems that the news was relayed by a representative of Taiwan based XYZ Printing, that has partnered a Lenovo subsidiary called Magic Factory, to 3D printers in China. We will have to wait and see what transpires in the end. The basic message, however, is that China intends to make an important investment in the application of 3D printing in education.

¹²¹ <http://www.rcbi.org>

¹²² <https://www.quantumvictoria.vic.edu.au/student-programs>

¹²³ <https://www.makersempire.com>

¹²⁴ <http://3dprint.com/56699/china-3d-printers-schools>

7 Comprehensive Policy Issues

Here we discuss the policy issues arising out of the previous discussions. In most cases the relevant policy issues are easy to compartmentalise and are discussed in conjunction with the relevant technology-specific recommendations. However, in the case of Additive Manufacturing and 3D printing, we provided a separate discussion around the policy issues in this area. This is because the area is riddled through with various policy issues that cut across many of the recommendations; indeed many of the policies mentioned in this particular discussion propagate throughout the entire technology spectrum that we are studying. It would have made no sense for issues with such comprehensive reach across the policy spectrum to be constrained to one recommendation or another.

7.1 Collaboration Technologies

7.1.1 Policy issues affecting economic growth

Policy Recommendation 1.1: Stimulate a free flow of co-created ideas. Co-created ideas are increasingly important for creating new products that satisfy a fast-changing market. To ensure EU competitiveness, copyright and IP rules need to become uniform across the EU. This will also stimulate creation and distribution of Open Source Software, Open Designs and Open Data, benefiting businesses that can build growth-driving new products on top of such open assets.

This relates to the Knowledge Economy, including the policy debate about a possible fifth freedom for content and knowledge¹²⁵, but focuses on crowd-sourced ideas rather than digital content and results of academic research. This remains a highly contentious policy area. The extreme ease of copying digital materials has led to suggestions that relaxing copyright rules might be beneficial for society, but on the other hand other incentives for creating valuable materials must then be found. Indeed some of our academic respondents made suggestions for relaxed patenting and copyright regulations. New collaborative Internet technologies will not fundamentally change the conflict between the desirability of reusing what exists and ensuring fair remuneration to original creators.

Freedom of expressing ideas (and conveying information) is already ensured¹²⁶. The European Commission has identified the completion of the Digital Single Market (DSM) as one of its ten political priorities and recently published a strategy for achieving this political goal¹²⁷.

Harmonisation of copyright and related rights (Directive 2001/29/EC¹²⁸) is in progress for implementation as an own-initiative of the European Parliament (see the report on this process¹²⁹), although it relates mainly to the cultural and creative sectors. However, the issue of *collective licensing* of works within music mentioned in the directive should be considered also for co-created ideas, as the difficulties of keeping track of individual rights is similar. We support the statement "*lessons may be drawn for other types of content from the approach taken in Directive 2014/26/EU on collective rights management*", in the following way:

Relying on national collective rights organizations to monitor use and to remunerate rights holders will not work for co-created ideas, as there are no existing organizations to pick up this task, and the

¹²⁵ *Report on a new Digital Agenda for Europe: 2015.eu*, European Parliament Committee on Industry, Research and Energy, 25 March 2010

¹²⁶ *European Declaration of Human Rights*, Article 10

¹²⁷ *A Digital Single Market Strategy for Europe*, Communication COM(2015) 192, European Commission May 2015

¹²⁸ *Directive on the harmonisation of certain aspects of copyright and related rights in the information society*, European Parliament and the Council (2001/29/EC), 22 May 2001

¹²⁹ *Implementation of harmonisation of certain aspects of copyright and related rights in the information society*, Report, European Parliament (2014/2256(INI)), 24th June 2015

involved stakeholders are widely fragmented. An official European Copyright Office is missing (N.B. a non-governmental initiative by that name exists), it should be similar to European Patent Office and the US Copyright Office for registering copyrights. We recommend however, to consider solutions that do not require a centralized entity for registering copyrights. Technologies for *distributed public ledgers* are emerging (similar to the block-chain technologies used by crypto-currencies), that can enable co-created ideas to be digitally signed and identify the rights holders and optionally who is the collective rights organization. If given legal recognition, such technologies will improve the handling of multi-party and multi-terrestrial rights in the highly dynamic Knowledge Economy, and provide a focal point for fighting copyright infringements. We propose a public consultation process on copyright registration, followed by either a tender for finding the best *distributed public copyright ledger* solution, or initiating a political process for establishing a *European Copyright Office* to be in charge of this and other EU copyright mechanisms.

A recently emerging issue is the so called freedom-of-panorama, which is “a provision in the copyright laws of various jurisdictions that permits taking photographs and video footage and creating other images (such as paintings) of buildings and sometimes sculptures and other art works which are permanently located in a public place” (Wikipedia). Directive 2001/29/EC makes it optional for member states to allow "freedom of panorama". The report on harmonising copyright rules mentioned above recommends to make the most restrictive rules mandatory for all member states, causing public controversy whether this is desirable and highlighting consequences for material already published under the less restrictive rules of several EU countries.

The possibility of protecting ideas (in the industrial sense) across Europe is ensured by the European patent process, but patenting is costly and often unsuitable for co-created ideas. Some academics argue for less strong patent protection rules (for example requiring direct use of patents for own products, therefore forbidding indirect use of patents for passive, offensive and defensive purposes), while large corporations with wide patent portfolios can be expected to be strongly against this.

We also recommend increase *funding to co-creation initiatives* through European research and innovation programmes (notably Horizon2020). However, we believe that it is important to require a review of the legality of using the research results before approving projects, to ensure that project results do not turn out to be un-exploitable at the end.

Policy Recommendation 1.2: Launch crowd funding initiatives that increase crowd funding awareness and understanding, and that eliminate the legal uncertainties that follow from the usually transnational nature of crowd-funding, and by following the evolution of innovative crowd funding schemes¹³⁰.

It relates to *shadow banking*, which is ‘a system of intermediaries, instruments, entities or financial contracts generating a combination of bank-like functions but outside the regulatory perimeter or under a regulatory regime which is either light or addresses issues other than systemic risks, and without guaranteed access to central bank liquidity facility or public sector credit guarantees’, and that represents 25 to 30 % of the total financial system¹³¹.

European innovative enterprises are under-financed, and stimulating crowd funding is a chance for the EU to strongly increase the transfer of innovations into commercial reality. In particular, SMEs may benefit from increased use of crowd funding¹³². Crowd funding may disintermediate traditional

¹³⁰ Unleashing the potential of Crowd funding in the European Union, COM(2014) 172, European Commission, March 2014.

¹³¹ *Shadow banking*, European Parliament resolution (2012/2115(INI)), 20 November 2012

¹³² *Communication on Long-Term Financing of the European Economy*, COM(2014) 168, European Commission, March 2014.

banking actors in Europe that possibly price risks too highly and that therefore miss opportunities for profitably funding digital innovations¹³³.

This may be part of a wider policy initiative, towards a proposed Capital Markets Union by 2019. A public consultation process is needed, for *simplifying the financial regulations* on banks and capital markets, and for *channelling all types of funding* towards entrepreneurs and businesses with high growth potential¹³⁴.

Policy Recommendation 1.3: Increase funding to initiatives that contribute to commons-based resources. Contributing improved or new assets to commons libraries maximises their utility. This is in direct conflict with the aims to stimulate a vibrant industry on the EU, based on some protected assets. This goal conflict is not easy to solve, but the "Power of crowds" will enable some commons-based initiatives to surpass existing commercial products, making any claims that we must protect the traditional industries in the EU a moot point - they need to change or will have to close shop. Already there are examples where commons-based approaches exceed the capabilities of commercial or governmental organisations, both in quantity and quality (eg. Wikipedia).

This area does not lend itself well to direct legislation, apart from ensuring that copyright and patenting frameworks do not unnecessarily hinder use of and contributions to commons libraries (see above, CI1). Already there are examples where commons-based approaches exceeds the capabilities of commercial or governmental organisations, both in quantity and quality (eg. Wikipedia).

If benefits from synergies between the activities of formal science and loosely connected online groups are to be increased, it will be necessary to create specific incentives for it, for example targeted European research initiatives in this direction¹³⁵. We recommend that the Horizon2020 programme (work programme 2016-2017 to be made official 14th September 2015) increases its focus on public results contributed as open source or to other kinds of public commons areas, in particular in the ICT Industrial Leadership and Societal Challenges sub-programmes.

7.1.2 Policy issues driving citizen value

Policy Recommendation 1.4: Increase citizen protection on use of crowd-sourced data. It is well known that most people do not read long-winded online agreements for giving consent, and there is therefore a strong need for minimum citizen protection against unfair or privacy-invading use of data about them. Trust is absolutely essential for citizens to voluntarily allow service providers to use personal data provided by them for valuable services, for example for resource sharing or for services based on "Big Data" analysis. Already it can be seen that dominating actors like Google and Facebook require their users to give far-reaching rights to them, allowing the analysis of personal data and to [commercially] re-use the results, even with third parties. The Digital Agenda however correctly identifies that "we expect control over our personal data"; however, control does not necessarily mean constraint.

In the US, there is on-going debate on how to best ensure privacy in the face of complex service offerings to consumers. In particular the principle of "notice and choice" has been used extensively in the past, as opposed to statutory and administrative regulation¹³⁶. This study claims that the Notice-

¹³³ *The Need for an Innovation Principle in Regulatory Impact Assessment: The Case of Finance and Innovation in Europe*, P. Zilgalvis, Policy & Internet Volume 6, Issue 4, pp377-392, December 2014, DOI: 10.1002/1944-2866.POI374

¹³⁴ *Joint Declaration on the Capital Markets Union*, AFME/EBF/BAE/EBAN/EBN/ECN/EUROCHAMBERS and European Issuers, May 2015

¹³⁵ *Employing digital crowdsourced information resources: Managing the emerging information commons*, Int. Journal of the Commons, Vol. 7, no2, August 2013, pp255-277, Igitur Publishing 2012, ISBN 1875-0281

¹³⁶ *Privacy Harms and the Effectiveness of the Notice and Choice Framework*, J. R. Reidenberg, Fordham Center on Law and Information Policy, 2014.

and-Choice principle is suitable for avoiding unauthorised disclosure of personal data, but only if the non-disclosure commitment is accurate, for example "we will only share with our affiliates" is not accurate enough.

Directive 95/46/EC is under a process of significantly reforming EU data protection rules (see Directive IP/12/46), with aims for both economic growth and for giving better protection for EU citizens. Specifically for citizens, MEMO/15/5170 confirms new rights for citizens to be forgotten, easier access to own data and how it is processed, and it also aims to ensure information to citizens via authorities when data breaches happen. The legislative process is expected to finish by the end of 2015.

We recommend as a policy option to strengthen the notify-and-choice aspects of EU data protection rules, since this is less well addressed by Directive IP/12/46.

Policy Recommendation 1.5: Increase citizen protection against fraud in crowd funding. While current law already prohibits publishing false or misleading prospects for funding, stronger restrictions and enforcement mechanisms are needed in the face of transnational crowd funding schemes. Similar to policies against tax evasion and money laundering, this will require international transparency agreements beyond EU, to ensure detection and accountability of fraudulent crowd funding offers.

Lacking specific legislation, the crowd funding community in the EU attempts to establish criteria for consumer protection that might be suitable to make firm as EU-wide policy, within operational and financial transparency, financial control, and security of information (www.crowdfundingframework.eu).

Policy Recommendation 6: Rework the Data Retention Directive (2006/24/EC). It mandates that member states have to store data about citizens' publicly available communications services, for a time of 6-24 months. However, on 8 April 2014 the Court of Justice of the European Union declared this directive invalid, so this is a contentious policy area and the directive needs to change. Here we only reflect upon what are the possible consequences of the directive in relation to new Internet collaboration technologies. Platforms for e-meetings, crowd-sourcing, crowd-funding, co-creation and social production all have features for communicating between people and are usually publicly available. As such, they probably fall under the invalid 2006/24/EC directive. The diversity of such services and the likely emergence of new collaboration technologies make it unfeasible to maintain a list of specific technologies in this type of directive. We give no specific policy recommendation in this area, since the court ruling already indicated the need for national data retention laws to ensure that only data that is strictly necessary for fighting serious crimes is retained, and that there must be mandatory substantive and procedural conditions for it. See also recommendation 1.4 above.

7.2 Big Data and Open Data

7.2.1 Open Data

Here we provide a range of recommendations for policy development, which could foster the creation of open datasets, as well as their exploitation and extensive use in applications with high socioeconomic impact. Along with these recommendations, we also provide examples of good practices and/or on-going policy initiatives that are related to the implementation of these recommendations (or at least parts of them). Most of the good practices provided stem from member states that have a pioneering role in the Open Data movement.

7.2.1.1 Policy issues fostering the production and publication of Open Data

Policy Recommendation 2.1: Encourage the publishing of open government data. Governmental organizations and public bodies (including municipal and regional governments) can become primary

providers of open data sets. This should not however be left only on their good will to structure and publish information as open data. Rather policies and regulations that would encourage or even oblige public bodies to publish information as open data are necessary. Such policies could for example relate to obligatory (rather than optional) publishing of information about public spending, legislation and governmental archives.

Examples of Policies and/or Good Practice: Activities that align to this recommendation, including for example the publication of clinical trials data as part of the EU Clinical Trials Register (<https://www.clinicaltrialsregister.eu/>), the establishment of open data portals at a national (e.g., <http://data.gov.uk/> in UK, and <http://dati.gov.it> in Italy) and EU (e.g., <http://publicdata.eu/>) levels. Furthermore, this policy recommendation is already substantiated on the basis of EU directives such as the EC Directive on the re-use of public sector information (Directive 2003/98/EC, known as the 'PSI Directive'), as well as on the basis of initiatives for publishing government data as open data sets such as the OpenSpending (<https://openspending.org/>) initiative. However, these Directives need further refinement to make them truly universal.

Policy Recommendation 2.2: Foster/Promote Digitization. Nowadays, many governments (in the EU and worldwide) are still producing data in paper format. Furthermore, state organizations and public bodies possess already large volumes of non-digital archival material. As more and more information becomes available in electronic form, public bodies are presented with more opportunities for generating and publishing open data sets. In this context, there is a need for policies that promote digitization of archived materials (e.g., maps, historic budget sheets, collections of images, old laws and regulations, state archives), along with policies that ensure the digitization of existing processes for the latter to generate data in electronic formats.

Examples of Policies and/or Good Practice: A prominent example of relevant policies includes the EC Recommendation on Digitisation & Digital Preservation¹³⁷, which targets to make available 30 million objects through Europeana by 2015, including all Europe's masterpieces that are no longer protected by copyright, along with materials digitised with public funding. Note that metadata in Europeana are available as linked open data¹³⁸, which is a good example for the exploitation of digitization for the publishing of open data sets. Member states have been implementing the directive. This successful example should be extended for other types of data, including, for example, research data, clinical trials data and more.

Policy Recommendation 2.3: Promote awareness in public sector bodies and employees. The creation and publication of open data sets, transcends several processes within governmental and public sector organizations. In order to maximize the effectiveness of Open Data production processes a holistic approach is necessary, which will treat all data producers/creators as potential open data contributors. Such processes should be supported by employees that understand the merits of Open Data generation, along with the details of the process of transforming data to Open Data. This asks for policies that promote Open Data awareness in the public sector, including targeted dissemination, communication and training activities.

Examples of Policies and/or Good Practice: Member states have invested in the training of public servants on open data opportunities. For example, in 2014 the UK Government allocated £150,000 towards funding a programme for training public servants to better understand the opportunities presented by open data. As part of this programme the Open Data Institute (ODI) trained public-sector employees on how to make data more usable. Specifically, public servants were offered free data training 'vouchers' (worth £250 per course) as part of the open data initiative. The vouchers were covered by the £1.5 million funding for open data projects. Likewise, public authorities in member

¹³⁷ <http://ec.europa.eu/digital-agenda/en/digitisation-digital-preservation>

¹³⁸ <http://labs.europeana.eu/api/linked-open-data/introduction/>

states provide “open data handbooks”, which provide advice and information on releasing open data. Such a handbook has for example been released as part of the Open Government Partnership in Denmark¹³⁹. Other member states should implement similar training programmes for public sector employees.

Policy Recommendation 2.4: Establish and encourage partnerships (Public-Private, Public-Public) for Open Data publication. Several meaningful Open Data sets can be only published on the basis of the collaboration of two or more organizations, as part of partnerships between governmental organizations or even between public and private organizations. Policies that encourage such partnerships could therefore act as a catalyst to the generation of more sophisticated and higher quality data sets with significant added value. The policies should remove any barriers preventing the sharing of data between organizations, while at the same time easing the establishment of agreements for formal or informal collaboration including MoUs (Memorandum of Understanding) between them.

Examples of Policies and/or Good Practice: As examples, one can consider the collaboration of statistical authorities with private sector enterprises towards publishing (aggregate) datasets associated with economic performance and/or innovation of the private sector. Similarly, the EC has established the “Big Data Value Public Private Partnership”, which links up European industry (large players and SMEs), researchers, academia and the European Commission to cooperate in data research and innovation, enhance community building around data and setting the grounds for a thriving data-driven economy in Europe ¹⁴⁰.

Policy Recommendation 2.5: Link the generation of open data to goals associated with accountability, transparency, trust and fair information practices. The publication and use of Open Data sets is a catalyst for the accomplishment of goals associated with a government’s accountability, transparency and trust, while at the same time boosting free and unrestricted access to information. Thus, policies that will directly link Open Data to these goals are needed. Such policies should be established as the next step in the production, publication and maintenance of public records. As a first step, policies associated with access to and availability of public records could be updated/enhanced on the basis of the Open Data concept. Furthermore, freedom of information laws in member states, usually including information about records management and data catalogs, could be revised/enhanced to mandate publishing of open data sets.

Examples of Policies and/or Good Practice: The publication and availability of several data sets in Europe has been a result of political commitments towards open and transparent government. Some prominent examples include: (A) The Government transparency and accountability policies of the Cabinet Office in the UK¹⁴¹; (B) In Finland political commitment towards open government have led to the open data programme¹⁴² (17 May 2013 – 30 June 2015), which was led by the Ministry of Finance and aimed at eliminating obstacles to the re-use of public data while at the same time facilitating the processing of making public administration data open. Beyond national policies, the Open Government Partnership¹⁴³ provides a global level international initiative towards open government, which includes currently 65 countries committed to the implementation of open government reforms, which in most cases involve the publication and use of open data sets.

¹³⁹ <http://www.opengovpartnership.org/country/denmark>

¹⁴⁰ <https://ec.europa.eu/digital-agenda/en/news/big-data-value-public-private-partnership>

¹⁴¹ <https://www.gov.uk/government/publications/open-data-white-paper-unleashing-the-potential>

¹⁴² www.vm.fi/opendata

¹⁴³ <http://www.opengovpartnership.org/>

The proliferation of political commitments and initiatives (at national, regional and local levels) towards open transparent government will be a catalyst for the production of a rapidly increasing number of open data sets and related applications.

Policy Recommendation 2.6: Safeguard the Open Data publication process against Security and Privacy concerns. The publication of Open Data sets could (in several cases) raise serious security and privacy concerns. This can be for example the case for data that comprise information about private individuals or government vendors, corporate data, or even data that should be disclosed for the sake of public interest. Therefore, policies should define exemptions in the process of Open Data publication (i.e. data that should not be made public), along with the type of data that should be scrutinized. Likewise, policies should be complemented with a description of relevant auditing processes (e.g., sensitivity review of archival records).

Examples of Policies and/or Good Practice: In the UK national records/archives are made available to the public as part of the Freedom of Information Act 2000¹⁴⁴. In order to enable the public's access to the records, government departments preparing and transferring the records to the National Archives must review the access requirements of those records towards identify parts/materials that: (A) Should be retained; (B) Should be transferred as closed i.e. due to some Freedom of Information (FOI) exemptions; (C) Could be transferred as open data, given that no FOI exemptions apply. Such a review process is a prerequisite for opening access to archives/records, thus increasing the volumes of available open data sets.

7.2.1.2 Policy issues fostering the exploitation and use of Open Data

Policy Recommendation 2.7: Remove barriers and restrictions associated with access to Open Data. In order to use and full leverage Open Data sets at a large scale, third-party organizations and individuals should be facilitated in accessing the respective datasets. This mandates policies that remove any unnecessary barriers and restriction to access and consumption of open data. Such restrictions may include requirements for registration and authentication, complex licensing schemes, limitations on usage (e.g., restrictions on the volumes of open data that can be accessed), copyright restrictions, access fees, provision of justifications prior to accessing/using the data and more. Policies dealing and/or impacting Open Data should ensure that such restrictions are imposed only when absolutely necessary. The trade-offs between ease of access and other concerns (e.g., malicious use) should be always considered. Legal or regulatory restrictions associated with access and use of the data should however be provided. These should include the limitations and responsibilities that particular parties have in order to work or provide the data.

Examples of Policies and/or Good Practice: As an example of barrier removal, any fees charged to the public in order to process Freedom of Information (FOI) requests should be removed. Such fees are or were in place in some Member States (e.g., Ireland as part of Freedom of Information (Amendment) Act 2003 and Malta (Freedom of Information Act (Chapter 496 of the Laws of Malta)).

Policy Recommendation 2.8: Ensure appropriate maintenance and updates. All policies that relate to the creation/generation of Open Data sets should make provisions for the maintenance and updating of the datasets in a sustainable fashion. One-time released but infrequently updated datasets may have very limited value in the scope of highly dynamic landscape. Similar to governmental databases, Open Data sets will be prone to become outdated or even wrong if not properly and frequently updated. Frequency and process of updates should be therefore specified in all relevant policies.

Examples of Policies and/or Good Practice: OpenData handbooks provided to the open data publishers (e.g., public authorities and cities) should provide detailed information and processing for editing and maintaining data sets. Currently, the importance of maintenance is underlined (e.g., in

¹⁴⁴ <http://www.legislation.gov.uk/ukpga/2000/36/contents>

UK" Government Data Service Design Manual¹⁴⁵), but lacks details on how maintenance should be performed.

Policy Recommendation 2.9: Promote the establishment of directories of Open Data sets, along with mechanisms for indexing and searching them. As we are witnessing a proliferation of open data repositories and open data portals, there is a pressing need for facilities that could index Open Data Portals and relevant websites, while at the same time enabling their search. We therefore need policies that will mandate indexing and searching across multiple Open Data sets. Searching and indexing policies will also provide a basis for defining more elaborate access and restrictions (if and only if needed).

Examples of Policies and/or Good Practice: All prominent open data sets come with online catalogues, which enable people to discovery subsets of the data subject to various criteria. Examples include the data catalogue of the World Bank¹⁴⁶, the City Of Amsterdam data sets¹⁴⁷, the official open data catalogue of the Senate of Berlin¹⁴⁸ and more. Furthermore, open data portals come typically with searchable catalogues that enable the discovery of specific open data subsets. Raw datasets should be typically made available in the catalogue, along with relevant documentation. These datasets should be reliably structured and documented, otherwise the will be providing only marginal added-value.

Policy Recommendation 2.10: Provide technical formats that facilitate computer-based processing. The extensive use of Open Data and the delivery of added-value applications will be based on the development of computer-based applications rather than on the manual processing of Open Data. To this end, Open Data publishing/generation policies should mandate their publication in technical formats, which are easily and flexible amendable by computer applications and tools (e.g., XML, JSON and CSV formats). Unstructured or less structured formats (e.g., PDF, HTML, Text Files) should be better avoided in favour of the more structured formats. Furthermore, the provision of Application Programming Interfaces (APIs) for access to the open data set is a prerequisite for data-driven innovation.

Examples of Policies and/or Good Practice: Good practices for publishing open data sets have given by standards organizations (e.g., W3C¹⁴⁹). They indicate the importance of publishing open data in well-known / popular formats such as XML, RDF and CSV. It is also suggested that formats that only the data to be seen, rather than extracted should be avoided. Best practices suggest that data are made human-readable as well (e.g., through their conversion to (X)HTML). As a practical example, one of the most prominent open data set in London is TFL (Transport for London) data. TFL data are offered in the form of static data files (i.e. Data files which rarely change) and feeds (i.e. Data files refreshed at regular intervals), which are accessed through a given API. This API enables thousands of innovative application developers to access the data in their efforts to design and build novel applications, services and tools. TFL data are presented as XML whenever possible.

The provision of data in formats that render them both human-readable and accessible by computer applications and tools, propels the wider use of the open data sets, while at the same facilitating the development of novel applications and services

Policy Recommendation 2.11: Promote Evidence based Policies. Open Data enable the implementation of evidence based policies. As a result, policies and directives that pave the ground for the implementation of evidence based policies (e.g., in areas such as education, innovation,

¹⁴⁵ <https://www.gov.uk/service-manual/technology/open-data.html>

¹⁴⁶ <http://datacatalog.worldbank.org/>

¹⁴⁷ <http://data.amsterdamopendata.nl/>

¹⁴⁸ <http://dataportals.org/catalog/berlin-open-data>

¹⁴⁹ <http://www.w3.org/TR/gov-data/>

research and public health) are expected to act as a catalyst for the rapid adoption and wider penetration of Open Data sets.

Several types of policy makers can benefit from evidence based policies including global and European policy makers (e.g., EC, OECD, UN), policy makers at national/regional levels, statistical offices and organizations, R&D organizations, civil society organizations, providers of BOD processing/visualization tools etc.

Examples of Policies and/or Good Practice: There are many examples of use of open data sets for policy making purposes, from all the above-listed types of organizations. For example, in the Netherlands, the Digital Delta consortium¹⁵⁰ (drawn from the private sector, public bodies and research institutions) explores how the integration and analysis of water data and a range of other data sources can contribute to an approx. 20-30% cost-reductions of future water projects. Digital Delta maintains and provides different data sets, including administrative data, sensor based data (water level) and static geo-information. As another example, the Department of Public Expenditure and Reform in Ireland¹⁵¹ has been recently established in order to reduce public spending to more sustainable levels and to reform and improve public services. It uses/analyses data from statistical offices and administrative data, as part of its effort to suggest ways for improving the budget. An inventory of similar examples has been recently developed by the Data4Policy initiative¹⁵².

Policy makers and evidence-based policy making processes boost the production and wider use of open data sets. At the same time, they propel the development of innovative applications that demonstrate the value of open data in the scope of a data-driven society.

Policy Recommendation 2.12: Facilitate combination and processing of cross-border Open Data. Significant application opportunities (including support for EU wide data and policies) can emerge on the basis of the combination of Open Data produced across multiple countries. To this end, harmonization of the Open Data publishing processes is required, as a means of reducing fragmentation and enabling cross-border services. At the policy level, enhancements to existing policies (e.g., Directive on the re-use of public sector information) will be therefore required.

Examples of Policies and/or Good Practice: Good practices can be derived from the INSPIRE Directive, which provides a basis for EU wide dissemination of environmental and spatial information, along with standardization of its access and use. Standardization is a prerequisite for cross-border open data processing and therefore data standards (e.g., OGC, INSPIRE, ISO, OASIS, W3C) should be considered.

7.2.2 Big Data

Most of the Open Data policy recommendations outlined above could also promote the development of BigData applications. For example policies that promote the production and publishing of large volumes of data, along with policies that facilitate their processing foster the development of BigData applications. However, in this section we also provide ideas about additional policies for BigData development, which could have a positive socioeconomic impact. Recommendations are accompanied

¹⁵⁰ <http://www.digitaledelta.nl/en>

¹⁵¹ <http://www.per.gov.ie>

¹⁵² Martijn Poel, Ralph Schroeder, Jérôme Treperman, Mor Rubinstein, Eric Meyer, Bea Mahieu, Chiel Scholten and Marina Svetachova, "Data for Policy: A study of big data and other innovative data-driven approaches for evidence-informed policy making- Draft report about the State-of-the-Art: invitation for reflection", May 2015 (<http://www.data4policy.eu/>)

by examples of good practices or even policy initiatives providing an early and/or partial implementation of the recommendation.

Policy Recommendation 2.13: Promote Education and Raise Awareness about BigData Technologies and applications. BigData, and most other areas of the Collaborative Economy, will benefit from a critical mass of educated individuals and organizations, including innovators, who will undertake the development of novel applications in areas with high socio-economic impact such as healthcare, climate change, customer-focused retailing and more. Note that the lack of expertise on data science and analytics is acknowledged as one of the main barrier against the development of data intensive computing and the establishment of a data driven economy.

Examples of Policies and/or Good Practice: The need for promoting education and raising awareness about BigData and data intensive computing is nowadays embraced by the action plans of member states, while being at the same time being addressed in the scope of EC initiatives. As a prominent example, the Finnish Ministry of Education has recently invested through its CSC - IT Center for Science Ltd.¹⁵³ in state-of-the-art information management solutions, data services as well as related expert support. Furthermore, several universities are starting new programmes/courses exclusively focused on data science and/or BigData, while also undertaking relevant collaborations within industries.

As another example, the European Commission is funding the European Data Science Academy (EDSA)¹⁵⁴ through its Horizon2020 programme. One of the objectives of EDSA is to provide education and training services to new data scientists across Europe. EDSA activities are carried out by both data science and pedagogical experts. The activities include: (A) An analysis of the required sector specific skillsets for data analysts across different industrial sectors; (B) The develop of appropriate data science curricula, which are able to meet identified needs; and (C) The development of training services in multiple languages based on the curricula developed by the project.

Overall, there is a proclaimed lack of data experts and scientists, which is a serious set-back against BigData innovation. Policies and initiatives encouraging BigData education and training are needed in order to fill this gap.

Policy Recommendation 2.14: Safeguard personal data protection. The safeguarding of sensitive information, along with adherence and compliance to data privacy regulations will unleash the potential of BigData through removing barriers against the wider use of BigData. This is particularly important for applications that leverage data sources which may contain personal data i.e. sources such as loyalty cards, healthcare records, personalized healthcare sensors/devices and social media. In general, the (new) European Data Protection Regulation addresses several of the concerns that have to do with the collection and analysis of personal data, thus providing a sound basis for data protection. However, the peculiarities of BigData analytics applications should be always considered, including: (A) The fact the BigData applications are likely to repurpose personal data sets i.e. use personal data in the scope of totally different applications including applications different from the ones originally anticipated/envisaged when the data were collected; (B) The fact that BigData contradicts the principles of data minimization, since it is likely to use/process all the data available without restrictions, thus creating a need for identifying and justifying the use of only those sources of data that are relevant and needed for the problem at hand; (C) The importance to ensure transparency regarding the use of the BigData, including the purpose, the implications and the expected socio-economic benefit of the processing, which is particularly important in areas such as medical/clinical applications.

¹⁵³ <https://www.csc.fi/en>

¹⁵⁴ <http://edsa-project.eu/>

Examples of Policies and/or Good Practice: The starting point for considering personal data protection in BigData contexts and applications in the EU General Data Protection Regulation (GDPR), which has been very recently approved by the European Council. The new European Data Protection Regulation targets the harmonization of existing data protection laws in the EU member states. Being a “regulation”, it will become directly applicable to all EU member states without a need for national implementing legislation. It addresses several of the data protection issues for BigData applications such as: (A) The provision of extensive information to the data subjects regarding the processing of their data; (B) Provisions data protection impact assessments, especially for high risk activities and applications; (C) The need to notify the individual that profiling is taking place, while also providing adequate details on the consequences of the profiling and the logic involved; (D) Provisions for administrative fines to enterprises violating data protection law.

While the regulation provides a sound basis for dealing with BigData protection issues, points peculiar to BigData applications should be considered in terms of: (A) Ensuring a good level of transparency for BigData applications; (B) Providing proper privacy assessments; (C) Ensuring that consent processes are adequate. In the coming years the regulation should be audited against its ability to respond to the challenges of large scale processing and analytics in BigData Environments. Moreover, provisions should be made in order to ensure that the digital traces of specific people are not excluded from BigData applications (e.g., policy development applications or healthcare applications), since this can lead to a form of social exclusion.

Policy Recommendation 2.15: Reduce fragmentation of BigData initiatives across the EU. Europe could benefit from a unified BigData environment that provides cross-border opportunities. In this direction, the harmonization and unification of the highly fragmented privacy and data protection laws/regulations as part of the single EU market vision, could significantly broaden the horizon of potential BigData applications, on the basis of novel applications that will leverage cross-border datasets. Furthermore, initiatives for novel applications that make use of cross-border infrastructures and datasets should be encouraged.

Examples of Policies and/or Good Practice: The EU Data Protection Regulation is a first step in the data protection harmonization forefront. At the innovation forefront the EC has supported (as part of the Horizon2020 framework) an open data incubator to help SMEs set up supply chains based on data and use cloud computing more. Furthermore, it has invited the development of novel cross-border applications¹⁵⁵, including applications combining cross-border data sets and creating supply chains.

7.3 Crypto-currency

Policy Recommendation 3.1: Define a Recognition process: Crypto currencies should go through a recognition phase by which they can be officially recognized as “money” once they fulfill certain criteria: as a store of value, a medium of exchange and a unit of account. A specific set of policies or laws should be created to categorize and clearly define the legal standing of crypto currencies and their users, businesses, and exchanges. Bitcoin miners should be mostly left unregulated by legislations, except for taxation issues.

Policy Recommendation 3.2: Define and Index Virtual Currency stakeholders: In order to increase consumer protection and have the ability to prevent illegitimacy, businesses dealing with virtual currencies and also related technology providers should be registered. This again should not be necessary for miners. As this technology is in an early stage of development and still relies on consumer adoption in order to become a viable solution, any regulation to restrict simple users such

¹⁵⁵ <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/87-ict-15-2014.html>

as miners should be pursued with care in order to not raise the levels of fear in the minds of potential users; services and offered products will determine the adoption of a crypto-currency. Thus financial privacy rights should be provided to users of crypto or virtual payments systems equal to those provided to users of more traditional payment systems.

What is suggested is that monitoring should be performed to the development of virtual currency providers. The possibility that such actors may choose to transform their products into commodities or securities should be taken into account; especially in the context of the potential use of crypto currencies to aid money laundering.

Position on the 4th Money Laundering Directive

The EU recently finalised, and published in the Official Journal, the 4th Anti-Money Laundering (AML) Directive¹⁵⁶. The directive came into effect on 26 June 2015. Countries will have two years¹⁵⁷ from then to implement the rules contained in the Directive into national laws.

The Directive applies to a range of businesses, from banks and other financial institutions to auditors and accountants. The rules will also have to be complied with by any other kinds of businesses involved in making or receiving cash payments for goods worth at least €10,000, regardless of whether payment is made in a single transaction, or via a series of linked, transactions.

In order to reduce the potential for financial systems to be manipulated in support of money-laundering activities, the Directive requires countries to set up registers¹⁵⁸ of the ultimate 'beneficiaries' (owners of corporate and other legal entities including trusts, etc.) that will be accessible by 'authorities' within each country. The Directive also requires 'obliged entities' such as banks to conduct due diligence on their customers. In the context of virtual or crypto currency transactions it is the 'Exchanges' that perform the role of gateway between the real and virtual worlds and these seem to be sensible places to monitor for potential misdeeds. However, these virtual or crypto currency exchanges (VC exchanges) are not explicitly mentioned in the directive, and thus it remains unclear, whether VC exchanges fall under its powers¹⁵⁹.

The new regime brings into force new customer due diligence checking requirements, together with new obligations to report suspicious transactions and maintain records of payments. Businesses subject to the rules will also have to install internal controls to combat money laundering and terrorist financing activities under the framework. At the moment, it seems that VC exchanges do not. Furthermore, the approved 'transfer of funds' regulation, which aims to improve the traceability of payers and payees and their assets by setting out rules on information on the payer accompanying transfers of funds throughout the payment chain, is NOT applicable to crypto currency transactions.

We consider that, at this stage, an opportunity was lost, to include the only feasible way of monitoring crypto currency transactions into the 4th AML. As previously explained, the nature of crypto currencies such as Bitcoin, does allow for AML controls to be applied to combat crime, financing terrorism or tax evasion activities but only at the place where these currencies are exchanged into fiat currency: the VC exchanges.

¹⁵⁶ http://ec.europa.eu/justice/civil/financial-crime/index_en.htm and <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52013PC0045>

¹⁵⁷ TimeLine of implementation of 3rd AML http://www.anti-moneylaundering.org/EU_Chart.aspx ; it took 3-4 years

¹⁵⁸ We should note that the registers were not included in the European Commission's initial proposal, but were added by MEPs during negotiations. Info: Money laundering accounted for 2.7% of global gross domestic product (GDP) in 2009, or \$1.6 trillion, according to the UN.

¹⁵⁹ Since work was based on the 2012 FATF recommendations, crypto currencies were not included http://europa.eu/rapid/press-release_MEMO-12-246_en.htm?locale=en

Since the laundering of criminal proceeds extends beyond real money into all assets types (bonds, equities, derivatives and crypto currencies) which can be moved easily in international markets and converted back into their only common denominator “cash”¹⁶⁰, we propose that VC exchanges be identified as Money Brokerage Services that have to be included in the registers, or in a separate register.

However, it should be noted that like all technological systems, crypto currencies are actually socio-technical systems. As such we have to consider the human element in this discussion. It should be noted that, for example, the Bitcoin community is split roughly 50/50 into two attitude groups.

- One group wants to take the Bitcoin currency into the mainstream and to comply with regulations. Other communities are even more enlightened and CCEDK¹⁶¹ (an online EU-based crypto currency marketplace, with a physical address in Denmark, abides by AML rules and other practices found in the financial industry. Despite the fact that CCEDK is not considered a financial company under Danish law it also complies with other EU directives such as 2005/60/EC, including the Due Diligence and KYC (Know Your Customer) policies.
- The other group considers the fact that Bitcoin is beyond regulation to be its most attractive feature. They are prepared to do what is necessary to keep the centralised powers away from their resources as they see government control as an evil greater than crime or terrorism.

These two attitudes clearly cannot be reconciled, so it must be expected that if VC exchanges are brought within the scope of the 4th AML directive then the community will fracture and a new community will emerge in a technology envelope that is much more difficult to regulate even than the current crypto currency communities. In other words: great care must be taken to close escape routes when preparing the policy around regulating the current crypto currencies. It is difficult to provide references to substantiate these claims as they emerge from text snippets and conversations; however, the ideals of the most respectable end of the ‘libertarian’ movement can be found encapsulated within the Windhover Principles¹⁶²

Policy Recommendation 3.3: Take a view on Technology. Focus on the technology behind cryptocurrencies (the block-chain). Bitcoin is an emerging technology, which allows two entities to exchange value over the net without relying upon centralized confidence mechanisms (e.g. the existing hierarchical public key infrastructures), or a shared previous history, to develop trust upon. In the Bitcoin model, the block-chain provides a fully peer distributed means of achieving the same end but now trust is based on a consensus and public ledger. The block-chain represents a fundamental breakthrough in trust technology. Introduced, in its fully peered form, by Bitcoin for the first time, the block-chain makes completely decentralized markets and exchanges possible, thus eliminating the need for intermediaries in complex financial transactions.

- The technology could be used for smart contracts, which are self-enforcing and/or self-executing. The block-chain eliminates the need for a third party to resolve a legal dispute. Tokens could be used to represent any asset. The ability to hard-code the transfer of ownership when trading these assets can potentially create “unbreakable” contracts.
- If one would embrace the fact that the entities involved in a transaction could be not humans but machines, adoption of these technology could revolutionize the Internet of Things (IoT) landscape since “things” (like sensors) could use crypto-currencies for financial transactions related to data exchange (paying each other for access to trusted data feeds with e.g. Bitcoin).

¹⁶⁰ <http://www.accuity.com/industry-updates/free-resources/LaunderingBeyondMoney/>

¹⁶¹ <https://www.ccedk.com>

¹⁴¹ <https://www.cryptocoinsnews.com/top-bitcoin-companies-propose-windhover-principles-new-digital-framework-digital-identity-trust-open-data/>

- In terms of non-financial uses, block-chain technology could be used not only for proof of ownership but also for “proof of existence”, and thus be useful in patents. Therefore, any form of asset (being a book by an author, a technical blueprint, a photograph, or song, etc.) could be digitally signed by an owner and associated with that owner until the owner decides to transfer the link to another entity.
- Block-chain is not anonymous, it is pseudonymous, and thus could be used in voting systems, since it allows each vote to be publically shared without identifying the voter and could ensure that a voter has voted only once. The complexity of the technology, secures the network and the transaction, and would be difficult to impossible to hack.
- Regulate around the technology types that can be used in the Bitcoin core service. Fraud is easier to commit if poor technology choices are made (e.g. Because there are huge volumes of data generated in the Bitcoin system and these data change rapidly, non-[ACID compliant data](#) stores are used, as opposed to fully ACID compliant “real” databases, to store transaction data in the block-chain). There is evidence¹⁶³ that inappropriate technology has been used in the past and this leaves the entire infrastructure open to fraud and other financial crime.

Policy Recommendation 3.4: Consider Regulatory Frameworks. Issues associated with different forms of regulation arise in crypto-currencies. In Bitcoin the architecture of the system is highly distributed and decentralized. It embodies a technically pseudonymous operational model, which maintains a level of user anonymity given an intelligent use of the Bitcoin “wallet”. Although there is a trust model built into the Bitcoin architecture at the transaction level, at the system level trust is more difficult to maintain. Issues related to consumer protection and the financial probity of actors within the system are currently impossible to establish and maintain. Supporters argue that the market will eventually exclude those behaving badly. However, the conventional financial markets have recently demonstrated that financial systems are not stable if left unregulated. Because the system has a distributed architecture, no conventional regulation is possible because there is no single responsible entity to regulate.

Decentralised stock exchanges and insurance companies will emerge and, again, it is possible that within these aspects of a cyber currency market, authorities will also not be able to regulate the activities taking place within them.

Policy Recommendation 3.5: Protect Government Revenues. The value of Bitcoin is based on “units of work”. It has no fiat properties and is, consequently, similar in nature to a commodity currency (e.g. gold); therefore, value is intrinsic, not extrinsic. Value is proportional to a unit of work. As the block chain gets longer the more effort the miners have to put into the mining operations and each Bitcoin becomes more valuable. It is microBitcoins that are now traded, not whole Bitcoins. Value still fluctuates in the market because of supply and demand pressures and there have been some wild fluctuations in value recently. Because it is not a fiat currency, no seigniorage is possible. Governments will lose a source of income not only as a result of depressed tax revenues in reachable financial systems but also as a result of the loss of seigniorage.

7.4 Additive Manufacturing, 3D Printing and Scanning

Policy Recommendation 4.1: Current approaches to the development of industrial, innovation and research policies at the EU level ignore how AM and 3D printing technologies go far beyond traditional manufacturing and are relevant for areas including healthcare, medicine, chemistry and construction. Current stakeholder groups may be too restricted, not just in the sense of mainly representing traditional manufacturing industries, but also because they mainly represent large established companies with their embodied need to preserve or increase competitiveness, often to the

¹⁶³ <http://money.cnn.com/2014/02/04/technology/silk-road/index.html?iid=EL>

exclusion of most new entrepreneurial possibilities. It might be of interest to re-invent the domain with a view to looking at the bigger economic opportunity that 3D printing represents, especially in terms of new ventures and new economic models and new more flexible supply chain structures.

Policy Recommendation 4.2: Countries such as the USA seem well placed to use public procurement as a lever for encouraging the emergence of new highly competitive practices in manufacturing. Organisations such as the DOE and the DOD have already targeted AM as a key technology to help achieve the new levels of performance they require. It may be useful to examine the role of public procurement as a level for the adoption and development of AM capabilities in Europe. Our economies are structured differently but there may be a wide range of advanced non-military or civilian products and services that require the involvement of the kind of novel advances promised by AM for those products and services to be realised.

Policy Recommendation 4.3: AM combined with low cost easy to use scanners, seems to raise issues in relation to the management of intellectual property. It would be helpful and useful for consumers, entrepreneurs and educators if this area were clarified. In a 3D printed future, it is important to understand the principles of fair use that may apply, and the good practices to adopt, in order to avoid conflict with IP owners. Prevent the use of IP in blocking activities by companies with a vested interest in maintaining the status quo.

Policy Recommendation 4.4: A new consumer economy based on home-printing or the use of 3D print services raises issues in relation to product liability and consumer protection. It would be helpful and useful for consumers and entrepreneurs to clarify the issues at stake, as well as the principles that may apply across Europe in the context of a single market, and the good practices needed to support good client-consumer relations.

Policy Recommendation 4.5: In the light of experience in the area of 3D printing in education, two issues that seem to arise include the need for training teachers in the use of 3D printing and related technologies, and the need to develop suitable curricula that go beyond the mere use of 3D printers as “demonstrators”. In terms of training teachers may need to know how to use and maintain, not only printers but scanners, design tools and open-data design repositories such as Thingiverse¹⁶⁴. In the case of curriculum development, it might be useful to explore the basic philosophy of the French *Licence, Master, Doctorate* (LMD) system which is implemented through the Bologna Process. The LMD system includes concepts such as the Competence Based Approach to learning, as well as the Project Based Approach and the Problem Based Approach to developing skills needed not only for 3D printing but also for the broader “open collaborative economy”.

7.4.1 Legal Issues Arising with Respect to the 3D Printing Recommendations

Putting 3D Printing into Perspective

In 2014 the EC published a communication to the European Parliament for a European Industrial Renaissance¹⁶⁵. This is a response to the increasingly tough competition from companies based in industrialised and emerging economies, as well as the need to combat the high levels of Euro-zone unemployment. 3D printing has been around for a long time. Until recently its impact was mainly seen in terms of its contribution to rapid-prototyping as well as to small run or one-off manufacturing tasks. The prevailing wisdom was that 3D printing would improve the competitiveness of European manufacturers. The future of 3D printing is pertinent to this debate because of the natural tension between, on one hand, preserving and increasing the competitiveness of existing European industry, while on the other hand enabling the emergence of new industrial paradigms with the potential to

¹⁶⁴ <https://www.thingiverse.com/>

¹⁶⁵ <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52014DC0014>

renew existing sectors and fuel the emergence of new ones, capable of creating entire new markets and new sources of employment.

3D printing has the potential to disrupt a wide variety of industrial sectors, not only those involved in the manufacturing of consumer goods from clothes and footwear, to furniture, household goods and accessories, but also those involved in the manufacture of medical devices and automobiles as well as components and systems for the aerospace industry. The potential for disruption is not limited to industrial manufacturing sectors. It is already spreading to the organic chemical and food sectors. In medicine where it has already revolutionised the creation of replacement joints, bone structures and prosthetic devices such as hearing aids, it is now spreading to medication and clinical trials, while a global race is on to create the first 3D printed complex organs for transplant into humans.

Each of these areas of economic activity is challenged by advances in 3D printing, and each is open to disruption not only in terms of the way in which products are made, but also in terms of the actors involved in production, the division of labour and liability between these actors, the relationship between these actors and consumers, as well as the ways in which production may need to be regulated.

In the same way that the digital economy challenged and transformed the music industry, in the same way that Uber is challenging and transforming the taxi industry, in the same way that AirBnB is challenging and transforming the hotel industry, 3D printing is now challenging traditional high barrier to entry businesses such as the manufacture of automobiles.

The recent emergence of new ultra high speed 3D printing technologies demonstrate that next generation car companies such as 'OS Vehicle' and 'Local motors' may not at all remain limited to small niche markets, but may simply be the first wave of an entirely new kind of 21st century supply chain, that has unprecedented levels of scalability and innovative capacity built in from the start.

Once the old guard comes to realise this they will fight such progress tooth and nail. They will react in the same way as the major music recording labels did in fighting Napster, in the same way the taxis companies are now fighting Uber and the hotel chains are now fighting AirBnB.

Ultimately these may be fighting losing battles, and the prize will be better service for a lower price and a whole new kind of service provider creating jobs where none existed before.

The Regulation of Manufactured Goods

Guns and Firearms

There are many categories of manufactured item that are subject to specific regulation which severely limit not only the use of an artefact, but also its manufacture and distribution. This is the case for medical devices, pharmaceutical and chemical products including explosives and pesticides, as well as firearms and other forms of offensive weapons. There are many legitimate reasons for such legislation and recently the alarm has been rung by concerned parties about the possibility of 3D printing or AM technologies being used to create firearms or other weapons outside of the usual channels and thanks to the method of manufacture, capable of avoiding detection or regulation in any reasonable and legitimate way.

Articles sometimes appear in the popular press voicing concern about the possible use of 3D printing technologies to create guns or weapons for illicit use. The concern is that a gun "printed" in this way will prove untraceable, will not be registered with relevant authorities and will be used for criminal or terrorist acts.

One of the first functional 3D printed guns was created by a US based organization called Defense Distributed¹⁶⁶. This gun, called the “Liberator”, was published in May 2013. It is now only one of several designs available on the net. Defense Distributed itself has also created a range of 3D printable gun components such as magazines and rifle receivers for the AR-15. It is interesting to note that these results were achieved thanks to a collaborative Internet project to create open source weapon designs, called “Wiki Weapon” that was financed at least in part by Bitcoin enthusiasts. The “Liberator” was designed to fire a single shot, whereas subsequent models of 3D printed gun are claimed to be capable of firing as many as 650 rounds. The designs were downloaded more than 100,000 times in the two days following publication. US authorities ordered Defense Distributed to remove the design from their website and they complied. Nevertheless the design is available elsewhere on the net for those with the energy and know-how to track it down on any of several pirate sites.

The founders of Defense Distributed are not terrorists. They are US based libertarians who support gun ownership, and found in 3D printing a means to allow ordinary people with no advanced skills to create and own a gun without having to obtain a license¹⁶⁷. It is not yet clear just how much this technology presents a real danger to the public, after all criminals and terrorists have many other ways for obtaining weapons.

The main concern of 3D printing advocates is that the over-regulation of 3D printing in reaction to perceived risks, might compromise the employment and entrepreneurial benefits it promises to create in other domains.

The acquisition and use of firearms in the EU is governed by Directive 91/477/EEC¹⁶⁸ also known as the “Firearms Directive”, its amendment by Directive 2008/51/CE¹⁶⁹ and more recent legislation implementing article 10 of the UN protocol against the trafficking of arms¹⁷⁰. Until recently there has been little mention of the impact of 3D printing on the regulation of arms for private or civilian use. COM(2013) 716 however, on “Firearms and the internal security of the EU: protecting citizens and disrupting illegal Trafficking” dated 21.10.2013, refers to the possible use of 3D printing to facilitate the illicit manufacture, distribution and use of firearms, and the challenges this creates for the EU and Member states. It refers to a 2010 action plan of the European Council of Ministers which will include a range of measures including one by Europol to develop a manual for combating internet-based firearms trafficking, as well as EC efforts to support the creation of cyber patrol teams in Member States, similar to those already established to combat the trafficking of drugs.

It is worth noting that the 2013 communication does not refer to challenges creating by the sharing of files containing designs for printing weapons or components. This may be an issue worthy of further study.

Medical Devices

The production of medical devices is another highly regulated area. The core legal framework is based on the 3 Council Directives and their amendments.

- Council Directive 90/385/EEC on Active Implantable Medical Devices (AIMDD) (1990)¹⁷¹
- Council Directive 93/42/EEC on Medical Devices (MDD) (1993)¹⁷²
- Council Directive 98/79/EC on In Vitro Diagnostic Medical Devices (IVDMD) (1998)¹⁷³

¹⁶⁶ <https://defdist.org/>

¹⁶⁷ Under US law guns manufactured by individuals for personal use are not subject to a licensing requirement.

¹⁶⁸ [Directive 91/477/EEC of 18 June 1991](#)

¹⁶⁹ [Directive 2008/51/CE of the European Parliament and of the Council of 21 May 2008](#)

¹⁷⁰ [Regulation 258/2012](#)

¹⁷¹ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1990L0385:20071011:EN:PDF>

¹⁷² <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1993L0042:20071011:EN:PDF>

These directives are designed to protect human health and safety as well as the functioning of the Single Market. They refer both to mass produced devices as well as customised devices. Until now the main area impacted by the introduction of 3D printing technologies is that of implantable devices such as replacement joints and other structural elements that replace structures lost through accident or disease. These artefacts are produced under the supervision of professionals that are fully aware of applicable laws and organised for compliance.

It may be less obvious to the average entrepreneur that assistive devices such as hearing aids and their components (ear buds), are also covered by legislation for medical devices. The same is true of walking frames, crutches and braces, wheelchairs, exoskeletons and other mobility devices as well as orthopaedic footwear. The same is true for sports or quality-of-life related devices not obviously intended for medical use as such, but integrating sensors for the monitoring of heartbeat or blood pressure. The conception and manufacture of these and many more devices may be well within the capabilities of entrepreneurs working in the 3D printing space. Through lack of awareness or experience they may not realise that they are subject to legislation governing medical devices, and may inadvertently fall foul of the law. On the other hand makers of medical devices may try to use this legislation to enforce a relative monopoly on the commercial development of entire categories of device that could benefit from a much higher rate of competition, in particular in terms of either functional or aesthetic design.

Medicines

Our list of recent innovations in 3D printing includes a series of innovations in the area of medicine, more specifically concerning the use of 3D printing technology to print precision pills with a specific shape so as to vary the rate at which the medicine is made available to the patient once ingested, as well as the precise volume of the dose provided so that it is better adapted to precise patient need.

The body of legislation relating to medication in the EU is vast. It covers areas such as:

- Legislation for medicinal products for human use
- Their interpretation via guidelines of a regulatory and scientific nature
- Marketing authorisation procedures
- Quality, safety and efficacy of medicinal products
- Good manufacturing practices, pharmaco-vigilance and clinical trials

A “printer” used for the provision of such personalized precision-medicine, would qualify as a medical device itself and would therefore be subject to medical device related legislation.

The legal framework governing medicines in Europe requires that medicinal products are made available on the market only after being granted authorization by the competent authorities. The prospect of continuously variable doses of medication, being delivered in this way, may raises issues related to the way in which medicine is prescribed and the assignment of responsibility in case of error. This may become an issue for further study as this area of application of the technology evolves.

Directive 2011/62/EU places an obligation on Member States to take appropriate measures to ensure that manufacturers of active substances on their territory comply with good manufacturing practice ('GMP') for active substances. In this case the medication is manufactured away from a traditional place of manufacture and is made-up either in a pharmacy or in the home. This raises the question of whether, and in what way, the production of a personalized medication based on 3D printing can qualify as a Good Manufacturing Practice.

¹⁷³ <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01998L0079-20120111&qid=1413308118275&from=EN>

Another issue of relevance concerns the issue of “falsified” medicines, for example “fake” medicines containing wrong ingredients, ingredients of poor quality or ingredients in the wrong dose, as well as counterfeits that violate intellectual property rights. New legislation was recently introduced in Europe, applicable from January 2013. Directive 2011/62/EU¹⁷⁴ amending Directive 2001/83/EC on the “Community code relating to medicinal products for human use, as regards the prevention of the entry into the legal supply chain of falsified medicinal products”. These measures include an obligatory authenticity feature on the outer packaging of the medicines.

It is not clear how at this stage how a 3D printed artefact could comply with rules that specifically refer to packaging or even if this might really become an issue. It may be too early to tell, the answer being dependant on the economic model adopted and the places where such 3D printers might be installed.

Chemicals

Our list of recent innovations includes a series of developments by scientists such as Glasgow based Cronin that enables the 3D printing of “chemical” and chemical “reactor” type systems. This very exciting development opens up the possibility of printing organic molecules using a range of precursor “inks” using the principles and pathways of organic synthesis observed in nature. Prof. Cronin sees it not just as a whole new approach to industrial chemistry, but also as a new way for doing research, that is well suited to open-innovation and citizen science-modes of experimentation and discovery of new and useful organic molecules.

If this works out as planned, Prof. Cronin and others who adopt 3D printing technologies as the basis for new entrepreneurial ventures in the chemical industry may have to deal with industry-specific legislation in relation to consumer and environmental protection, occupational health, chemical processes and transport of chemicals. Arguably one of the most important bodies of regulatory practice is based on the REACH Directive¹⁷⁵ for the Registration, Evaluation, Authorization and Restriction of Chemicals. This entered into force in 2007 and was created for the purpose of protecting the environment. It is based on a process whereby the producers of chemicals are required to gather information on the properties and hazards associated with the product, and publish then on the database of the European Chemicals Agency based in Helsinki, so that it is available to users of those products, enabling them to understand and manage the risks associated with their use.

Food

European food related legislation is based on an integrated “farm to fork” approach and covers all parts of the food chain, starting from feed and primary production, going on to food processing, transport and storage as well as retail-sale. Regulation (EC) No 178/2002¹⁷⁶ provides the general food law regulation, whereas an independent agency called EFSA (the European Food Safety Authority) provides technical and scientific advice on the interpretation of the regulation.

So far the application of 3D printing to the food industry has more or less been limited to the printing of edible artefacts using sugar or chocolate. These are just the first of a long series of food sector innovations. As indicated in our list of new and emerging applications of 3D printing technologies, the first 3D printed foods aimed at elderly consumers should appear on European shelves as early as 2016.

The US army envisages 3D printed food solutions for soldiers in active combat. They have a vision whereby food is printed from standard cartridges, adapted to the dietary and nutritional needs of

¹⁷⁴ http://ec.europa.eu/health/files/eudralex/vol-1/dir_2011_62/dir_2011_62_en.pdf

¹⁷⁵ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1907>

¹⁷⁶ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002R0178:EN:NOT>

individual soldiers even in active combat situations. Some of the emerging new food concepts are based on the use of fresh ingredients, whereas others are based on the use of processed ingredients. Some aim at ready-to-eat meals, while others aim at ready-to-cook meals or even entirely new food categories where the artefact is prepared by a printer to be eaten much later and only after it has “fermented”.

One of the potential benefits concerns the possibility of cutting down on food waste by reducing the need to store large number of specialised food products, if the similar taste and nutrition can be obtained from a printing process based on combinations of a smaller number of basic inputs.

It remains to be seen how printers will mainly be deployed, in professional environments or in the home. It remains to be seen what kind of open source food design communities might emerge from this evolving eco-system. For all of these reasons it is not easy to anticipate what new or unexpected challenges might arise as a result of existing legislation. One can anticipate challenges related to food labelling and ingredients, especially if the quantities, proportions and ingredients are actually decided by the “printer” and not by the person doing printing the food. In addition to possible issues related to eat-by dates, there may be issues with cleaning of machines and cross contamination with allergens, and the age old question of whether to blame the provider of the recipe, the printer or the “inks” if the result is not what was expected.

Just as in medicine, the food industry has its own models for Good Manufacturing Practice. At this stage it is not yet clear if there is a need to adapt GMP or relevant health and safety or quality assurance practices to accommodate 3D printed foods.

Another area for concern is the possibility of 3D printing being used to create low cost “adulterated” foods that are then foisted on unwary consumers, while the producers just packs up and moves on the next victim.

Product Safety and Liability

Product safety in Europe is governed by the General Product Safety Directive (2001/95/EC). For specific categories of product other more specific legislation may apply. For example in the case of toys it is the European Directive on Toy Safety (2009/48/EC).

Product liability law establishes “strict liability” for producers in the case of defective products. This is also known as “absolute liability” or “liability without fault”. It means that the producer can be considered liable for any accident, injury or damage caused by a defective product, without the need to prove negligence, error or fault on the side of the producer. Typically a product might be deemed dangerous or defective because it does not provide the safety which a person is entitled to expect, taking all circumstances into account, including the presentation of the product, the reasonable use of the product and the moment the product is put into circulation. Under these circumstances the producer will be deemed liable for damages caused, despite their best efforts to ensure that the product is safe-to-use. The consequences of this can be catastrophic for the producer, not to mention of course for those who suffer damages due to the defective product.

Many observers feel that product liability law in Europe may be ill-suited to new ventures and entrepreneurial activities based on the use of 3D printing. The main basis for this view being that new business models based on 3D printing blur the lines between the producer and the user. It is possible that product liability may not apply to suppliers of the 3D design templates when they are sold directly to consumers for 3D printing at home. This is because of an exemption that applies when the product is not put into circulation by the manufacturer itself.

The issue of product liability is relevant for the producers of 3D printing equipment, accessories and supplies as well as for the producers of 3D printed objects, to the extent they are commercialized and sold to the public. Depending on the details of the case, it is possible that liability resides with the

manufacturer of the printer, the provider of print services or the provider of the inks used in the printer. It is also possible that liability for damages to third parties may be covered by the personal liability of the individual who printed or used the product.

For the time being we are not aware of legal cases where existing product liability law has been called into question. We are not aware of any rigorously worked cases intended to clarify these points. However we are aware of articles written by law firms or individuals from the legal professions indicating that these issues may require attention, especially on the part of start-up firms and other companies venturing into these new domains.

One of the most exciting areas for development is in the automobile industry. Although it is not clear to what extent new 3D printing based ventures, pose a competitive threat to the mainstream car industry, at least two interesting cases come to mind. One is the case of Local Motors¹⁷⁷ a US based producer of niche vehicles based on a co-development approach to design and on a distributed micro-factory approach to construction. Although Local Motors has been advertising the imminent release of the world's first 3D printed car for about 2 years, it is not yet available for sale, though there are plans for its release sometime in 2015.

Another example is Hong Kong based OSVehicle¹⁷⁸ a provider of a "platform" based on an Open Source design that consists of wheels, suspension, a chassis and steering column, for sale to companies or individuals who will complete the car by adding their own 3D printed bodywork and interiors. Their idea is to shorten the path to market for a new generation of car designers by providing the basic platform from which they can build new and creative EV concepts. Commentators compared the company to IKEA, a provider of affordable designer furniture delivered as user-assembled kits. The claim is that a fully functional car intended for driving in an urban environment and reaching speeds of 70 to 90kmph, costing between \$4000 and \$6000 can be assembled in as little as 60 minutes.

Local Motors hopes to offer the "Strati¹⁷⁹" its first commercially produced 3D printed car for sale towards the end of 2015. They claim that this will be the world's first commercially available 3D printed car. According to their publicity it took only 4 months to design and prototype. Various sources claim that it takes less than 24 hours or less than 40 hours to print, and up to 4 days to assemble. Local Motors has already established its roadworthiness. They are now waiting for approval from the US Vehicle Standards Authority before putting it on sale. This they hope to do before the end of 2015.

It is illegal in Europe and indeed in most parts of the world to sell a car that is not road-worthy. However it is not clear if the same applies to a kit. It is not clear whether the buyer of a kit to assemble a 3D printed car, should reasonably expect that the assembled car will be roadworthy, or merely that it should be capable of passing a roadworthiness test.

Under EU legislation the main directives that apply include the following:

- **Directive 2007/46/EC**¹⁸⁰ of the European Parliament and of the Council of 5 September 2007 which establishes a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles

¹⁷⁷ <https://localmotors.com/>

¹⁷⁸ <https://www.osvehicle.com/>

¹⁷⁹

<https://www.google.com/search?q=the+strati&tbm=isch&imgil=dEvgVg04jmIWRM%3A%3BGZcDQpn6KXOrXM%3Bhttp%3A%2F%2F3dscanningservices.net%2Fblog%2Findex.php%2Fmeet-the-strati-the-worlds-first-eco-friendly-3d-printed-car%2F&source>

¹⁸⁰ <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32007L0046>

- **Regulation (EC) No 661/2009**¹⁸¹ of the European Parliament and of the Council of 13 July 2009 concerning type-approval requirements for the general safety of motor vehicles, their trailers and systems, components and separate technical units intended therefore
- **Directive 2009/40/EC**¹⁸² of the European Parliament and of the Council of 6 May 2009 on roadworthiness tests for motor vehicles and their trailers

It is interesting to note that despite these legal reservations, companies like Local Motors and OSVehicle are finding ways forward. It will be very interesting to follow their progress over the coming months and years.

Advocates of 3D printing say little about the frustration of users of 3D printing technology once they get over the honeymoon phase of adoption. The time required to print an item is nevertheless quite long compared to traditional methods such as cold-pressing metal sheets, the extrusion of liquid plastic and the use of moulds. Much of the savings in time are a result of the smaller number of components and saving time spent assembling products from a large number of discrete component parts.

Although the speed of printers is increasing rapidly, and this is rapidly reducing the long wait for the printed part, a related issue is the need to discard pieces halfway through the print process due to the occurrence of errors. An error means that the printer simply fails to deposit a droplet in the right place or the print head jumps even microscopically to deposit it in the wrong place. These errors may or may not be important. They may happen for a variety of reasons. For example due to variations in the quality of the "inks", or due to operation in environments that are not sufficiently isolated from vibration. In the best case such errors can be ignored. In other cases the whole print-run may have to be abandoned and started all-over from the beginning, leading to waste and to loss of time. In the worst case however these errors may lie undetected, a collection of microscopic defects in the printed structure that may one day lead to unexpected and even catastrophic failures of 3D Printed devices.

This indicates a number of areas where liability for defects may lie with the producer of the 3D printer rather than with the producer of the printed artefact. It also indicates area for future research in 3D printing based production systems. Namely research that helps to;

- Understand and characterize the occurrence of such errors,
- Detect and map the presence of such errors and evaluate their importance,
- Improve the performance of printers and eliminate such errors at reasonable cost.

Product Warranty

A warranty is a legally binding assurance that a good or service is fit for use as represented by the seller, that it is free of defective material or workmanship, and that it meets statutory or other specifications. A warranty may or may not exist in written form. Where it does not exist in written form, EU consumers of purchased goods are protected by Directive (1999/44/EC)¹⁸³. All companies that sell to consumers in Europe are bound by this directive. More specifically it states that the seller of a products is "liable to the consumer for any lack of conformity which exists when the goods are delivered to the consumer and which becomes apparent within a period of two years, unless, at the moment of conclusion of the contract of sale, the consumer knew or could not reasonably be unaware of the lack of conformity."

As a minimum the liability law provides the consumer with a right:

¹⁸¹ <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009R0661>

¹⁸² <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0040>

¹⁸³ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0044:en:HTML>

- To have the goods repaired or replaced free of charge within a reasonable period of time and without major inconvenience
- To obtain an appropriate reduction in price
- The contract annulled where repair or replacement is impossible or impractical.

National legislation may provide consumers with additional rights and differences exist from one country to another. The seller is only liable for any lack of conformity that exists at the time of delivery of the product and that appears within a period of two years from the time of purchase. A warranty is not the same as a “guarantee” in the sense that the defect cannot be the result of normal wear and tear.

Legislation concerning warranties may be a cause for concern for the same reasons as legislation concerning product safety, although the cost to the producer may be much less and the consequences for her business less catastrophic.

Product Labelling and Packaging

Great importance is given to product labelling and product packaging. Packaging is used not only to carry and display labels, but to provide important information intended for the buyer or the user, in relation to the contents, the method and condition of use, as well as any warnings that may apply.

Labels and packaging have important roles to play in the management of user expectations and in the application of laws governing warranty, product safety and liability. They have important roles to play in quality assurance for example via the display of CE marking, by providing support for the display of product identification numbers or for the display of use-by dates. They have a role to play in environmental protection via eco-design, recycling or disposal and energy effectiveness.

The legislation pertaining to labelling is quite extensive. 3D printing, which provides important opportunities for dispensing with packaging, and could be considered a boon for the environment, may also be considered as creating risks for the consumer. It is therefore worth considering how the phenomenon of 3D printing might impact the packaging industry and the practice of labelling, to identify alternative ways for fulfilling the roles played of labels and packaging while retaining the advantages that 3D printing might offer in terms of waste avoidance and the better management of the environment.

Labels are also used to display information about the patents employed in the construction of the artefact. This raises the question of how best to inform the user of the possibility of patent violation when the artefact is reproduced or the need to pay royalties to the rights holder or appropriate organizations acting on their behalf. The case of the music industry may be instructive. Music as such bears no formal label when it is played. Dues are collected on behalf of artists and other actors by collecting societies acting on their behalf.

Intellectual Property Issues

Piracy, Counterfeiting and Passing Off

Counterfeiting is the practice of manufacturing goods and selling them under a brand name without the brand owner’s authorization. Often these goods are of inferior quality to the original goods. The illicit sale of these goods may cause reputational damage as well as financial loss to the manufacturer of the original goods.

Passing off is different from counterfeiting in that focus is on the appearance of the product, which is sufficiently similar to that of another recognizable product as to cause confusion in the mind of the consumer, who might buy it mistaking it for something else.

Under EU law passing-off is usually dealt with on the basis of trademark legislation, whereas counterfeiting might involve infringement not only of trademark and trade dress, but infringement of design, patent or copyright law as well.

Concerns are sometimes expressed, that the 3D Printing technologies might facilitate trade in counterfeit goods and illicit behaviours such as “passing off” thanks to the ease with which physical objects and even relatively complex devices may be reproduced using 3D scanning and printing technologies. This could affect many categories of product including luxury goods and accessories, toys, food items, cosmetics, drugs and medicines, guns and weaponry, machinery and spare-parts.

In January 2014 new anti-piracy laws came into effect in Europe, based on EU Customs Regulation (EU) No 608/2013¹⁸⁴ of 12 June 2013 concerning customs enforcement of intellectual property rights and repealing Council Regulation (EC) No 1383/2003.

The regulation deals with the role of customs authorities in seizing and destroying goods entering or in transit through the EU. It does not address the identification or characterization of goods being pirated or passed-off. It is designed to simplify enforcement of anti-piracy law and relations between customs and rights holders. It simplifies procedures for rights holders by allowing customs officers to act on the basis of a Community Application for Action. It strengthens the role of customs in the following ways:

- It allows EU Custom’s officials to seize goods on the basis of reasonable indications of infringement on a broad scope of registered and non-registered IP-rights including trademarks, patents, designs, and copyrights.
- Customs can act not only against counterfeit or pirated goods but also against confusingly similar trademarks and trade names.
- Customs can destroy small consignments of counterfeit goods based on the principle of applied consent.
- Customs can destroy seized goods based on the consent of the rights holder without the need to obtain a court order.

Trademark Law

Of all aspects of European intellectual property law, trademark law is considered by some to be one of the most important areas where users of 3D printing technology might inadvertently run foul of the law. The risks are greatest when 3D printed artefacts are developed with the aid of file derived from 3D scanning technology.

European Trade Mark law is based on the following texts:

- Directive 2008/95/EC¹⁸⁵ of 22 October 2008 to approximate the laws of the Member States relating to trade marks
- Council Regulation (EC) No 207/2009¹⁸⁶ of 26 February 2009 on the Community trade mark
- Commission Regulation (EC) No 2868/95¹⁸⁷ of on the implementation of the Community trade mark

This legislation can be applied for the protection of any sign capable of being represented graphically, which can include words, designs, letters, numerals as well as “the shape of goods or of their packaging, provided that such signs are capable of distinguishing the goods or services of one undertaking from those of other undertakings”.

¹⁸⁴ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:181:0015:0034:en:PDF>

¹⁸⁵ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:299:0025:0033:en:PDF>

¹⁸⁶ <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:078:0001:0042:en:PDF>

¹⁸⁷ <http://oami.europa.eu/en/mark/aspects/reg/reg2868.htm>

In this sense it clearly applied to 3D printed goods where these are capable of distinguishing the goods of one undertaking from those of another undertaking. The example often given is that of a Coca Cola bottle. The shape of the bottle is highly recognisable as belonging to Coca Cola and trade mark law provides the Coca Cola Company with rights that include a veto on the public use of 3D printed replicas of Coca Cola bottles regardless of the material employed or their intended use. More generally the level of protection afforded varies depending on whether or not the “mark” is registered. Even in the case of an unregistered mark, protection is afforded based on prior commercial use.

In reality the registration of a 3D trademark in Europe is not as straightforward as appears at first sight. Legal blogs contains references to a number of cases that challenge basic intuition as to what might or might not be eligible for registration as a 3D trademark. The source of confusion seems to be claim that the mark should be “distinctive”. This is ambiguous because it is subjective, relying on the perception of the average consumer. Even when a 3D trademark is judged to be “distinctive” it may not qualify for registration thanks to technical exceptions to eligibility that apply when the shape is dictated by the nature of the product, the shape is necessary to obtain technical effect, or the shape adds significant value to the product. In each of these cases the shape does not qualify for registration as a 3D trademark.

Although legal professionals have written about the possible risks to entrepreneurs and even private individuals, arising from the accidental or unintended infringement of trade-mark law, they seem to agree that this type of risk is not new in the sense that it very much resembles risks associated with the reproduction of 2D files which became accessible to almost everyone with the introduction of low cost personal printers and scanners for use in conjunction with laptops and desktop computers.

Copyright Law

It appears that the first 3D printing copyright “incident” occurred in 2011. A Dutch designer called Ulrich Schwanitz began selling a 3D printed version of something called the Penrose Triangle, a variation on the impossible waterfall sketch by M. C. Escher. Schwanich wanted to keep his digital design secret and refused to distribute it. Despite these efforts a colleague called Artur Tchoukanov had little difficulty buying a copy, reverse-engineering it and then posting the design file to Thingiverse¹⁸⁸ - an online catalogue of open source 3D printed design files. Schwanitz issued a takedown notice and the file was quickly removed. By the standards of online activism this was a very low key incident, but it marked a turning point in that Digital Rights Management would from now on become an issue for 3D printing.

Since then at least one company, Intellectual Ventures¹⁸⁹ has filed a patent for an embedded technology that would monitor 3D printers for some forms of IP violation. Other companies such as Fabulonia¹⁹⁰ have started to develop cloud-based solutions for 3D copyright protection such as Fabsecure¹⁹¹. Whereas another company called Authentise¹⁹² has created a system called SendShapes¹⁹³ that allows the owners of copyright for 3D digital design files to stream an encrypted version of their file directly to a 3D printer so that it can be printed without exposing the design file to the general public, therefore eschewing the possibility of it being illicitly copied or used.

¹⁸⁸ <https://www.thingiverse.com/>

¹⁸⁹ <http://www.intellectualventures.com/>

¹⁹⁰ <http://fabulonia.com/>

¹⁹¹ <http://www.fabsecure.com/>

¹⁹² <http://authentise.com/>

¹⁹³ <http://www.sendshapes.com>

Although the photocopies of a bank note might not easily fool a human, they are often good enough to fool a cash machine. The thief only has to use a €20 note to purchase a low cost item and pocket the change. For this reason modern photocopiers and photo editing software contain embedded software to prevent the copying of banknotes, based on the use of watermarks that can be recognised by digital vision systems.

The Protection of Designs

Whereas copyright normally applies to written texts, designs apply to a more general category of options for creative and aesthetic expression.

Designs are protected within the EU whether or not they are registered. Unregistered designs have up to 3 years protection from the moment they are put into general circulation. Designs registered at EU level are valid in all 28 EU member states and registration can be renewed every 5 years, up to a maximum of 25 years. In some sectors such as fashion it is less common to register designs because of the very short shelf life of products, often only a couple of months, due to changing seasons and a desire on the consumer side to have something different and new.

It is interesting that there is in some sense a convergence of copyright and design implied by the possibility of 3D printed objects. This is due to the fact that all information necessary to print the object and necessary for the faithful reproduction of all design features, is contained in the design file which is afforded protection under copyright law. The design itself, as embodied in the physical object is also afforded protection under design law.

It may be of interest to clarify how design law and copyright law interacts in the case of 3D printed objects and examine the implications of this interaction for strategies to protect the rights of designers, to enforce protection and claim compensation when infractions are found to occur.

The matter is further complicated by the introduction of the Resale Rights Directive 2001/84/EC of 27 September 2001, which is now implemented in all EU nations and grants artists the *droit de suite* on their original works, to bring their rights more in line with the advantages provided by conventional Copyright protections to other creators. This begs the question of 'is art original or not' if it is 3D printed? A further complication is introduced when one considers the implications of restrictions on 'Freedom of Panorama', which recently got the Wikipedia community very agitated and which is provided for within Directive 2001/29/EC. However, this directive is not enforced uniformly across the EU. How the combinatorial effects of these two directives working in conjunction can be ratified is unclear, at the moment it appears that certain classes of artist are better rewarded than others for their efforts: depending upon in which EU nation their work is placed and whether it is visible in public. Who owns the rights to a 3D printed building?

Patent Law

There is already a lot of patent litigation in the 3D printing space. This is an inevitable consequence of the very high level of innovation that has occurred in this domain in recent years. But this is nothing new.

More interesting is the possibility of patent infringement that might occur unwittingly or otherwise when an existing object is reproduced using a combination of 3D scanning and printing technologies.

One of the much touted benefits of 3D scanning and printing is the possibility of printing a hard or impossible to find component, which has been lost or damaged and which is necessary for the functioning of a device or system. In doing so it is possible that one or more patents may in effect be violated. In these cases it may or may not be justifiable. But this will depend on the intentions of the patent holder and the extent to which they want to enforce patent protection to realize a commercial strategy based on obsolescence.

In many cases it will be very difficult for a patent holder to know about this and intervene to stop the practice based on the enforcement of patent law. Encouraging the re-use, continued or recycling of older devices and machines, by virtue of repairs made in this way, could become a business for some entrepreneurs. This practice could clearly provide benefits to actors who avoid the purchase of expensive machinery. It could also provide benefits to the environment by enabling society to avoid over production of alternatives. It may lead to the cancellation of warranties or unexpected quality issues if the materials used in the repair are not the same as used in the original component.

For now these are really only possibilities. It remains to be seen how this will evolve in reality.

The Special Case of 'Individual Identity' as Intellectual Property

The increasing ease with which physical objects can be scanned and reproduced using 3D printing technologies, opens up a whole new world of possibilities for identity theft and the impersonation of individual in new and hitherto unexpected ways. When we consider how this can be combined with advances in robotics, the design of prosthetic limbs, the simulation of voices with different tonalities and patterns of speech, the recording and simulation of facial expressions and other forms of body language, we see the possibility of new forms of identity theft and new possibilities for the impersonation of individuals. Add to this the possibility of an individual's DNA and other biological data becoming more generally "available" as a consequence of advances in 3D bio-printing either for new approaches to clinical trials, personalized medicine and the printing of replacement organs, we see that even biological approaches to identification may also become avenues for the theft of identity and for the impersonation of individuals.

All of this suggests the need for the further investigation of the concept of "Individual Identity'." Perhaps we need a concept of a data oriented "Extended Individual Identity'" that includes the individual and their prosthetic enhancements as well as all data that may potentially be gathered about the 'Individual Identity' and the physical appearance of an individual. This would include genetic data, data about ones whereabouts, health and well-being, as well as all available and possible representational data. This includes 1D data such as voice samples, 2D data such as photos or medical images and 3D data representations such as those that might be obtained by or used in image processing, scanning or reproduction using 3D printing technologies. We should also consider higher dimensional data such as data about how a person moves their facial expressions, their body language, the vocabulary they use, the tonality of their voice and their patterns of speech. This data can be employed by advanced robotic and holographic systems to create life-like, life-size, animated representations of individuals which may one day become the avenue of choice for unscrupulous people intending to impersonate an individual or steal their identity, or simple sell representations of the individual based on figurines, masks or recognizable body parts, animated objects and holographs.

One of the main sectors concerned by identity theft is the financial sector. One of the main pieces of EU legislation dealing with identity theft is Directive 95/46/EC¹⁹⁴ on the protection of individuals with regard to the processing of personal data and on the free movement of such data.

In 2012 the EU published a study on the impact of a proposal for a new legal framework on identity theft¹⁹⁵. This document makes no reference to the possibility of identity theft based on the use of 3D printing, holographic images or advanced robotics. Technology moves on so fast that these options which may have seen far-fetched in 2012 seem less so today.

¹⁹⁴ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31995L0046>

¹⁹⁵ http://ec.europa.eu/dgs/home-affairs/e-library/documents/policies/organized-crime-and-human-trafficking/cybercrime/docs/final_report_identity_theft_11_december_2012_en.pdf

Import Restrictions and Taxation

One of the advantages of 3D printing is the possibility of cutting down on transport costs. This is due to the fact that an object can be designed anywhere in the world, and then printed anywhere there exists access to a 3D printer or to a suitable 3D printing service. This has profound implications for the costs of products related to the transport and storage of goods, as well as supply chain dynamics and for the impact of manufacturing on the environment.

It also means that some imported goods will effectively be substituted by goods whose designs files are imported and produced locally. In other words some trade in physical goods will be replaced by trade in intellectual property. This may provide environmental benefits. It may also mean that certain goods, which used to be subject to physical border controls, may enter the EU “virtually”, avoiding physical controls entirely.

The upside of this is the possible on-shoring of goods made abroad as well as any labour and environmental benefits that this might obtain. The downside is a possible loss of revenue from the taxation or control of goods that were previously taxed on entry and the loss of a means of monitoring trade in restricted items.

It is difficult to tell at this stage what the overall impact will be on the economy of Europe, on the environment as a whole, on European security and on its ability to control trade in fake goods. It is very early days yet, but as the virtualization of international trade scales, and the volume of 3D printed goods increases, it may be worth investigating this in more detail.

7.5 Crosscutting Issues

These issues emerged from the investigation of, and exploration around, the issues emerging out of the Crosscutting themes study and also the analysis of interview responses. They are presented separately as they do not relate to any one technology within the context of The Collaborative Economy. Many issues, in fact, only loosely relate to a technology but instead relate to their potential impact upon society.

Policy Recommendation 5.1: In the Collaborative Economy, everything is data. All aspects of life are to some extent conducted in the digital domain. Data will become the main source of desire, the preeminent medium of exchange and the main source of tension. Global policy formulations are required in the collaborative economy because it operates on a global scale, regardless of national or regional borders. The creation of global policies that can be implemented, regulated and enforced will be crucial to the success of the collaborative economy.

Policy Recommendation 5.2: In the Collaborative Economy, all data will be digital. Digital data are stored and processed in an electronic network environment. The services supported on the network will become a fundamental and essential part of most people’s lives. Access to the digital environment will be essential. Fixed and mobile devices need reliable network connectivity. In many parts of Europe this is still not available even in the wealthiest member states. These gaps must be filled. Furthermore, the electricity supply that all electronic devices rely upon must be secured.

Policy Recommendation 5.3 Disintermediation is the key concept to emerge in this study. However, in the context of personal relationships there are signs of a new form of Intermediation emerging. Concentrating now on Disintermediation as the dominant concept; the technologies embraced in the Collaborative Economy will ultimately eliminate conventional professional people from the work place and destroy large hierarchical corporations. Corporations and professionals will, of course, resist using disingenuous means to protect their own positions. This may slow the uptake of these technologies but it will not stop the uptake. We will use the music industry as an example.

Ignoring the fact that famously closing the Pirate Bay website had no effect on illegal downloading¹⁹⁶, we see that the decentralisation technologies are having a far wider and much more profound impact on the music industry. By focussing on one (illegal) symptom, rather than the broader issues, the music industry has missed the considerably larger (legal) threat of decentralisation technology uptake. All of this is possible now and is, in our opinion, more likely to be the reason the music industry is in trouble.

- A musician can record music on a laptop with no particularly expensive software. No recording studio is needed.
- The musician can sign a contract with an online distribution and delivery platform (iTunes, Spotify, etc) without needing a lawyer. No record label is required.
- If the music is popular an album can be crowd funded and concerts can be crowd sourced (audiences commit to attending a venue at a particular date and time and when the limit is reached the concert is sufficiently de-risked to begin promotion on social media, surplus ticket sales are profit). No tour organiser or ticketing agency is needed.
- Tickets are purchased using crypto-currency and form a legally binding contract between the parties. No or lawyers or banks are needed.

We must make sure that the broader application of decentralisation and disintermediation technologies within the Collaborative Economy context are not handled in the same way.

Other disintermediation and decentralisation concepts include:

- Economy without (big) industry
 - Open design – open data
 - Additive manufacturing
- Products without manufacturers
- Currency without money: Ideas as currency
- Money without banks
- Food without agriculture
- Shops without stock
 - Design services only
- Nation without State
- Digital Representation without political representation, viz. falling voter turn outs in elections but a proliferation of online polling and voting for just about everything imaginable.
- More with less ([distributed] economic activity) versus
 - Less with more (pollution and energy consumption)

Policy Recommendation 5.4: All of this disintermediation and distribution make consumer and market regulation very difficult to draft, deploy and enforce. The disintermediated economy could result in a new barter model where services are traded directly. Also consider that ideas themselves could become currency and that for this currency to be effective, ideas need to flow freely wherever they need to go. It seems we are actually talking about ideas as intangible and tradable resources in

¹⁹⁶ <http://variety.com/2014/digital/news/pirate-bay-shutdown-has-had-virtually-no-effect-on-digital-piracy-levels-1201378756/>

the internal market, which should be treated in the same way as other forms of goods, services, capital and persons in order to protect their free movement.

Policy Recommendation 5.5: The main disruptive effects of previous industrial revolutions have been felt mainly and most painfully by agricultural or blue-collar workers. This industrial revolution is going to hit the professional classes very hard. Disintermediation mainly disrupts the skilled and decision-making sectors. Leaders require new technocratic skills. A classical education can no longer be a ticket to power and influence. New social and economic structures emerge.

Policy Recommendation 5.6: In a centralised model, there are many opportunities to add value at every step through the hierarchical organisation of markets, supply chains and payment systems. What will happen to economies when disintermediated decentralised systems replace the monolithic multinationals and the taxes, which currently support all western nations, begin to disappear?

Policy Recommendation 5.7: Personalisation penetrates many aspects of life from clothing and online environments to transport and health provision. This trend drives the increasing demand for more and more data collection and more and more data access. Data everywhere is old hat. Now, at a very fundamental level, everything is data: at least partly.

Policy Recommendation 5.8: Ideas of 'Individual Identity' need revision in the data-is-everything world. Not only are data about our activities and our specific composition collected and stored but also data about our appearance. The ability to synthesise people is a real consideration. Initially this will be through clever digital animation; eventually it will be possible to print avatars and finally, flesh and blood facsimiles. New codes of morals and ethics need to be considered. When printed everything is possible, what will real mean? Real food. Real homes. Real furniture (Chippendale, etc.)... Really me! How can "real" be regulated?

Policy Recommendation 5.9: "Personal" and "Private" need new definitions in a world where data are universal and even personal data sets are a tradable good (legal if the subject/owner is doing the trading). There needs to be a distinction between data subject, data owner, data collector and data user. Data owner is not the same entity as data subject. Personal data sets are now like appearance - models make a living by trading on their looks: now everyone has something to trade. Personal data and privacy have variable value depending on generation, age and culture. Again moral considerations creep in: especially in the public good vs individual good debate (more so in the clinical trials context). Personal data needs to be protected but it must not be isolated at all costs. Many important (medical/clinical) advances depend increasingly upon access to personal data. This is not necessarily Big Fast Open Data (BFOD) but is (probably partial) data that does represent very large numbers of people. The trick is to find a way of enabling this capacity without harming individual liberty and opportunity.

Policy Recommendation 5.10: Eventually, as data becomes a tradable asset or commodity, the responsibility for protecting and securing data will have to be ceded back to the data subject. Data protection issues will be impossible to enforce from central locations and the new empowered owners will need the support of specially designed enforcement tools, which will work in a decentralised environment.

Policy Recommendation 5.11: On the other hand, while personalisation kills the mass market, niche markets proliferate and artists & artisans are able to reach dedicated niches directly. NB Archived data was always seen as providing a record of acts and outcomes and evidence of process compliance. Archives are now executable resources that can add considerable value in many, many endeavours. Digital archives must archive the applications used to create the data as well as the data itself.

Policy Recommendation 5.12: The bottom up distributed data collection model is not suitable for all activities e.g. politics, especially when creating strategic policy. To help leaders make good decisions, they have access to information the public is unaware of, and access to highly refined analyses. Public

opinion is easily manipulated (e.g. by the media) and often contains a heavy emotional payload. Therefore, public policy, which is driven from the bottom up by public opinion is unlikely to be objective. The same degree of unsuitability is true of conventional lobby-based influence creation by powerful single-issue interest/pressure groups in relation to policy formulation that affects them. At a time when the future economy requires brave, objective and decisive leadership, powerful, influential and wealthy, reactive and vested interests will always fight against change. On the other hand, there is a long tradition of social single-issue pressure groups forming around important subjects. In future, virtual flash mobs could instantly and disruptively collaborate around... anything at all. Both aspects need to be considered but objective policies are required. The future will not be structurally similar to the present. How we get there makes a difference and we should choose a sensible route.

Policy Recommendation 5.13: Policy makers should not focus on policy for current digital technologies and capabilities. Digital technology evolves so fast that policy implementation always lags behind and, generally, harms the prospects of what follows. Instead, policy makers should look ahead and devise policy in a manner that regulations are in place as technology arrives. A catch up approach cannot ever work.

Policy Recommendation 5.14: In the disintermediated and decentralised online world supporting the Collaborative Economy communication is vital. Communication is more than telecommunication, it is people sharing knowledge through information exchange. Data-centric telecommunications systems help to make the connections between people and reduce distance but a new layer of communication protocol may be required to avoid linguistic manipulation, especially in relation to communications between polyglot teams which may or may not depend upon some translation mechanism or other. In the model of continuing change, education will become a natural part of the work cycle. It will no longer be something that children must do before they can find work.

Policy Recommendation 5.15: Many technologies, which may be employed in the Collaborative Economy, can be abused, used inappropriately, used incorrectly, used dangerously, or not used when it should be used. In the same way that regulations are in place to ensure rocket cars cannot be used on public roads and to ensure that drivers wear seat belts in conventional cars, technology-level usage policies and regulations will be needed to ensure that the Collaborative Economy is a safe place to operate within.

Policy Recommendation 5.16: Co-creation and co-development concepts, as working models, have already arrived in the scientific domain. Sandbox is a virtual laboratory with staff and equipment to rent. Sandbox¹⁹⁷ has just launched after being incubated and spun out of the Massachusetts Institute of Technology in the USA. In Europe, the new European Grid Infrastructure¹⁹⁸ (EGI) strategy¹⁹⁹ (version 2.21) explicitly defines policies promoting Co-creation and Co-development practices to improve the quality of European science and the accessibility of scientific results. EGI is also very heavily promoting Open Data. Both initiatives are tightly bound to the notion of delivering the scientific element in support of the Digital Agenda for Europe²⁰⁰. Co-working models will eventually

¹⁹⁷ <http://www.sandboxef.com>

¹⁹⁸ <http://www.egi.eu>

¹⁹⁹ <http://go.egi.eu/strategy2020>

²⁰⁰ Within the DAE, Europe's ambitions are:

(I) to create a connected single digital market in which the free movement of goods, persons, services and capital is ensured and where individuals and businesses can seamlessly access and exercise online activities under conditions of fair competition, and a high level of consumer and personal data protection, irrespective of their nationality or place of residence;

(II) to create a unified research area, an open space for knowledge, research and innovation; this European Research Area (ERA) will enable researchers, research institutions and businesses to work and co-operate freely across borders.

reduce and eliminate the need for antisocial hours working in the Collaborative Economy, as tasks can be allocated and dispatched to those parts of the world where it is day time and people are awake.

Policy Recommendation 5.17: In all areas of our research we found concern that the technologies under investigation may be used with criminal intent. In some cases this fear had resulted in government studies and recommendations for draconian regulation and oversight: specifically in the case of crypto-currency. It is true that all of these technologies might be used for illegal purposes but so may any other technology. Cars can be used in burglaries and bank robberies; guns do not need to be printed in order that they can be proliferated; big data is not the only repository of information useful to extortionists; terrorists have many means of collaborating and spreading their message. It is also true the technologies under investigation bring with them new and unusual problems that must be overcome before they can become mainstream. However, these are not reasons to outlaw and over-regulate, we are in danger of “throwing out the baby with the bathwater” and must avoid overreaction at all costs. Newness and change always bring fear but we no longer live in caves and hunt our food, so we must have dealt with these kinds of problems many times in the past. We must move forward cautiously, not allowing ourselves to submit to the natural human reaction to lock ourselves away and hide from the future.

8 Policy Options

The “perfect storm” of technologies related to Collaborative Internet, Big/Open Data, Crypto Currency and Additive Manufacturing will bring about fundamental changes in our lives and in the economy. The effects will be profound and those with an interest in maintaining the status quo will resist the anticipated changes. Such efforts should be resisted, as there are also potential long-term benefits. The following is a synthesis of the main policy options that could help decision-makers embrace the future that is coming upon us.

1. Stimulate the free flow of co-created ideas

Co-created ideas are increasingly important for creating new products that satisfy a fast-changing market; supporting those who work across borders to work effectively will help grow the European economy; model future legislative proposals in relation to the updating of [Directive 2001/29/EC](#)²⁰¹ (on the harmonisation of copyright and related rights in the information society) on the approach taken with [Directive 2014/26/EU](#)²⁰² (on collective management of copyright), which introduces the possibility of EU-wide multi-territorial licencing for online musical works. Tensions between [Directive 2001/84/EC](#)²⁰³ (resale right) and the legislative measures which are expected to adapt the [2001/29/EC](#) Directive to technological developments in the digital age will most probably also need to be resolved.

2. Reforming EU IP rules, fair use and consumer protection policies to enable emerging capabilities

To increase EU competitiveness in a collaborative economy, rules relating to copyright and Intellectual Property Rights need to be based on the same principles across the EU given the variety of national legal approaches. From the perspective of the existing EU acquis on product liability and consumer protection the emergence of the collaborative economy raises the need, among others, for the delineation and, in fact, extension of the existing limitations on fair use. For example, it is possible that current IP rules will have to be reconsidered in light of the need for collaboratively developed open data for the 3D printing of products. It is important for IPR rules to be applied as a balanced incentive system that on the one hand encourages inventors and compensates them for their creativity, and on the other, promotes benefit-sharing, fair use and further creativity. In fact, the concepts of 'intellectual property', 'access' and 'sharing' need to be redefined in the context of the collaborative economy as the latter may reshape the traditional defences to copyright infringement. The collaborative economy is likely to heighten the tensions between traditional legal approaches of ownership and the introduction of modern practices that focus on fair use, open access creative licences and flexible licensing structures. . In this regard, the [recently adopted resolution](#) of the European Parliament concerning the modernization of the EU copyright system clarifies the scope of certain fair use exceptions, such as for Text and Data Mining (TDM). These reforms are expected to contribute to enabling the development of such "welfare-enhancing" technologies²⁰⁴.

²⁰¹ Directive 2001/29/EC of the European Parliament and of the Council of 22 May 2001 on the harmonisation of certain aspects of copyright and related rights in the information society

²⁰² Directive 2014/26/EU of the European Parliament and of the Council of 26 February 2014 on collective management of copyright and related rights and multi-territorial licensing of rights in musical works for online use in the internal market

²⁰³ Directive 2001/84/EC of the European Parliament and of the Council of 27 September 2001 on the resale right for the benefit of the author of an original work of art

²⁰⁴ For further information see: "Review of the EU Copyright Framework - European Implementation Assessment", EPRS October 2015 at: [http://www.europarl.europa.eu/RegData/etudes/STUD/2015/558762/EPRS_STU\(2015\)558762_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/STUD/2015/558762/EPRS_STU(2015)558762_EN.pdf)

3. Create new enforceable regulations capable of supporting and protecting all stakeholders in the Collaborative Economy

Steps could be taken to eliminate the legal uncertainties that follow from the usually transnational nature of collaborative technologies ([Directives 2004/48/EC](#)²⁰⁵ (on enforcement of IPR) and [98/44/EC](#)²⁰⁶ (on biotechnological inventions) apply to producers, [Directive 1999/44/EC](#)²⁰⁷ (on aspects of sale of consumer goods) and [Regulation 178/2002](#)²⁰⁸ (on general principles and requirements of food law) apply to consumers and [Directive 2001/29/EC](#) applies to both. Getting this right gives the EU a leading opportunity to increase the rate at which innovations can be transferred into commercial reality and to reduce the potential for fraud. Similar policies against tax evasion and money laundering are also required and should be addressed through revisiting the 4th Anti Money Laundering (AML) Directive. This will require a global transparency agreement, to ensure monitoring and accountability of fraudulent activity.

4. Create new enforceable regulations capable of supporting and protecting users of derivative services growing out of the Collaborative Economy

Decentralized stock exchanges and insurance companies will very likely emerge and, again, it is possible that within these aspects of a collaborative cyber currency market, authorities will not be able to regulate the activities taking place within them using current approaches. Again, revisiting the 4th AML Directive is advisable.

5. Re-consider laws that currently limit what someone can do with their own data

“Personal” and “Private” need new definitions in a world where data are universal and even personal data sets are a tradable good (legal if the subject/owner is doing the trading). There needs to be a distinction between data subject, data owner, data collector and data user in future versions of the Data Protection [Directive 95/46/EC](#)²⁰⁹ (on the processing of personal data) and The EU General Data Protection Regulation, as a 'data owner' is not the same entity as a 'data subject'. All terms used should be explicitly defined. Personal data sets are now like appearance - models make a living by trading on their looks: now everyone has something to trade. Reconsider laws that currently limit what someone can do with their own data. Individuals need to be able to protect or use their own data in whichever way they choose. However, data protection issues will be impossible to enforce from central locations and the new empowered owners will need the support of specially designed enforcement tools, which will work in a decentralised environment. It is also necessary to establish a mechanism to determine the relative values of public good vs individual good especially in the clinical trials context. Many important (medical/clinical) advances depend upon access to personal data and are suffering from lack of clarity around terms used in current policies.

²⁰⁵ Directive 2004/48/EC of the European Parliament and of the Council of 29 April 2004 on the enforcement of intellectual property rights

²⁰⁶ Directive 98/44/EC of the European Parliament and of the Council of 6 July 1998 on the legal protection of biotechnological inventions

²⁰⁷ Directive 1999/44/EC of the European Parliament and of the Council of 25 May 1999 on certain aspects of the sale of consumer goods and associated guarantees

²⁰⁸ Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety

²⁰⁹ Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data

6. Establish a recognition process for crypto currencies

Driving the communities using crypto currencies underground will complicate matters in the future. It is better to proactively legislate, perhaps through a revision of the 4th AML Directive, to incorporate crypto currencies into the wider economy. View a crypto currency as just another currency which should not be feared but rather recognise that the sociological part of the system needs careful handling.

7. Engage with a wider set of consultative bodies in the Additive Manufacturing policy debate

Current approaches to the development of industrial, innovation and research policies at the EU level neglect how Additive Manufacturing and 3D printing technologies go far beyond traditional manufacturing and are relevant for areas including healthcare, medicine, chemistry and construction. Current stakeholder groups may be too restricted, not just in the sense of mainly representing traditional manufacturing industries, but also because they represent large established companies with their embodied need to preserve or increase competitiveness, often to the exclusion of most new entrepreneurial possibilities.

8. Modify education policies to ensure that relevant skills are in place when they are needed

In the light of experience in the area of 3D printing in education, two issues that seem to arise in the wider Collaborative Economy context include the need for training teachers in the use of 3D printing and related technologies, and the need to develop suitable curricula that go beyond the mere use of 3D printers as “demonstrators”. In the broader context, a new techno-centric and multidisciplinary approach to education will have to be designed and deployed. Knowledge transfer is critical in all aspects of the Collaborative Economy. For those who are engaged in this kind of society, the rapid change in all aspects of life implies that education will become a continuing function in everyone's lives. The EC ‘Opening up Education’ initiative²¹⁰ should recognise these strategic issues in its plans.

9. Implement policies at the global level

In the Collaborative Economy, everything is data. All aspects of life are to some extent conducted in the digital domain. Data will become the main source of desire, the preeminent medium of exchange and the main source of tension. Global policy formulations are required in the Collaborative Economy because it operates on a global scale, regardless of national or regional borders. The creation of global policies that can be implemented, regulated and enforced will be crucial to the success of the Collaborative Economy. National or regional policies will be meaningless. Follow the lead set by those involved in developing the General Data Protection Regulation in its approach to extra-regional policy-making.

10. Stay ahead with policy

Policy makers should not try to make policy for current digital technologies and capabilities. Digital technology evolves so fast that policy implementation may lag behind and, generally, harms the prospects of what follows. Instead, policy makers should look ahead and devise policy in a manner that regulations are in place as technology arrives. A catch up approach might be problematic when chasing increasingly short technology innovation cycles.

11. Disintermediation and decentralisation will have profound effects upon society and market structures. Radically new ways of policy making, deployment and regulating will need to be developed.

Disintermediation is a key concept to emerge in this study. The technologies embraced in the Collaborative Economy will ultimately eliminate conventional professional people from the

²¹⁰ <http://openeducationeuropa.eu/>

workplace and destroy large hierarchical corporations. Once services are decentralised, new means of enforcing policy measures and regulations should be constructed, perhaps in a revised [Directive 1999/44/EC](#).

12. Protecting and regulating for the notion of individual identity

The morals and ethics of Identity and individual identity are concepts that will eventually need to be regulated in the Collaborative Economy; possibly in the same way as IP, and protected in the same way; through revisions of [Directive 2014/26/EU](#), and [Regulation No. 608/2013](#)²¹¹ (on customs enforcement of IPR). Ideas of individual identity need revision in the data-is-everything world. Not only is it possible to collect and store data about our activities and other aspects of our lives, now it is possible to capture appearance data. The ability to synthesise (parts of) people is a real consideration. New codes of morals and ethics need to be considered. When a printed everything is possible, what will “real” or “individual identity” mean?

13. Objectively consider the fears of criminal use

It is true that all of the technologies covered in the study might be used for illegal purposes but so may any other technology. Cars can be used in burglaries and bank robberies; the proliferation of guns does not depend upon new forms of printing; big data is not the only repository of information useful to extortionists; terrorists have many means of collaborating and spreading their message outside of Internet collaboration technologies. It is also true that the technologies under investigation bring with them new and unusual problems that must be overcome before they can become mainstream.

14. Foundational issues associated with Access and Availability need to be addressed

In the Collaborative Economy, all data will be digital. Digital data are stored and processed in an electronic network environment. The services supported on the network will become a fundamental and essential part of most people’s lives. Fair access to the digital environment will be essential. Fixed and mobile devices need reliable network connectivity. In many parts of Europe this is still not available even in the wealthiest member states. These gaps must be filled. Furthermore, the electricity supply that all electronic devices rely upon must be secured. Directives on electronic communications networks and services, namely [2002/21/EC](#)²¹², [2009/140/EC](#)²¹³, [2002/19/EC](#)²¹⁴, [2002/20/EC](#)²¹⁵, [2002/22/EC](#)²¹⁶, [2009/136/EC](#)²¹⁷ and [2002/58/EC](#)²¹⁸ (as well as its amending [Directive 2006/24/EC](#)²¹⁹)

²¹¹ Regulation (EU) No 608/2013 of the European Parliament and of the Council of 12 June 2013 concerning customs enforcement of intellectual property rights and repealing Council Regulation (EC) No 1383/2003

²¹² Directive 2002/21/EC of the European Parliament and of the Council of 7 March 2002 on a common regulatory framework for electronic communications networks and services

²¹³ Directive 2009/140/EC of the European Parliament and of the Council of 25 November 2009 amending Directives 2002/21/EC on a common regulatory framework for electronic communications networks and services, 2002/19/EC on access to, and interconnection of, electronic communications networks and associated facilities, and 2002/20/EC on the authorisation of electronic communications networks and services

²¹⁴ Directive 2002/19/EC of the European Parliament and of the Council of 7 March 2002 on access to, and interconnection of, electronic communications networks and associated facilities

²¹⁵ Directive 2002/20/EC of the European Parliament and of the Council of 7 March 2002 on the authorisation of electronic communications networks and services

²¹⁶ Directive 2002/22/EC of the European Parliament and of the Council of 7 March 2002 on universal service and users' rights relating to electronic communications networks and services

²¹⁷ Directive 2009/136/EC of the European Parliament and of the Council of 25 November 2009 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

and Regulations No 1211/2009²²⁰ and No 531/2012²²¹ (on roaming) all apply here. The education system is very wide and no technology will be adequate to solve all problems. Moreover there are many and fast evolving technologies while every region and country face specific challenges and have specific contextual factors. Therefore the policy options are intended as strategic approaches that provide a framework for decision-makers to define more concrete policies.

electronic communications sector and Regulation (EC) No 2006/2004 on cooperation between national authorities responsible for the enforcement of consumer protection laws

²¹⁸ Directive 2002/58/EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector

²¹⁹ Directive 2006/24/EC of the European Parliament and of the Council of 15 March 2006 on the retention of data generated or processed in connection with the provision of publicly available electronic communications services or of public communications networks and amending Directive 2002/58/EC

²²⁰ Regulation (EC) No 1211/2009 of the European Parliament and of the Council of 25 November 2009 establishing the Body of European Regulators for Electronic Communications (BEREC) and the Office

²²¹ Regulation (EU) No 531/2012 of the European Parliament and of the Council of 13 June 2012 on roaming on public mobile communications networks within the Union

9 Conclusions

Four emerging and potentially disruptive technologies were the subjects of a small foresight study: Collaborative Internet Technologies, Big/Open Data, Crypto Currency, and Additive Manufacturing.

The objectives of the foresight study reported here, were to

1. Analyse what the combined potential and long-term impacts of new Internet and manufacturing technologies may be,
2. Investigate what the macroeconomic and societal effects of these technologies might be.

The report begins with a short description of the methodology employed in the study. Following this, the four technology areas are introduced. Subsequently the scenarios used in the study are introduced before the interview designs are enumerated. The expert responses are summarised before an analysis of them is revealed. Highlights of the study context are discussed before the main policy recommendations are summarised. The body of the report is composed of summarised information and discussion around the salient points. All of the associated detailed and supporting information is enclosed in Annexes 1 to 5.

The objectives were very ambitious given the broad scope required and the time allowed. However, the modified Delphi method that we developed compensated very well and we derived a great deal of useful data, which we employed to develop policy options.

The main output of the study is a set of policy options for consideration by MEPs. Some of the policy options are provocative and/or contentious. This is not because the authors particularly want to cause friction but because of:

1. The potential of the new economic model discussed in the report to create a truly transformative impact for the whole of Europe.
2. They reflect the considered opinions of the expert stakeholders who were interviewed and which were confirmed by our own research results.

In other words, the opportunity is too important for its significance to be hidden behind obscure language.

If Europe can adapt to the forthcoming changes and deploy policy and regulations suitable to support itself through the early stages of the change process, then there are very many significant benefits to be derived: social as well as economic. If Europe moves quickly and acts decisively then it can assume a leadership role and profit from the associated benefits. If Europe moves slowly, the leadership benefits will be lost and we will become part of the following herd. If Europe tries to fight against this change, it will suffer badly because the change will eventually come, whether it is wanted or not, and it will be shaped according to someone else's agenda.

This report represents only an overview of the implications associated with the forthcoming changes, yet it offers an effective first step in understanding this important economic and social opportunity for Europe. More detailed work should be carried out in order to understand some of the more nuanced and subtle aspects of the potential contained within the Collaborative Economy concept and the technologies that underpin it. Despite this, the policy options provide a useful platform upon which a forward-looking policy formulation/revision process can already be investigated and developed.

Annex 1: Terminology

3D Printing: The ability to construct objects with a device that receives data from a computer and employs a variety of input materials to output the finished object.

3D Scanning: The ability to record data sets that represent, in a variety of resolutions, all of the data required to reconstruct an exact copy of the surface of a real object.

ACID Compliance: A technical acronym standing for Atomicity, Consistency, Isolation, and Durability. These are critical features of a “safe” transaction when managed in a database.

Additive Manufacturing (AM): An umbrella term covering contour crafting and all types of 3D printing technology.

AML: Anti Money Laundering.

4AMLD: Fourth Anti Money Laundering Directive.

Automation: The process of replacing people with machines.

Big Data: A relative term applied to vast amounts of data that are useful for processing and for which the application of traditional data processing techniques prove inadequate. A relative quantification of data volume, velocity or volatility.

BFOD: An acronym for Big, Fast and Open Data as a conjunction of all three areas. See Big Data, Fast Data and Open Data, elsewhere in this list for further detail.

CCEDK: A Danish Crypto Currency Exchange platform.

Collaboration: People and / or machines working together.

Collaborative Internet Technologies: Online tools that bring people together. Examples include: social media, eMeetings, Crowd-sourcing, Crowd-funding, etc.

Contour Crafting: The industrial application of large-scale 3D scanning and printing technologies across an emerging market where production migrates out of conventional factories.

Crypto currency: A medium of exchange that securely originates within a computer network and can be used to buy goods and services online or in the real world.

Data Owner: The entity currently responsible for stewarding data.

Data Subject: The entity the data describes or represents.

Decentralisation: The removal of core components from a system, usually these are the conventional management and control components. Such functions are performed differently in decentralised systems.

Digitisation: The technique that efficiently captures information as discrete quanta. The quanta are reassembled to create accurate facsimiles of the original in data processing systems. Binary digitisation techniques are easily embodied within electronic data processing systems

Disintermediation: The removal of intermediary functions from a system. Decentralisation is one simple form of disintermediation. If intermediation is the existence, within a system, of an entity between two others, which performs some form of agency, brokerage, or another value adding function, then disintermediation is the removal of these functions from the system. The study found many examples of marketplace disintermediation.

DSM: (The) Digital Single Market.

EDSA: (The) European Data Science Academy.

FabLab: A contraction of Fabrication Laboratory, a facility where small to medium sized 3D objects are printed as a service.

Fast Data: Non-static data moving within a network e.g. movie files in transit over the Internet.

Fiat: A term describing a feature of money that is backed by a promise, e.g. a government backing for a national currency. In other words the currency unit carries no intrinsic value.

Fungibility: The feature of an asset that ensures it carries the same value as every other example of the same asset. Gold and Euros are fungible, apples and motorcars are not.

Gamification: Derived from Game. The process by which something important is made more engaging by building in elements of game play to encourage interaction, increase levels of learning and change behaviour.

GDPR: (The EU) General Data Protection Regulation.

Globalisation: The tendency for issues, processes, functions. etc. to spread beyond national and regional boundaries, especially in business.

GMP: Good manufacturing practice.

Personalisation: The creation or adaption of goods and services to meet the exact requirements of each user or consumer.

Intermediation: The introduction of functions into a system or process to enable or improve its functionality. The existence, within a system, of an entity between two others, which performs some form of agency, brokerage, or another value adding function. In the study, we found new examples of (fully virtual or technology augmented) intermediation, especially within the personal and private spaces.

IPR: An acronym for Intellectual Property Rights, which can typically take the form of patents, copyrights, design rights, or trademarks and trade dress.

ISO: International Organization for Standardisation.

OASIS: Organization for the Advancement of Structured Information Standards.

OGC: Office of Government Commerce (UK).

Open Data: Data that are made available for use at no cost to the consumer and presented in a manner that anyone can access for any legitimate purpose.

Privacy: The function that makes something unavailable to third parties.

Prosumer: A conflation of producer and consumer. It happens when some entity occupies both roles in a system. In this case citizens, who formerly consumed data, now become producers of it as well. They become prosumers and their data becomes an asset or a commodity to trade.

Security: The function that protects something from harm, interference or unauthorised removal.

Seigniorage: The difference between the values of a fiat currency token. The currency value of a €10 note is greater than the cost to produce it. The difference in the value represents one source of government income.

VC Exchange: An organisation that converts real currency into virtual or crypto currency, and vice versa.

W3C: The World-wide Web Consortium. An industrial body overseeing online technical web standards.

Annex 2: Scenarios

1. Condensed Domain Scenarios

The Future Context of the Scenarios

Brazil and South Africa are still leading global suppliers of industrial commodities but Nigeria is working hard to steal some of their market, especially in the automotive sector. China and India have passed their economic peak but still have enormous importance on the world stage because of their massive populations. The US and EU economies remain world forces and the EU is still working to improve economic development opportunities in poorer regions of the world.

Most high-value economic activity is now conducted through collaborative working on the Internet by groups of people who share a common interest, regardless of their location in the world. These people are all technically minded, well educated, self-motivated and goal-driven. As no one can predict when and what opportunity will arise and what skills mix is required to address it, they embrace distributed trust and credential maintenance mechanisms²²² to facilitate the rapid creation of work teams to address opportunities with very low latency.

Low Carbon Energy sources are fully developed and integrated to the point where they are able to provide base-load as well as intermittent and peak load to the power grid. The demand for power is still not satisfied as the world economy continues to develop and the global population is still growing, though the growth rate is slowing.

Data are everything. Data directly underpins all technology²²³ and indirectly most life experiences. Collectively, there is already so much data that to call any part of them specifically big or fast data, is no longer meaningful. Big data sets are all around us, invisibly affecting everything we do, like the atmosphere. Like the atmosphere, data are very fragile and we must carefully protect them from harm.

Data are stored in a globally accessible environment called Gaia. Gaia exists within an abstract IT infrastructure, the technology and architecture of which changes with advances made in the relevant field. Users call it Gaia-data, and don't care about the technology and architectures underpinning it. These are irrelevant to all but those tasked with maintaining it. Most people think of Gaia-data like coal or oil, silver or gold. It is a resource to be mined and processed to generate value; the material they have to "dig through" to get at this resource is no longer relevant to them.

The need for physical travel has reduced and most journeys are now local. They are made in shared driverless cars, which run on low carbon fuels best suited to the location. Most cars are communally owned and shared between many users, working life is so flexible that there are no more rush hours when everyone wants to be moving at the same time. The use of community vehicles is heavily subsidised through their ability to sell data they collect on journeys to various organisations interested in it, even tourists buy it in an aggregated form. Only enthusiasts own their own car. Chances are they will have designed it with friends and printed it themselves. This is the age of personalised public transport.

²²² The block chain structure beneath some old current crypto-currencies (e.g. Bitcoin) enables this function.

²²³ Additive manufacturing relies on Big Fast Open Data for input designs, patterns and process instructions. Crypto-currency relies on Big Fast Open Data for value generation, identity verification and security. The escalation of collaborative endeavours would not be possible if it were not for the ability to move increasingly large volumes of data between participants in activities that

The times when gender equality and ethnic diversity were high on societal agendas are over. Inequality and prejudice still exists but they are now associated with access to data, skill levels and whichever online tribe an individual belongs to.

Medical

Bob is not feeling well and he visits his local community centre, where he books a session in the medical suite. Diagnoses are carried out through virtual diagnostic stations. A doctor remotely runs tests on Bob and the data are streamed directly into Bob's electronic personal medical record. The doctor reviews the new data in context. The doctor makes a diagnosis prescribing a personalized synthetic drug to help inhibit the development of a disease. Bob then checks the credentials and fees of a number of suppliers and securely shares his medical and genetic data with a remote drug team who collaboratively design a personalised drug for him. The specifications and dosages are sent to the Bob's printer and he produces his own drugs at home every time he is told he needs them by his interactive medical diary.

Conditions not susceptible to drug therapy can be treated through a bio-printing capability which replaces damaged parts of the human body, including (small parts of) the brain (over time), using a patient's own stem cells as raw material for the printer. These are not domestic printers. Whole organs such as kidneys can be bio-printed to replace malfunctioning kidneys. These personalised organ transplants are now commonplace and whole limbs are even being transplanted as well. Real skin can be grown over bionic limbs for those injuries where a genetically matched bio-tissue limb cannot yet be printed.

Data Creation and Sharing

Sensors, connected to home automation systems, record everything that happens in Brenda's domestic environment.

Sensors connected to vehicles and fixed to structures gather environmental and activity data outside of her home.

Data are stored in the global Gaia information system. Data are now so dense that it is possible to buy modelling apps that are able to make predictions about the future in the way that it once was with weather forecasting. Now, though, Brenda's car can predict where it might find a parking place close to her office (and book it and pay for it) or where she should go to find a good meal in a strange town.

Brenda now treats the data she collects as a tradable commodity and exchanges access to it for goods, services or payment. For Brenda, data have become a personal income stream and an asset in many different dimensions.

Brenda's privacy is ensured through strict protocols that severely restrict the routing of data in Gaia. Gaia has several protocols within it that ensure that personally identifiable data can be accessed only by the data subject, regardless of who the data originator/owner is. Family data stays in the family. Friend data stays with friends. Brenda sets access and sharing permissions on a case-by-case basis. All other data are public unless Brenda sets it as private. Brenda does not need to provide any reason for doing so but may be required to justify the act, or release the data, if access is required by an authority (e.g. as evidence in a court case). Brenda is identified in Gaia through the same distributed identity system that underpins some crypto currencies, i.e. the block-chain.

Forms of Collaboration

Graham finds that with ever increasing frequency, people routinely collaborate with other people around the world at work, at rest and at play.

He favours the benefits of collaborating with domestic devices to make his life easier. Going home isn't a nightmare anymore, because in the morning Graham tasked a robot with instructions to: wash and dry dirty laundry, clean the house and cook dinner so that it was ready when he got home (most people still prefer the robot to cook for them as they are still a bit squeamish about printed food). This last job required the domestic robot to collaborate with Graham's car to know when he was on his way home. Unfortunately, Graham still has to load the dishwasher; the robot is still too clumsy to deal with crockery.

Devices collaborate with other devices to further simplify Graham's life. Service robots work together in his neighbourhood to get unsupervised chores done more efficiently. The robots understand enough about their domain that they will cut the grass when it needs cutting and clear the snow when it blocks the path. They work together to clear the road to a cluster of houses and jointly cut the grass in communal areas: all without specific instruction. Intelligent entertainment devices share preference data between themselves, so if one of Graham's friends shares similar tastes with him and enjoys a new TV programme, their TV tells Bib's TV to recover the transmitted episode from the archive and set itself to record future episodes, just in case Graham wants to watch it as well.

Domestic Aspects

Sue's home is furnished with furniture designed by herself, to exactly fit her style and the space available. Furniture is printed from designs downloaded from the Thingiverse area inside of Gaia. Traditional furniture stores struggled with the transition but finally became service businesses offering low cost printing for large items: not everyone can afford a printer large enough to produce a settee. In fact all forms of commodity production is still centralised but bespoke manufacture is performed through additive processes. There is a premium for 3D printing commodity items if they are required in a hurry or at very remote locations, which are difficult to reach by transport.

Structurally, Sue's home is also printed but by specialist companies employing contour crafting fabricators. They use a very wide range of raw materials as their input to the printing process and no longer have to consider the engineering qualities of their source material, so they can use diseased wood, stone rubble etc. This is a much more environmentally friendly approach than the wasteful (yet essential) requirement to produce building materials to certain structural standards. It is one of the reasons Sue chose this style of house. The structural qualities are now ensured in the design of the output materials, which take a matter of hours to erect. The output material is also designed to be thermally efficient and incorporates a complex system of ventilation channels to maintain the inside environment however a resident likes it to be.

Sue's personal virtual assistants (PVA) wakes her at times that are defined by her preferences, the context (does she need to travel, travel conditions, etc.) and her schedule, which it manages for her. It recommends suitable clothes and tells the domestic robot to make breakfast while Sue showers. It knows what to tell the robot to cook in the same way it knows what to recommend what to wear; it knows what Sue has because she used it to transfer payment when she bought the food and clothes in the first place. It knows what she has already worn and what is yet to be laundered. It knows what she has eaten and what might be out of date in the fridge. It is the brains behind all of the home automation and transportation systems. It even helps at work but here, Sue has more of a say!

Payment and Commerce

Currency is currency; Alice doesn't care what sort it is as long as it is accepted where she wants to shop. Like cash, Alice prefers crypto currencies to the older forms of ePayment systems because they

give her a degree of anonymity. ePayment systems don't. Alice does not want supermarkets, insurance companies and, heaven forbid, governments snooping on her purchasing habits²²⁴.

Alice uses her PVA to affect payments for her, so that it can help her run her lives more smoothly.

Alice is able to sell access to her data when she can/wants to. It adds an additional income stream to her portfolio of income streams. She buys data services from others when she needs them, for example the in-car entertainment system may recommended a concert this evening, and after Alice has accepted it, her PVA automatically buys the ticket and uploads details of the concert into her schedule.

Opening up and connecting pharmaceutical data libraries allowed acceleration in drug and therapy development. IP was protected by a micro-payment system, which ensured that owners were appropriately whenever their ideas were used. Income streams initially dropped, in comparison with the old business model, but strengthened when the value of this joined data started attracting massive interest from drug discovery collaborations.

Communications

Jack employs a form of additive manufacturing in his primary communication system. A remote holographic communicator scans a caller's image and the data are transmitted to the Jack's receiver, where they are assembled and printed in polarised light onto a plasma field by a specialised form of 3D printer. The reverse process happens at the remote end, where Jack's avatar is printed at the caller's location, when he accepts the call. Both Jack and the caller can see representations of each other in front of them when they speak. If they want to! And if they can afford the data shipping service fees!

2. Crosscutting Themes

Introduction

I'm sitting here in the Hyperspace museum café orbiting Alpha Centauri, with my quadrant-hopping, mates Jimmy, Jean and Ben; we are waiting for Kate, who is late, probably because she's lost again. While we wait, we discuss the human history that got us all here. It all started long, long ago in the early 21st century on Earth. The socio-technical changes then taking place eventually led to the data wars and these pushed some renegade humans to seek other civilisations as a diversion from fighting for data supremacy on Earth. We found ourselves discussing the issues around a few cross-cutting themes: Industry and Politics, Data Handling, Currency and Economics, Identity and privacy, and finally Ethics and Conflict.

Industry and Politics

Back then; manufacturing had historically taken place in centralised locations in order to gain the benefits of production (assembly) efficiency. With the advent of full function 3D printing technology all that changed. Peer-to-peer manufacturing became a reality and anything could be printed anywhere at any time by anyone with access to the relevant design files. The designers could work

²²⁴ In addition to being peer-distributed and decentralised, the benefit of crypto-currency isn't in its use online, but in the technology underlying it. The technology does two things:

It generates value without association with an artefact or process in the real world.

It establishes a sufficient proof of identity that is strengthened in each transaction.

In this way a crypto-currency is detached from observation and user transactions are *quantitatively* verifiable. A crypto-currency is more like cash than a centralised ePayment system. The technology underlying them is of use far beyond the scope of crypto-currency.

collaboratively anywhere in the world, and eventually: off it. The conventional multinational concept disappeared almost overnight (where products owned by western brands were manufactured and assembled in the east with raw materials dug fresh from the ground and shipped from elsewhere (e.g. Africa), and imported back into the west along vast supply lines. Under the new global manufacturing model, product designs were collaboratively developed by teams working remotely anywhere in the world and held in virtualised repositories in the Cloud. These design files could then be shipped electronically to any location, on demand, to configure printers, which assembled the finished product automatically and with no human intervention.

Creative and technical people moved into online collaborative spaces and ideas become the asset. Intangibles became the marketed product: a corporation now traded in embodied ideas; there was no need to create the means by which they were made material. Former industrial business conglomerates collapsed: executives and other professionals lost their jobs. Third world manufacturing and assembly plants closed down: assembly workers and their managers lost their jobs. Conventional supply chains and associated shipping companies disappeared. Much energy was saved. Consumers were liberated and enjoyed on-demand bespoke products at bargain prices. Pollution was reduced through the radical reduction of distribution chains and the recycling of raw materials, which fed the printers. Many designers and coders continued to work through the open source model and many formerly commercial goods became accessible through a new form of product commons. Consequently, economic activity shifted to new services offered around those commons e.g. stewardship, discovery and access-control services.

Local and regional politicians saw this model of manufacturing as a boost for regional economies and begin a massive support drive for their local print studios... to enhance the performance of their own localities/regions at the expense of neighbouring localities/regions. Eventually, the former battle between multinationals at the global scale shrank to the local scale, where print shops manoeuvred to gain regional and local political support. This model, in conjunction with the effects of successful crypto currencies finally saw the collapse of the primary powerbases of national politics. With the shift away from national control of a national economy (and a little later the national control of a national currency), regional efforts to gain autonomy and control their own economic affairs became more strident. Eventually, the model of the EU shifted from an organisation of nations to an organisation of regions and the old notions of nationality declined.

Eventually, with the rise of easy-to-use and scalable crypto currencies, even those last vestiges of the old societies eventually ceded to the primacy of virtual societies: those aggregated around ideas, beliefs and activities rather than geographical proximity. Representation grew around those new cyber-social norms and political aspiration moved away from leading nations and regions to leading collaboration and thought creation. Although people all then still lived on the physical planet, they no longer existed solely there; they also existed in the virtual digital envelope they had created around it. Literally and digitally their lives moved freely between the two realms and people began to find it difficult to distinguish between them. Critically, the last bridge between the two realms was energy generation: life in the real world without easy access to large volumes of (electrical) power was difficult but possible. Life in the (composite) digital world was utterly impossible without easy access to abundant and affordable electrical power. When energy sustainability was reached, through the widespread deployment of nuclear fusion generators, data itself (by now totally represented in electronic digital systems) became the new focus of attention in the power struggles between these new political groupings.

The already existing frustration with the social status quo (growing since the early 21st century when citizens began to voluntarily disenfranchise themselves from the political process because of

widespread dissatisfaction²²⁵ with [perceptions of] the system and its related power-bases) led to a willingness to proceed beyond the tipping point when this new political model emerged. They then had (for example) citizens of the Reality TV realm, with voters electing representatives from the X-Factor, Eurovision and Strictly Come Dancing parties; with citizens of geek-land continuing to fight between the relative merits of the Java, C# and Ruby-on-Rails parties but because of the psychologies of citizens here, the newest programming paradigms always won out leading to perpetual short term turbulence, and nothing advanced socially in this cyber realm as a consequence.

With the restructuring of politics, the economy and business, and the new focus on thought generation, idea coding and code curation, (yes, even in the Reality-TV realm), a seismic shift in employment occurred. Creative and technical education increased in importance. New governments were forced to invest more in the education infrastructure. There was no longer any opportunity to learn on the job and those same jobs were ALL highly skilled. An effective economy could no longer accommodate people who could only sweep floors or guard warehouses. Some conventional capacity did remain however, but only to construct and distribute the 3D printers themselves; however, this formed only a tiny part of most economies.

The only remaining relevant conventional representative model would eventually coalesce into a world government to represent the whole human race in relations with other extra-terrestrial civilisations, which did not participate in the then current cyber-hybrid existence of human beings.

Data Handling

Big, Fast and Open data (BFOD) were (and still are) relative terms and even today, their bounds continue to grow as the capacity in data processing and handling grows. In the early days, none of this affected people until the point was reached where the volume of stored data and the richness of the links within data-structures, especially those coupling with open data sets, effectively reduced any claims about anonymity and privacy to fiction. Apparently, anonymity and privacy are important issues for previous generations. This fact was exacerbated with the virtualisation of repositories and their subsequent migration into the Cloud. The Cloud was then accessed over the Internet and this meant that anyone with even basic (data)mining skills could uncover a great deal of sensitive and valuable information from publically accessible datasets. The inability of the then current leaderships to comprehend the complexity and nuances of the emerging world led to some disastrously poor regulation which irritated nearly every citizen for different legitimate reasons: this was one of the drivers pushing humans towards the virtualised citizenship tipping point...

As mentioned, access to BFOD stored in virtual repositories was provided over the Internet. In the new order, therefore, the ability of a community to exercise power shifted away from an ability to influence attitudes and behaviours around the globe; power projection was, from then on, to be associated with the centralisation of, and control of access to, BFOD. Controlling and protecting sufficient volumes of BFOD and maintaining the ability to faithfully fuse further data into repositories; with a subsequent capacity to infer further data points into the sets of linked BFOD became a military mission and data commands were inaugurated.

It is a given that armed conflict is about gaining and holding power. Historically, the different mechanisms through which power has been achieved and wielded has evolved: it was then no longer about territory, ethnicity, faith, or energy but about data (actually, there was also the issue of access to

²²⁵ The “race to the middle”, in search of floating votes, by traditional political parties disenfranchised many voters. Citizens lost interest and associated more with their online communities and expressed their citizenship there more and more frequently. Collaboration by and between interest groups online reduced conventional political influence.

water but that is a side issue as it is the other reason that motivated the quest to seek new worlds and explore new civilisations, from which we got water creation technology).

Back then, money was also becoming digital. In the migration towards a crypto-currency society, the point that payments were reduced to data points was overlooked until it was too late. Cashless payment systems had already been reducing the utility of “real” cash. People were already being driven (forced through lack of choice) to make digital payments... What they bought, when they bought it, where they bought it, who they bought it from were all data points harvested from transactions and fused into collated BFOD repositories. Regardless of what “it” was. The fusing of this data with all the other data into the “BFOD Cloud” resulted in everyone’s privacy simply disappearing. Anonymity in big data was impossible to achieve and rogue entities frequently trawled through the anonymised data to gain valuable insights which they sold on to conventional corporate clients which were desperately fighting a last ditch battle for survival against the decentralised virtual corporates now emerging.

Another financial aspect was that of cost reduction. In order to reduce costs many governments actively supported eGovernment deployment. Services delivered in such a way often came with terms of service vastly different from those of the services they replaced. The ability of civil servants to then compose data sets through linking between previously (practically and legally) un-linkable data sets opened the door to several kinds of opportunity to deliver better and more personalised services. However, the door was also opened to potential abuse that should have been better guarded against but weren’t... Subsequent justification ranged from short-sighted revenue generating policy decisions, through incompetence driven oversights, to outright criminality motivated by greed or spite.

All of this provided further impetus to the “need for change” movement.

Currency and Economics

Eventually, the ability to use “real” cash disappeared in many cities and regions in the developed world... despite the resistance. Cashless payment systems were easier and less expensive to deploy and manage than coin-based systems. They were also less expensive to operate. However, these digital Payment Systems created another centralisation of data that could easily be linked. The rapid escalation in the centralisation of payment data and centralised government personal data collection and storage, in conjunction with data fusion advances caused a massive public reaction and the consequent adoption of decentralised crypto currencies accelerated rapidly. Note here that the difference between a digital payment system and a crypto-currency then became crystal clear to the leadership but only when it was too late to put the genie back in the bottle. Politicians and central bankers lost control of their ability to “manage” economies and the world moved to a decentralised model of economic balance where, collective performance and survival depended on pure (Pareto, Nash, Sen, etc.) systemic optimisation rather than oversight and regulation: a move back towards the laws of the jungle from a regulated set of centrally agreed and managed controls, shared between groups of collaborating nations. This model ideally matched the decentralised virtualisation of community that was emerging simultaneously.

This was the catalyst... A currency expresses an important feature of any economy: the ability of individuals and organisations to participate in trade. Economy, finance and participation were, and still are, linked with democratic freedoms expressed through political systems. With the reduction of the significance of “real money” as a bearer of wealth in data-centric currency models of society, data became the key bearer of wealth and another form of digital divide emerged, where access to data and the ability to manipulate it were critical in the collective effort to create and maintain collective identity. This identity no longer needed to be organised around conventional national concepts; instead, groups could decide to self-organise around technologies or services or philosophies, as was already the case in the Open Source Software movement that had existed from over two decades prior to this time. Moreover, the direct value rewards found in an open source community differed

radically from the indirect (salary/wage) rewards found in conventional economies. Initially, services were wrapped around the data assets and they were used to add further value around them, these values were initially based on prestige and barter: concepts much closer to primitive economies than the previous economic model. However, this model was soon replaced by other fungible data payment models; so, it was now the case that although these data assets remained an economic asset, they were no longer themselves used as a currency. The virtual crypto-currency economy had now caught up with the previous economic model, maintaining the required low operational cost, while retaining the desired anonymity.

When such crypto-currencies were able to fully support the data driven economies of the emerging virtual technocratic nations, other issues emerged. The big issues of funding the new social structures then had to be answered. Issues such as: where is tax levied? How are the representational organs of these abstract nations to be supported? Where and how are a citizen's rights protected? All had to be answered. If currencies were no longer under the control of conventional regulated entities and beyond the reach of traditional law enforcement/judicial systems, where did the ability to exercise redress exist? Fortunately, as the new digitally sophisticated socio-technocratic leaderships resolved their democratic styles, solutions were found and the new society moved on. We are all very pleased that there is now no money, in the old sense of the word, at all now except for the "credits" that support our recreational spending.

Identity and Privacy

Another, almost invisible change process had been progressing in parallel with these other socio-technical changes. It was invisible because it was largely hidden in plain sight. At the time, the physical appearance of an individual could already be scanned and stored as data in a file... broadly, an image file. Such technology was used almost exclusively in the entertainment industry. It was also the case that any image could be inserted or removed from images and movies... in real time, through a process called, at its inception, digital infilling. This process was originally an innocent development of the image processing industry and used to remove blemishes in digital images prior to their use.

When 3D data image files were first captured, they could only be manipulated at unrealistic levels of performance but this performance level changed very quickly and it soon became possible to generate entirely synthetic renderings of individuals that were indistinguishable from (images or movies of) the real thing. In such situations, film studios no longer needed actors; just the image files generated from the 3D scans of them. The form of an actor (or other 3D scanned person) could then be rendered over animated armatures, which could either be entirely synthetic in their generation or derived from the motion capture of third parties. Through these techniques, animators were able to give "life" to the armatures clothed in the appearance of an actor. The armatures could do anything; they were not constrained by the morals, laws and limits of our physical world. Constrained within the entertainment context this capability was only a problem for a few actors and everyone missed the wider application of such technology. They missed the point that, in the wrong hands, any person could be made to seem to do anything, not only actors. Eventually, it became possible to execute these processes on consumer devices. Given access to the image files, the peer manipulation of individuals could then be conducted, by anyone, to appear to be doing anything at all (through manipulating and recording utterly lifelike avatars of the subject).

Whatever appeared in an image could then no longer be relied upon as representative of the scene when it was recorded... if any part of the image was ever real in the sense that it recorded a real world scene. Evidence presentation in court was seriously affected. Conventional forensic techniques could not always then be relied upon.

The technology was used positively: businessmen began to generate digital personas to represent them in virtual meetings whilst they were otherwise engaged. Artificial Intelligence profiles took care of controlling the behaviour of the persona. Legal person status was then bestowed on these personas,

with owners setting the limits and scope of negotiation freedoms and decision-making powers through delegation mechanisms.

However, the technology could also be used negatively: after the You Tube scandals apparently involving notable individuals, people in the public eye took steps to protect (and license access to) their physical and psychological appearance. But, too late, the cat was out of the bag and illicit productions continued, with a criminal underworld providing access to illegal copies of data files. No longer could anyone believe anything that they could not touch in front of themselves. Seeing was no longer believing, not any more. A whole new chapter in the IPR debate was opened... It took a destructive technical solution to overcome this problem but a period of nearly 50 years of uncertainty existed until this solution was found and deployed.

Ethics and Conflict

Many questions in relation to the issues faced in the early 21st century had to be resolved very quickly and as a result it took some time for these quick reaction responses to be refined through various iterations until they were fully fit for purpose. The most difficult issues revolved around matters related to the ethics and boundaries to be placed around many of these new capacities and capabilities. The thorniest of these were those to do with tissue printing. Tissue could already be printed, so it became an extension of the virtual representative avatar argument “if it is representing a human in a particular role, (business man, etc.) is it sufficiently human-like to deserve rights”? Now the questions became: “if organs and body parts can be printed, how much of a body can be printed before it becomes something that deserves the bestowal of rights?”, “if an entire human can be printed, is it human”? What rights will such an entity enjoy? Of course these questions are history to us but it was a very difficult area to navigate through for the first time and took many attempts to get right... if, indeed, we have it right now.

At the time, what was really worrying the legislators on Earth was the question which begins with the premise that if 3D scanners could capture the physical appearance of a human and human tissue could be printed, then duplicates/facsimiles of an individual human could be printed, using 3D scanned image files as input to 3D tissue printers. What form of “life” will this be they wondered? We, none of us – human or not, still do not have the answer but synthetic life does exist now and we all just accept it as another form of life and we get along just fine. Is that because we are all now familiar with other, alien, forms of life? I wonder if, actually, it is not just a human trait: that, once the shock of the new has been absorbed and the associated prejudices are eroded, we do seem to tend towards acceptance.

Of course the really big questions were around “Who owns data”? “How is ownership enforced and protected”? and “How can access be ensured in a fair and equitable manner for the benefit if all”? These were easy to perceive because they all had financial dimensions associated with them. The inability to find good answers to these questions led indirectly to the great data wars on Earth.

Net neutrality was seen as a crucial regulatory first step in the direction needed to answer these questions. It was determined to be the lowest common denominator required to assure BFOD repository access in support of data transfer and streaming operations, without exposing citizens to mechanisms designed to allow minorities to profit from offering preferential access to services for those few prepared, and able, to pay a dividend for the better service. Taking as their inspiration, the practices of the automotive titans and oil oligarchs of the previous epoch, those trying to protect the old business model developed paramilitary organisations to protect their interests. These began to systematically attack the emerging virtual society but completely missed the point that it was so decentralised that they could never deliver the knockout punch using conventional tactics. Hence the first data war was won by the new order. The second war was fought using radically new tactics and saw power shift back before the cataclysmic third and final war was forced on both societies through

the fear-based-tactics of cyber terrorists, whose only motivation was to usher in an apocalypse for their own quasi-religious reasons.

We all learned the terrible lesson. Now we use data as a tool, it is not our master. We view it as a commons, not a good. We are no longer frightened of it: as we once were.

Thank goodness we had the sense to start working on “Prime Directives”, the first two of which were:

1. 3D Printers cannot automatically print another 3D printer, or part thereof.
2. 3D Printers cannot print design files for 3D printers.

Annex 3: Question List and Response Classification SchemA

1. Question List

A) What is the state of the art of this (these) technology(s) and what are the potential long-term (10 years) breakthroughs?

A1: What breakthroughs related to the state-of-the art do you foresee in the next 10 years?

A2: Are you aware of any public policies that hinder or will facilitate these breakthroughs?

B) Will these technologies revolutionise the service and manufacturing industry and will they have a global macro-economic effect in the long term (10 years)?

B1: What areas of the related industry (service and/or manufacturing) will be disrupted and what will be the macro-economic effect?

B2: How will the usual business models in this area(s) change?

C) To which extent is a paradigm shift going to happen or not happen? What are the likely pessimistic, optimistic and realistic scenarios?

C1: What is your most optimistic view on this paradigm shift (if any)?

C2: What is your most pessimistic view?

D) Who are the key players and stakeholders involved? What are the risks and opportunities identified for the different key players and stakeholders identified?

D1: Can you mention 1-3 key stakeholders, please?

D2: For each stakeholder, what are the main interests of this stakeholder? How does this stakeholder influence the area? What risks and external opportunities affect the aims of this stakeholder, and how can policy address them?

E) What are the possible (technical, legal and policy) barriers to the successful development and adoption of these technologies and how might they be overcome?

F) What are the (policy) options you anticipate for promoting the development of these technologies in order to achieve maximum societal and macro-economic benefit?

2. Classification Schema

Expert Profile

Respondent Role

[Scientist, Engineer, Innovator, Producer, Supplier, Consumer, Facilitator, Manager]

Respondent Status

[Global, Europe, National, Domain]

Respondent Origin

University, Research Institute, Industry, Commerce, Application Area]

Technology Focus

[Internet Collaboration, Big / Open Data, Additive Manufacturing, Crypto-currency]

Overall Mood

[Positive, Neutral, Negative]

Response Typology

1. Idealistic, Pragmatic, Ignorant
2. Scope [overreaching, ambitious, mundane]
3. Scope [overreaching, ambitious, mundane]
4. Yes / No (Quantitative comparison with 5)
5. Yes / No (Quantitative comparison with 4)
6. Yes/ No
7. Yes/ No
8. Raw materials, Suppliers, Organisation, Performance, Distribution, Consumers
9. Optimistic, Neutral, Pessimistic
10. Complicate, Status Quo, Simplify
11. Minor, Moderate, Major
12. Minor, Moderate, Major
13. None, Few, Many
14. None, Few, Many
15. None, Few, Many
16. None, Constrained, Unconstrained
17. None, Constrained, Unconstrained
18. None, Name, List of Names
19. None, Name, List of Names
20. None, Risk, List of Risks
21. None, Risk, List of Risks
22. None, Opportunity, List of Opportunities
23. None, Opportunity, List of Opportunities
24. None, Name, List of Names
26. None, Interest, List of Interests
26. None, Single Influence, Many Influences
27. None, Risk, List of Risks (Specific)
28. None, Opportunity, List of Opportunities (Specific)
29. Can, [direct, indirect], Cannot
30. Mood [positive, neutral, negative]
31. Mood [positive, neutral, negative]

Annex 4: Study Respondents

List of names and affiliations of some individuals who participated in our study:

1. Brian Azzopardi. Senior Lecturer at Malta College of Arts, Science and Technology (MCAST)
2. Payam Barnaghi. Assistant Professor /Project Coordinator at University of Surrey
3. Maarten Botterman. Director at GNKS Consult BV
4. Sam Cole. CEO at KNCmining
5. Jacques Demotes. DG at ECRIN
6. Bengt Grahn. CEO at Compodium International
7. Panagiotis Kikiras. VP IoT Analytics at AGT International
8. John Lindström. CEO at ProcessIT Innovations Excellence Centre
9. Jesus Marco de Lucas. Research Professor at National Research Council in Spain
10. Craig Macdonald. Researcher at University of Glasgow
11. Caldon Mercieca. Project Leader at Valletta Design Cluster
12. Vassilis Nikolopoulos. CEO at Intelen
13. Iadh Ounis. Researcher at University of Glasgow
14. Ricardo Jimenez-Peris. CEO & Co-Founder at LeanXcale
15. Nikolaos Konstantinou. Senior Researcher at National Technical University of Athens
16. Michael Nilsson. Chief Operating Officer at Cloudberry Datacenters
17. Peter Parnes. Professor at Luleå University of Technology
18. Fermin Serrano. Executive Director and Researcher at Fundación Ibercivis - Universidad de Zaragoza
19. Antonio Skarmeta. Full Professor at Universidad de Murcia
20. Lionel Slusny. Crowdfunding Expert at Loft Solutions
21. Kåre Synnes.
 - Futurist at EIT Digital
 - Professor in Media Technology at Blekinge Institute of Technology
 - Professor in Pervasive Computing at Luleå University of Technology
22. Christoph Thuemmler. Professor at Edinburgh Napier University and Technische Universität München
23. Beverley Vaughan. Business Development & Executive Liaison at Stevenage Bioscience Catalyst
24. RR Venkatesha Prasad. Assistant Professor at TUDelft
25. Bengt Wittgren. Researcher at Västernorrland County Museum

Further notes:

- The study was conducted anonymously. None of the respondents knew who the other respondents were during the study.
- Respondents are listed in alphabetical order of surname.
- The list order does not correspond with the order of questionnaire or interview completion.
- The list does not reflect the complete set of respondents who participated in the study. It is merely a list of those *willing to be identified* as having participated in the study. Many industrial respondents did not / would not be identified publicly with their contributions. This has much to do with internal company politics and the sanitisation process involved in obtaining formal approval for company-identifying comments to be made public.

This study on the 'Impact and potential of collaborative Internet and additive manufacturing technologies' has been conducted on the request of the Science and Technology Options Assessment (STOA) Panel of the European Parliament.

The Collaborative Economy is approaching thanks to advances in technologies related to Collaborative Internet, Big/Open Data, Crypto Currency and Additive Manufacturing.

The study reveals a wide range of opportunities and threats associated with the technologies supporting the Collaborative Economy. In the wider context, attention is drawn to a number of social, political, economic, moral and ethical issues also associated with the migration into this new way of working.

This report presents a number of policy options for the consideration of policy makers, to help them to anticipate with effective policies to nurture the positive impacts of collaborative Internet and additive manufacturing technologies and avoid the negative ones.

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