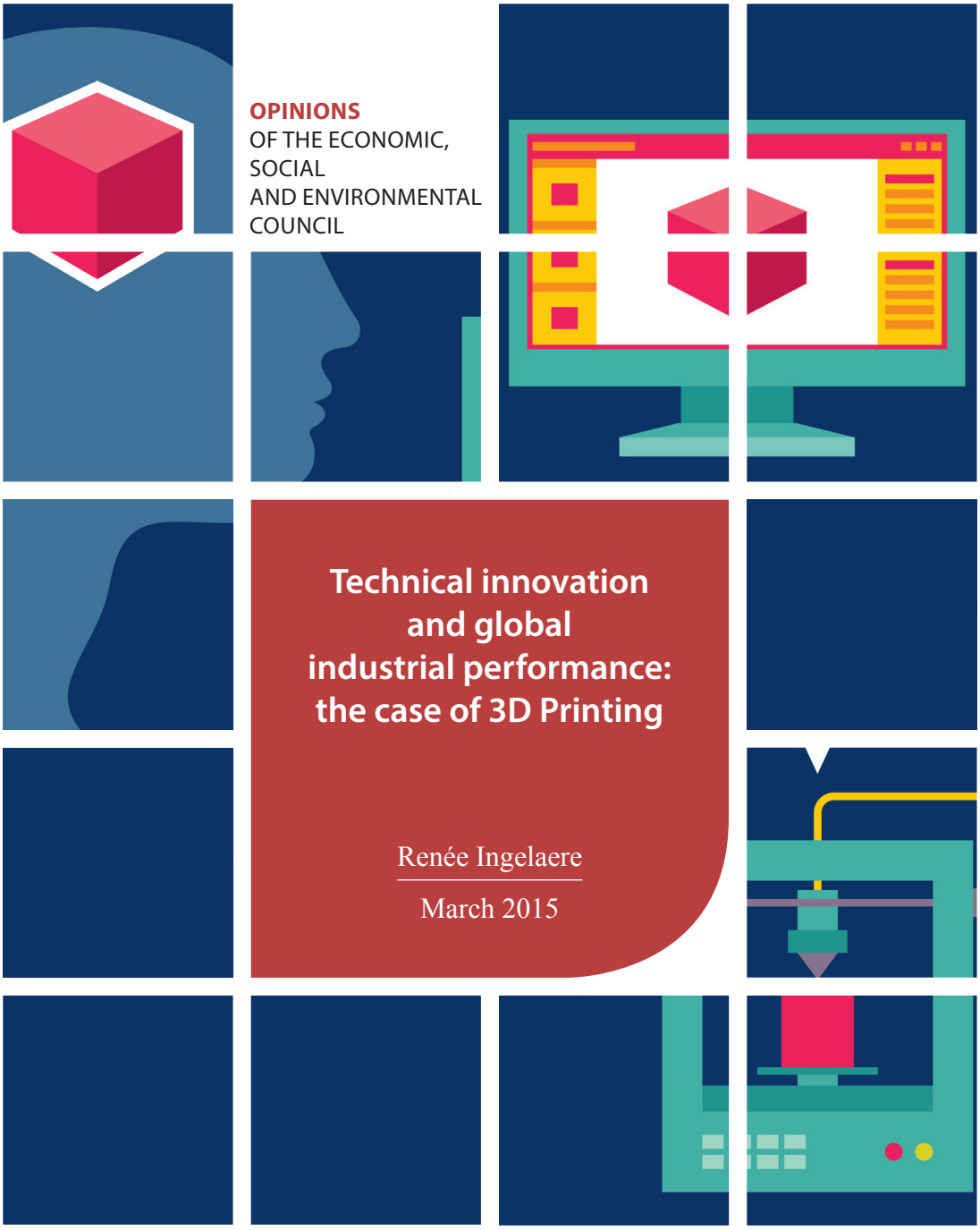

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SOCIAL
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COUNCIL

Technical innovation and global industrial performance: the case of 3D Printing

Renée Ingelaere

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TECHNICAL INNOVATION AND GLOBAL INDUSTRIAL PERFORMANCE: THE CASE OF 3D PRINTING

Opinion of the Economic, Social and Environmental Council on the report submitted by
Mrs Renée Ingelaere, rapporteur

on behalf of the
Section for Economic Activities

Issue brought before the Economic, Social and Environmental Council through a decision by its bureau on 25 March 2014 pursuant to Article 3 of Order No. 58-1360 dated 29 December 1958 as amended, concerning the Organic Law on the Economic, Social and Environmental Council. The bureau entrusted to the Section for Economic Activities the drafting of an opinion and a report entitled *Technical innovation and global industrial performance: the case of 3D Printing.* The Section for Economic Activities, presided over by Mr Jean-Louis Schilansky, appointed Mrs Renée Ingelaere as rapporteur.

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presented on behalf of the Section for Economic Activities

by Mrs Renée Ingelaere

TECHNICAL INNOVATION AND GLOBAL INDUSTRIAL PERFORMANCE: THE CASE OF 3D PRINTING[1]

Opinion

Introduction

Although the fundamental principles of 3D printing (or 'additive manufacturing' - both terms now being used indifferently) were developed some thirty years ago, the technology has only really attracted the attention of the mass media over the past three or four years owing to the significant increase in its applications, both actual and potential. The innovation achieved recognition of sorts when President of the United States Barack Obama referred to it directly in his address on the state of the Union in February 2013, confirming that it had "the potential to revolutionise the way we make almost everything".

In actual fact, 3D printing covers a whole series of processes, all of which are used to manufacture objects by depositing a series of extremely fines layers of materials that are hardened as they are applied using a particular source of energy (such as a laser, for example). This enables accurate and complex shapes to be formed directly, as opposed to traditional so-called "substractive" methods whereby the material is machined to achieve the desired result. Additive manufacturing is driven by a software programme that is itself based on a virtual 3D plan, meaning that its development is closely linked to that of digital technologies.

3D printing is therefore now considered - alongside the likes of mobile Internet, the Internet of Things, cloud computing, big data, the automation of knowledge-based roles, cutting-edge robotics and even advanced materials - as one of the technologies associated with the digital sphere that could radically transform production methods and therefore current economic models to an as-yet unknown extent.

This new technology is therefore representative of all of those that our country must quickly and fully get to grips with in order to improve its global industrial performance. Whilst they have naturally been adapted more specifically to additive manufacturing, the recommendations put forward by our Assembly and outlined below are based on a series of basic notions common to all of these major transformations. In this respect, 3D printing is a fine example of the equations that our economy, and indeed our society in the wider sense, must solve, as a practical example of the difficulties our country encounters with regard to acclimatising to an innovation.

1 **The draft opinion was adopted in its entirety by public vote with 168 votes and 2 abstentions** (see annexed voting results).

3D printing - one of the key technologies of the digital era

Is this innovation to be used only in high-added-value niche markets or is it intended to eventually replace virtually all current production methods? Although it is still too early to definitively answer this question, it appears that additive manufacturing will, and has indeed already started to, occupy a considerable place on the new global industrial landscape, which it could well help to profoundly alter. This is more than reason enough for our country, in this field as in others, to rule out the risk of letting an opportunity to contribute to its global competitiveness by means of the widespread distribution of this technology pass it by.

3D printing now an industrial reality

3D printing was initially used for the purposes of "rapid prototyping", helping to improve lead times and costs and give greater consideration to the issue of complexity with regard to producing models and experimental projects. This currently represents a considerable need, for example, on the part of engineers, architects and product designers (as well as certain artists). The distribution of additive manufacturing machines has also resulted in the varied production of small plastic parts which once appeared to imply that this technology was likely to remain confined to the distribution of gadgets, although these early stages have clearly now been overcome.

Significant recent progress

The continuous development of the capacities this technology has to offer has resulted in a multi-pronged improvement concerning both the diversity of the machines available on the market (there are currently over 80 different models of industrial 3D printing machines in the global market, not to mention those designed for personal use), manufacturing speeds (with specialists claiming that these double every two years) and the variety of materials that can now be used.

The latter, which stood at around 200 in 2014 and increase year upon year, now include not only plastics and composites but also metals (and their alloys), ceramics and even organic materials. The most fascinating possibilities are therefore beginning to emerge with the huge potential represented by the use of biological tissue and nanomaterials.

Furthermore, some machines are now able to use several materials of the same kind, plastics or metals, simultaneously, and it will inevitably become possible to use materials of different kinds at the same time at some point in the future. Huge progress has also been made with regard to the size of the products manufactured (from just a few centimetres to several metres) and their precision (down to the micron).

Practical applications in a number of sectors

The technology can now be used in the most varied of sectors and to various extents as a result of this major development,

but it is the health sphere that first springs to mind nowadays with the development of custom-made prostheses and implants designed to perfectly suit each patient thanks to the digitisation of their morphological characteristics. Dentures and hearing aids are now frequently produced by means of 3D printing, which is also used for the purposes of facial reconstruction, not only to simulate delicate procedures but also for the operations themselves (restoring the function of organs that still present delicate problems that need to be resolved, and tissue revascularisation in particular).

The aviation industry has also been one of the very first to adopt the technology, with thousands of complex aircraft parts (wings, engines, etc.) now produced by means of additive manufacturing. Furthermore, it should be noted that the space agencies (United States, Europe and Japan) have also shown a very keen interest in the technology. The automotive industry, for its part, is also starting to use the technology to manufacture actual parts rather than just prototypes and tools, whilst major companies in the energy sector have invested heavily with a view to creating parts for gas turbines.

Jewellery, including the watch-making and crystal glass-making sectors (for the design of complex one-piece objects requiring extreme precision), is another of the most cutting-edge fields with regard to this technology, along with the food industry (for professionals and, based on ready-to-use fresh ingredient capsules, for individuals, too). The toy and furniture industries or professionals in the building and civil engineering (and even home construction) sectors, not forgetting those stakeholders operating online and being in the process of becoming global, are seriously considering the new opportunities presented by the 3D printing technology.

Considerable potential to challenge the current production model

Additive manufacturing is still, of course, by no means able to compete with the output (and therefore production costs per unit) of the mass production methods that characterise today's industry. In addition to the fact that the progress outlined above is starting to make it possible for certain goods produced on a large scale to find an economic balance, however, the assets specific to this technology could well bring about significant changes with regard to the way in which the manufacturing industry operates and even the way in which society as a whole is structured.

From mass-production to customisation

The first of these assets involves the possibility of producing customised objects based on a single investment by modifying basic digital files. This "customisation" enables the end-user - be they an individual creating or altering a model using a personal 3D printer or a client benefiting from the services of a professional - to choose certain specific product characteristics or even to be involved, to a greater or lesser extent, in its very design.

With this in mind, additive manufacturing can now meet very specific small-scale needs, such as those of the motor sport and luxury jewellery industries (for creating unique pieces with a great deal of finesse), for example.

The manufacturing of figurines on demand and the option of choosing certain shapes or shades for pieces of furniture, which are geared more towards the general public and

involve larger production volumes, show that both traditional players and new, more reactive competitors will, at some point in the future, be required to take this direction.

Promising prospects for the convenient location of activities

This new technology represents the potential to shorten distances and time frames between the product design, production and consumption stages. Whilst 3D printing is often associated, in many reports, with the idea of "relocating production", it is important not to give the impression that it could result in mass production runs that are currently undertaken in emerging countries being brought back to home soils. What it means in actual fact is that a significant part of future activities - with a high digital content - could be developed by promoting the opening of a regional base close to their consumer markets. This would involve an ecosystem that is conducive to 3D printing, such as the introduction of new qualifications, for example, which therefore raises the issue of appropriate basic and ongoing training.

Within this new context, of course, it is important to underline the fact that the overall impact in terms of volume of employment remains very uncertain in light of the simultaneous cuts resulting from the increased automation of processes and the reduction in activity, such as where transportation and logistics are concerned, for example. We can nevertheless expect to see a certain increase in local employment requiring various levels of qualification. SMEs in the business and cottage industry spheres, for example, could therefore play a considerable role in developing the repair sector, driven by the possibility of printing spare parts. Alongside the activity undertaken by individuals on their own behalf, this professional sector would also provide certain safety-related guarantees.

It is therefore important that we prepare for "the factory of the future", bearing in mind that this concept should be understood as the combination - within a new productive fabric - of businesses of all sizes, from those requiring significant investment of capital to much smaller and more specialist units positioned at the interface between services and industry.

Raw material and energy savings

Additive manufacturing also appears to offer tangible benefits with regard to optimising natural resources. It does, for example present opportunities to make savings on raw materials, in comparison with traditional "substractive" manufacturing processes, by using only the amounts that are strictly necessary. It also results in energy savings; in the aviation industry, for example, the decrease in the weight of aircraft achieved through the use of 3D printing for manufacturing certain parts helps to save fuel.

Furthermore, the environmental efficiency of all economic activities could be improved by limiting goods transportation as a result of manufacturing the goods closer to their market.

At the same time, the recycling of used materials (with increased consumption of the plastic materials that currently still account for the majority of the materials used) and the risks of air pollution (microparticles) remain issues of concern that must imperatively be taken into account.

New stakeholders in production chains

Certain concerns regarding product quality and safety will also need to be dealt with and responsibilities in the event of defects and damage determined given the increased number of new players involved right throughout the production chain (machine and material manufacturers and sellers, software and digital file designers, and producers themselves, both professionals and individuals).

This point is a particularly sensitive one with regard to the health sphere and the manufacturing of medical devices using 3D printing. The ESEC opinion on *The place of medical devices in the national health strategy* (rapporteurs: Thierry Beaudet and Edouard Couty, January 2015) sets out a series of recommendations for ensuring the safety and quality of such devices.

New employment organisations

The gradual generalisation of digital technologies is radically altering the organisation of labour. The 3D printing technology can amplify such transformations by facilitating more direct links between innovation, design and production. Combined with a more cooperative management method, it can also encourage more cross-functional and collaborative forms of working that require a greater degree of creativity on the part of the individual employee.

Makers and Fab-Labs - a new societal situation

Beyond the potential transformations in the economic sphere, it would appear to be society as a whole that should be affected by these new technologies that offer not only new tools but also a new approach with regard to innovation. As a result, the philosophy based on the 'do-it-yourself' approach and on sharing information ('open source'), combined with the rapid generalisation of the use of digital technologies (including 3D printing), has given rise to the 'Makers' movement and to new locations - both physical meeting points and interconnected spaces - in the form of Fab-Labs.

This has, in turn, resulted in an increasingly porous boundary between purely personal activity (leisure, DIY, etc.) and the creation of businesses, and artisan businesses in particular, with the potential to access an almost global market. It is this new reality that must imperatively be taken into account for the purposes of establishing an ecosystem that favours innovation within our country.

France must seize this opportunity to strengthen its production offering and its global competitiveness

3D printing was invented at the same time (1984) in France and in the United States, but the excellent level of research was not as quick to translate into economic activity on this side of the Atlantic, which is why there is now an urgent need to outline a clear and defined strategy in this respect.

A currently modest share of the global market

The data published in the Wohlers Report 2014 reveal a distinct predominance on the part of the United States, which account for 38% of the total number of 3D printers installed

around the world to date, a good way ahead of Japan, Germany and China (which account for around 9% each). France ranks in 7th place on the global scale in this user ranking, with just over 3%, slightly behind the United Kingdom and Italy and ahead of South Korea.

The United States are also home to two world leaders in the sector, namely 3D Systems and Stratasys, which regularly acquire other companies - in the fields of both professional equipment and personal 3D printers - in order to maintain their position amid the current proliferation of new businesses within a sector that still has a long way to go before it reaches maturity. Within Europe, however, it is the German companies that are leading the way, particularly with regard to machines using metal powders - a segment that is still rather small but growing rapidly.

In France, meanwhile, a very limited number of key players in the manufacturing of machines are now emerging following the 2013 buyout of Phénix Systems by 3D Systems. The independent professional 3D printing machinery industry in France now rests primarily on the shoulders of the Gorgé group via its Prodways subsidiary, which notably specialises in 3D printers for dentures and operates in the medical, aviation and even jewellery markets. Alsace-based start-up BeAM, which operates in the aviation industry, is also worthy of mention.

Indisputable assets in the fields of software, services and materials

Whilst the equipment market is now largely out of the reach of French businesses, it is also important to highlight the fact that these machines represent only a third ($1 billion) of the global 3D printing market (which accounted for some $3 billion worldwide in 2013), with half being made up of associated services ($1.5 billion) and the remainder corresponding to the materials used ($0.5 billion).

In order to benefit from the significant potential for growth in a market that is very much still in its infancy (around 33% a year, with the potential for a global additive manufacturing market that could exceed $20 billion by 2020), French businesses would first and foremost need to draw on the recognised assets they possess in the fields of software (with world leaders such as Dassault Systèmes), services (such as Sculpteo) and research into new materials.

At the same time, it is essential that this technology be gradually incorporated into the industrial and artisan fabric of our country, particularly where SMEs are concerned, since the few field studies undertaken to date show that there is still a great lack of awareness surrounding the possibilities that 3D printing offers.

The ESEC recommendations aimed at public authorities and professionals: creating a favourable "ecosystem" in France

It is important, in this respect, to consider the main conditions that would make it possible to incorporate additive manufacturing and the associated applications into our country's production base as quickly as possible. As is the case with the majority of technological innovations, improvements need to be made with regard to the corresponding training,

research & development and funding. It is also important to think about the sometimes radical changes that need to be taken into account in terms of legal certainty and standards. Last but not least, it is vital that the potential implications of integrating this new technology in terms of developing economic activity and creating jobs within the country be carefully examined.

Better information regarding 3D printing

The work undertaken by our Assembly has revealed a lack of information on the part of both businesses and the general public with regard to 3D printing and the type, pace and content of the transformations it might bring about in terms of the production system, the structuring of the value chain, the various professions concerned and the organisation of labour.

It is for this reason that, in order to facilitate and support the implementation of the other recommendations outlined in the present opinion, the ESEC would ask that economic and social stakeholders take care to observe the changes taking place as a result of digital technologies, including 3D printing, notably in the framework of prospective analysis observatories of professions and qualifications, at both regional level and within individual professional sectors, to inform all interested parties of their prospective analyses and to adapt their policies, or at least those that concern them directly, for anticipating such changes (HRP, training, qualifications, standards, etc.).

The ESEC would invite the public authorities, the National Council for Industry (CNI - *Conseil national de l'industrie*), along with its sector-specific strategic committees, and the National Services Commission (*Commission nationale des services*) to instigate a series of prospective analyses with a view to enriching their work and therefore more effectively determining their actions.

Developing training and qualifications at all levels

France can only hope to create an ecosystem that favours the development of the 3D printing technology - or indeed any other innovation of such a scale - if it affords itself the means to continuously increase knowledge and expertise in this field.

Providing opportunities to give young people a taste of science and innovation

There is a real sense of disaffection with regard to science and the associated professions which has led to the deterioration of the culture of innovation in our country, something that has often been highlighted by our Assembly (*cf.* Competitiveness: stake of a new model for development, rapporteur: Isabelle de Kerviler, 2011). Greater recognition of scientific professions would lead many engineering school graduates to put their training and expertise to use in these sectors rather than in other spheres such as finance.

Whilst innovation based on the digital sphere continues to increase, the various surveys on innovation (undertaken notably by the Organisation for Economic Co-operation and

Development (OECD) and the European Union) show that businesses consider the lack of qualified staff to be one of the primary obstacles to innovation.

The teaching of IT in its various forms and immersion in the digital sphere must be introduced into the school curriculum as early as possible (primary, lower secondary, etc.) and promoted among both boys and girls alike. Greater diversity within IT and digital professions is vital if we are to meet the needs of the economy. In the framework of an overhaul of the school curriculum in the United Kingdom with the aim of better preparing the young working population of tomorrow, the British Education Minister has released £500,000 to help schools to purchase 3D printers and plans to **teach computer programming and the use of 3D printers from as early as five years of age. The ESEC would recommend that an ambitious programme be trialled in this respect in France.**

This should involve an approach that would allow for trialling and experimentation, as facilitated by 3D printing, following on from the *La Main à la Pâte* ('Let's all muck in') programmes implemented in the mid-1990s. The context would appear to be particularly favourable in that for children growing up in the 21st Century, IT, in its various forms, is anything but a 'new technology' since they have never known a world without it. According to the reflection undertaken and the proposals put forward by the French Academy of Sciences in May 2013 ('The teaching of IT in France - The need for immediate action'), young children should be introduced to such technologies in primary school and become independent in using them when they begin their lower secondary education. **Only at *lycée* (upper secondary) level, however, should children be expected to become advanced users of IT. Such advanced use should also be expected of young people receiving training at apprentice training centres (CFAs)** in relation to the vocational specialisation they have chosen.

At the same time, **the ESEC believes it essential that training courses designed to reflect these different levels of learning be provided for teaching staff**.

Our Assembly believes that the development of local Fab-Labs also meets this need to encourage people to use digital technologies as early in life as possible.

Creating real specialisms

The report showed that the training currently available in the field of 3D printing was not altogether very visible in comparison with other specialisations in the digital sphere, such as robotics, for example. Only a handful of vocational *lycées*, universities and engineering schools offer training modules such as, for example, the 'Computer engineer and graphics and 3D technology engineering applications' ('Ingénieur informatique et applications ingénierie graphique et technologies 3D') course offered by the ESIEE graduate school of engineering in Paris (a consular engineering school). When questioned, professionals - manufacturers - are quick to lament such a situation whereby the provision of in-house training is in fact required.

As far as the ESEC is concerned, it is vital that centres of excellence in 3D training at 'engineering school' level be created or given greater visibility with regard to the manufacturing of the necessary machinery, the development of software and the various associated services. The creation of a network comprising a number of these centres would lend crucial visibility to national expertise. In this age of the network economy, it would not be appropriate to encourage a physical consolidation. It would be more beneficial to create

a distinctive sign, in the framework of the Carnot Institutes, for example, that would provide controlled information on the training provided.

Whilst true 3D specialisation is perfectly justified with regard to training engineers and technicians, **the development of new specialist professional expertise is also essential in the logistics, commercial and legal fields and, in the wider sense, in the services sphere**. Such "technologically intense" skills can notably concern the eco-efficiency aspect, which involves the optimal use of resources.

It is also important to **encourage the development of training in the use of 3D printing within regional universities for arts and crafts (URMA - *Universités régionales des métiers et de l'artisanat*)**, which provide training from CAP to bachelor's level.

Adapting the continuing education offering to new professions

The speed at which digital innovation penetrates the production sphere is on a different level than what would have traditionally been expected, which gave all concerned the opportunity to truly adapt to the new technology. Companies' needs in terms of qualifications are not always met by the basic training system, and the number of students graduating from engineering schools and universities every year is insufficient to meet the demand on the part of the production base. The role of ongoing training is therefore key, particularly given the increased rate at which specific skills are becoming obsolete. Of course, there is still certain knowledge that might be considered basic, although the use of special training courses of varying durations is now an integral part of the ongoing training offering and justifies **the development of a system for monitoring qualifications and the progression thereof that is closely linked to the technological monitoring of 3D printing prospects**.

Our Assembly is examining a number of fields of training that correspond to emerging or highly specialised digital specialisations. It is indeed these skills, as highlighted by the digital professional sphere, that companies are seeking for some of their departments (marketing, communication and sales). They do, however, experience great difficulty in meeting their recruitment needs and therefore seek the expertise they require from service provision companies operating in the fields in question.

It is important to highlight that needs for ongoing training in the use of 3D printers must also affect all sectors of activity and not just professionals in the digital sphere. **The ESEC would underline the role of professional organisations and Consular chambers in contributing to raising awareness among professionals of the opportunities presented by this new technology, on the one hand, and to the development of training opportunities in this field, on the other.**

Vital efforts in the field of research and development

With regard to R&D, there is still progress to be made not only in terms of the amounts invested but also with regard to using them effectively.

Encouraging research in public laboratories and promoting partnerships

Our Assembly has pondered the logic behind the structuring of the French research system, along with the funding thereof, on a number of occasions. Various mechanisms have been put in place and very few withdrawn over the past twenty or so years, as a result of which the system has become somewhat illegible and sometimes superfluous.

The quality of public research in France is widely recognised and explains why our country maintains its position with the front-runners when it comes to research. Within the digital sphere and with regard to 3D printing in particular, the report showed that research - regardless of the country in which it is undertaken - had reached a stage whereby the costs were often shared between public and corporate budgets, representing a significant partnership. This has, in fact, been demonstrated notably in the United States via the interplay between the various federal agencies but also in Federal Germany by means of the Fraunhofer Institutes.

In France, meanwhile, the increase in the economic impact of public research (laboratories, universities, etc.) by means of the switch from R&D to production and marketing over recent years has become a priority objective and has therefore been incorporated in the "France Europe 2020" strategic agenda. As a result, certain major public research bodies are establishing partnerships with companies, as is the case of the CEA-LITEN, which has formed a partnership with Prodways, part of the Gorgé group. As far as the LITEN is concerned, this partnership involves accelerating innovation to the benefit of manufacturers and will help the company to achieve a leading position in various segments of the rapidly expanding 3D printing market.

As far as the ESEC is concerned, this type of partnership between public research and innovative companies is naturally worth developing, particularly since companies specialising in the 3D technology tend to be SMEs rather than ISEs or large groups, with a few exceptions. **It is vital that the pace of research be stepped up, particularly in a field in which France boasts major assets, namely the field of innovative materials (metals and alloys and organic materials)**.

With this in mind, the ESEC appreciates and will follow with interest the introduction and development of the 'LabCom' call for proposals launched by the French National Research Agency (ANR), which aims to create 100 joint laboratories for academic and SME/ISE research and thus help bridge the gap between public research and the world of business.

Encouraging synergies between the organisations responsible for promoting research

Many organisations are now promoting research, to such an extent that the Court of Accounts has referred to them as representing a 'proliferation system'. The fact nevertheless remains that this proliferation makes the situation as a whole somewhat illegible, particularly for stakeholders in the field and especially taking into account certain organisations of European scope.

According to the OECD, this diversity of systems also results in "an impossible situation - or at least significant difficulties - with regard to the coordination and monitoring of systems with the aim of achieving the objectives set by the State" (unofficial translation). Neither

does it really facilitate the search on the part of small businesses for the best representatives to meet their needs.

Our Assembly appreciates the benefits of the Carnot Institutes, competitiveness clusters, technological research institutes and Technological Transfer Acceleration Companies (SATT), created in the framework of the national fund for the promotion and scheduling of future investment. It equally appreciates the benefits both of industrial technology centres that operate with the support of professional bodies and permeate the entire country, and of cottage industry innovation clusters.

Nevertheless, **as far as the ESEC is concerned, it is important, in this age of the 'digital revolution', that the synergies required to introduce a sole point of contact for companies be coordinated as a matter of urgency**.

The aim of this initiative is to improve ties between players in the innovation ecosystem, the identification of projects and the support they receive to bring them to market across all regions.

Scaling up the financing of innovation in France

It is vitally important to find sources of funding at every stage in the development of an innovation, from basic research to the marketing stage, with the most risky stage often being the transfer to sales support representatives, followed by the industrialisation process.

Whilst new instruments do already exist or are being introduced - including the research tax credit (CIR) scheme, support for large groups and innovative SMEs (corporate venture), region-specific schemes, crowdfunding, etc. -, there are still certain gaps that need to be filled with regard to the funding pathway.

Improving public support

Bpifrance is a key stakeholder in policies designed to support innovation in France and one that compensates for the now highly inadequate role played by the banking system in financing the economy, and innovation in particular. Created in 2013 as a result of the merger of OSEO, CDC-Entreprises and the strategic investment fund, the public bank offers a range of additional tools designed to support SMEs and ISEs, the uses of which are characterised by their drive capacity.

In addition to its efforts that are supported by a traditional banking offering, Bpifrance develops additional funding tools designed to meet specific company needs that are not met by the market, including development and start-up loans and short-term funding. It also provides guarantees that help secure funding for high-risk projects in three segments, namely the creation or handover of businesses, business development loans and cash flow improvement.

Bpifrance recently took on the issue of 3D printing in the framework of a series of themed seminars designed to incorporate all companies of all sizes, including academic research, drawing on a national comparative advantage that can be summarised by the fact that France is one of the most digital countries in the world but lags some way behind when it comes to using this technology in business. Whereas, according to some experts, the machine production battle might appear to have been lost, there remain, in the fields

of software and services, a number of major segments in which French companies are well placed since they are supported in their endeavours.

The ESEC would recommend that Bpifrance acquire sufficient human and financial resources to enable it to continue its efforts in the long run and thus achieve its stated objectives in the 3D printing sector by means of a leverage effect.

As the National Council for Industry has highlighted, the international comparison of satisfaction levels with regard to bank loan applications from SMEs, undertaken by the European Central Bank, ranks France distinctly below Germany. Indeed, business leaders lament the lack of knowledge of this sector of industry on the part of local banking establishments. With this in mind, **the ESEC would invite the banking sector to establish trusting relationships between SMEs and the managers of credit establishments in the long term**.

At the same time, and notably to compensate for the unadventurous nature of the French banking system, **the ESEC would recommend that the public authorities introduce some form of incentive with the aim of steering the long-term savings managed by investors (including insurance companies) towards innovation and risk-taking**.

The ESEC would also invite local authorities to join forces with local partners with a view to setting up funds for financing innovation following the initial regional experience gained in this field (Auvergne, Nord-Pas de Calais, etc.) - **something that can only serve to reinforce the local anchoring of production activities.**

Making optimal use of EU financing

The various Framework Programmes for Research and Technological Development (FPRTDs) introduced by the European Union are of great significance, with the results obtained from the seven FPRTDs highlighting the same observation after each campaign, namely that French involvement is relatively low and inferior to the value of its contribution to the Union's budget. Indeed, France received 8.2% of all contributions made in the framework of the 7th FPRTD (2007-2013) in the field comprising 'materials and new production technologies', putting it 5th in the ranking, a long way behind Germany (20.3%). As far as the ESEC is concerned, this could represent an interesting avenue of investigation, particularly as the FPRTDs have been the only way of implementing joint research initiatives in certain fields at Community level in recent decades.

The 8th FPRTD, "Horizon 2020", which came into force in 2014, comprises a series of priorities intended to reflect the expectations of French stakeholders in the research sphere and will incorporate the various Community research and innovation programmes in a single document.

The French strategic agenda "France Europe 2020" aims to structure and reinforce the national support system for European projects and those pertaining to "the factory of the future" in particular.

The fact that the financial resources allocated to the 8th FPRTD have increased greatly based on the proposal of our country (by 54% in relation to the previous FPRTD), from €50 to 77 billion, should also be highlighted.

As far as the ESEC is concerned, the "Horizon 2020" programme represents a major opportunity with regard to structuring both national and European research initiatives - and indeed the regional implications thereof - concerning digital technologies and

one that should not be missed. The amounts that will be allocated to such technologies should enable the European continent not to allow itself to be left behind by the United States and the Asian economies.

Last but not least, our Assembly has underlined the progress made by the European Union with regard to promoting innovation through the creation of various risk financing instruments for SMEs. Such efforts are conveyed in France through Bpifrance, which also offers various training programmes in risk financing aimed at support mediators. **The ESEC would stress the need to further improve support for small and medium-sized enterprises in compiling such applications, notably by making the European system far more legible.**

Structuring long-term research ("investments for the future").

Future investment is responsible for the long-term structuring of research efforts. Indeed, the digital sector is one of the strategic avenues selected both because of the fact that it is a sector with potential for growth and because of its "catalytic impact on the rest of the economy, helping to improve the global competitiveness of both industry and services and being able to support innovative offerings in all sectors" (unofficial translation, report entitled *Investir pour l'avenir : priorités stratégiques d'investissement et emprunt national,* Michel Rocard and Alain Juppé, 2009).

A second future investment programme was announced in July 2013 to finance some of the priorities identified in the framework of the energy transition, as well as innovation, industrial competitiveness, the digital sphere, research and health. A total of €12 billion has been released by the Initial Budget Act for 2014.

The ESEC is insistent that the amounts released represent a long-term investment in research and its applications.

Addressing the new intellectual property and security challenges

We have seen that progress in the manufacturing of objects using the 3D printing technology is closely linked to the most recent developments in the field of digitisation. It is therefore logical to refer back to the issues already raised some years ago within the publishing sectors (music, films, books, etc.) with regard to copyright protection. The issue of literary and artistic property rights (copyright and other associated rights), in fact, largely resembles the issue of industrial property rights (patents, designs and models, brands, etc.).

At the same time, the application of the traditional rule of the Civil Code, which incriminates the "manufacturer" in the event of any damages caused by a defect, must be adapted to reflect the emergence of new players in the production chain (digital file creators, sharing and sales platforms, printing services, etc.). The same is true with regard to the increased responsibility on the part of the producer that makes the latter responsible for the goods they produce, including the end of their lifespan (recycling or processing).

Making businesses aware of new risks

It would appear, firstly, that the legal rules in force are not, in principle, challenged by digital innovation, or in this case by 3D printing, meaning that, in the absence of any authorisation on the part of the party that owns the rights, the manufacturing of the protected object will be considered counterfeiting, implicating both the producer and the end-client, regardless of the technology used. In the case of additive manufacturing too, it will be down to case law to establish the responsibilities of each party and therefore to gradually clarify the legal framework.

At this stage, therefore, it is essential to draw the attention of companies entering the additive manufacturing sector to the risks involved, particularly at this time of emerging case law. **As far as the ESEC is concerned, the various consular bodies - in the framework of their new strategies and in conjunction with professional federations - should strive to promote and acquire the necessary resources in the fields of consultancy and training** to enable entrepreneurs to avoid the two contradictory pitfalls, namely rashly launching themselves into a new technology and overlooking an opportunity to develop their activity out of fear of an uncontrolled risk.

Securing the legal landscape for businesses

Private user's rights - which generally state that if a copy is produced outside of the framework of any commercial relationship then it is not considered counterfeiting - would appear to give rise to particular concerns in that 3D printing could enable individuals to manufacture - for their own personal needs but to the detriment of professional activity - everyday objects in large quantities.

It is important, first and foremost, to underline the fact that, in light of the technical and cost constraints involved, this risk is still far from becoming a reality. Furthermore, the misfortunes of the Hadopi system have proven that it would be increasingly illusory to try and hold end-users responsible (the withdrawal of the very principle of private copy exception - under copyright - or private user's rights - under intellectual property rights - representing a mere variation).

Certain new types of regulation should, however, make it possible to reconcile the increased legal supervision of this new method of production and its development. Beyond the conditional access technology systems ("Digital Rights Management") that companies themselves can put in place, **the ESEC notably believes that intermediating platforms (file hosters) should be more clearly held responsible in order to encourage them to effectively verify the lawful nature of the files they host**.

More generally, and given the scope of the issues at hand in economic and employment terms, the ESEC would encourage the public authorities to put their proposals to the debate, notably in the framework of the major law on the digital sphere announced some months ago, which has been somewhat delayed and should notably outline new legal systems designed to protect against counterfeiting.

Taking into account ecological and health impacts

As the ESEC report on *Transitions towards a raw material-efficient industry* (rapporteur: Yves Legrain, 2014) has already highlighted, the concept of a circular economy takes into account the entire product life cycle and is based on eco-design, striving to extend

the product lifespan and anticipating the product being recycled at the end of its life. It complements the concept of industrial ecology, which aims to optimise the circularisation of product and waste flows and the development of an economy of use.

The sustainability, adaptability, repairability and recyclability criteria must be incorporated from as early as the design stage.

Furthermore, in light of the risks of air pollution and the impact on health created by additive manufacturing processes, **the ESEC would draw the attention of the relevant stakeholders to the importance of complying with the legislation in force regarding materials and equipment and their use.**

Playing a greater role in international standard-setting processes

Whilst they undoubtedly represent a direct or indirect cost for companies, such processes are particularly useful when it comes to distributing innovation in that they provide companies with certain guarantees. The fact remains that contributing as much as possible to the definition of new standards can prove a significant competitive advantage.

Maintaining the standardisation process in the framework of the ISO and CEN systems

A symbol of the transition to the industrialisation stage, the international standardisation of 3D printing is increasing at a rapid pace, with an increasing number of countries contributing at international level and representatives of Asian countries now involved alongside those from the United States and Europe. According to the latest information available to us, the standardisation programme is expanding and a number of additional working groups have been set up.

Of course, standards are applied, in principle, on a voluntary basis, although some of regulatory value must be applied as a matter of obligation. Indeed, access to certain markets, including those involving international invitations to tender, is dependent upon such standards being applied. **The ESEC considers the need to bring standardisation up to the level of the International Organization for Standardization (ISO) and the European Committee for Standardization (CEN) to be of the utmost importance**, thus allowing for a degree of confrontation between national and 'regional' standardisation bodies.

Extensively involving interested French businesses

The ESEC has noted with interest that our country and our industry are represented by the UNM (sectorial Standardization Office of the French standardization system in the field of mechanical engineering and rubber industries) (on behalf of the AFNOR). Since the entrepreneurial fabric of the 3D printing sector in France does not incorporate enough large companies with a strong interest, at least in the manufacturing of machines, this representation clearly ensures an active presence on the part of our country within the committees responsible for producing the various technical texts. Technological monitoring is, in any case, a key factor in assessing the changes that are taking place within the standardisation system.

The ESEC would welcome a greater presence of French companies on special standardisation committees, by means of professional federations if need be.

The Ministry for the Economy, Industry and the Digital Sector has introduced a financial aid system with a view to encouraging the involvement of SMEs in European and international standardisation projects. Financial aid is granted to experts from SMEs looking to apply themselves to such projects by means of a collective body (professional association, competitiveness cluster, etc.) that has signed the agreement. **The ESEC would like to see this system more heavily promoted among SMEs in order to ensure that it is used to the greatest effect**.

Fostering the emergence of activities and jobs in the territories

New digital tools have made production more efficient and more liberal. In this respect, 3D printing makes it possible to customise objects - simply by modifying the digital file -, to increase the profitability of short-series production and to improve the flexibility of the production chain.

For many experts, 3D printing could result in the "relocation" of industrial production facilities to developed countries; indeed, all professionals in the sector allude to this possibility, it being understood, however, that it would be illusory to envisage a return to an identical situation. Given that 3D printing provides an opportunity to increase both the agility and pace of innovation, it provides all of the assets required to develop new activities at regional level.

Clarifying and accelerating industrial plans linked to technological innovations

A number of re-industrialisation projects have emerged in recent years, resulting in support for industrial sectors, as demonstrated by the introduction of a National Council for Industry and the 34 "New Industrial France" plans. Of these, the so-called "Factory of the Future" plan states that it "will enable France to hold its own with regard to rapid prototyping, the convergence of social networks, the hyper-connection of companies, man-machine interfaces, robotics, augmented reality, the digital sphere, 3D printing, artificial intelligence and design" (unofficial translation).

The ESEC would like to see a rapid clarification of the intentions of public authorities with regard to the 34 industrial plans and, more specifically, the one devoted to the "Factory of the Future", the seven pilot schemes associated with which are yet to secure funding. Indeed, it is essential that a clear vision of the industrial policy that will be implemented over the coming years - and designed to promote additive manufacturing, among other technological innovations - be implemented for the purposes of introducing a production system designed to reflect a situation of global competition.

Developing new production units in the territories

The ESEC believes that the development of digital technologies, and of 3D printing in particular, should be given greater consideration and encouraged as part of the global transition towards a more circular economy.

The 'industrial' development of 3D printing could result in market demand for small-series production being better met and encourage the development of small production units.

Additive manufacturing is also, in itself, a technology that lends itself particularly well to the production of spare parts and therefore to the development of repair businesses, which has the potential to create local jobs. It also lends itself to the development of a maintenance and repair sector. **The ESEC would recommend that manufacturers be able to provide approved repairers with access to 3D spare parts manufacturing files and repair methods.**

Exploiting the advantages of French software and new materials development businesses and translating this into a proactive strategy for France.

French companies boast various assets that are recognised by world leaders in the fields of software, services and the research and production of new materials. **The ESEC recommends that this potential be promoted and supported.**

Drawing upon aspirations towards independence and collective creativity

The development of 3D technologies is largely down to the simultaneous generalisation of Makers, the development of which owes a great deal to the increasingly widespread use of cutting-edge digital technologies and the Internet. 3D printing, along with other technologies in the digital sphere, therefore draws heavily on the qualitative aspect of the sector, an aspect that is of interest to 'agile' companies with the ability to find the right niche at the right time. Start-ups and new employees are also likely to always be one step ahead of major organisations.

As far as the ESEC is concerned, such alterations to the production landscape should bring about changes in the organisation of labour that will make it possible to combine the resulting new skills with existing skills, to increase capacities for independence, initiative and innovation, and to develop new collaborative systems within the company with re-examined relationships and a revised organisation of labour.

The ESEC would recommend that the prospective observation and anticipation of these changes incorporate this aspect of organisation in order to move forward in a way that promotes the humanisation and valuing of labour.

Conclusion

Although it is still too early to gauge exactly what role 3D printing will play in all economic activities, it is already certain that this technology will become increasingly essential in many sectors and it does appear to offer considerable potential in some of the key sectors of the future.

Clearly, then, France cannot afford to take the risk of its production base not fully embracing this innovation. The recommendations made by the ESEC in the present opinion seek, accordingly, to boost its advantages and to address certain weaknesses from which French companies are suffering, particularly in the areas of training, research and financing.

Beyond the concept of additive manufacturing itself, the present report highlights certain issues that can now be applied to all of the most recent technological innovations, particularly those that are closely linked to the development of the digital sphere. Virtually all such innovations have at least one thing in common in that they are able to profoundly alter the nature of production (better suited to the end-user of the product or service), the location of activities (with the potential to result in renewed regional development), the number of relevant stakeholders (and the distribution of added value between them) and even professional qualifications and the organisation of labour.

Taking 3D printing as an example, the ESEC would advocate that the public authorities and all economic and social stakeholders in France seize upon what the technology has to offer in order to improve the global performance of the French economy.

Voting

Voting on the full text of the draft opinion

presented by rapporteur Renée Ingelaere

Number of voters	170
Voting in favour	168
Abstentions	2

The ESEC adopted the opinion.

Voted for: 168

Agriculture Group	Mrs Bernard, Mr Ferey, Mr Giroud, Mr Pelhate, Mr Roustan, Mrs Sinay and Mr Vasseur.
Cottage Industry Group	Mrs Amoros, Mr Bressy, Mr Crouzet, Mrs Foucher, Mrs Gaultier, Mr Griset, Mr Le Lann and Mr Liébus.
Associations Group	Mr Allier, Ms Arnoult-Brill, Mr Charhon, Mr Da Costa, Mrs Jond, Mr Leclercq and Mrs Prado.
CFDT Group	Mr Blanc, Mrs Boutrand, Mr Cadart, Mr Duchemin, Mr Gillier, Mrs Hervé, Mrs Houbairi, Mr Le Clézio, Mr Mussot, Mrs Nathan, Mr Nau, Mrs Nicolle, Mrs Pajéres y Sanchez, Mrs Prévost and Mr Ritzenthaler.
CFE-CGC Group	Mr Artero, Mrs Couturier, Mrs Couvert, Mr Dos Santos, Mr Lamy and Mrs Weber.
CFTC Group	Mr Coquillion, Mrs Courtoux, Mr Louis and Mrs Parle.
CGT Group	Mrs Crosemarie, Mrs Dumas, Mr Durand, Mrs Farache, Mrs Hacquemand, Mr Mansouri-Guilani, Mr Marie, Mr Michel, Mr Naton and Mr Teskouk.
CGT-FO Group	Mrs Baltazar, Mr Bellanca, Mr Bernus, Mrs Boutaric, Mr Chorin, Mr Lardy, Mrs Millan, Mr Nedzynski, Mrs Nicoletta, Mr Peres, Mrs Perrot, Mr Pihet, Mr Porte, Mrs Thomas and Mr Veyrier.
Cooperation Group	Mr Argueyrolles, Mrs de L'Estoile, Mr Lenancker, Mrs Rafael, Mrs Roudil and Mr Verdier.
Enterprise Group	Mr Bailly, Mr Bernasconi, Mrs Castera, Mrs Coisne-Roquette, Mrs Dubrac, Mrs Duhamel, Mrs Duprez, Mrs Frisch, Mr Gailly, Mrs Ingelaere, Mr Jamet, Mr Lebrun, Mr Marcon, Mr Mariotti, Mr Mongereau, Mr Pottier, Mrs Prévot-Madère, Mrs Roy, Mr Schilansky and Mrs Vilain.
Environment and Nature Group	Mr Beall, Mr Bonduelle, Mr Bougrain Dubourg, Mrs de Béthencourt, Mrs Ducroux, Mr Genest, Mr Genty, Mr Guérin, Mrs de Thiersant, Mrs Laplante, Mrs Mesquida, Mrs Vincent-Sweet and Mr Virlouvet.
Mutual Insurance Group	Mr Andreck, Mr Davant and Mrs Vion.
Student Bodies and Youth Movements	Mr Dulin, Mrs Guichet and Mrs Trellu-Kane.

Overseas Group	Mr Budoc, Mr Janky, Mr Kanimoa, Mr Osénat, Mrs Romouli-Zouhair and Mrs Tjibaou.
Qualified Leading Figures Group	Mr Bailly, Mrs Ballaloud, Mrs Brishoual, Mrs Brunet, Mrs Cayet, Mrs Chabaud, Mr Delevoye, Mrs Dussaussois, Mrs El Okki, Mrs Flessel-Colovic, Mrs Fontenoy, Mr Fremont, Mr Geveaux, Mrs Gibault, Mrs Grard, Mrs Graz, Mrs Hezard, Mr Jouzel, Mrs Kerviler, Mr Le Bris, Mrs Levaux, Mr Martin, Mrs de Menthon, Mrs Meyer, Mr Obadia, Mrs Ricard, Mr Richard, Mrs du Roscoät, Mr Soubie, Mr Terzian and Mr Urieta.
Liberal Professions Group	Mr Capdeville, Mr Gordon-Krief and Mrs Riquier-Sauvage.
UNAF Group	Mrs Basset, Mr Damien, Mr Farriol, Mr Feretti, Mr Fondard, Mr Joyeux, Mrs Koné, Mrs Therry and Mr de Viguerie.
UNSA Group	Mr Bérille and Mr Grosset-Brauer.

Abstentions: 2

Qualified Leading Figures Group	Mr Hochart and Mr Khalfa.

Annexes

Annex 1: Composition of the Section for Economic Activities on the date of the vote

✓ **Président** : Jean-Louis SCHILANSKY
✓ **Vice présidents** : André LECLERCQ et Isabelle de KERVILER

❒ **Agriculture**
✓ Dominique BARRAU
✓ Roger CHOIX
❒ **Artisanat**
✓ Jean-Pierre CROUZET
❒ **Associations**
✓ André LECLERCQ
❒ **CFDT**
✓ Monique BOUTRAND
✓ Dominique GILLIER
❒ **CFE-CGC**
✓ Gabriel ARTERO
❒ **CFTC**
✓ Agnès COURTOUX
❒ **CGT**
✓ Maryse DUMAS
✓ Marie-José KOTLICKI
❒ **CGT-FO**
✓ Jacky CHORIN
✓ Andrée THOMAS
❒ **Coopération**
✓ Amélie RAFAEL

❒ **Entreprises**

✓ Patrick BAILLY

✓ Françoise FRISCH

✓ Renée INGELAERE

✓ Gontran LEJEUNE

✓ Jean-Louis SCHILANSKY

❒ **Environnement et nature**

✓ Anne de BÉTHENCOURT

✓ Pénélope VINCENT-SWEET

❒ **Mutualité**

✓ Jean-Pierre DAVANT

❒ **Outre-mer**

✓ Patrick GALENON

❒ **Personnalités qualifiées**

✓ Jean-Pierre FREMONT

✓ Laurence HEZARD

✓ Isabelle de KERVILER

✓ Alain OBADIA

❒ **UNAF**

✓ Aminata KONÉ

✓ Paul de VIGUERIE

❒ **UNSA**

✓ Luc BÉRILLE

❒ **Personnalités associées**

✓ Pierre BURBAN

✓ Yves GIQUEL

✓ Frédéric GRIVOT

✓ Sonia HAMOUDI

✓ Mohamed MECHMACHE

✓ Jean-Marc PLANTADE

✓ Sylvie PRADELLE

✓ Denis SEGRESTIN

Annex 2: List of persons heard and met

✓ **M. Jean-Gilles Cahn**
économiste à la CCIP

✓ **Philippe Heinrich**
consultant, spécialiste de l'Impression 3D

✓ **M. Alain Bernard**
professeur à l'École Centrale de Nantes

✓ **Mme Aude Vives-Albertini**
avocat au Barreau de Paris en droit de la propriété intellectuelle et nouvelles technologies

✓ **M. Joseph Puzo**
président-directeur général d'Axon Cable

✓ **M. Clément Moreau**
directeur général et co-fondateur de Sculpteo

✓ **M. Bernard Devauchelle**
professeur des universités, chef du service de chirurgie maxillo-faciale et stomatologie du CHU d'Amiens

La section s'est rendue à Vélizy pour visiter Dassault Systèmes. La section a entendu une présentation de l'impression 3D par :

✓ **M. Frédéric Vacher**
directeur stratégie marketing.

Le rapporteur a, par ailleurs, rencontré en entretien individuel les personnes suivantes :

✓ **Mme Mathilde Berchon**
rédactrice en chef Making Society

✓ **Mme Nathalie Geslin-Levasseur**
responsable développement, ingénierie industrielle biens d'équipements et matériaux, AFNOR Normalisation

✓ **Mme Catherine Lubineau**
directeur technique, Union de normalisation de la mécanique (UNM)

✓ **M. Jean-Marie Pruvot**
directeur Nord France Invest Développement

✓ **M. Olivier Durteste**
directeur du pôle mécanique « Mecanov »

✓ **M. Paul-François Fournier**
directeur exécutif de BPIfrance

✓ **Mme Émilie Garcia**
responsable sectorielle à la direction de l'innovation à BPIfrance

- ✓ **M. Paul Perpere**
  délégué général de l'Association française des investisseurs pour la croissance
- ✓ **M. Dominique Rencurel**
  président de la commission Capital Innov de l'Association française des investisseurs pour la croissance, associé, Orkos Capital
- ✓ **M. Raphaël Gorgé**
  président-directeur général, Gorgé groupe
- ✓ **M. Oliver Strebelle**
  directeur général adjoint, Gorgé groupe
- ✓ **M. Jérôme Dubois**
  responsable innovation process de fabrication scientifique et technologie du futur, PSA Peugeot Citroën
- ✓ **Mme Dominique Boudin**
  manager service innovation et économie numérique CCI Grand Lille, expert auprès de la Commission européenne
- ✓ **M. Gérard Chevalier**
  président-directeur général de CYBEL
- ✓ **M. Pierre Faure**
  président de l'Association Française des utilisateurs du Net
- ✓ **M. Jean-Charles Rosier**
  Assemblée permanente des Chambres des Métiers et de l'Artisanat
- ✓ **Mme Mathilde Jacquemet**
  chargé de mission veille/innovation à l'Institut supérieur des Métiers
- ✓ **M. Jean-Baptiste Mozziconacci**
  directeur à l'INPI
- ✓ **M. Philppe Vasseur**
  président du CCI de Région Nord de France
- ✓ **M. Luc Doublet**
  président de Nord France Invest
- ✓ **M. Marc Verly**
  directeur général du Groupe IRD
- ✓ **Mme Sylvie Duchassaing**
  directrice régionale des études à la CCI de Région Nord de France
- ✓ **M. David Brusselle**
  directeur de la Direction régionale des finances
- ✓ **M. Gontran Lejeune**
  ancien président du CJD, membre de la section des activités économiques du CESE

Le rapporteur et l'ensemble des membres de la section des activités économiques remercient vivement toutes ces personnes pour leur apport aux travaux.

Le rapporteur remercie vivement M. Philippe CLERC, conseiller expert intelligence économique internationale de CCI France, pour la qualité de son expertise.

Annex 3: List of Bibliographical References

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Annex 4: Table of Acronyms

ASTM	*American society for technics and materials*
AFIC	Association française des investisseurs pour la croissance
AFNOR	Association française de normalisation
AFPR	Association française de prototypage rapide
AII	Agence pour l'innovation industrielle
AMA	*Asian Manufacturing Association*
ANR	Agence nationale de la recherche
ANRT	Association nationale de la recherche et de la technologie
BEI	Banque européenne d'investissement
CEI	Commission électronique internationale
CEN	Comité européen de normalisation
CENELEC	Comité européen de normalisation électrotechnique
CESE	Conseil économique, social et environnemental
CETIM	Centre technique des industries de la mécanique
CIFRE	Conventions industrielles de formation par la recherche
CRITT	Centre régional d'innovation et de transfert de technologie
CSIS	Collège des sciences de l'ingénierie et des systèmes
CT	Comités techniques
DIN	*Deutsch Institut für Normung*
DIY	*Do it yourself*
DLP	*Digital Light Processing*
DMLS	*Direct Metal Laser Sintering*
3DPM	*Three-Dimensional Printing*
EBM	*Electric Beam Melting*
ESA	Agence spatiale européenne
ETSI	*European télécommunications standards institute*
FUI	Fonds unique interministériel
IDA	*Institute for Defense Analyses*
INPI	Institut national de la propriété industrielle
ISO	*International Organization for Standardization*
ITU	Union internationale des télécommunications
JAXA	Agence spatiale japonaise
KET	*Key enabling technologies*
MIT	*Massachusetts Institute of Technology*
MJM	*Multi-Jet Modeling*
NAMII	*National additive manufacturing innovation Institute*
NASA	Agence spatiale des États-Unis
NNMI	*National network for manufacturing innovation* (Réseau national pour l'innovation industrielle)

OEB	Office européen des brevets
OMC	Organisation mondiale du commerce
OMPI	Organisation mondiale de la propriété intellectuelle
OTC	Obstacles techniques au commerce
PCRDT	Programmes cadre de recherche et développement technologique
2PP	*Two-Photon polymerization*
PPP	Partenariats public-privé
PSPC	Projets de recherche et développement structurants pour la compétitivité
SASAM	*Support action for standardisation in additive manufacturing*
SLS	*Selective Laser Sintering*
TCG	Technologies clés génériques
TIC	Technologies de l'information et de la communication
TPE	Très petites entreprises
UNM	Union de normalisation de la mécanique
UTBM	Université de technologie Belfort-Montbéliard

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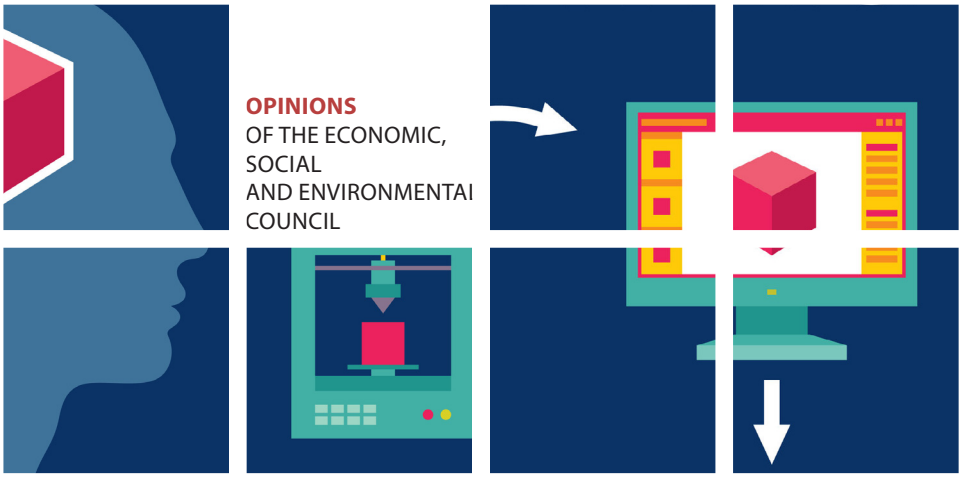

OPINIONS
OF THE ECONOMIC,
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Although it is still too early to gauge exactly what role this additive manufacturing (better known as '3D printing') will play in all economic activities, the technology does seem to offer considerable potential and it is already certain that it will be indispensable in many sectors. Clearly, France cannot allow this opportunity to pass it by and must encourage its production base to fully embrace this innovation. The recommendations made by the ESEC seek, accordingly, to boost our advantages and to address certain weaknesses, particularly in the areas of training, research and financing. This opinion also highlights certain issues common to all digital technologies. What they share is the fact that they profoundly alter the nature of products and services (better suited to the end-user) and the location of activities, cause new actors to emerge and even radically change the organisation of labour. Taking 3D printing as an example, the ESEC would advocate that the public authorities and all economic and social stakeholders in France seize upon what the technology has to offer in order to improve the global performance of the French economy.

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