Intellectual Property Aspects of Robotics

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I. THE ROBOTICS INDUSTRY AND ITS INNOVATION ECOSYSTEM

The field of robotics is remarkably wide, with many social settings now entailing and increasingly requiring the use of robots to support a variety of human activities. Unsurprisingly, robots' form and shape, their level of intelligence and intended purpose can vary significantly depending on the relevant industry.[1] Domestic robots are already a reality in a growing number of family homes. They include both humanoid robots which support those in need (such as the elderly, people with disabilities or children) and robots for household consumer markets, including domestic vacuum cleaners and grass-trimmers. Humanoid robots only account for a small fraction of the industry with robotic arms for industrial automation being instead widespread.[2]

According to the International Organization for Standardization (ISO) and International Federation of Robotics (IFR), a robot is an actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks.[3] The ISO and IFR further distinguish between *industrial* and *service* robots.[4] While robots in the former category handle tasks such as packaging, assembling and palletizing,[5] professional service robots on the other hand include logistic systems, defence robots and medical robots.[6] As mentioned above, there are also personal and domestic service robots which are used for domestic tasks as well as entertainment and leisure purposes.[7]

Furthermore, innovation in artificial intelligence (AI),[8] processing power and sensors have all helped to enhance the field of robotics[9] and increased the type of tasks that robots can perform.[10] As

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[1] See discussion by H. James Wilson, What Is a Robot, Anyway? (2015) Harvard Business Review, available at: https://hbr.org/2015/04/what-is-a-robot-anyway.

[2] C. Andrew Keisner, Julio Raffo, Sacha Wunsch-Vincent, Economic Research Working Paper No. 30, Breakthrough technologies – Robotics, innovation and intellectual property, WIPO Publication, at p.4.

[3] See ISO 8373:2012(en) Robots and robotic devices — Vocabulary, available at https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-2:v1:en. ISO is an international organisation with a membership of 161 national standards bodies. Through its members, ISO develops voluntary International Standards which aims to support innovation and provide solutions to global challenges (https://www.iso.org/about-us.html). ISO 8373 is an International Standard that specifies vocabulary used in relation to *inter alia* robots operating in industrial and non-industrial environments. As such, ISO 8373 provides definitions and explanations of the most commonly used terms that are grouped into clauses by main topics of robotics. See also IFR, Service Robots - *Definition and Classification WR 2016*, available https://ifr.org/img/office/Service_Robots_2016_Chapter_1_2.pdf. The IFR was established as a non-profit organisation in 1987 and consists of members from the robotics industry, national or international industry associations and research & development institutes. Amongst other things, the organisation provides market data, stimulates research in robotics and promotes links between science and industry (https://ifr.org/association).

[4] See ISO webpages at https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-2:v1:en; IFR (Service Robots), https://ifr.org/img/office/Service_Robots_2016_Chapter_1_2.pdf; IFR (Industrial Robots), https://ifr.org/img/office/Industrial_Robots_2016_Chapter_1_2.pdf.

[5] See IFR webpages at https://ifr.org/img/office/Industrial_Robots_2016_Chapter_1_2.pdf.

[6] See Executive Summary at https://ifr.org/downloads/press/Executive_Summary_WR_Service_Robots_2017_1.pdf, p.12.

[7] Ibid., p.14.

[8] Although exploring a comprehensive definition of AI is beyond the scope of this article, it is thought of as an area of technology that focuses on the creation of intelligent machines that work and react like human beings. Examples of technologies that can currently be termed AI include spam filters, algorithmic trading systems and medical systems generating diagnoses (see https://ifr.org/downloads/papers/Media_Backgrounder_on_Artificial_Intelligence_in_Robotics_May_2018.pdf, p.1).

[9] Keisner, Raffo, Wunsch-Vincent, above note 2, at p.7.

[10] See IFR Artificial Intelligence in Robotics, May 2018 at https://ifr.org/downloads/papers/Media_Backgrounder_on_Artificial_Intelligence_in_Robotics_May_2018.pdf, p.1

explained by the IFR, "the output of an artificial intelligence algorithm can be used as the input to another programme or physical machine ... such as a robot."[11] Robotics companies can use AI to make their final products more functional, and future improvements and incorporation of AI into robots will make them more interactive, accepted and appreciated. The European Parliament has even expressed that " … there is a possibility that in the long-term, AI could surpass human intellectual capacity ... "[12]

According to Keisner, Raffo and Wunsch-Vincent, there are certain core features which characterise the 'robotics innovation ecosystem'.[13] First, robotics R&D and innovation are highly concentrated in a handful of countries, such as the US, EU (especially Germany) and Japan. Available patent data also reflects this geographical concentration, with applicants from the above countries accounting for the vast majority of patent applications in the field. Second, the ecosystem consists of a network of different actors, eg individuals, universities and research institutions (with their spin-out companies) as well as technology-intensive firms, all collaborating to drive innovation forward. Third, government funding is often key to supporting robotics R&D.

In terms of structure, this article consists of two parts. The first part deals with intellectual property (IP) strategies that can be pursued by robotics companies. It also mentions legal disputes concerning alleged infringements of robot-related IP rights. The second part then expands on the thorny issues of whether AI-embedded robots and machines can create works that could be protected by copyright and come up with inventions that could be patentable; and, if so, who should be considered as author or inventor, and thus owner of the copyright or patent. The focus will be on the European landscape. Yet, as robotic related IP litigations have predominantly occurred in the US and many scholarly papers on this subject have been penned by US scholars and commentators, references will also be made to the American scenario.

II. ROBOTICS AND IP

IP protection is vital in all R&D intensive industries, and the field of robotics is no exception. Robotics firms often undertake years of intensive (and expensive) research before being in a position to sell their products and reach commercial success.[14] The lengthy and costly process of delivering profitable products highlights the role of IP rights which are viewed as necessary to recoup up-front investments and to fend off competitors seeking to capitalise on the R&D investments of their rivals. Any company subject to due diligence because of, for instance, a strategic investment plan, acquisition or IPO, will likely have its IP portfolio reviewed as part of this process, with potential investors likely to view robotics firms without a strong IP portfolio as a less attractive investment option.[15] Investors will not only want to see the potential for promising robotic applications but also the protection via IP

[11] Ibid., p.1.
[12] See the European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)), letter P.
[13] See the discussion in Keisner, Raffo, Wunsch-Vincent, above note 2, at p.12.
[14] See for example C. Andrew Keisner, Consultant, Julio Raffo and Sacha Wunsch-Vincent, Breakthrough Technologies – Robotics and IP, December 2016, Economics and Statistics Division, WIPO 2016, available at http://www.wipo.int/wipo_magazine/en/2016/06/article_0002.html.
[15] See the article "Making Your Robotics Company a More Attractive Investment", in Robotic Business Review of 21 October 2012, at https://www.roboticsbusinessreview.com/unmanned/making_your_robotics_company_a_more_attractive_investment.

rights so that their company can achieve and defend success.[16] As has been suggested, those within the "…robotics industry are marathon runners, not sprinters … ", meaning that if a business is getting closer to the finish line, it (and its investors) will not want competitors who did not "... run the first twenty five miles of the race to jump in and compete ... on that last mile."[17]

We will now look at how the acquisition and management of IP rights – i.e. patents, trade secrets, copyright, trade marks and designs – may benefit robotics companies, especially in Europe. We will also highlight a number of court disputes where robotics companies have sought to enforce such rights against alleged infringers, with several of these cases having been settled out-of-court (most IP litigation involving robotics firms has occurred in the US, though).

1. Patents

R&D within the robotics industry often takes place for several years before resulting in a viable commercial opportunity, with patents being the main legal instrument to recoup investments. Patents protect inventions and give their owners a right to prevent others from exploiting the patented technology. In other words, they are legal monopolies which give innovators a tool to maximise profits from the developed technology. Both large and small companies can rely on patents to attract investors as well as protect their investments in technology. For example, smaller and more specialised firms often use patents to protect their IP assets defensively against larger players.[18]

Robotics companies active within the European market often apply for a European Patent, which is a bundle of national patents granted by the European Patent Office.[19] This route can prove useful when robotics firms aim at protecting their inventions in several European countries. It is a matter of strategy, with companies deciding their filing plans depending on whether a national market is of particular interest and where infringements by direct or indirect competitors are likely to occur.[20]

The patent route can be particularly valuable for companies whose robots, or their elements, can be easily reverse-engineered (reverse-engineering is the process whereby a product can be deconstructed to disclose its elements and the way it is manufactured). Indeed, in situations where reverse-engineering is straightforward, filing for a patent may be favoured over the alternative tactic - trying to protect the process of manufacturing and/or the relevant product by keeping them secret - with that patent being enforceable against any third party that exploits the invention without the patentee's consent. Symmetrically, relying on trade secrets to protect robotics inventions can work well where: (i) robots are produced and used in a controlled environment; (ii) reverse-engineering is not easy to carry out; and (iii) those working with the products are committed to secrecy.[21] Furthermore, trade secret protection may potentially last much longer than that offered by patents (20

[16] Ibid.
[17] Ibid.
[18] See Keisner, Raffo, Wunsch-Vincent, above note 2, at p.27.
[19] The European Patent Office is based in Munich (Germany), its activity, and the patents it grants, being regulated by the European Patent Convention (Convention on the Grant of European Patents (European Patent Convention: "EPC") of 5 October 1973 as revised by the Act revising Article 63 EPC of 17 December 1991 and the Act revising the EPC of 29 November 2000).
[20] Linda J. Thayer; Rachel L. Emsley, Be Competitive: Patent Planning for Robotics Companies (2011) *Robot Magazine*, available at https://www.finnegan.com/en/insights/be-competitive-patent-planning-for-robotics-companies.html.
[21] See the webpages of Finnegan law firm at https://www.finnegan.com/images/content/8/6/v3/866/IntellectualPropertyConsiderationsfortheRoboticsIndustry-revised.pdf.

years from the filing date), as industrial secrets that meet the relevant requirements are protected for as long as they remain confidential (potentially for an indefinite period). Thus, the decision to apply for a patent may be influenced by the complexity of the company's products and whether the company's competitors are likely to get their hands on such products and subsequently reverse-engineer them. For example, are the robots likely to reach millions of private homes or will they merely be deployed behind closed factory doors? These are factors that need to be considered when it comes to protecting robotics innovation through IP.

Some notable patent-related disputes have involved robotics companies, especially in the US, with the firm iRobot having been particularly active in the courtroom. A dispute is the 2005 lawsuit against Urus Industrial Corporation before the court of Massachusetts.[22] iRobot claimed that Urus' vacuum cleaner "Koolvac" infringed the patents covering its famous "Roomba", sought a permanent injunction and asked for damages.[23] The parties eventually reached a settlement whereby the defendant agreed not to sell its Koolvac robotic vacuum cleaner in the US after a set period of time during which the defendant was entitled to dispose of its current inventory.[24] The final consent judgment confirmed that iRobot's patents – namely U.S. Patent No. 6,594,844, Patent No. 6,809.490 and Patent No. 6,883,201 – were all valid and enforceable.[25] In 2007 iRobot filed another patent infringement suit in the US District Court for the Northern District of Alabama against Robotic FX Inc., alleging *inter alia* that the latter had exploited iRobot's patented technology covering its "PackBot" robot.[26] PackBot was the first military robot used by the US Army and aimed at recognising and clearing roadside bombs. Subsequently, iRobot and the defendant entered into a settlement agreement recorded in a consent judgment.[27] The agreement confirmed that the parties agreed that iRobot is the owner of all rights, title and interest in and to the patents in question, which Robotic FX infringed by producing and selling its Negotiator robot.[28]

iRobot has also enforced its patents in Europe. In 2013 it filed a lawsuit before the Court of Dusseldorf (Germany) against several companies including Solac GmbH, asserting that the Solac Ecogenic AA3400 vacuum robot had infringed five of its European patents. The case was subsequently settled. In 2013 iRobot brought another legal action, this time against the Chinese company Shenzhen Silver Star Intelligent Technology Co., Ltd., again before the Court of Dusseldorf. It obtained four preliminary injunctions, based on the German portions of four European patents,[29] preventing the sale by the defendant of vacuum cleaner robots of the types XR210, M-H688 and M-788 in Germany.[30]

[22] *iRobot Corporation v Urus Industrial Corporation Case* 1:05-cv-10914-RGS.
[23] Ibid.
[24] Ibid. (Final Consent Judgment); see also iRobot's announcement of the settlement at http://investor.irobot.com/news-releases/news-release-details/irobot-settles-patent-and-copyright-infringement-lawsuit.
[25] Ibid. (Final Consent Judgment).
[26] *iRobot Corporation v Robotic FX, INC*, Civil Action No. CV-07-RRA-1511-S.
[27] *iRobot Corporation v Robotic FX INC*, C.A. No. 2:07-cv-1511-RRA (Stipulated Consent Judgement and Permanent Injunction).
[28] Ibid.
[29] The patents in question are EP 1 331 537 B1, EP 2 251 757 B1, EP 1 969 438 B1, and EP 1 395 888 B1.
[30] See iRobot's press release at http://investor.irobot.com/news-releases/news-release-details/irobots-preliminary-injunctions-against-shenzhen-silver-star.

2. Trade Secrets

As mentioned, robotics firms may rely on trade secrets and the legal protection given to such information, to protect their investments in technology. Trade secrets are protected in most countries of the world, although the type and degree of protection varies. In the EU, Directive 2016/943 was approved in June 2016 with the aim of harmonising the laws that protect undisclosed know-how and business information against unlawful acquisition, use and disclosure.[31]

As observed by Keisner, Raffo and Wunsch-Vincent, "[t]here are multiple reasons why a robotics company may prefer to keep certain technologies ... as trade secrets rather than seeking patent protection."[32] First, trade secrets confer protection without the need to adhere to certain prescribed formalities, such as filing an application with an office. Robotics companies can therefore avoid certain costs and complexities associated with patent filing and prosecution. This may be particularly useful in Europe where, due to fragmentation, obtaining and enforcing patents is more expensive than in other jurisdictions such as US and Japan. For example, the European Patent Office requires the payment of several fees to get European patents, including filing fees, search fees, fees per Designated States, fees per claim over ten claims, examination fees and finally fees for granting/printing (it has been estimated that obtaining a European Patent in all the EU Member States would cost applicants roughly €32,000, of which €23,000 would be incurred for translation fees).[33] The costs of enforcing European patents may also skyrocket as patentees that seek to take action over infringements in various countries must file multiple legal actions before the national courts of those jurisdictions This is not only expensive, but also brings legal uncertainty as courts in different countries sometimes reach divergent decisions regarding the alleged infringement and the validity of the national portion of the European patent.[34]

Second, trade secrets (rather obviously) do not require disclosure, as the patent system does. A patent (and the monopoly coming with it) is granted in return for the disclosure of technical information so that the public at large, including patentees' competitors, will be able to exploit the invention after the 20-years term of protection expires. Therefore, as mentioned above, for robotics inventions that are more difficult to reverse-engineer, the trade secrets option may prove a superior alternative as the protection could potentially last indefinitely.[35] Indeed, patenting robots does not always produce benefits. It has been noted, for instance, that in the 1980s several companies in this field obtained numerous patents that ended up expiring before the owners could commercialise the protected products.[36] As has also been stressed, "trade secrets can be critical to [robotics] inventions that may not gain market acceptance and momentum for a long time."[37]

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[31] The aim of this piece of legislation is to harmonise national regimes on the protection of confidential information.
[32] Keisner, Raffo, Wunsch-Vincent, above note 2, at p. 27.
[33] Enrico Bonadio, The EU Embraces Enhanced Cooperation in Patent Matters: Towards a Unitary Patent Protection System (2011) European Journal of Risk Regulation, Vol. 3, p. 416.
[34] Luke McDonagh, European Patent Litigation in the Shadow of the Unified Patent Court (Edward Elgar, 2016).
[35] See discussion at the website of the Finnegan law firm https://www.finnegan.com/images/content/8/6/v3/866/IntellectualPropertyConsiderationsfortheRoboticsIndustry-revised.pdf, p.3
[36] Keisner, Raffo, Wunsch-Vincent, above note 2, at p. 32.
[37] See discussion at the website of the Finnegan law firm at https://www.finnegan.com/images/content/8/6/v3/866/IntellectualPropertyConsiderationsfortheRoboticsIndustry-revised.pdf at p.3

Third, trade secrets can protect subject matter that patents may not,[38] for example innovation related to software and computer code. This option would be particularly beneficial also in light of the fact that protecting software inventions via patents has proven to be contentious (and complicated) at national and international levels. Take for example the 2014 US Supreme Court decision in *Alice Corp. v. CLS Bank International*,[39] which found that certain claims about a computer-implemented, electronic escrow service for facilitating financial transactions were merely abstract ideas that cannot be patented.[40]

3. Copyright

Certain elements of robotics devices, especially software code, could be protected by copyright if they satisfy the relevant requirements, including originality (copyright is the main legal tool for protecting software, and the EU has harmonised such protection since 1991).[41] This is an important option in light of the fact that – as we have just discussed - availability of patents for computer programs has proven contentious.[42] Software is crucial in this field, with robots being unable to function without underlying code – robots deprived of software would basically be unable to perform their intended tasks. While typical tasks performed by robot include path-finding, control, locating and sharing data, some programming code also aims to imbue robots with the ability to create artistic, literary and musical works (as we will discuss in more detail in the second part of the article). Relying on copyright to protect such software is therefore key for the robotics industry.[43]

Firms in this field may also rely on "technological protection measures" to restrict access to, and prevent copying of, a robot's copyright-protected code.[44] More precisely, what these companies may be interested in is to attempt to make it difficult for third parties, both competitors and users, to get their hands on relevant software code, by inserting electronic barriers to prevent access. Copyright laws allow this construction of barriers. Moreover, circumventing electronic barriers to gain access to copyrightable computer code is considered a violation of copyright. Take for example the EU Directive 2001/29 on "Copyright in the Information Society", which provides that adequate legal protection must be given "against the circumvention of any effective technological measures, which

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[38] Ibid.
[39] *Alice Corp. v. CLS Bank International*, 573 U.S., 134 S. Ct. 2347 (2014).
[40] A couple of reported disputes focusing on alleged misappropriation of robot-related industrial secrets have occurred in the US. We have already mentioned iRobot's lawsuit against Robotic FX Inc in the US District Court for the District of Northern Alabama. It is interesting to note that iRobot filed a separate lawsuit against the same defendant before a court in Massachusetts for violation of trade secrets. The Massachusetts Court ruled that the defendant had misappropriated iRobot's proprietary and confidential information, violated fair trade practices and destroyed evidence: see iRobot's press release at http://investor.irobot.com/news-releases/news-release-details/irobot-prevails-lawsuits-against-robotic-fx. Another relevant legal action was started in 2013 by Mako Surgical against Blue Belt Technologies and Mako's former sales manager who had joined the defendant for a position working on the Navio surgical system. The defendants had been sued for alleged trade secret misappropriation and for the former employee's violation of the non-compete obligation to his former employer (Mako Surgical). Mako obtained an order preventing that employee (former Mako's sales manager) from working for BBT for a certain period, in any position, and Blue Belt Technologies from using confidential information: see the article "MAKO Surgical Sues Blue Belt Technologies", in Robotic Business Review of 10 June 2014 at www.roboticsbusinessreview.com/legal/mako_surgical_sues_blue_belt_technologies.
[41] See Council Directive 91/250/EEC of 14 May 1991 on the legal protection of computer programs, repealed by Directive 2009/24/EC.
[42] See also C. Leroux et al, EU Robotics Coordination Action: A green paper on legal issues in robotics (2012), p. 29, available at https://www.unipv-lawtech.eu/files/euRobotics-legal-issues-in-robotics-DRAFT_6j6ryjyp.pdf.
[43] Alleged copyright infringement has also been the focus of the above mentioned dispute *iRobot v Urus Industrial Corporation* (which was eventually settled). That case was not just about alleged infringement of the patents covering certain functional aspects of the Roomba. iRobot also claimed that Urus' vacuum cleaner robot infringed copyright in iRobot's product literature and system interface, including its musical audio feedback features.
[44] Keisner, Raffo, Wunsch-Vincent, above note 2, at p.34.

the person concerned carries out in the knowledge, or with reasonable grounds to know, that he or she is pursuing that objective." [45] It is a type of protection that may be useful against users or competitors that want to access commercially valuable software code.

4. Trademarks

What about trademarks? How can this IP right add value to robotics companies and their products? In general, registering trademarks is crucial to protect products' goodwill and reputation, especially in business-to-consumer industries. Notably, robotics is increasingly becoming an industry where products are sold directly to millions of end-users (consumers). The commercial success of products such as nanny-robots, pet-robots, caretaker-robots and medical-robots also depends on a reliable brand which consumers know, trust, appreciate and remember.[46] For this reason, robotics companies with a strong brand name and solid reputation are indeed investing on and registering trademarks, especially with the European Union Intellectual Property Office (EUIPO), which grants registrations valid and effective in all EU Member States. Brands such as "iRobot",[47] "ABB"[48] and "Kawasaki"[49] as well as "Roomba" (the vacuum cleaner from iRobot)[50] have all been registered with the EUIPO. Given the growing propensity of companies in this sector to register trademarks and build overarching brand identities, and the increasing availability of robots amongst consumers, disputes about robotics trademark infringements may soon reach courts, in Europe and elsewhere.

5. Designs

Today robots are becoming consumer facing. A robot's physical appearance and its "look and feel" plays a role in influencing consumer choice.[51] Robot designs that meet certain requirements, including novelty and individual character, can be registered with the EUIPO, such registrations protecting the ornamental features of the machines. Under EU law, for example, it is possible to obtain an EU design registration which is valid in all Member States (up to 25 years), with a shorter protection of three years also offered to unregistered designs.[52] The exclusive rights given by the registrations can then be enforced against third parties that use designs that are perceived by an informed user as giving the same overall impression.

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[45] Article 6 of Directive 2001/29. A similar provision is set forth by the US Digital Millennium Copyright Act (DMCA): a rule which was invoked in 2001 by Sony when a programmer created and distributed via a website free software to enhance the capabilities of the robot dog named Aibo produced by said Japanese company (such user basically decrypted the code defining the robotic dog's abilities). Sony complained that the website in question provided the means to circumvent the copy protection protocol of Sony's AIBO memory stick to allow access to the relevant software, and therefore constituted a violation of the DMCA anti-circumvention provision. On this case see Matthew Rimmer, Respect the Code or the Dog Gets It (December 2001) InCite, p. 31, available at https://eprints.qut.edu.au/98504/1/aibo.pdf

[46] Luke McDonagh. 'From Brand Performance to Consumer Performativity: Exploring Trade Mark Law in the Aftermath of Anthropological Marketing', Journal of Law & Society (2015).

[47] See the webpage https://euipo.europa.eu/eSearch/#details/trademarks/W01353068.

[48] See the webpage https://euipo.europa.eu/eSearch/#details/trademarks/002628964.

[49] See the webpage https://euipo.europa.eu/eSearch/#details/trademarks/000814681.

[50] See the webpage https://euipo.europa.eu/eSearch/#details/trademarks/002995108.

[51] See Meenakshy Chakravorty, Elizabeth D. Ferrill, Linda J. Thayer, and Robert D. Wells, Design-Patent Protection for Modern Robotics Companies: What to Do When the Face of Your Robot Becomes the "Face" of Your Company, published in Robotics Business Review, July 1, 2014, at p.6.

[52] EU Regulation 6/2002.

Some robotics companies in Europe have taken advantage of this chance and obtained EU design registrations protecting the ornamental features of products such as vacuum cleaners,[53] robotic lawnmowers[54] and transportation robots.[55] Also, design rights may soon be regularly sought by companies active in the field of wearable robots, ie devices that are used to enhance people's motion and physical abilities. Despite having functional elements, these products may be devised in a way which makes them more appealing to final consumers – and design rights could be the appropriate legal tool in the hands of such firms to protect the eye-catching elements of their products. In other words, these rights may help these companies to keep pace with the likely "fashionalisation" of the robotics industry.

6. Cooperative approaches in the pre-commercial stages

While IP protection and enforcement strategies can help robotics companies to reach commercial success, one should not neglect the importance of open-source platforms for this industry. Through such platforms robotics firms and university researchers allow and even invite third parties (especially competitors) to use and improve on existing content, without enforcing IP rights.[56] As mentioned above, a characteristic of the robotic innovation ecosystem is *collaboration* between different actors, and open-source approaches can arguably facilitate such collaboration and allow flexible experimentation. These open platform approaches are used to develop not just software for robotics research and product development, but also blueprints including drawings and designs.[57]

An example of open source project is the Robot Operating System (ROS), whose code is the result of the combined efforts of an international community of programmers. It is basically a collection of frameworks for writing robot software consisting of various tools aimed at simplifying the task of creating more complex and robust robots for a variety of uses. As explained by the ROS website: "From the robot's perspective, problems that seem trivial to humans often vary wildly between instances of tasks and environments.[58] Dealing with these variations is so hard that no single individual, laboratory, or institution can hope to do it on their own."[59] Those are the reasons why ROS was designed, namely to help groups to collaborate and build upon each other's work.[60]

Other examples of non-IP cooperative approaches include iCub, an open source cognitive humanoid robotic platform developed at Istituto Italiano di Tecnologia[61] as well as Poppy, a platform for the creation, use and sharing of interactive 3D printed robots, designed by the public research body Inria in Bordeaux. The Poppy Community in particular promotes the sharing of hardware as well as software, and features beginners, experts and scientists.[62]

As explained by Keisner, Raffo and Wunsch-Vincent, who mentioned in their paper the above

[53] See https://euipo.europa.eu/eSearch/#details/designs/004680866-0025; https://euipo.europa.eu/eSearch/#details/designs/004680866-0026.
[54] See the webpage https://euipo.europa.eu/eSearch/#details/designs/002524462-0002.
[55] See the webpage https://euipo.europa.eu/eSearch/#details/designs/005418506-0001.
[56] Keisner, Raffo, Wunsch-Vincent, above note 2, at p.31.
[57] Ibid.
[58] See the webpages at http://www.ros.org/about-ros/.
[59] Ibid.
[60] Ibid.
[61] See the webpage http://www.icub.org.
[62] See the webpage at https://www.poppy-project.org/en/.

examples, collaborative open source approaches tend to take place at a pre-commercialisation stage, where the type of research which is conducted is basic and does not aim to differentiate the final products. As they put it: "[a]ctors ... apply cooperative open-source approaches to obtain common robotics platforms, as this allows them to share the substantial up-front investment, avoid duplication of effort and perfect existing approaches."[63] But when robotics companies pass from the pre-commercialisation stage to a phase where investments in their own R&D are necessary, especially to differentiate their end-products from those of competitors, proprietary IP is taken into account by these firms and monopolistic rights start to be secured.[64]

III. WORKS AND INVENTIONS CREATED BY MACHINES

In the previous sections we have looked at how robots and their components can be protected by various IP rights, and how cooperative non-IP focused approaches may better serve the interests of the robotics industry in pre-commercial phases of development. We now turn our attention to the fascinating issue of whether robots can generate unpredictable output that can be protected by IP. Indeed, as the software-hardware integration becomes increasingly central for the robotic industry, robots with an express ability to create and invent in their own right could be soon become widespread and of common use. After all, there are already robots embedded with AI which can be seen as exhibiting such abilities.

Should these outputs be protected by copyright and patent laws? Should they be left to the public domain? If they are protectable, who should be deemed the owner of the resulting copyright or patent? The programmer? Or the user? We now delve into these legal issues, that have already caught the attention of several scholars and commentators who have focused on intangible AI, i.e. software-guided machines that are capable of creating and inventing and do not rely on any physical components.[65] In this article, we will also take into account creative output produced by AI-embedded robots equipped with physical and tangible elements, which give them enhanced abilities to create.[66] A striking example is Paul, a robot that uses its camera eye and arm to draw portraits of human subjects.[67] The above identified IP issues however remain pretty much the same, whether we talk about intangible AI-empowered software or we consider AI-equipped robots that can also rely on physical embodiment to enhance creativity. In tackling the legal issues reference will be made to various jurisdictions, especially the EU and some of its Member States.

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[63] Keisner, Raffo, Wunsch-Vincent, above note 2, at p.31.
[64] Ibid.
[65] See, amongst others, Ana Ramalho, Will Robots Rule the (Artistic) World? A Proposed Model for the Legal Status of Creations by Artificial Intelligence Systems (2017) Journal of Internet Law Andres Guadamuz, Do androids dream of electric copyright? Comparative analysis of originality in artificial intelligence generated works, 2 Intell. Prop. Q. 169, (2017); Ryan Abbott, 'Artificial intelligence, big data and intellectual property: protecting computer-generated works in the United Kingdom', in Tanya Aplin (ed), Research Handbook on Intellectual Property and Digital Technologies (2017 Elgar); Robert C. Denicola, Ex Machina: Copyright Protection for Computer-Generated Works 69 Rutgers L. Rev. 251 (2016); Jani McCutcheon, The Vanishing Author in Computer-Generated Works: A Critical Analysis of Recent Australian Case Law (2013) Melbourne University Law Review, 36; Annemarie Bridy, Coding Creativity: Copyright and the Artificially Intelligent Author, 2012 Stan. Tech. L. Rev. 5 (2012); Ryan Abbott, I Think, Therefore I Invent: Creative Computers and the Future of Patent Law (2016) 57 Boston College Law Review; Ben Hattenbach – Joshua Glucoft, Patents in an Era of Infinite Monkeys and Artificial Intelligence (2015) 19 Stanford Technology Law Review 32.
[66] For the sake of clarity, we will use in the remainder of the article the terms "machine", "robot" and "computer" interchangeably.
[67] See the BBC webpage http://www.bbc.co.uk/programmes/articles/1f4Z6k7Clz6qY6Q2K56nkzZ/robotticelli-the-mechanical-marvel-creating-extraordinary-works-of-art.

1. Machines, creative works and copyright

Music, literature and art are already being produced by computers and machines today. Examples abound: from Jukedeck (a startup that uses AI to produce music)[68] to the Cybernetic Poet (a software which allows a computer to write poetry)[69] and The Next Rembrandt (a 3D printed painting made solely from data of Rembrandt's body of work),[70] amongst many others. That most works created by robots are capable of falling within the subject matter of copyright is not in doubt. Simply listening to the music, reading the poems, or looking at the art in question confirms it.[71] This is also recognised by copyright statutes such as the UK Copyright Designs Patent Act (CDPA) that includes computer generated works amongst the subject matter of copyright.[72]

To help understand the copyright debate around these categories of works, a distinction should be made between computer-*aided* and computer-*generated* works, with the former category representing works that are produced by humans with the mere help of machines and the latter referring to output autonomously created by AI. Abbott explores this distinction by reference to a spectrum: "On the one end, computers may function as simple tools that assist human authors …, much the way that a pen … can help someone to write."[73] He continues by noting that "[a]t the other end of the spectrum, computers generate works under circumstances in which no human author … can be identified."[74] In other words, the level of machine autonomy in producing the work is inversely proportional to the presence of human input in the creative process: more machine autonomy means less human input.

This debate is not entirely new, and judges in the past have looked at situations where the creation of works occurred with the help of machines. The 1980 English case *Express Newspapers plc v Liverpool Daily Post* is quite interesting.[75] This dispute arose out of the competition between newspapers in their lottery contest. The lottery at issue was the 'Millionaire of the month' competition managed by the *Daily Express*. It consisted of sequences of letters set out in a grid of five rows and five columns. The defence by the Liverpool Daily Post focused on the argument that no copyright subsisted in the letters as they had been produced by a computer, with no human author involved. Mr Justice Whitford was not convinced and clarified that "the computer was no more than a tool with which the sequences and grids were produced using the instruction of the programmer".[76] He then compared such scenario to a person using a pen: "[i]t is ... unrealistic ... to suggest that, if you write your work with a pen, it is the pen which is the author of the work rather than the person who drives the pen". The judge concluded that "output from a computer that has been randomly generated by the

[68] See the webpage https://www.jukedeck.com.
[69] See the webpage http://www.kurzweilcyberart.com/poetry/rkcp_poetry_samples.php.
[70] See the webpage https://www.nextrembrandt.com.
[71] Artworks produced by AI have also started being auctioned: see for example a sale by Christie of an AI-created portrait in a gilt frame in October 2018 (see Christie webpage at https://www.christies.com/features/A-collaboration-between-two-artists-one-human-one-a-machine-9332-1.aspx).
[72] Section 178 of the UK Copyright, Designs and Patents Act 1988.
[73] Abbott (2017), above note 65, p.2.
[74] Abbott (2017), above note 65, p.3.
[75] Express Newspapers Plc. v Liverpool Daily Post & Echo Plc. and Others [1985] 1 W.L.R. 1089.
[76] Ibid.

machine itself is a copyright work".

Express Newspapers plc v Liverpool Daily Post is a case from the 1980s, and it goes without saying that technology has advanced significantly since then. Recent developments have led to machines that can independently learn and create, with the human input in the creative process becoming more and more redundant.[77] Take the Painting Fool, a striking example of a creative machine, and an "aspiring painter":[78] it is a computer program which can simulate the physical painting process and detect emotions of people as well as use its abilities to paint portraits and invent visual scenes by means of generative techniques.[79] Another example is the above mentioned Paul, described as a robotic installation which uses its camera eye to create portraits of people.[80] As opposed to the Painting Fool, which is a computer program, Paul consists of a physical robotic arm. As explained by its creators Tresset and Leymarie, "[t]he drawings we are aiming to produce with an embodied system such as Paul are distinct from those made by a human hand, and yet it is our experience that they have comparable emotional and aesthetic artistic effects on the observer."[81] Reactions by critics have been positive, with collectors and artists accepting Paul's productions as artworks of good quality (a drawing by Paul is part of the Victoria and Albert museum collection).

Evidently, the era where judges and scholars debated about whether the author of the work is the pen "rather than the person who drives the pen" looks prehistoric now – and one may presume that creative machines will become even more widespread in the future.[82] Obviously, these developments suggest that works created by AI-embedded robots may be considered as within the subject matter of copyright. With that said, we now assess whether machine-created outputs are capable of meeting the requirements for protection.[83]

a. Originality and authorship

Copyright protects works that satisfy the originality requirement. The EU originality criterion as affirmed in *Infopaq* requires the work to be the author's own intellectual creation: "... works such as computer programs, databases or photographs are protected by copyright only if they are original in the sense that they are their author's own intellectual creation."[84] Following *Infopaq*, this is considered a generalised standard of originality applying not only to computer programs, photographs or databases,[85] but to all literary, dramatic, musical and artistic works. In *Eva-Maria Painer* (focusing on copyright protection of portray photographs), the Court of Justice of the European Union (CJEU)

[77] Madeleine de Cock Buning, 'Autonomous Intelligent Systems as Creative Agents under the EU framework for Intellectual Property' (2016) European Journal of Risk Regulation, p. 311.
[78] See the webpage at http://www.thepaintingfool.com. Simon Colton, a Professor of Computational Creativity in the Department of Computing of Goldsmiths College, University of London, is the academic behind the Painting Fool.
[79] See the webpage at www.thepaintingfool.com/about/index.html.
[80] Patrick Tresset and Frederic Fol Leymarie, Portrait drawing by Paul the robot, Computers & Graphics 37 (2013) 348–363 at p.348.
[81] Idem.
[82] See also Bridy, above note 65, p. 4 (discussing on the generative art movement, which aims at exploring 'computational creativity' via "a set of creative practices whereby the artist cedes control to a system that is self-contained enough to operate autonomously").
[83] The fixation requirement, provided by several copyright acts (for example, in the US and UK), will not be analysed here. There is indeed little doubt that most of machine-produced works meet this requirement.
[84] Case C-5/08 Infopaq International A/S v Danske Dagblades Forening at [35].
[85] See respectively Article 1(3) of the Software Directive (Directive 2009/24), Article 6 of the Copyright Term Directive (Directive 93/98) and Article 3(1) of the Database Directive (Directive 96/9).

clarified that an intellectual creation is an author's own if it reflects her personality.[86] This would be the case, the court added, if the author were able to express her abilities in the production of the work by making free and creative choices.[87] These choices would therefore enable the author to stamp the work with her 'personal touch'.[88]

The emphasis on the author's "own intellectual creation" and "personal touch" suggests that the originality requirement involves some degree of human authorship.[89] This is reinforced by what Advocate General Trstenjak noted in *Eva-Maria Painer:* "… only *human creations* are … protected, which can also include those for which the person employs a technical aid, such as a camera" (emphasis added).[90] This comment calls to mind the distinction between computer-*aided* works and computer-*generated* works. It also seems to suggest that only computer-aided works can be protected by copyright, where computer-generated works cannot qualify as 'human creations' due to lack of human input. One may reasonably doubt about whether a machine can stamp its output with its personal touch by making free and creative choices, and in general whether it can have a personality at all, let alone legal personality, and all the rights that status would bring.

Yet, an examination of how some machines actually work may lead to another conclusion. Think again about Painting Fool as an example: during a festival on computational creativity in 2013, the machine was used to create 'mood-driven' portraits of the guests. The software's mood was determined by its analysis of newspaper articles from *The Guardian*. The average sentiment was then used to simulate the Painting Fool, being it a positive, very positive, experimental, reflective, negative or very negative mood.[91] As explained by Colton and Ventura: "[i]f in a positive/very positive mood, the software [the Painting Fool] chooses one/two of nine upbeat adjectives (e.g. *bright, colorful, happy*) and directs the sitter to smile while it extracts their image from a video recording. ... If in a negative mood, the software chooses one of six downbeat adjectives (e.g. *bleary*, *bloody*, *chilling*) and directs the sitter to express a sad face. If in an experimental mood, it chooses one of 11 neutral adjectives (e.g. *glazed*, *abstract*, *calm*) and asks the sitter to pull an unusual face ...".[92] The chosen adjective is used to select a filter to achieve an appropriate visualisation. The program also selected one of seven rendering styles involving the simulation of paints, pencils and pastels to produce the portrait.

That said, could one argue that the behaviour of the Painting Fool displays an ability to make creative and independent choices which renders its works original? After all, in *Eva-Maria Painer* the CJEU suggested that an author could stamp a portrait photograph with her personal touch by making choices such as the applicable background, lightning, angel and atmosphere of the portrait.[93] Similarly,

[86] Case C-145/10 Eva-Maria Painer v Standard Verlags GmbH and Others at [88].
[87] Case C-145/10 Eva-Maria Painer v Standard VerlagsGmbH and Others at [89]. See also Case C-604/10 Football Dataco at [39] (citing also, by analogy, Case C-393/09 Bezpecnostni Softwarova Asociace at [48] and [49], and Joined Cases C-403/08 and C-429/08 *Football Association Premier League and Others* at [98]).
[88] Case C-145/10 Eva-Maria Painer v Standard VerlagsGmbH and Others at [92].
[89] Madeleine de Cock Buning, above note 77, p.314.
[90] Case C-145/10 Eva-Maria Painer v Standard VerlagsGmbH, Opinion of Advocate General Trsteniak, 12 April 2011, at [121].
[91] See webpage at http://www.thepaintingfool.com/galleries/you_cant_know_my_mind/ICCC_YCKMM.pdf.
[92] Ibid.
[93] Case C-145/10 Eva-Maria Painer v Standard VerlagsGmbH and Others at [91]-[92].

in light of the software's freedom to make creative choices by reference to its mood, it could be said that the Painting Fool could be considered as imbuing the portraits with its personal touch.

Yet, one may counter-argue that machines such as the Painting Fool or robots like Paul lack a fundamental ingredient of any copyright work, namely a human being. This point brings into the picture another requirement for copyright protection, ie authorship, which entails that no creation that does not entail at least some degree of human intervention is eligible for copyright protection.[94] The concept of authorship is intertwined with the originality requirement.[95] Indeed, the latter's focus on the 'author's own intellectual creation' seems to imply a *human* author behind the work. Several copyright laws limit authorship to natural persons. Spanish law for example provides that the author is the natural person creating the work;[96] French law states that only a natural person can be the author.[97] Likewise, the US Copyright Office emphasises the importance of the human element in the creative process, with no claim that does not satisfy the Human Authorship Requirement being registered. In other words, the US Office only registers an original work of authorship "…provided that the work was created by a human being."[98]

The authorship requirement will not raise significant issues when the machine merely *aids* a natural person in the creative process (and indeed in *Express Newspapers plc v Liverpool Daily Post* Mr Justice Whtiford found no authorship issue). This is also the point made by Advocate General Trstenjak in *Eva-Maria Painer*; ie that copyright protection is available for human creations, including those for which the person employs a technical aid, such as a camera.[99] Another example is that of a person using the aid of editing software to produce a picture.[100] Here, the end product will reflect the creative impulses of the artist and thereby her personality.[101]

Authorship issues may instead arise where the machine input materially outweighs that of the human which uses it, ie where the level of human intervention in the creative process is minimal and when that of the robot is predominant. This is when the line has been crossed from a situation where the machine has merely aided the human to create towards a scenario where the work has been generated by the robot itself. Verifying when such line is crossed may not be easy, and a thorough case by case analysis may often be required to determine the level of human input in the whole creative process. In other words, deciding whether a work qualifies for copyright protection under EU

[94] Most copyright acts, including in the US and UK, however, still do not provide a definition of "authors". Just judicial decisions address what authorship means, and who an author is (see Jane C. Ginsburg, The Concept of Authorship in Comparative Copyright Law, 52 DePaul L. Rev. 1063, 1066 (2002)). In the US for example the Supreme Court has defined an author as 'he to whom anything owes its origin; originator; maker; one who completes a work of science or literature' (*Burrow-Giles Lithographic Co. v. Sarony*, 111 U.S. 53, 58 (1884)). US lower courts have also noted that an author must be more than one who contributes creativity or originality to a work (*Aalmuhammed v. Lee*, 202 F. 3d 1227, 1233 (9th Cir. 2000)); basically, it must be one 'who superintended the whole work, the "master mind"'' (Ibid. (citing *Burrow-Giles Lithographic Co.*, 111 U.S. at 53, 61)).

[95] See also Ramalho, above note 65, p.10.

[96] See Preambulo, Ley 22/11 sobre la Propiedad Intelectual de 1987: "los derechos que corresponden al autor, que es quien realiza la tarea puramente humana y personal de creacion de la obra y que, por lo mismo, constituyen el nucleo esencial del objeto de la presente Ley".

[97] The French Code of intellectual property defines protectable subject matter as 'oeuvres de l'esprit': see Article L112-1 of the French Code de la Propriete' Intellectuelle.

[98] U.S. Copyright Office, Compendium of U.S. Copyright Office Practices § 101 (3d ed. 2017), 306. Examples of works that fail the authorship requirement include, for instance, a photograph taken by a monkey and works "... produced by a machine ... that operates randomly or automatically without any creative input or intervention from a human author" (see Compendium 313.2).

[99] Case C-145/10 Eva-Maria Painer v Standard VerlagsGmbH, Opinion of Advocate General Trsteniak, 12 April 2011, at 121.

[100] Guadamuz, above note 65, p.178.

[101] Guadamuz, above note 65, p.178.

copyright law (as well as under US law, which as mentioned does require authorship)[102] requires an assessment of the level of human as opposed to machine input.[103] The aim of this analysis is to determine whether the work can be said to reflect predominantly the (human) author's own intellectual creation, and thus attract copyright. If such human element lacks, copyright may not subsist.

b. The UK solution

An approach that aims at finding a pragmatic solution has been adopted by the UK. Section 9(3) of the CDPA provides that "[i]n the case of a literary, dramatic, musical or artistic work which is computer-generated, the author shall be taken to be the person by whom the arrangements necessary for the creation of the work are undertaken." A few other common law jurisdictions have followed this approach.[104] The CPDA also defines a computer-generated work as one generated by a computer in circumstances where there is no human author.[105] What these provisions do is basically to broaden the concept of author in a way which is sufficient enough to subsume human beings that simply instigate and trigger the creation of the work. In other words, the author (and owner of the relevant economic rights) will be considered a person (either natural or legal) who may have played no role at all in the actual production of the work. The law here basically introduces a legal fiction as it considers author a person who has not directly produced the word, but has merely made the necessary arrangements for such production.[106]

This solution clearly departs from the anthropocentric and human focus of copyright laws in jurisdictions such as the EU and US (Guadamuz also notes that these provisions that recognise copyright in computer generated works with no human input constitute an exception to the originality requirement, as the works in question do not directly originate from an author).[107] Indeed, such solution does not look at whether a human being has actually produced the work. It just considers the objective creation of the output, and then "finds" who the author (and thus the copyright owner) should be, i.e. the person who has come up with the necessary arrangements, which could also be a company. Yet, it is not quite a revolutionary approach, as copyright laws in several jurisdictions including UK sometimes attributes ownership to persons who have not directly created the work. This is the case with regard to employees' works with the employer being the copyright owner.

The UK regime is certainly helpful and may be used to identify authorship, and accordingly ownership, in many scenarios where original works are produced by computers or robots with no or

[102] That authorship is a requirement under US copyright law is confirmed by a string of cases that have dealt with who should be considered author in situations where "celestial voices" may have played a role (psychography cases): *Oliver v Saint Germain Foundation*, 41 F. Supp. 296 (S.D. Cal. 1941); *Urantia Foundation v Burton*, No K 75-255 CA 4, 1980; *Urantia Foundation v Maaherra*, 895 F. Supp. 1337 (D. Ariz. 1995); *Penguin Books, Inc. v. New Christian Church of Full Endeavour*, No 96 CIV. 4126. Indeed, when faced with claims of supernational authorship, US courts in those disputes concluded that only humans can own the copyright. Similarities can also be drawn with claims of "animal authorship", where US courts have confirmed this line of argument: see *Naruto v. Slater*, 2018 U.S. App. LEXIS 10129 (9th Cir. Cal., Apr. 23, 2018) (rejecting the argument brought by the plaintiff, an animal rights organisation, that US copyright law does not prohibit an animal – in the case at issue, a monkey that have taken a selfie - from owning a copyright. The court held that while the animal had constitutional standing it "lacked statutory standing to claim copyright infringement of photographs)."

[103] Guadamuz, above note 65, p.179.

[104] Namely, Ireland, New Zealand, India, South Africa and Hong Kong.

[105] See again Sec. 178 of the Copyright, Designs and Patents Act 1988.

[106] McCutcheon, above note 65, at pp. 44-45.

[107] Guadamuz, above note 65, p.176.

little human input.[108] Yet, it might not be always easy to identify who the person who has made the necessary "arrangements" is, namely who puts the machine in the condition to create the work. Is this person the machine's programmer? Or the user? Section 9(3) of the CDPA 1988 may not help much here. It could be argued that determining who is that person entails a careful analysis of the facts, circumstances and specific robotics application that generated the work. A case by case analysis again is therefore necessary. For example, in *Nova Productions v Mazooma Games*,[109] the only UK case where s. 9(3) CDPA has been applied so far, the court had to determine whether copyrights had been infringed in the graphics and frames generated and displayed by the users on a screen when playing a videogame. It was held that such frames were computer generated works, and that the programmer was the person making the arrangements and therefore the author and owner of the copyright. As the Court of Appeal put it, "the player is not ... an author of any of the artistic works created in the successive frame images. His input is not artistic in nature ... and he has contributed no skill or labour of an artisitc kind ... All he has done is to play the game".[110]

With that said, what about other more robot-focused examples? Let's take again Paul, the robotic arm that produces observational face drawings of people, by using an eye camera to focus on and take snapshots of the person to be drawn and then executing the drawing with a pen hold by the arm. Whoever uses Paul does not really have the power to change the settings, for example to direct or change the process that leads to the artistic output. It could thus be argued that Paul's creator (and not the person who actually uses it) should be considered the person that makes the necessary arrangements. The same is true of the Painting Fool, a computer program that simulates the physical painting process without giving users much control on how to drive such process.

On the other hand, whenever users of the machines or robots have actually the chance to manage or influence the whole or part of the process (in other words, where they do not have to just press a button), they may be considered the authors and owners of the resulting work. Two scenarios may here be distinguished. First, we could have a situation where the user merely manages the creative process by running the program and generating the output. An example might be Deep Dream, a popular computer vision program that employs a convolutional neural network to find and enhance patterns in images through algorithms. It has been argued that, as the creator of the program (Google) has released the code as open source and any user can run the program and actually generate art (for example, by choosing predetermined styles), it would be the users the ones that make the necessary arrangements and thus should be considered authors under Section 9(3) CDPA.[111] Second, we could also have a scenario where users' input is more creative than managerial, for instance when it's the user that makes the most important creative choices with the machine or robot merely

[108] For an opposite opinion see Lionel Bently, mentioned by Begoña González Otero and Joao Pedro Quintais Before the Singularity: Copyright and the Challenges of Artificial Intelligence (2018) Kluwer Copyright Blog, available at http://copyrightblog.kluweriplaw.com/2018/09/25/singularity-copyright-challenges-artificial-intelligence/ (stressing that the CDPA provisions on computer-generated works do not offer a useful model for protecting AI outputs, because of their incompatibility with the EU copyright *acquis* and failure to address the issue of originality).
[109] *Nova Productions v Mazooma Games* [2007] EWCA Civ. 219.
[110] Ibid., at [106].
[111] Guadamuz, above note 65, p.177.

executing such decisions.[112] In this case we would probably move towards the other side of the spectrum identified by Abbott, where computers function as simple tools that assist human authors. Such works would therefore be more comparable to machine-aided works, with no need to trigger the "authorial" legal fiction engineered by Section 9(3) CDPA.[113]

c. Copyright or Public Domain?

We have considered whether copyright *can* subsist in machine generated works, and who would be considered author and owner of the economic rights that result under the law. But what also ought to be discussed is whether copyright *should* apply to these outputs at all, as a matter of policy. Some scholars have proposed leaving such works – works generated autonomously by machines - in the public domain, with the result that everyone would be able to use them, even for commercial purposes.[114] As has been noted, outputs produced by robots would be comparable to things found in nature, like music that the wind generates when it moves through wind chimes or the sounds of a waterfall, or birds singing at dawn.[115]

But is this outcome desirable? Would the refusal to offer copyright to machine-generated works discourage investments in, and dissemination of, these "creative" technologies?[116] It could indeed be argued that without the lure of monopolistic rights offered by copyright not many persons and/or their employers would bother to develop machines or robots capable of creating musical, literary or artistic outputs. As this is already a field where investments are necessary (let's think of companies that offer music production software), the need to secure copyright may become apparent with the industry, especially to avoid the inevitable market failure that would be caused by an absence of exclusive rights over the created content.[117]

Proposals have been put forward by Ana Ramalho that take into account the above concerns.[118] The first is the introduction of a sui generis right of a limited period of time protecting output created by AI embedded machines and robots, similar to the EU database right which aims at protecting investments.[119] This right would incentivise and reward the investments made in the development of those machines and robots. The second proposal, more concerned with enhancing the accessibility of

[112] This scenario may soon become a common reality, for example in the field of computer games, taking into consideration the increasingly relevant roles of users in such interactive games: see Ramalho, above note 65, p.11.

[113] See also Denicola, pp.283-285 (noting that, should users be considered the authors of computer-generated works, there would not be need anymore to distinguish between machine-generated works and machine-aided works. Indeed, if the creative output is considered to be authored by someone other than the user of the machine (or is not deemed copyrigthable at all), it would be necessary to differentiate situations where the computer is simply a tool from scenarios where the machine itself is the creator. Denicola thus believes that the "users' option" should be preferred. The market – he stresses - already supplies programmers with the incentive to create software and machines which are used to create works, such incentive mainly coming from the prospect of maximising sales. Also, should programmers be deemed as authors and owners of the copyright over the work produced by the machine – his argument goes - users may not be encouraged to purchase and use the software to create works as they would not be the copyright holders: which would eventually jeopardise the interests of programmers that may see sales of their machines decrease. Finally, attributing programmers copyright may often turn out to be useless as programmers themselves would frequently be anaware of the creation of works by users.

[114] Amir H. Khouri, Intellectual Property Rights for Hubots: on the Legal Implications of Human-like Robots as Innovators and Creators (2017) Cardozo Arts & Entertainment Law Journal, Volume 35, Issue 3.

[115] Khouri, above note 114, p. 668.

[116] See also McCutcheon, above note 65, p.952 (noting that "while the incentive of copyright may be irrelevant to a novelist compelled to write their opus, it may well explain why an expensive computer-generated production is made. Without that reward, the work may not be made ... or disseminated").

[117] See Tatiana Synodinou, mentioned by González Otero and Quintais, above note 108.

[118] Ramalho, above note 65, p.16-20.

[119] Database Directive (Directive 96/9).

the content produced by AI, is to create a sort of "disseminator's right" comparable to the publisher's right in the publication of previously unpublished works provided by the EU Term of Protection Directive.[120] While this right would be inherently economic, which would allow the right holder to extract value out of the creations, it would also intend to stimulate the dissemination of output that is increasingly perceived as being meritorious.

2. Inventions developed by machines, and patents

This section explores the issue of patentability of robot-generated inventions. Again, the focus here is not on machines which merely *aid* humans during the inventive process, but rather on robots that *generate* inventions without human input. The burning question is whether such inventions can be protected under patent law. No patent statute, and related case law authority, specifically addresses computational subject matter and no patent office has adopted detailed policies on these issues. This is not a purely academic exercise - and the debate on whether machine-generated inventions should be considered patentable is much needed also in light of the fact that patent protection in this field may further encourage the development of creative computers and systems, which may be deemed a socially desirable target.

It has been noted that computers have already come up with inventions. For example, Hattenbach and Glucoft reported that a company named Cloem use brute-force computing to mechanically compose text for thousands of claims covering potential new inventions.[121] More precisely, automated software here employ automated drafting techniques which can create tens of thousands of alternative patent claims.[122] Also, Abbott mentions the so-called Creativity Machine, a patented[123] computational machine created by US computer scientist Stephen Thaler that is capable of generating novel (patentable) ideas via software concept referred to as artificial neural networks.[124] One of such ideas – called "Neural Network Based Prototyping System and Method" - was actually patented,[125] but who was designated as inventor in the application was not the Creativity Machine itself, but its creator Stephen Thaler who listed himself as the actual inventor. Abbott uses this example to make the point that patent offices (in this case, the US patent office) have already granted patents for inventions developed by non-human inventors, probably without being aware of such non human element; and to stress that this has probably occurred because the applicants did not want to risk losing the opportunity to get the patent, as there is a lack of legal clarity about whether machine-generated inventions can qualify for patent protection.[126] Thus, omitting to disclose the role of the machine in the inventive process can be seen as an appealing option to avoid the patent being

[120] Article 4 of Copyright Term Directive (Directive 93/98) provides that "Any person who, after the expiry of copyright protection, for the first time lawfully publishes or lawfully communicates to the public a previously unpublished work, shall benefit from a protection equivalent to the economic rights of the author. The term of protection of such rights shall be 25 years from the time when the work was first lawfully published or lawfully communicated to the public".
[121] Hattenbach – Glucoft, above note 65, p. 35 (reporting that said brute-force computing has also been used to create defensive publications aimed at preventing others from patenting in the same field).
[122] Hattenbach – Glucoft, above note 65, pp. 36 and 51 et seqq. (noting however that many of these claims appear non-sensical, and that therefore their validity needs to be assessed on a case-by-case basis).
[123] See US patent No 5,659,666.
[124] Abbott (2016), above note 65, pp.1083-1086.
[125] See US patent No 5,852,815.
[126] Abbott (2016), above note 65, p.1081.

challenged on the grounds of lack of human inventorship.

As noted, there is not much clarity with regards to whether inventors need to be human beings. For example, what does the EPC provide? It does state that applications need to mention the designation of the inventor,[127] which must include among other information the inventor's family name, given names and full address.[128] This would suggest that the inventor is to be a natural person. Likewise, the UK Patents Act 1977 refers to natural persons many times.[129] Section 7(1), for instance, confirms that any *person* may make an application for a patent, with section 13(2) requiring an applicant to identify the *person* who is believed to be the inventor. It should also be reminded that in March 2013 the EU IPR Helpdesk published a Fact Sheet relating to inventorship, authorship and ownership, which interestingly noted: "…the inventor is always a *natural person* and the first owner" (emphasis added).[130] While these provisions and statement do not expressly point out that machine and robot-generated inventions cannot obtain patent protection, they epitomise the importance of considering inventors as human beings.

Yet, one may also argue that no human inventorship requirement exists, at least in Europe, by pointing to the Guidelines for the examination of European Patents. Part A, Chapter III, Section 5(2) of such Guidelines refer to the possibility for inventors to waive the right to be mentioned as inventor: "The inventor designated by the applicant may address to the EPO a written waiver of his right to be mentioned as inventor in the published European patent application and the European patent specification, in which case his name is not mentioned".[131] This echoes what the EPO Guidelines for international applicants that choose the so-called PCT route[132] suggest in relation to the designation of the inventor: "It is recommended that the inventor always be identified … *unless there are special reasons for not doing so*" (emphasis added).[133] These guidelines confirm that patent applications can be prosecuted, even until the final issuance of the patent, without designating any *human* inventor: which in turn may seem to indirectly suggest that patentable inventions could also be developed by non-human agents (the above emphasised sentence strengthens this argument).

That said, it remains to be seen whether AI-triggered inventions satisfy the patentability requirements, especially the inventive step (or non-obviousness) requirement. Indeed, no invention is patented if it is obvious to a person skilled in the art (as provided for example by Article 56 EPC and most patent statutes around the world). This requirement aims at raising the bar to getting patents, excluding from protection innovation that is within the reach of the average expert of the field. Can then a machine or robot-generated invention satisfy this criteria? One may argue that - taking into account a machine's or robot's potentially high level of intelligence – the inventions reached by such

[127] EPC Rule 19(1); See also Article 41(2)(j) of the EPC confirming that the request for a grant of a European patent shall contain the designation of the inventor, where the applicant is the inventor.
[128] EPC Rule 19(1)
[129] Abbott, (2016) above note 65, p.7
[130] European IPR Helpdesk, 'Fact Sheet Inventorship, Authorship and Ownership' March 2013 see https://www.iprhelpdesk.eu/sites/default/files/newsdocuments/Fact-Sheet-Inventorship-Authorship-Ownership.pdf, at p.3.
[131] See the EPO webpage at https://www.epo.org/law-practice/legal-texts/html/guidelines/e/a_iii_5_2.htm.
[132] PCT stands for Patent Cooperation Treaty, an international treaty administered by the World Intellectual Property Organization (WIPO) which assists applicants in obtaining patent protection internationally for their inventions and helps offices, including the EPO, with their decisions to grant or refuse the patent.
[133] See the EPO webpage at https://www.epo.org/applying/international/guide-for-applicants/html/e/ga_b_18.html.

machine or robot would often meet the threshold in question.[134] Take for example the question-answering computer system Watson, developed by IBM, which is capable of answering questions posed in natural language.[135] Abbott noted that some Watson's results have been so surprising to its creators that they may be considered non obvious and therefore as meeting this requirement.[136]

The attraction of machine and robot developed inventions into the realm of patentable subject matter may also change the way the inventive step criteria is assessed by patent examiners and judges. Currently, patent officers and courts take into account, as benchmark, the "person skilled in the art", i.e. somebody who is considered as having good knowledge of the relevant prior art, and an understanding of whether the invention to be examined departs significantly from that existing body of knowledge. Yet, as interestingly noted by Abbott, the acceptance of computational innovation by patent laws may trigger a "substitution" of the concept of "skilled (human) person" with the notion of "skilled computer", with the inevitable result that patenting inventions may become more difficult.[137] Indeed, because of the way they have been programmed, machines and computers have an incredible extensive knowledge of the prior art, much broader than the knowledge a human being may have, even in fields not strictly related to those of the inventions to be analysed: this would likely raise the bar to obtaining patents. While stricter patent procedures are certainly to be welcomed (patent offices have often been accused of being too generous for granting patents for trivial inventions), a system where the benchmark becomes the "skilled machine" would also pose challenges. For example, patent examiners and judges would have "to put themselves in the shoes" of the skilled computer and take into consideration the prior art which may be within the reach of powerful machines, but not human beings:[138] which might turn out to be practically (and humanly) undoable.

Finally, the issue of ownership of patent rights over the inventions developed by machines or robots should also be mentioned. This point will likely be crucial if and when applications designating computers as inventors start to be accepted. As computers cannot (at least, yet) own legal rights, possible "candidates" for holding ownership rights would be: (i) the programmer of the AI software which produced the invention; (ii) the user of such program who gives the AI tasks; or (iii) even the owner of the machine or robot themselves.[139] The issue is undoubtedly difficult to resolve, and once more a case-by-case analysis aimed at finding out who has substantially contributed the most to the invention will probably be needed to identify the owner of the resulting patent.

IV. CONCLUSION

The robot revolution is already a reality, and firms and ventures specialising in the area of robotics will certainly continue to thrive in the future. In this article we have focused on the intersection

[134] Yet, it has also been noted that certain mechanically generated claims may be considered obvious. For example, the linguistic manipulation software devised by the company Cloem (see above, including note 121) often merely adds or deletes sentences. As noted by Hattenbach and Glucoft, above note 65, p. 45, many of these claims are "the result of relatively slight rearrangements, and these minor modifications that work in predictable ways would by definition be considered obvious".
[135] See Watson related webpages at https://www.ibm.com/watson.
[136] Abbott (2016), noted above 65, pp.1091
[137] Abbott (2016), noted above 65, pp.1124-1125.
[138] Abbott (2016), noted above 65, pp.1125.
[139] Abbott (2016), above note 65, p.1114.

between robotics and IP, and stressed the importance of patents, trade secrets, copyright, trademarks and designs as tools to attract and recoup the big investments that are needed in this field. While there are phases within the life of robotics firms where a cooperative and non-IP focused policy is better suited to support the growth of the venture, IP strategies based on the exploitation of proprietary rights are certainly key in shaping and strengthening this industry. Just filing a patent, design or trademark application may not be enough – taking legal action against competitors that try to free-ride on the investments made by someone else is also increasingly necessary. We have mentioned some of these lawsuits, several of which have been settled with a consent judgement that has left the claimant that enforced its IP in a stronger position than the alleged infringer. Yet, some legal actions aimed at protecting IP in robotics have also been criticised, particularly where patents have been granted by patent offices with broadly drafted claims and aggressively enforced against competitors.[140]

Robots, especially those embedded with AI, may also be capable of coming up with works or inventions that are usually created by human beings, being them painters, illustrators, poets or engineers. Whether these artistic, literary, musical or technical outputs meet the requirements for copyright or patent protection, and who the author or the inventor is, are thorny issues that are currently giving IP scholars and lawyers food for thought: issues that will become even more burning as technology keeps advancing and allows robots and machines to perform behaviours or tasks with a higher degree of autonomy. What we may be witnessing in the not so distant future is not only the continued progress of robotics technology which will increase AI capabilities, but also an evolution of copyright and patent regimes that will put at the centre of the debate the creation of "works" or the development of "inventions", possibly diminishing the roles of "authors" and "inventors". Are we moving from the "laws of authors and inventors" to the "laws of copyright works and patentable inventions"? The robotics and AI industry may be the innovative sectors that will provide answers to these questions.[141] Time will tell.

[140] See article "The IP Battle Continues for Robotics Companies", in Robotic Business Review of 7 January 2018, at https://www.roboticsbusinessreview.com/legal/the_ip_battle_continues_for_robotics_companies.
[141] See also Massimo Maggiore, Artificial Intelligence, Computer-Generated Works and Copyright, in Enrico Bonadio – Nicola Lucchi, Non-Conventional Copyright – Do New and Atypical Works Deserve Protection? (2018 Elgar), p.391.