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Article

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A *De Lege Ferenda* Perspective on Artificial Intelligence Systems Designated as Inventors in the European Patent System

The European patent system was designed around a paradigm of human inventorship. This paper will analyse in depth and from a *de lege ferenda* perspective the rather general arguments against and in favour of a possible designation of artificial intelligence (AI) systems as inventors. For the sake of a more concrete discussion, it will also outline a potential reform of the European patent system to implement AI inventorship and allocate the right to the European patent for such inventions by default to the machine's operator. In the process, it will highlight the major specific issues associated with a reform that acknowledges AI inventorship and touch upon possible alternative approaches to addressing the growing autonomy of machines within the R&D process. The study must not be understood as a call for a reform to recognise AI systems as inventors but rather as a manner of laying the foundations for a more concrete, critical and fruitful discussion on non-human inventorship and its alternatives. The analysis will show that the more general, highly conceptional reservations advanced in the current discussion against AI inventorship are somewhat unfounded, e.g. the alleged break with the functions of the current patent system or the alleged need to endow AI with legal personality. More convincing arguments against a reform that allows for the designation of AI systems as inventor might instead relate to the specific difficulties associated with such reform.

I. The need to review the paradigm of human inventorship

The foundations and core concepts of the European patent system were mainly developed in the 19th and the first half of the 20th century.[1] In this era, machines were person-driven mechanical devices performing an intended action without autonomous[2] creative capabilities.[3] The paradigm of human inventorship was self-evident. Even today, this notion underlies the present European patent system.[4] Recently, several patent offices and courts have been faced with patent applications designating a certain type of artificial intelligence system under the name of DABUS as inventor.[5] Two of these were filed with the European Patent Office (EPO).[6] In both cases, its Receiving Section refused the application based on two procedural grounds, one of them referring to Article 81 and Rule 19(1) EPC, which require the applicant to designate an inventor and in particular to state his or her 'family name, given names and full address'[7] – a requirement clearly deriving from the paradigm of human inventorship.[8]

Notwithstanding the correctness of the decision of the EPO *de lege lata*,[9] the justification of such a paradigm appears to waver with the development of enhanced AI. The more artificial agents replace humans in the R&D process, the more urgent becomes the question of the justification of such a paradigm for the patent system.[10] It is hard to predict the contribution that these machines will make to the innovation system in the near future and to

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1 The European Patent Convention was signed on 5 October 1973 and entered into effect on 7 October 1977. The conceptual foundations, however, are based on the structures of the national patent systems which were mainly developed in the 19th and at the beginning of the 20th century.

2 In this paper the term 'autonomous' is used to describe an enhanced level of machines independent of human input. For a technical distinction of automation and autonomy see Daria Kim, ''AI Generated Inventions': Time to Get the Record Straight?' [2020] GRUR International 446 f.

3 cf Lewis Mumford, *Technics and Human Development* (Harcourt, Brace & World 1967) 191 (defining a machine, 'more or less in accord with the classic definition of Franz Reuleaux, as a combination of resistant parts, each specialized in function, operating under human control, to utilize energy and to perform work [. . .]').

4 Martin Stierle, 'Artificial Intelligence Designated as Inventor – An Analysis of the Recent EPO Case Law' [2020] GRUR International 918, 923.

5 See for the US: USPTO, In re application of 16/524,350. See for the UK: UKIPO, Decision of 4 December 2019, BL O/741/19, on GB1816909.4 and GB1818161.0 as well as the appeal *Thaler v The Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat).

6 See EP18275163.6 and EP18275174.3.

7 EPO, Grounds for decisions of 27 January 2020 on EP18275163.6 (para 19 ff) and EP18275174.3 (para 20 ff).

8 Besides art 81, r 19(1) EPC as one ground for the decision, the EPO argued that the indications by the applicant would not meet the requirements of art 81, 60(1) EPC (EPO, Grounds for decisions of 27 January 2020 on EP18275163.6 (para 30 ff) and EP18275174.3 (para 31 ff)). This finding is surprising in the light of art 60(3) EPC (cf critically Stierle (n 4) 922).

9 Stierle (n 4).

10 cf UKIPO, Decision of 4 December 2019, BL O/741/19, on GB1816909.4 and GB1818161.0, para 29 and CIPA, 'Patenting Inventions created using an AI system, A CIPA Discussion Paper' <https://www.cipa.org.uk/_resources/assets/attachment/full/0/260456.pdf> accessed 27 July 2020; Andreas Engel, 'Can a Patent Be Granted for an AI-Generated Invention?' [2020] GRUR International, sub I.1. (forthcoming).

foresee the extent of their autonomy in the inventive process over the coming years or decades. Although there is no knowing when important milestones[11] will be reached and certainly not when human-like artificial general intelligence[12] will be created, the current developments leave no doubt that AI will acquire more and more inventive capabilities and become increasingly independent of human determination. Already today, artificial agents outclass humans when it comes to very specific tasks and processes[13] and they appear to have the potential to enable innovations that would be impossible through human ingenuity due to our cognitive 'blind spots'.[14] These foreseeable developments impose the need to reconsider the paradigm of human inventorship within the European patent system.

Usually, dealing with new issues from the perspective of the traditional functions and concepts of the patent system is a sound approach. It helps to avoid overreacting whenever a new technology looms on the horizon. However, AI is not just *any* technology. Unlike others, it is having a tremendous impact on *all* sectors of industry today and it seems that it will be a significant driving force for the entire technological progress in the future.[15] Bearing in mind the primary task of technology law, which is to provide a proper ecosystem for the development of cutting-edge technologies,[16] a fresh in-depth analysis should not be required to remain within rigid structures. For this reason, this study will adopt a complete *de lege ferenda* perspective on the designation of AI as inventor.

II. Scope and outline of the analysis

This paper will focus on the designation of AI as inventor. Although it will address the discussion on the present capacity of such systems and their impact on R&D processes today and in the future, it will not cover the technological background, particularly the various types of systems referred to as AI[17] and their controversial potential.[18] Based on the recent DABUS decisions, this study will solely examine whether applicants for a European patent should be able to designate an AI system as inventor, identify the potentially necessary amendments which would allow such an indication, emphasise potential problems associated with such a reform, and investigate alternative solutions. Although the technical background is significant, the actual capacity and extent to which an AI system can invent is only of secondary importance in this study, which focuses predominantly on the legal question of designation and its alternatives. However, it will have a certain constellation in mind when analysing AI inventorship: In this constellation, the AI system will not be used merely as a tool by a human inventor. In order to qualify as a true inventor, it will need to be an enhanced system that might work within a specific framework or task set by a natural person but one that researches and develops within the core inventive process free of any specific human commands or guidance.[19]

The study proceeds as follows: Firstly, it will discuss general arguments against (Section III.) and in favour of

11 Another major technology that might boost the autonomy of AI systems is unsupervised training. For this method see for example Nils J Nilsson, *The Quest for Artificial Intelligence: A History of Ideas and Achievements* 513 ff <https://ai.stanford.edu/~nilsson/QAI/qai.pdf> accessed 27 July 2020, and Yann LeCun, Yoshua Bengio and Geoffrey Hinton, 'Deep learning' [2015] Nature 521, 436, 442 with further references.

12 For the term artificial general intelligence see Allen Newell and Herbert A Simon, 'Computer Science as Empirical Inquiry: Symbols and Search' [1976] CACM 113, 116. For certain predictions when this scope of intelligence might be developed see Vincent C Müller and Nick Bostrom, 'Future progress in artificial intelligence: A survey of expert opinion' in Vincent C Müller (ed), *Fundamental Issues of Artificial Intelligence* (Springer 2016) 553 (median estimate of respondents for a one in two chance for around 2040-2050, rising to a nine in ten chance by 2075) or Martin Ford, *Architects of Intelligence: The Truth about AI from the People Building it* (Packt Publishing 2018) 528 (survey conducted among 18 prominent researchers with predictions spanning from 2029 to 2200).

13 In March 2016, AlphaGo, a computer program using a combination of machine learning and tree search techniques, defeated 18-time world Go champion Lee Sedol by four games to one. For the implementation of AlphaGo see David Silver and others, 'Mastering the game of Go with deep neural networks and tree search' [2016] Nature 529, 484.

14 cf Erica Fraser, 'Computers as inventors – legal and policy implications of artificial intelligence on patent law' (2016) 13(3) SCRIPTed 305, 323 with further references.

15 See for example European Parliament, P8_TA(2017)0051, 'Civil Law Rules on Robotics, European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL))' sub B; Peter Stone and others, 'Artificial Intelligence and Life in 2030, One Hundred Year Study on Artificial Intelligence: Report of the 2015-2016 Study Panel, Stanford University' <https://ai100.stanford.edu/2016-report> accessed 27 July 2020; Ekkehard Ernst, Rossana Merola and Daniel Samaan, 'The economics of artificial intelligence: Implications for the future of work' (ILO 2018) <https://www.ilo.org/wcmsp5/groups/public/—dgreports/—cabinet/documents/publication/wcms_647306.pdf> accessed 27 July 2020.

16 See Herbert Zech, 'Life Sciences and Intellectual Property: Technology Law Put to the Test' (2015) 7 IPJ 1, 3 (describing different functions of technology law, the first being influencing the creation of technology).

17 See for example Nilsson (n 11), particularly 433 ff; David L Poole and Alan K Mackworth, *Artificial Intelligence: Foundations of Computational Agents* (2nd edn, Cambridge University Press 2017); Josef Drexl and others, 'Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective' (2019) Max Planck Institute for Innovation and Competition Research Paper No 19-13 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3465577> accessed 27 July 2020.

18 Exemplary for the discussion, see on the one hand: Ryan Abbott, 'I Think, Therefore I Invent: Creative Computers and the Future of Patent Law' (2016) 57 B.C. L. Rev. 1079, 1079 ff (AI has been generating inventive output for decades); Peter Blok, 'The inventor's new tool: artificial intelligence – how does it fit in the European patent system?' (2017) 39 E.I.P.R. 69, 70 (AI systems have become capable of delivering input in the inventive process which would be rewarded with (co-)inventorship if performed by a human); Shlomit Yanisky Ravid and Xiaoqiong Liu, 'When Artificial Intelligence Systems Produce Inventions: An Alternative Model for Patent Law at the 3A Era' (2018) 39 Cardozo L. Rev. 2215, 2219 (AI systems create a wide range of innovative, new and non-obvious products and services which might be patentable if created by humans); Nick Li and Tzeyi Koay, 'Artificial intelligence and inventorship: an Australian perspective' (2020) 15 JIPLP 399, 400 ('The question is no longer 'can AI invent'– the answer to that must be a resounding yes.'). On the other hand, see: Noam Shemtov, 'A study on inventorship in inventions involving AI activity' (*EPO*, February 2019) 22 <http://documents.epo.org/projects/babylon/eponet.nsf/0/3918F57B010A3540C125841900280653/$File/Concept_of_Inventorship_in_Inventions_involving_AI_Activity_en.pdf> accessed 27 July 2020, arguing that such machine learning systems do not appear to exist at present; Yann Ménière and Heli Pihlajamaa, 'Künstliche Intelligenz in der Praxis des EPA' [2019] GRUR 332, 335 (some participants in the discussion on AI-generated inventions might overestimate the creative capacities of AI); Lea Tochtermann, 'Immaterialgüterrechtlicher Schutz von KI *de lege ferenda*' in Markus Kaulartz and Tom Braegelmann (eds), *Rechtshandbuch Artificial Intelligence und Machine Learning* (Vahlen 2020) 7.3 para 38 (there will not be a sufficient level of autonomy in the near future); Kim (n 3) 443 (arguing that current patent literature overestimates the autonomy of AI systems); EPO, 'WIPO Conversation on Intellectual Property (IP) Artificial Intelligence (AI), Second Session July 7 to 9, 2020, Revised Issues Paper on Intellectual Property Policy and Artificial Intelligence (WIPO/IP/AI/2/GE20/1 Rev.)' 3 ff <https://www.wipo.int/export/sites/www/about-ip/en/artificial_intelligence/conversation_ip_ai/pdf/igo_epo.pdf> accessed 27 July 2020.

19 See Abbott (n 18) 1082 ff (2016) for alleged examples of such computers generating patentable results.

(Section IV.) the admission of AI inventorship. In the process, it will demonstrate that the major and rather general reservations which have been raised against the acknowledgment of AI inventorship in the current discussion are somewhat unfounded. Thereafter, in order to allow for a more concrete analysis, the paper will sketch out a potential reform of the European patent system to admit artificial agents as inventors and entitle their operators as default patent owners (Section V.). The study will then touch upon the specific and rather substantial problems associated with such a reform (Section VI.) before analysing alternative approaches (Section VII.). It will conclude with a summary of its main findings (Section VIII.).

III. General arguments against the designation of AI as inventor

The current European patent system does not accept artificial agents as inventors.[20] The EPO insists that the current legal framework is suitable for addressing inventorship and ownership of inventions involving AI activity both at present and in the foreseeable future.[21] A study commissioned by the Office[22] shares this opinion as well as further analysis conducted by legal scholarship.[23] We will analyse the general arguments put forward against the designation of AI as inventor in the current discussion.

1. Current limited capacity of AI

A frequent argument used by many – including representatives of the EPO – for refusing to allow AI the status of inventor refers to the alleged limited capacity of current systems. According to this view, some participants in the discussion on AI inventorship overestimate the creative capacities that AI systems have today or will acquire within the foreseeable future.[24] Thus, debates on changing the status quo should not be our concern at the moment.

Indeed, against the backdrop of the extensive literature on the intersection of AI and the law, there might be a risk of overestimating the autonomous capacity of machines. Often, the existence of fully autonomous artificial systems is taken as a premise without proper inquiry regarding the technical background. Stakeholders, in particular judges, scholars and policymakers, need to be careful and diligent in understanding the underlying technology before applying, revising or making the law. For this reason, a discussion on the actual autonomous capacities of AI systems at present and in the (near) future is of the utmost importance.

This paper cannot conduct such an analysis, nor will it take a final position on the present capacity of AI to invent; rather it will refer to the existing literature in this regard.[25] Nevertheless, it seems worth mentioning that the critical scholarship on AI-generated inventions primarily emphasises the lack of autonomy of current AI systems.[26] However, the extent to which inventorship requires autonomy appears to be highly questionable. There is no binding definition[27] of (human) inventorship by the EPO Boards of Appeal. In an obiter dictum, one Technical Board referred to the concept of inventor as a 'natural person who has performed the creative act of invention'.[28] UK patent law[29] requires the person to 'devise' the invention, which is generally understood by courts as coming up with the inventive concept,[30] while the German Federal Supreme Court[31] defined 'inventor' as the person who conceives how a concrete technical problem can be solved by specific technical means, and who sets out this knowledge in such a way that it can be used as an instruction for technical action. We will come back later to the issue of creativity and personhood as a potential prerequisite of inventorship, but in the light of these definitions of the required act itself, it does not appear impossible for a machine, without working in a fully autonomous manner, to establish inventorship by creating the subject matter, devising it, or conceiving and putting it in an instruction for technical action. Even the capacity of the narrow AI systems[32] already available used for specific topics and processes might be sufficient. This is even more true for the concept of joint inventorship, where courts do not require a full inventive contribution for someone to become co-inventor.[33] Thus, while some authors and institutions seem to overestimate the present capacity of AI, others appear to overestimate the autonomy required to establish inventorship. In particular the scope of autonomy of a human-like artificial general intelligence is not required.[34]

20 EPO, Grounds for decisions of 27 January 2020 on EP18275163.6 and EP18275174.3; Shemtov (n 18) 33; Roman Konertz and Raoul Schönhof, 'Erfindungen durch Computer und künstliche Intelligenz – eine aktuelle Herausforderung für das Patentrecht?'[2018] IPJ 379, 401; Joel Nägerl, Benedikt Neuburger and Frank Steinbach, 'Künstliche Intelligenz: Paradigmenwechsel im Patentsystem [2019] GRUR 336, 340; Ménière and Pihlajamaa (n 18) 335 f; Stefan Papastefanou, 'KI-gestützte Schöpfungsprozesse im geistigen Eigentum [2020] WRP 290, 293.

21 Ménière and Pihlajamaa (n 18) 336.

22 Shemtov (n 18) particularly 33 (the EPC is suitable for addressing inventorship and ownership of inventions involving AI activity both at present and in the near future).

23 Anne Lauber-Rönsberg and Sven Hetmank, 'The Concept of Authorship and Inventorship under Pressure: Does Artificial Intelligence Shift Paradigms?' [2019] GRUR Int 641, 642 (current patent law seems to be well prepared and might cope with the forthcoming changes in the technical world); Tochtermann (n 18) 7.3 para 37 f and 48 (the current legal framework is appropriate and well prepared).

24 Ménière and Pihlajamaa (n 18) 335; Shemtov (n 18) 9 f; Kim (n 3). See also Tochtermann (n 18) 7.3 para 38 (arguing that we should only consider AI inventorship if AI reaches a certain level of autonomy).

25 See n 18 with further references.

26 Ménière and Pihlajamaa (n 18) 335; Shemtov (n 18) 22, Kim (n 3); Tochtermann (n 18) 7.3 para 38.

27 For the limited binding effect of Board of Appeal decisions in general see Stierle (n 4) particularly fn 15.

28 J 7/99 n 2.

29 s 7(3) UK Patent Act of 1977.

30 See *University of Southampton's Applications* [2005] RPC 220, 234 and *Yeda Research and Development Company Ltd. v Rhone-Poulenc Rorer International Holdings* [2007] UKHL 43 at 20. For a recent decision specifically on AI inventorship see, however, *Thaler v The Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat). This paper will return to it later.

31 Federal Supreme Court, [2010] GRUR 817 para 28 – *Steuervorrichtung;* cf Klaus-Jürgen Melullis, '§ 6'in Georg Benkard, *Patentgesetz* (11th edn, CH Beck 2015) para 30.

32 Narrow AI is a term used to describe AI systems that are designed to handle a singular or limited task. See for example MaryAnne M Gobble, 'The Road to Artificial General Intelligence' (2019) 62(3) Res. Technol. Manag. 55.

33 cf Federal Supreme Court, [2001] GRUR 226, 227 – *Rollenantriebseinheit* (contribution of a co-inventor needs to be inventive itself). See also Federal Supreme Court, [1966] GRUR 558, 560 – *Motorkettensäge* (denying that co-inventorship requires a creative contribution). See also Klaus-Jürgen Melullis, 'art 60 para 20' in Georg Benkard, *EPÜ* (3th edn, CH Beck 2019), Lauber-Rönsberg and Hetmank (n 23) 642, and Engel (n 10) sub V.3. with further references.

34 See, however, EPO (n 18) 3 (referring to literature and estimates on artificial general intelligence with regard to the necessary level of autonomy).

Moreover, concerning the specific issue of the designation of AI as inventor within patent law, it might actually be of minor importance whether AI systems truly invent at present or will need more time to acquire such capability. Firstly, a discussion of the right approach and the implementation of the amendments that may be required to the European Patent Convention[35] or its Implementing Regulations[36] will take time (not to mention the political difficulties such a reform will entail), which means that there is an urgent need to address the issue proactively today. Even if a new legal framework were to be developed on that basis before AI systems actually have the proper capacity to truly invent, no harm would be done. It appears to be generally accepted that AI will acquire the necessary capability at some time in the future (if it does not already have it today). There is no disadvantage in technology law being ahead of technological developments, providing a visionary and appropriate framework for upcoming technologies instead of lagging behind.

Secondly, even if present AI systems lack the capacity required to invent autonomously at the moment, with the exaggeration of their potential being due to marketing purposes,[37] the patent community will not be ahead of the curve by discussing or allowing the designation of AI as inventor today. The question as to whether a machine like DABUS truly invents must be distinguished from the issue of the designation of DABUS as inventor. Patent offices and courts are at present faced with the second scenario.[38] Currently, they have to – in the words of the Hearing Officer of the UKIPO – shoehorn such inventions arbitrarily into existing legislation before a sufficient debate about a policy change with all relevant stakeholders has taken place.[39] It is therefore already high time to discuss the impact and the potential need for a change to the legal framework and not to end a concrete discussion before it has even started.[40]

2. Legal personality and ownership of AI

Many authors and institutions advance the notion that accepting AI as a potential inventor necessarily leads to conferring legal capacity on AI.[41] This idea can be found even in the recent decisions of the EPO, when the Receiving Section raised DABUS' lack of legal capacity to argue against its inventorship.[42] Amending the EPC to endow a machine with legal capacity would interfere with general concepts in the civil law of every EPC contracting state, thus extending far beyond the boundaries of IP law and into the general discussion on the legal personality of robots.[43, 44]

However, there is no need to assign legal personality to artificial agents when acknowledging their inventorship. The fact that the act of inventing is not a legal but a factual one is generally recognised.[45] We have already referred to descriptions of inventorship. Although conceptually a creative act (i.e. a human act) might be required – this issue will be addressed in detail below – none of the definitions of 'inventor' explicitly sets up legal capacity as a requirement in order to qualify for the act of inventing. Some court definitions might refer to a natural person as inventor.[46] However, this criterion appears to be used traditionally to exclude legal persons as inventors but not to emphasise any requirement of legal capacity.

Furthermore, machine inventorship does not necessarily entail the acknowledgment of patent ownership by a machine.[47] Even in today's patent system, inventorship does not necessarily imply ownership and vice versa.[48] The two are distinct concepts. Inventorship only represents a general criterion for attributing the rights to the invention. It is only a first-level allocation mechanism. By default, the inventor is the first owner unless an exception applies. However, in practice, the application of the statutory exceptions (particularly that based on an employment relationship) seems to be the general case.[49] These

35 For the procedure to revise the EPC see art 172 EPC requiring a Conference of the Contracting States with at least three-quarters of the Contracting States represented at it.

36 The Administrative Council is competent to amend the Implementing Regulations (see art 33 para 1 lit c EPC).

37 Apparently, the team behind the applications designating DABUS as inventor describe these as test cases (see Engel (n 10) 1124, sub I.3.).

38 See n 5 and n 7.

39 UKIPO, Decision of 4 December 2019, BL O/741/19, on GB1816909.4 and GB1818161.0, para 29. See also Fraser (n 14) 333 (warning for the development that patent offices as well as courts have to deal with such issues without being able to consider the broader policy implications).

40 cf Nägerl, Neuburger and Steinbach (n 20) 340 (describing the issue as highly topical); CIPA (n 10) (asking for a proper investigation of such issues now). Various IP offices and institutions are looking into the issue at the moment. See Department of Commerce, Patent and Trademark Office, 'Request for Comments on Patenting Artificial Intelligence Inventions' 84 Fed. Reg. 44,889 (22 August 2019); Department of Commerce, Patent and Trademark Office, 'Request for Comments on Intellectual Property Protection for Artificial Intelligence Innovation' 84 Fed. Reg. 58,141 (30 October 2019); WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI) (WIPO/IP/AI/2/GE/20/1); AIPPI, 2020 – Study Question: Inventorship of inventions made using Artificial Intelligence (Q272-SGL-P-2020).

41 cf EPO (n 18) 2 (arguing that the issue of AI inventorship must be seen in a broader context of rights allocated to persons); Fraser (n 14) 330 (the acknowledgement of AI inventorship would require recognizing computers as legal persons); Shemtov (n 18) 10, 25 (arguing that identifying AI systems as inventors may not only require accepting inventorship beyond natural persons but also recognizing computers as legal persons). See also Tochtermann (n 18) 7.3 para 39 (arguing that creating e-persons might extend inventorship to AI).

42 EPO, Grounds for decisions of 27 January 2020 on EP18275163.6 (para 26 f) and EP18275174.3 (para 27 f).

43 For the general discussion on AI and legal personality see for example: Robert van den Hoven van Genderen, 'Do We Need New Legal Personhood in the Age of Robots and AI?' in Marcelo Corrales, Mark Fenwick and Nikolaus Forgó (eds), *Robotics, AI and the Future of Law* (Springer 2019) 15; Jan-Erik Schirmer, 'Artificial Intelligence and Legal Personality' in Thomas Wischmeyer and Timo Rademacher (eds), *Regulating Artificial Intelligence* (Springer 2020) 123.

44 cf Engel (n 10) 1128, sub V.2. (considering that it might not be necessary that an AI system as inventor would need to hold patent rights). See, however, Fraser (n 14) 330 (arguing that the consequences of recognizing computers as legal persons would not be insurmountable). See also *Thaler v The Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat) at 40.

45 Rudolf Kraßer and Christoph Ann, *Patentrecht* (7th edn, CH Beck 2016) § 19 para 10; Melullis in Benkard (n 33) art 60 para 15; cf Otto Bossung, 'art 81 para 41' in Friedrich Karl Beier, Kurt Haertel and Gerhard Schricker (eds), *Münchner Gemeinschaftskommentar, EPÜ* (Carl Heymanns 1986) (not requiring a capacity to contract). See also from a German patent law perspective Regional Court of Nürnberg-Fürth, [1968] GRUR 252, 254; Uwe Fitzner, '§ 6' in Uwe Fitzner, Raimund Lutz and Theo Bodewig (eds), *BeckOK Patentrecht*, (16th edn, CH Beck 15 April 2020) para 16; Jochen Ehlers and others, 'Internationale Vereinigung für den Schutz des Geistigen Eigentums (AIPPI): Berichte der Deutschen Landesgruppe für den Weltkongress der AIPPI 2015 in Rio de Janeiro, Brasilien' [2015] GRUR Int 909 (there is no legal requirement such as contractual capacity).

46 J 7/99 n 2; *Yeda Research and Development Company Ltd. v Rhone-Poulenc Rorer International Holdings* [2007] UKHL 43 at 20.

47 See, however, Shemtov (n 18) (n 20) 11 (AI inventorship must then lead courts to find AI ownership) and Thomas Heinz Meitinger, 'Künstliche Intelligenz als Erfinder?' [2020] Mitt. 49, 50 (the consequence of machine inventorship would be patent ownership).

48 See art 60 para 1 EPC.

49 cf Konertz and Schönhof (n 20) 408.

legal exceptions and their typical application in practice demonstrate the distinction between the concepts of inventorship and ownership as already embedded in today's system. Thus, admitting AI systems as possible inventors does not necessarily entail acknowledgment of machines as the owners of patents. It might be just another case where ownership and inventorship are not vested in the same 'person'.

3. Inventor's rights

Inventor's rights are sometimes classified as moral rights[50] which are directly connected to the personhood of the inventor. From this definition, conferring inventor's rights on AI appears to be highly problematic at first glance.[51] However, as just demonstrated, the acknowledgment of machine inventorship does not entail the need to confer legal personality on AI. Since AI systems at the moment lack legal personality in all EPC contracting states and current policy discussions suggest that this status will not (and should not) change in the near future, artificial agents must not and will not be entitled to inventor's rights through the acknowledgement of their inventorship.

The existence of patent inventors without inventor's rights does not create a structural problem within the patent system. Unlike the intertwined nature of economic and moral rights in the copyright law of some jurisdictions,[52] moral rights deriving from inventorship are generally not inseparably connected to the patent or its economic rights.[53] Today's European patent system already provides two types of protection, forming two distinct regimes of entitlement: one by ownership with regard to exploitation rights and a second by inventorship with regard to moral and other inventor's rights.[54] Both regimes can work independently of each other, meaning different persons can be entitled within different patent law sub-regimes. Such a constellation is not inconsistent with the functional structure of the patent system, as this paper will analyse below.

4. Break with current functions of the patent system

Critics of the acknowledgment of AI inventorship claim that inconsistencies in the patent system will emerge if the law allows for artificial inventors. According to them, the present structure aims at providing incentives for humans.[55] AI inventorship would shift the system from a (human) inventor-based to an investment protection system.[56]

Firstly, assuming, *arguendo*, that recalibrations of the present inventive structure might be needed to allow for the designation of AI systems as inventor, the need for such adaptions must not bar the acknowledgment of AI inventorship. Bearing in mind that the primary task of technology law is to provide a proper ecosystem for the development of cutting-edge technologies,[57] and given the foreseeable impact of AI on various industries and technological progress as a whole, it might not be AI that needs to fit into the legal framework of the patent system. It might rather be the legal framework which needs to recalibrate or adjust to the massive and useful deployment of AI in R&D processes.

Secondly, even today, the functional structure of the European patent system does not focus primarily on the human inventor as an individual creator. Although a paradigm of human inventorship underlies this system[58] (among other core concepts[59]), the deontological theories which justify such a regime by stressing principles such as fairness towards the human inventor cannot explain today's patent law and practice.[60] The foundation of the present system is purely based on incentives – we will return to this aspect later. Acquiring ownership of an invention is therefore the result of an investment in R&D and/or the disclosure of its fruits.[61] Inventor's rights, moral rights and inventorship-based employee remuneration are fairness-driven rights or rewards to the human inventor as a person.[62] However, they are just an add-on to the core structure of patent law functions but not a part essential to its operation in general.[63] Thus, as mentioned above, the European patent system can work with

50 Georg Hendrik Christiaan Bodenhausen, 'art 4ter' in *Paris Convention for the Protection of Industrial Property as Revised at Stockholm in 1967* (WIPO reprint 2007) art 4ter sub (a); Bossung (n 45) art 81 para 9 with further references; Kaisa Suominen, 'art 60(1)' in Derk Visser and others, *European Patent Convention* (2019 Edition, Wolters Kluwer 2020) No 1.

51 cf Meitinger (n 47) 50 (arguing that if AI can be the inventor it will own a moral right, which strikes the author as absurd). See also Christian Osterrieth, *Patentrecht* (5th edn, CH Beck 2015) para 555 (existence of a moral right of the inventor would demonstrate the requirement of a natural person as inventor).

52 As a prime example see the monistic approach of Germany copyright law: s 11 of the German Copyright Act (BT-Drs. IV/270, 43; Eugen Ulmer, *Urheber- und Verlagsrecht* (3rd edn, Springer 1980) 112 f). See also Francesco Banterle, 'Ownership of inventions created by Artificial Intelligence' AIDA 2018, sub 5.3 (moral rights in patent law enjoy a lower level of protection than in copyright law, as inventorship is less central in the patent system).

53 See in comparison s 29 para 1 of the German Copyright Code which renders the transfer of the copyright void due to the intertwined nature of economic and moral rights. Before the Revision Conference in London of the PC, certain member states like Germany had a patent system running without such right.

54 cf Banterle (n 52) sub 2. and 4.

55 EPO (n 18) 2; Shemtov (n 18) 23; Ménière and Pihlajamaa (n 18) 335; cf Sven Hetmank and Anne Lauber-Rönsberg, 'Künstliche Intelligenz – Herausforderungen für das Immaterialgüterrecht' [2018] GRUR 574, 576 (traditional theories risk failing if innovation is not generated mainly by humans but by AI) and Nägerl, Neuburger and Steinbach (n 20) 340 (traditional theories on patent functions might fail). See also Papastefanou (n 20) 293 f (the patent system would require fundamental changes). From a US perspective: Liza Vertinsky, 'Thinking machines and patent law' in Woodrow Barfield and Ugo Pagallo (eds), *Research Handbook on the Law of Artificial Intelligence* (Edward Elgar 2018) 489, 494 f.

56 Banterle (n 52) sub 1.

57 See n 16.

58 See n 4.

59 eg the general believe in technological progress as something desirable.

60 Edwin C Hettinger, 'Justifying Intellectual Property' (1989) 18 Phil. & Pub. Aff. 31; Sven JR Bostyn, *Enabling Biotechnological Inventions in Europe and the United States. A study of the patentability of proteins and DNA sequences with special emphasis on the disclosure requirement* (EPO script 2001) 33; Mark A Lemley, 'Faith-Based Intellectual Property' (2015) 62 UCLA L. Rev 1328; Martin Stierle, *Das nicht-praktizierte Patent* (Mohr Siebeck 2018) 191 ff. See, however: Adam M Moore, 'A Lockean Theory of Intellectual Property' (1997) 21 Hamline L. Rev. 65; Adam M Moore, 'A Lockean Theory of Intellectual Property Revisited' (2012) 49 San Diego L. Rev. 1069; Robert P Merges, *Justifying Intellectual Property* (Harvard University Press 2011).

61 cf Banterle (n 52) sub 4.2. (the entitlement to acquire the ownership of the invention is based on the investment and the assumption of the economic risks of the research activity).

62 See, however, Jeanne C Fromer, 'Expressive Incentives in Intellectual Property' (2012) 98 Va. L. Rev. 1745 (seeing a utility to moral-rights concerns). However, a utility side-effect does not constitute an intended normative function needed to operate the system as a whole.

63 This finding is supported by the genesis of inventor's rights, which were not provided by some national patent systems such as the German one before the London Conference of Revision of the PC.

inventors having no inventor's rights in specific situations if fairness- and personality-based considerations do not warrant them.[64] AI inventorship would establish such a constellation, as such systems lack legal personality.

Thirdly, accepting AI as the inventor might slightly alter the inventive function of the patent system but will not create any inconsistencies with the foundations of its current structure.[65] The present system is based on four different sub-functions which jointly provide for technological progress to the benefit of society.[66] The pre-grant structure of the patent system provides incentives for investing in inventing (inventive function)[67] and for disclosing a resulting invention for the benefit of the public (information function)[68] by granting an exclusive right in return. The post-grant structure[69] aims at incentivizing patent holders by prohibiting the free-riding exploitation of their patents and placing innovative products and services implementing the patented technology on the market (innovation/commercialization function).[70] This incentive also includes the possibility of transferring the right to work the patent to a third party who produces and commercializes the invention (transaction function).[71]

If the output produced by AI systems is protected by Art. 52 ff. EPC, natural persons and companies will be encouraged to invest in enhanced autonomic inventing machines.[72] Investors will be incentivized to invest in AI in the same way as they are currently incentivized to invest in efficient tools needed during the process of inventing. There would therefore be no major change to the functional structure of patent law. Whether such incentives are desired is a different question. The study will return later to the potential need to have them implemented.

5. Human inventor as a prerequisite for substantive patentability ('person skilled in the art')

The aforementioned arguments are related to the understanding of a human contribution as a prerequisite to substantive patentability. The EPO was able to base its decisions in the DABUS cases on formal patentability requirements. However, if Art. 52 ff. EPC are built on the notion of a human inventor, acknowledging AI as a potential inventor by changing procedural law might cause inconsistencies in the application of substantive patentability requirements, thereby stretching the system to breaking point.

The concept of the 'person skilled in the art' provided for by Art. 56 EPC could potentially be understood as a requirement within substantive patent law that the inventor has to be human. However, Art. 56 EPC does not exclude the acknowledgment of AI inventorship on a conceptual level, although the wording seems to refer to a natural person as the potential inventor.[73] The 'person skilled in the art' is a mere tool for the assessment of the necessary degree of inventiveness. The yardstick is needed to represent the group of potential inventors, given the existing paradigm of human inventorship, namely natural persons only. If the patent system were to extend the group of potential inventors, particularly to AI systems, there would be no reason to justify patent law not working with a different legal fiction as a measuring device. First drafts of the EPC did not even refer to a 'person skilled in the art' but described an invention as involving an inventive step if it was not obvious in the light of the state of the art.[74] In fact, the concept of the 'person skilled in the art' was introduced for the sole reason that some EPC member states feared a very subjective application of the standard by patent examiners: the 'person skilled in the art' was therefore included as an objective legal fiction.[75]

6. Human act as a prerequisite for substantive patentability ('creative act')

Some scholars base the human requirement for substantive patentability on the argument that the concept of invention referred to in Art. 52 ff. EPC involves a creation

64 Indirectly, this finding is supported by the scholarship advancing the idea of company inventions (Lauber-Rönsberg and Hetmank (n 23) 647; Engel (n 10) sub V.4.) as the German patent system used to accept until its reform in 1936 ('*Betriebserfindung*'). For this concept and its abolition see Joachim Schwahn, *Die Betriebserfindung im deutschen Patentrecht* (1954); Jürgen Witte, *Die Betriebserfindung* (1957); Jürgen Witte, 'Die Betriebserfindung' [1958] GRUR 163; Hans Schade, 'Der Erfinder' [1977] GRUR 390; Alexander K Schmidt, *Erfinderprinzip und Erfinderpersönlichkeitsrecht im deutschen Patentrecht von 1877 bis 1936* (Mohr Siebeck 2009) i.a. 214 ff, 235 f.

65 Abbott (n 18) 1104; Konertz and Schönhof (n 20) 407.

66 For this combined theory see Stierle (n 60) 237 ff in detail. See also Martin Stierle, 'Patent Injunctions – Identifying Common Elements' (2019) 11 IPJ 334, 349.

67 Fritz Machlup, *An Economic Review of the Patent System* (US Government Printing Office 1958), 21; Hettinger (n 60) 47 ff; William M Landes and Richard A Posner, *The Economic Structure of Intellectual Property Law* (Harvard University Press 2003) 13; Suzanne Scotchmer, *Innovation and Incentives* (MIT Press 2004/2006) 38.

68 *Cont'l Paper Bag Co. v Eastern Paper Bag Co.* 210 U.S. 405, 424 (1908) ('[T]he inventor could have kept his discovery to himself; but, to induce a disclosure of it, Congress has [. . .] guaranteed to him an exclusive right [. . .].'); Machlup (n 67) 21; Jeanne C Fromer, 'Patent Disclosure' (2009) 94 Iowa L. Rev. 539, 547 ff.

69 Against ex post justifications for IP: Mark A Lemley, 'Ex Ante versus Ex Post Justifications for Intellectual Property Law' (2004) 71 U. Chi. L. Rev. 129. Critical also Scotchmer (n 67).

70 Giles S Rich, 'The Relation between Patent Practices and the Anti-Monopoly Laws' (1942) 24 J. Pat. & Trademark Off. Soc'y 159, 177 ff; Seabury Colum Gilfillan, *Invention and the Patent System* (U.S. Government Printing Office 1964) 62 f (n 171); Frederic M Scherer, *Industrial market structure and economic performance* (2nd edn, Houghton Mifflin 1980); Scott F Kieff, 'Property Rights and Property Rules for Commercializing Inventions' (2001) 85 Minn. L. Rev. 697; Scott F Kieff, 'On the economics of patent law and policy' in Toshiko Takenaka (ed), *Patent Law and Theory* (Edward Elgar 2008) 3; Stierle (n 60) 215 ff. See also Machlup (n 67) 21 (referring to the incentive to exploit industrially).

71 Kenneth J Arrow, 'Economic Welfare and the Allocation of Resources for Invention' in National Bureau of Economic Research, *The Rate and Direction of Inventive Activity: Economic and Social Factors* (Princeton University Press 1962) 609, 614 ff; Robert P Merges, 'A Transactional View of Property Rights' (2005) 20 Berkeley Tech. L.J. 1477; Dominique Guellec, Bruno van Pottelsberghe and Nicolas van Zeebroeck, 'Patent as a Market Instrument' in Dominique Guellec and Bruno van Pottelsberghe (eds), *The Economics of the European Patent System* (Oxford University Press 2007) 88 f.

72 KF Milde, 'Can a Computer be an 'Author' or 'Inventor'' (1969) 51 J. Pat. Off. Soc'y 378, 390; Abbott (n 18) 1104; Blok (n 18) 72; Fraser (n 14) 326.

73 cf Banterle (n 52) sub 3.1. With regard to the non-obviousness standard of US patent law see Ryan Abbott, 'Everything Is Obvious' (2018) 66 UCLA L. Rev. 2, 31.

74 EXP/Brev. (60) 5, 4; [1962] GRUR Ausl 561, 564. See also art 5 of the Strasbourg Convention.

75 See for example the following reports with further references Klaus Pfanner, 'Vereinheitlichung des materiellen Patentrechts im Rahmen des Europarats' [1962] GRUR Ausl 545, 553; Martijn van Empel, *The granting of European patents* (Wolters Kluwer 1974) n 89 ff; Jochen Pagenberg, 'art 56' in Friedrich Karl Beier, Kurt Haertel and Gerhard Schricker (eds), *Münchner Gemeinschaftskommentar, EPÜ* (Carl Heymanns 1984) para 5 ff.

by a human being,[76] similar to author's rights which require a personal creation and hence a human individual.[77] The proponents of this idea are supported by a decision of the Boards of Appeal describing the inventive act as creative conduct.[78]

However, substantive patentability is not based on the notion of human creativity.[79] A mental act by a human is not required.[80] Article 52 ff. EPC do not ask *explicitly* for such a contribution as a prerequisite for patentability.[81] The heading of Art. 56 EPC, in particular in the French and German versions, is misleading, since it seems to involve some kind of activity.[82] However, the wording ('invention … is not obvious') of the provision itself demonstrates that the law compares only the claimed subject matter to solutions which are obvious to a fictitious person skilled in the art. The EPO and national courts applying Art. 56 EPC will investigate neither the way the subject matter has been invented nor the nature (human or artificial) of the actual creator.[83] There is no requirement to explain how the invention was reduced to practice or even conceptualized.

Moreover, such a concept does *not underlie* the wording of Art. 52 ff. EPC. As demonstrated above, the functional structure of the patent regime is not human-centred. Although a paradigm of human inventorship is associated with the European patent system, the system's justification is not based on the mere protection of creative human conduct but rather works as an incentive mechanism, in particular to encourage investment,[84] as already pointed out. Referring to inventive activity as a creative act may rightly pay tribute to the efforts of a human inventor. The description, however, does not derive from the core structure of the patent system. Its mechanisms can work without the individual and creative contribution of a human.

7. The need for an internationally uniform understanding of inventorship

According to officials of the EPO, the global patent system requires an internationally uniform understanding of the concept of inventorship, which would argue against artificial inventors.[85] The representatives cited Art. 4ter of the Paris Convention for the Protection of Industrial Property (PC) as well as Rules 4.6, 4.17 (i), 51bis1(a)(i) and 51bis2(i) of the Patent Cooperation Treaty (PCT) in support of their argument. Furthermore, the fact that all major patent systems now seem to require a human inventor appears to underpin this finding.

Article 4ter PC ensures that inventors have the right to be mentioned as such. As this provision was enacted with the London Revision of the Convention in the 1930s, it seems to be natural to interpret it as only safeguarding the rights of human inventors. The interpretation along historical lines might be supported by the understanding of Art. 4ter PC as conferring a *moral* right, since machines cannot have such a right.[86] However, given the character of the Paris Convention as harmonizing a mere minimum standard, this interpretation of the provision referring only to human inventors does not bar the acknowledgment of AI inventorship on a national or European level. In such a case, it would simply mean that artificial inventors do not enjoy the protection of Art. 4ter PC.

The wording of various PCT Rules referred to by the representatives of the EPO does not establish a clear case against AI inventorship either.[87] Only Rule 4.6(c) suggests a concept of human inventorship by referring to 'different persons as inventors'. Nevertheless, even though the Regulations under the PCT are based on such a concept, the 'global patent system' does not necessarily require an international understanding of inventorship. Firstly, the PCT merely offers a unified procedure for filing an international patent application to protect inventions in each of its contracting states. Its Regulations have to provide sufficient flexibility to allow an applicant to file the application and give the information he or she is required to provide pursuant to the national law of the relevant designated states. It does not give any guidance or constitute a role model for the national laws on inventorship.[88] If the Rules do not provide for the necessary openness, even though this may be required by certain jurisdictions, they should be amended – a rather simple process[89] in comparison to an amendment of the PCT itself.

Secondly, given the understanding of the European concept of inventorship by the representatives of the EPO, the need for a uniform international understanding is unlikely. There is a long-running debate as to whether the term 'inventor' must be applied autonomously within

76 In the context of AI inventorship: Shemtov (n 18) 20 ('as an inventor under the present definition one must be able to employ human faculties rather than merely produce a certain output'). In general: Josef Kohler, *Deutsches Patentrecht* (Bensheimer 1878) 32 (defining an invention as an individual creation); Kraßer and Ann (n 45) § 11 para 4 (arguing a human is essential and inventor's rights are just one expression of this general principle); Melullis in Benkard (n 33) art 60 para 12 f (referring to an inventor as a creator and requiring a creative act).

77 See Case C-145/10 *Painer* ECLI:EU:C:2013:138 = [2012] GRUR Int 158 para 87 ff and Case C-683/17 *Cofemel/G-Star* ECLI:EU:C:2019:721 = [2020] GRUR International 322 para 29 ff (requiring a subject matter which is original in the sense that it is its author's own intellectual creation reflecting his personality).

78 J 7/99 n 2.

79 Konertz and Schönhof (n 20) 389 ff; Banterle (n 52) sub 3; Li and Koay (n 18) 400. See also EPO (n 18) 1 f (arguing that AI-generated inventions would fulfil the substantive patentability requirements of art 52 ff EPC).

80 Hetmank and Lauber-Rönsberg (n 55) 576. See also Abbott (n 18) 1108 ff for US law.

81 Banterle (n 52) sub 3. For scientific and legal difficulties in the assessment of such conduct see Abbott (n 18) 1108 ff, describing the scientific problems that ultimately led to the Turing Test.

82 See, however, also *Thaler v The Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat) at 45 regarding the UK requirement of 'inventive step'.

83 Hetmank and Lauber-Rönsberg (n 55) 576. See also for the U.S. 35 U.S. § 103 ('Patentability shall not be negated by the manner in which the invention was made.'), although it was not intended to address AI-generated inventions (see Ben Hattenbach and Joshua Glucoft, 'Patents in the Era of Infinite Monkeys and Artificial Intelligence' (2015) 19 Stan. Tech. L. Rev. 32, 44).

84 Banterle (n 52) sub 3.

85 Ménière and Pihlajamaa (n 18) 335. See also Engel (n 10) 1124, sub I.2. (there is a broad, albeit implicit, international consensus that only humans can be inventors).

86 Bodenhausen (n 50).

87 Most of the cited provisions ask the applicant to state 'identity', 'name' and 'address' of the inventor – terms that do not necessarily exclude artificial inventors. Even the term 'identity' does not require a natural person, since it refers only to information that can be used to uniquely identify something – a person or an object.

88 cf Yanisky Ravid and Liu (n 18) 2260.

89 See art 58 PCT.

the EPC[90] or whether the Convention has left its interpretation as a matter for national law.[91, 92] According to the EPO, the EPC leaves the interpretation of the term 'inventor' primarily to national courts.[93] If there is no need for a uniform interpretation within the European patent system, there can be no substantial need for a uniform international understanding either. Most recently, the EPO even stated that the 'question of AI inventorship will have to be regulated by national legislative authorities'[94] thereby undermining its own argument of a necessary internationally uniform understanding of inventorship to the fullest extent possible.[95]

8. Patent thickets

The opponents of AI inventorship fear the increase of patent thickets[96] which hinder rather than stimulate innovation. AI inventorship would lead to an automation of R&D processes resulting in a tremendous amount of inventions and patents.[97] Patent thickets are already a problem within the current system.[98] Even more crowded patent fields would result in even higher examining and licensing costs, prohibiting companies from commercialising new products.

Indeed, the intensified use and enhanced capacity of AI will most likely lead to a growth in patent applications at the EPO. Although AI will be deployed to a certain extent in any event, the situation might be exacerbated if the law were to allow for AI inventors, thereby providing incentives to invest in AI technology. The study will return to these incentives later. However, from a patent-system-internal perspective, one should not fear patents being granted for such AI-generated inventions if they fulfil the substantive patentability requirements. If such patents were to create an obstacle to innovation, the problem would not be based on the acknowledgment of AI inventorship as a patent-system-internal policy decision but would rather show that the innovation mechanisms of patent law are defective in general and need to be replaced.

Secondly, AI systems deployed by the EPO within the examination process will help to deal with the increased number of patent applications.[99] Various patent offices are currently analysing how to use AI within their research.[100] The deployment of such tools will be crucial in ensuring that the system keeps up with the speed of future R&D dynamics.

Thirdly, the acknowledgment of AI inventorship will raise the bar by including artificial capacities in the non-obviousness standard.[101] We will return later to this consequence of AI inventorship. This change of standard might to some extent generate a compensating effect to the increasing number of potential inventions. Some scholars go so far as to advance the idea of requiring a greater degree of non-obviousness or industrial application,[102] which would even intensify this effect.

Fourthly, other measures in the post-grant stage might help to alleviate the problem of thickets. The negative effects resulting from a high concentration of patents within certain fields can be addressed by reducing the scope of protection of such patents[103] as well as their patent term.[104] A prominent enforcement-oriented solution discussed with regard to patent thickets in general aims at using liability rule characteristics to replace strong property rule elements within the patent system.[105] Blocking effects would be reduced. Implementing such amendments in reaction to an increased grant rate would be within the competency and responsibility of the national states and not the European Patent Organisation as such.[106]

9. Conclusion

The analysis of the most prominent arguments against the potential designation of AI as inventor has demonstrated that the general reservations associated with AI as inventor are mostly unfounded and even have – at least in parts – the tendency to misdirect the current debate. The alleged limited capacity of present AI systems does not argue against a discussion of the possibility of designating AI as inventor, particularly given the present cases at the EPO and other major patent offices and the time required

90 Luigi Carlo Ubertazzi, *Profili soggettivi del brevetto* (Giuffrè 1985) 275 ff; Axel Cronauer, *Das Recht auf das Patent im Europäischen Patentübereinkommen* (Carl Heymanns 1988) 48 ff, 95 ff; Tobias Bremi and Dieter Stauder, 'art 60' in Romuald Singer, Dieter Stauder and Stefan Luginbühl (eds), *EPÜ* (8th edn, Wolters Kluwer 2019) para 5; Melullis in Benkard (n 33) art 60 para 12.

91 van Empel (n 75) 152 ff and 195; Suominen (n 50) 1; AIPPI, 'Q 244, Inventorship of multinational inventions' No 17.

92 See also Bossung (n 45) art 81 para 44 and Stierle (n 4) 918 f, 923 f raising this issue but leaving it open.

93 EPO (n 18) 3 f; Ménière and Pihlajamaa (n 18) 335.

94 EPO (n 18) 5.

95 Moreover, with this statement the EPO fails to recognize the paradigm of human inventorship manifested in certain provisions of the EPC and its Implementing Regulations, which appears to be highly confusing in the light of its DABUS decisions.

96 For a modern understanding of this term see Carl Shapiro, 'Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting' in Adam B Jaffe, Josh Lerner and Scott Stern (eds), *Innovation Policy and the Economy I* (MIT Press 2001) 119. The term seems to derive from the litigation between SCM and Xerox in the 1970s and 1980s (*In re Xerox Corp*. 86 FTC 364 (1975); *SCM Corp. v Xerox Corp*. 645 F.2d 1195 (2d Cir. 1981)).

97 Blok (n 18) 73; Ménière and Pihlajamaa (n 18) 335; Meitinger (n 47) 50. See also Liza Vertinsky and Todd M Rice, 'Thinking about thinking machines: Implications of Machine Inventors for Patent Law' (2002) 8 B.U.J. Sci. & Tech. L. 574, 596 f, 608; Fraser (n 14) 327 f; Liza Vertinsky, 'Thinking machines and patent law' in Woodrow Barfield and Ugo Pagallo (eds), *Research Handbook on the Law of Artificial Intelligence* (Edward Elgar 2018) 489, 504.

98 Shapiro (n 96); Mark A Lemley, 'Patenting Nanotechnology' (2005) 58 Stan. L. Rev. 601, 618; Gavin Clarkson and David DeKorte, 'The Problem of Patent Thickets in Convergent Technologies' (2006) 1093(1) Ann. N. Y. Acad. Sci. 180; Olga Gurgula, 'Strategic Accumulation of Patents in the Pharmaceutical Industry and Patent Thickets in Complex Technologies – Two Different Concepts Sharing Similar Features' (2017) 48 IIC 385; Stierle (n 60) 149 f.

99 cf Christian Heinze and Andreas Engel, 'KI und Patentrecht' in Martin Ebers and others (eds), *Künstliche Intelligenz und Robotik* (CH Beck 2020) § 10 para 92.

100 See for example EPO, *Strategic Plan 2023* 44, 46, 121 <http://documents.epo.org/projects/babylon/eponet.nsf/0/2217f5b7cc07d47cc125841c00610386/$FILE/EPO_Strategic_Plan_2023_en.pdf> accessed 27 July 2020. See also Vertinsky and Rice (n 97) 607 f (already asking for such deployment). See also WIPO, Standing Committee on the Law of Patents, 'Background Document on Patents and Emerging Technologies' (28 May 2019), SCP/30/5, para 84 ff.

101 Vertinsky (n 55) 502; Abbott (n 18) 1124 f; Abbott (n 73) 34. See also Heinze and Engel (n 99) § 10 para 57, 63, 92.

102 Vertinsky and Rice (n 97) 609; Fraser (n 14) 332.

103 Vertinsky and Rice (n 97) 608.

104 Fraser (n 14) 332.

105 Geertrui van Overwalle and Jens Schovsbo, 'Policy Options for the Improvement of the European Patent System' (2007) 38 IIC 834, 838; Marcus Sonnenberg, *Die Einschränkbarkeit des patentrechtlichen Unterlassungsanspruchs im Einzelfall* (Springer 2014) 13, 28, 69 ff, 180, 218, 233; Daniel Krauspenhaar, *Liability Rules in Patent Law. A Legal and Economic Analysis* (Springer 2015) 53 f.

106 art 2(2), 64 (1), (3) EPC.

to adjust the European patent framework. Allowing applicants to designate AI systems as inventor will not require the assignment of legal personality to AI, its ownership of the patent or the establishment of inventor's rights for AI. Moreover, machine inventorship would not stretch the functional structure of patent law to breaking point. Such developments would be consistent with the investment and incentive-oriented notion of today's system. Since the present functional structure is not based on a deontological approach focusing on the personality of the inventor, substantive patentability requirements can work – from a conceptual perspective – without a human. Furthermore, there is no need for an internationally uniform understanding of the concept of inventorship. Finally, allowing applicants to indicate AI as an inventor would not necessarily entail the risk of intensifying the problem of patent thickets.

Nevertheless, this critical analysis of the general arguments must not be misunderstood. A reform acknowledging AI as inventor would raise serious issues but on a more concrete level. The study will touch upon some of them later while reflecting on a potential amendment in part VI.

IV. General arguments for the designation of AI as inventor

Some experts suggest that the current approach of the European patent system to AI inventorship might not be able to cope with future developments in every respect, and expect amendments to the law.[107] Some scholars even ask for AI inventorship to be acknowledged by patent law.[108] The foregoing investigation already referred *en passant* to several arguments in favour of acknowledging AI inventorship. The following analysis will touch upon three general arguments further supporting the designation of AI systems as inventor.

1. Reduced consequences of uncertainty

Accepting machine inventorship would reduce fatal uncertainties regarding the success of patent applications.[109] With the rise of AI in R&D companies, applicants will have to deal with borderline cases characterized by massive machine involvement and a minor contribution by human inventors. In a system strictly requiring human inventorship, before deciding to file a patent application, the law-abiding applicant will need to consider whether the human contribution is sufficient to establish human inventorship. If not, he will refrain from filing, since the attribution of inventorship to an AI system will lead to a refusal under the current law, as seen in the DABUS cases with the EPO.

If the patent system accepts machine inventorship, this model applicant can be assured of his right to file for a patent. The uncertainties would be shifted from the level of patent protection to the level of inventorship. As a rule, uncertainties on the first level (will there be patent protection?) are more problematic for the applicant than uncertainties on the second level (who is entitled to inventor's rights?), particularly when it comes to further investment in product development.

Most recently, Justice Marcus Smith, in the High Court's appellate decisions of the DABUS cases, suggested that the owner of the machine which did the invention might be the inventor under the UK Patents Act 1977.[110] This understanding would reduce the consequences of uncertainty since AI inventions would be patentable in each and every case. However, the approach would not work under the current EPC regime as in the majority of cases the AI system would be owned by a legal entity.[111] Against the backdrop of Art. 4ter of the Paris Convention[112] and the statements in the *Travaux Préparatoires*,[113] the general understanding is that a legal person cannot be inventor under the EPC,[114] a notion that can be found in Rule 19(1) EPC.[115]

2. Avoidance of false statements and inappropriate inventor's rights

A second argument refers to the incentive to provide false statements within the current system.[116] As the applicant in the DABUS cases argued, without the acknowledgment of AI inventorship, companies might be encouraged to designate a natural person as inventor in order to gain IP protection for AI-created inventions. The alternative of refraining from filing for a patent would not appear very tempting to the applicant and is not in line with patent law's overall policy goal of fostering technological progress.[117] If the law does not allow the patenting of novel, non-obvious, and industrially applicable AI-generated inventions, the system might become redundant as a mechanism for creating innovation, and might appear to be taking the first step towards its abolition – particularly considering the potential impact of AI on R&D processes

107 Melullis in Benkard (n 33) art 60 para 13 (arguing that the law in its current version does not appear to be able to cope with future developments of AI and machine learning in every respect). See also Fraser (n 14) 325 (there is a need to re-examine the human requirement in the light of the advancement of computational capabilities) and CIPA (n 10) 3 (suggesting that AI should at least be considered as inventor).
108 Abbott (n 18) 1103 ff.
109 Li and Koay (n 18) 402.
110 *Thaler v The Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat) at 49(3)(d) (referring to s 7(2)(a) of the UK Patents Act 1977).
111 At least if Justice Smith was referring to the ownership of the AI system itself (tangible property) and not to the ownership of the software.
112 art 4ter of the Paris Convention was introduced into the Paris Convention at the Revision Conference of London in 1934 in order to grant the natural person inventor a moral right to be named.
113 Discussed for instance at M/PR/I, No 286 ff. The literature (see Cronauer (n 90) 96 ff; Bossung in Beier, Haertel and Schricker (n 45) art 81 para 42) seems to understand these documents as not permitting legal persons as inventors, which appears doubtful. See also IV/4860/61-F, 18.
114 For the general opinion (no company inventorship within the current framework of the EPC but a requirement for a natural person), see J 7/99, No 2; Cronauer (n 90) 96 ff; Bossung in Beier, Haertel and Schricker (n 45) art 81 para 42; Melullis in Benkard (n 33) art 60 para 14; Bremi and Stauder in Singer, Stauder and Luginbühl (n 90) para 4; Thomas Heinz Meitinger, 'Erfinderlose Erfindungen durch Know-how einer Organisation und Erfinderprinzip: kein Widerspruch' [2017] Mitt. 149, 151. Arguing that the EPC system would provide leeway for 'factory inventions': van Empel (n 75) No 195.
115 r 19(1) EPC requires the applicant to state the inventor's 'family name' and 'given names', thereby, suggesting a natural person inventor.
116 cf Banterle (n 52) sub 6. (iii) (the acknowledgment of AI inventorship would avoid untruthful human designations).
117 cf Malte Köllner and Markus Rieck, case note regarding UKIPO DABUS, Mitt. 2020, 76, 77 (refraining from patent applications for AI-generated inventions might not be a policy goal in the light of the importance of AI within the pharmaceutical industry). As demonstrated above, the functional structure does not require a human inventor, although the notion of human inventorship underlies the patent system.

in all fields. This paper will come back to the incentive structure shortly.

In the DABUS case, the Receiving Section addressed the issue of designating a human as inventor of AI-generated subject matter by explaining that the EPO will not verify the designation, which future applicants could perceive as an invitation to designate a natural person as the inventor contrary to the truth. Indeed, the current law induces applicants to knowingly provide false data, which might be a legal offence in certain jurisdictions.[118]

Considering the present paradigm of human inventorship, one might argue that designating the first human to conceive the invention as inventor is not providing false information to the EPO, even though an AI system generated the subject matter and indicated its patentability to the natural person. This understanding appears to be in line with one current approach to computer-assisted inventions.[119] From this perspective, the designation of a natural person would be accurate.

However, such an approach entails improper consequences:[120] Firstly, the indicated inventor will be entitled to *moral* inventor's rights, although he might not have contributed to the creation of the subject matter but was the first one to read the inventing machine's results. This consequence is not unfair to the machine, which has no interest in being acknowledged, but it is unfair[121] to other human inventors who genuinely invented, as it devalues their individual accomplishments by comparison. Secondly, the indicated inventor might be entitled to compensation for employee invention either by law[122] or pursuant to his or her employment contract. This consequence is unfair to the employer who might have financed the AI system, thereby contributing considerably more to the invention than the operator of the machine.[123] Thirdly, both aspects, granting the designated human inventor moral rights and potential employee-inventor's rights although a machine created the subject matter, would be detrimental not only to the perception of inventorship and the rights deriving from inventorship but also to the integrity of the patent system in general.[124] Accepting AI as inventor would reduce the enticement to provide false statements and would avoid the above preposterous consequences.

3. Incentives to invest in AI

It is important to come back to the functions of the patent system. Since AI has the potential to be the driving force in generating technological progress in the future, it is the task of patent law to provide sufficient incentives where needed. As the scope of patent protection for AI as such is restricted,[125] protecting the products of its work would create an indirect incentive to spend money and efforts in the development and enhancement of artificial agents.[126] In this way, the patent system would avoid an overly broad and unnecessary protection of the AI system itself.

Currently, in the early stage of AI systems, companies invest in this technology despite the lack of IP protection as such, since an investment brings publicity, raises market value and convinces third parties to invest capital in the company. The situation will change once machines have predominantly replaced human inventors in certain sectors. Without a system in place for the protection of AI-invented work products, it appears that investment in AI development and training will begin to face a free-rider problem, as is the case with human inventorship.[127] Admitting AI as inventor would thus mitigate this problem by protecting inventions by AI, thereby stimulating investment.[128]

One might argue that the incentives to invest in AI will be safeguarded even if AI is considered as a tool for a human inventor.[129] However, this approach of the present law is limited once a human inventor cannot be identified or should not be identified due to the entitlement of the natural person to inappropriate inventor's rights that this would entail in the current system.

118 Peter Heinrich, 'art 62' in Uwe Fitzner, Raimund Lutz and Theo Bodewig (eds), *BeckOK Patentrecht* (16th edn, CH Beck 15 October 2019) para 28 (such behaviour might be a criminal offence under the law of the contracting states). For Germany Hans-Joachim Stortnik, '§ 37' in Uwe Fitzner, Raimund Lutz and Theo Bodewig (eds), *BeckOK Patentrecht* (16th edn, CH Beck 15 April 2020) para 10 (such conduct entails a liability according to s 271 of the German Criminal Code). Moreover, under the German Patent Act a wrong indication might be in violation of s 124. One could argue that this obligation is also stipulated by art 125 EPC (cf the respondent's argument sub. D in T 22/09).

119 cf Melullis (n 31) para 32; Ryan Abbott, 'Hal the Inventor: Big Data and Its Use by Artificial Intelligence' in Cassidy R Sugimoto, Hamid Ekbia and Michael Mattioli (eds), *Big data is not a monolith* (MIT Press 2016) 187, 194 f; Meitinger (n 47) 50; cf Abbott (n 18) 1098.

120 See also Ralph D Clifford, 'Intellectual Property in the Era of the Creative Computer Program: Will the True Creator Please Stand Up?' (1997) 71 Tul. L. Rev. 1675, 1698 (claiming the invention by the user would be inappropriate since neither the conception nor the reduction to practice was done by the user).

121 Abbott (n 18) 1103.

122 See for example s 40 UK Patent Act of 1977 or s 9 of the German Employee Invention Act. For an overview see Morag Peberdy and Alain Strowel, 'Employee's rights to compensation for inventions – a European perspective' in *PLC Cross-border Life Sciences Handbook 2009/10* (PLC 2010) 63.

123 Köllner and Rieck (n 117) 77.

124 cf Li and Koay (n 18) 402.

125 cf EPO Guidelines for Examination, Part G, ch II, 3.3.1. For comments on patentability see: Ronny Hauck and Baltasar Cevc, 'Patentschutz für Systeme Künstlicher Intelligenz' [2019] 11 IPJ 135; Tochtermann (n 18) 7.3 para 10 ff; Oliver Baldus, 'Der Schutz von Erfindungen auf dem Gebiet der künstlichen Intelligenz' [2020] Mitt. 51; Heinze and Engel (n 99) § 10 para 9 ff. See also Vertinsky and Rice (n 97) 609 ('Don't Patent the Inventor.').

126 Milde (n 72) 390; Blok (n 18) 72; Abbott (n 18) 1104; cf Banterle (n 52) sub 6. (iii); Li and Koay (n 18) 402.

127 Engel (n 10) 1127, sub V.1. (mentioning these incentives, but also stating that there is no clear consensus). The ratio behind the patent system aims at solving a problem of technology free-riding: Roger D Blair and Thomas F Cotter, *Intellectual Property. Economic and Legal Dimensions of Rights and Remedies* (Cambridge University Press 2005) 15 ff (see particularly 17: 'Correcting for the free-rider problem in this manner is the genius of the patent system.'); Jeremy A Cubert and Richard GA Bone, 'The law of intellectual property created by artificial intelligence' in Woodrow Barfield and Ugo Pagallo (eds), *Research Handbook on the Law of Artificial Intelligence* (Edward Elgar 2018), 411, 414 f; Yanisky Ravid and Liu (n 18) 2237 ff. See also, however, Mark A Lemley, 'Property, Intellectual Property, and Free Riding' (2005) 83 Tex. L. Rev. 1031 (arguing that the rhetoric of free riding in IP is fundamentally misguided). For general literature on the free-rider problem with regard to public goods see James M Buchanan, *The Demand and Supply of Public Goods* (Rand McNally 1968) 86 ff; Robert Cooter and Thomas Ulen, *Law & Economics* (6th edn, Pearson Education 2012) 101 f.

128 Engel (n 10) 1127, sub V.1. See, however, Yanisky Ravid and Liu (n 18) 2252 ff suggesting relying on first mover advantages. Such advantages, however, work only in technology fields were work products are hard to copy.

129 See reasoning of Shemtov (n 18) 24. We will return to the concept of AI as a tool later.

4. Conclusion

Ultimately, there are substantial reasons for considering a possible designation of AI as inventor. It would reduce the consequences of uncertainty. Moreover, AI inventorship would avoid the filing of false statements with the EPO and the granting of inappropriate inventor's rights to an alleged natural person inventor. It would also create indirect incentives to invest in AI technology.

V. A sketch of a reform acknowledging AI inventorship

In this part, the study will outline a potential reform of the European patent system that would introduce the admission of AI inventorship in order to allow for a more concrete discussion of the upsides and downsides of such an approach. It will analyse in detail the core features of a possible reform as well as the necessary implementation measures.

1. Non-human inventorship

a) Implementation agenda

The centrepiece of such a reform is the acknowledgment of AI as inventor. If an artificial agent acts within the inventive process in a way that would constitute inventorship for a human being, the machine is the inventor and can be designated as such. However, opening the concept of inventorship to non-human inventors will require the European Patent Organisation to either define which group of non-human inventors are acknowledged or accept all non-human objects as potential inventors. Admitting only AI systems will make a clear definition of such systems necessary, which seems to be difficult given the vague nature of this term. Moreover, the EPO would need – within the formality proceedings conducted by the Receiving Section – to distinguish on a case-by-case basis between computer systems that are considered sufficiently autonomous AI systems on the one hand and 'regular' computers on the other. Given the complexity involved, it seems more plausible to acknowledge machines as inventor generally. Non-inventive subject matter will in any event be sorted out during the substantive examination (Art. 52 ff. EPC).

However, such an amendment allowing for AI or machine inventorship involves the issue of non-human inventorship in general. Living organisms, in particular animals, are more similar to humans and thereby more similar to human inventors than machines.[130] Some animals – e.g. chimpanzees or bonobos – share a great sense of inventive capacity, which appears to be entirely sufficient to create an invention.[131] Even a virus or a bacterium might fulfil the general requirements for an inventive act. For this reason, further research will need to analyse whether a coherent approach to non-human inventorship would require the European patent system to acknowledge other non-human inventors when implementing machine inventorship.

b) Implementation measure

The Convention does not explicitly restrict inventorship to natural persons.[132] Nevertheless, Art. 60(2) EPC, a provision governing the case of independent parallel inventions, mentions the word 'persons'. The paragraph is not however intended to restrict inventorship to natural persons as such. This becomes clear by cross-checking the German version of Art. 60(2) EPC. The latter does not use to the term '(*natürliche*) *Person*' or similar, which shows that the provision merely aims at regulating cases of parallel inventions. With this comparative analysis in mind, Art. 60(2) EPC can remain unchanged if its interpretation follows the lines of its German wording. Accordingly, the acknowledgment of AI as inventor does not require a direct change of the EPC, although some amendments regarding entitlement and inventive step will be necessary to make the system work. The study will come back to them below.

However, the Implementing Regulations need to be changed to allow for AI inventorship. By referring to 'family name, given names and full address of the inventor', Rule 19(1) EPC appears to assume that an inventor must be a natural person. This was the major argument of the EPO in the DABUS case.[133] An amendment would need to avoid such suggestion. We will come back to the proposal of a reformed wording of Rule 19 EPC when we look into the attribution of the right to the European patent. Rule 19 EPC will also need to be changed in this respect.

2. Entitlement of the AI's operator or the operator's employer

a) Implementation agenda

Acknowledging AI's inventorship entails, as a major consequence, the need to allocate the right to the European patent to a natural or legal person since granting rights to an object without legal capacity would not be consistent with general legal doctrine. If no allocation mechanism is implemented for the case of a non-human inventor, nobody would be entitled to the right to the European patent in such a case.[134] Scholarship is discussing three

130 Although the rationale behind these laws does not refer to the inventive capacity of animals, the stronger similarity between humans and animals as compared with humans and machines is legally underpinned in the civil laws of those Contracting States that do not consider animals as things, unlike machines. See s 90a of the German Civil Code; cf also art 515-14 of the French Civil Code.

131 cf Julio Mercader and others, '4,300-Year-old chimpanzee sites and the origins of percussive stone technology' (2007) 104(9) Proc. Natl. Acad. Sci. USA 3043 and see also Heather Whipps, 'Chimps Learned Tool Use Long Ago Without Human Help' <https://www.livescience.com/4354-chimps-learned-tool-long-human.html> accessed 27 July 2020 (chimpanzees were already able to make and use tools thousands of years ago independently of human beings). Whether animals can invent subject matter that is new and non-obvious according to human standards appears not to be decisive for the issue of inventorship but only for the substantive patentability requirements. For the prominent parallel constellation of animal creatorship in copyright law see *Naruto, et al. v Slater, et al.* No 15-CV-04324 (N.D. Cal. 28 January 2016) and *Naruto v Slater* No 16-15469 (9th Cir. 2018). However, given the anthropocentric foundation of at least continental European copyright law, creatorship for animals within copyright law would be even more far-reaching than inventorship in patent law.

132 See Stierle (n 4) 920.

133 EPO, Grounds for decisions of 27 January 2020 on EP18275163.6 (para 19 ff) and EP18275174.3 (para 20 ff).

134 The EPO referred to this issue in the DABUS cases. Its Receiving Section based the second ground of its decisions on the applicant's lack of entitlement to the right to the European patent. Even if AI systems were to be possible inventors, the applicant could not be DABUS' successor (or employer) since the machine did not possess legal capacity. The

potential persons that could be entitled: First, the owner[135] of the AI (software or machine), second, its designer or trainer,[136] or third, its user.[137, 138] A further option would be the applicant for the European patent.

However, the most appropriate person to be entitled by default to the European patent appears to be the operator of the designated AI system.[139] Allocating the right to the operator comes close to the idea of entitling the user but avoids the connotation that the AI was merely *used* like a tool and did not create the subject matter in a more autonomous way. The designation of an AI system must be reserved only for constellations where the invention was processed by the machine and not a natural person.

Certain arguments plead for the operator: Firstly, in comparison to other natural persons, he is the one who has the closest link to the AI's inventive process. He is in charge of initiating the inventive process by the machine and has, with the exception of the machine itself, the most control over the process. The designer and trainer as well as the owner (particularly the software owner) might be connected to the inventive process but only loosely, especially if the machine was rented by the user and operated in conjunction with other systems. The applicant might not have been involved in the inventive process at all. He might have merely picked up the generated output and was the fastest to file for a patent.

Secondly, attributing the right to the European patent to the operator will guarantee a fair allocation of remuneration. Typically, he will have access to the AI system through a direct or indirect contractual relationship with everyone else involved in the R&D process, particularly with the owner. Thus, even if the operator did not contribute to the invention in a substantive way, contractual law will directly or indirectly guarantee a fair allocation.

Thirdly, and most importantly, entitling the operator will diminish uncertainties regarding ownership. In complex borderline cases where it is disputable whether a human or the AI system is the sole inventor or whether they have been co-inventors, the operator will in any event own the right to the patent by default.[140] If the law chooses the owner or the trainer of the AI as being entitled, the uncertainty regarding inventorship will cause severe uncertainty regarding the right to the patent.

As a rule, inventors are employees. In such a case, the EPC provides that the right to a European patent is governed by the law of the state in which the employee is mainly employed (Art. 60(1) EPC). Some national laws assign the right to the patent to the employer of the employee-inventor in exchange for employee-inventor remuneration,[141] since their national labour law considers the employer to be the economic beneficiary of employee-made work products. The drafters of the EPC could not agree upon a uniform concept for employee inventions.[142] The EPC therefore states that the applicable law is the law of the state in which the inventor is mainly employed, or if this state cannot be determined, the law of the state where the employer has his place of business.

The same concept should apply in the case of employee-operators of artificial inventors.[143] The EPC should offer the contracting states the option of assigning the right to the patent to the employer of the machine's operator. If the employer were to be entitled to the right to the European patent in the case where the operator himself invented, he must *a fortiori* be entitled in the case where the operator deploys AI and the machine generates the invention, particularly if the employer financed the AI system. The EPC should therefore provide its contracting states with the choice of implementing similar provisions regarding AI-generated inventions or of leaving the right to the European patent with the operator.

In practical terms, the operator's employer will be entitled to the right to the European patent in the vast majority of cases.[144] Considering this effect in practice, one could argue in favour of accepting legal entities as possible inventors of the invention,[145] leading to a direct attribution of the right to the patent to the employer, without the need for any national regulation. However, entitling the operator as the default owner of the right to the European patent with the option of transferring the right by virtue of national legislation to his employer appears to be more reasonable. The attribution of the right to a patent which covers an invention generated within an employment relationship triggers core principles of national labour law. The EPC should therefore give national laws the leeway to decide on the allocation and remuneration of the inventor.

b) Implementation measures

Although the acknowledgment of AI inventorship itself will not require a change to the EPC, the attribution of the right to the European patent to the operator might.[146]

Receiving Section did not have the power to examine the issue by virtue of the legal fiction of art 60 (3) EPC (see Stierle (n 4) 922).

135 Fraser (n 14) 331 f; Abbott (n 18) 1113 ff (owner of the software); Nägerl, Neuburger and Steinbach (n 20) 340 (however, arguing that besides the AI owner, the AI user might also be the right person depending on the function of patent law); CIPA (n 10) 3 (owner as one possibility). See also *Thaler v The Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat) at 49(3)(d) (suggesting that the owner of an AI which invented could already be inventor under the current regime of the UK Patent Act 1977).

136 Tochtermann (n 18) 7.3 para 47.

137 See also Li and Koay (n 18) 403. For a Coasean justification of such allocation to the user see W Michael Schuster, 'Artificial Intelligence and Patent Ownership' (2018) 75 Wash. & Lee L. Rev. 1945, 1981 ff. See also Nägerl, Neuburger and Steinbach (n 20) 340 (arguing that the AI owner or the AI user might be the right person depending on the function of patent law).

138 Some argue that the person who has invested in the AI system should own the right to the patent (cf Hetmank and Lauber-Rönsberg (n 55) 581). This might be the owner, designer or trainer of the system.

139 In some cases, however, the operator might be the trainer or the owner of the AI as well.

140 There will be only uncertainties whether he is entitled to moral rights and employee compensation. We will come to this later.

141 See n 122.

142 Melullis in Benkard (n 33) art 60 para 31.

143 cf Li and Koay (n 18) 403.

144 The EPO does not provide data on the percentage of employee inventions. However, EPO reports indicate that less than 18 percent of patent applications were filed by an individual inventor, thereby suggesting a high rate of employee inventions (see Facts and figures 2020 <http://documents.epo.org/projects/babylon/eponet.nsf/0/09AC830BDBAC2749C12585280059CD40/$File/epo_facts_and_figures_2020_en.pdf> accessed 27 July 2020).

145 This would be similar to the concept of company inventions ('*Betriebserfindungen*') which was implemented in Germany until 1936. For references regarding the law on company inventions as well as the current scholarship advancing such a concept see n 64.

146 Amending the EPC itself is politically complex. The European Patent Organisation might be able to implement such reform by merely amending the Regulation, for example with a new chapter within Part II of the Rules regulating the entitlement in the case of an inventor that lacks legal

Article 60(1) EPC states that the right to a European patent shall belong to the inventor or his successor in title and that such a right shall be determined in accordance with the national law under which the employee is mainly employed. The wording of the first sentence might need to be changed to 'The right to a European patent shall belong to the inventor, his successor in title, or, in the case of an inventor lacking legal capacity, the natural person operating the inventor or his successor in title.' Analogous to the amendment within the first sentence, the beginning of the second sentence would read: 'If the inventor or, in the case of an inventor without legal capacity, the natural person operating the inventor'.

The legislator should consider defining the term 'operator' – at least within the Implementing Regulations. Given Art. 60(3), 61 EPC, national courts will decide on its meaning, which entails a serious risk of having different definitions and applications in practice, although the term has to be understood as referring to an EPC-autonomous concept. A European definition could describe the operator as the person initiating the inventive process or interacting substantially with the inventor during such a process. It should be open to co-operatorship if more than one natural person operates the AI system in the required way.

Opening up access to inventorship for AI inventors does not entail a change of the entitlement to apply for a European patent. Article 58 EPC would remain unchanged. An artificial inventor cannot file an application as long as it is not a natural or legal person, or equivalent to a legal person by virtue of a contracting state's law. Unlike AI itself, the operator of the system or the operator's employer will be able to file an application based on Art. 58 EPC if they have legal capacity.

As mentioned above, the wording of Rule 19(1) EPC will need to be amended to allow for the designation of AI as inventor but also to require indication of the AI operator's data. The latter should not serve as a moral right of the operator, but rather to allow the communication stipulated in Rule 19(3) EPC.[147] Accordingly, Rule 19(1) EPC should ask for 'the name of the inventor and, in the case of an inventor lacking legal capacity, for the name of the person operating the inventor'. Additionally, it should ask not only for the 'full address of the inventor', but also for the 'full address of the operator of the inventor, as the case may be'. In the case of AI inventorship, this amendment would require the applicant to indicate the name of the AI in addition to the name and the address of its operator. Rule 19(2) to (4) should be amended accordingly.

3. Co-inventorship

The acknowledgment of inventorship for AI systems entails the access for such systems to co-inventorship.[148] Such joint inventorship can involve non-humans exclusively or consist of humans and non-humans working together. If the European patent system acknowledges non-human inventors, there is no conceptual reason to keep a human requirement within the concept of co-inventorship. Both concepts run in parallel. Otherwise a human inventor could acquire sole inventorship, even though substantial parts of the invention derived from AI which might have been built, trained, owned and operated by a third party. Moreover, in constellations of two AI systems inventing together, nobody would be the inventor, although both systems are eligible to sole-inventorship.

No further changes to the law are required to allow for the co-inventorship of non-human inventors, since the EPC does not contain any provision governing co-inventorship in general. Problems arising from the extension of the concept of co-inventorship will be outlined later in this study.

4. Novelty and non-obviousness

a) Implementation agenda

AI will need to be considered in the standards for novelty and non-obviousness.[149] Naturally, the yardstick of Arts. 54 and 56 EPC needs to include all types of possible inventors, since otherwise subject matter that might be obvious to a specific type of inventor would be patentable. Consequently, given the paradigm of human inventorship, the current standards ('the public' and 'the person skilled in the art') refer to humans only. In line with the acknowledgment of non-human inventors, an AI perspective will need to be included.[150] In the long run, this will substantially raise the bar for patentability.[151] These amendments, however, do entail some problems, which will be discussed later on.

b) Implementation measures

Article 54 EPC does not need to be amended. The term 'public' can be interpreted as referring to humans as well as non-humans. However, Article 56 EPC would need to be changed. An updated wording could define inventive step as an invention 'not obvious to a person or object skilled in the art.'[152]

capacity. Some will argue that the provisions of the EPC prevail in the event of a conflict with the Rules (see art 164(2) EPC) and that art 60(1) EPC specifically attributes the right to the patent to the inventor and not its operator. However, one might also argue that art 60(1) EPC does not govern the case of an inventor without legal capacity. Such a regulatory gap might speak against a conflict between this provision of the Convention and the new Rule of the Implementing Regulation allocating the right to the operator.

147 Alternatively, the European Patent Organisation should consider the abolition of r 19(3) and (4) EPC. The notification is an exception to the patent laws of the EPC member states, since national legislations regularly oblige the employer to inform the employee-inventor about such a patent application (cf art L611-7 CPI or s 15(1) of the German Employee Inventions Act). One might argue in favour of keeping the communication to the designated inventor in order to enable him to waive the right to be mentioned but such waivers are extremely rare in practice.

148 For co-inventorship of humans and AI see Abbott (n 18) 1095; Vertinsky (n 97) 500. See also Chile, 'Questions and comments to be presented in the open public consultation by WIPO in relation to the working document on AI' 1 <https://www.wipo.int/export/sites/www/about-ip/en/artificial_intelligence/call_for_comments/pdf/ms_chile.pdf> accessed 27 July 2020 and Engel (n 10) 1128, sub V.2. (leaving this issue open). Banterle (n 52) sub 6. (iii) expects co-inventorship of humans and machines to be a common scenario, given the complexity of modern research projects.

149 cf Banterle (n 52) sub 6. (iii) (referring to a change in the concept of inventive step as a consequence); Cubert and Bone (n 127) 421 (referring to such standard); Vertinsky (n 55) 502 (stating the possibility to include such standard).

150 cf Heinze and Engel (n 99) § 10 para 57.

151 Vertinsky (n 55) 502; Abbott (n 18); Abbott (n 73) 34.

152 For reasons of simplification we will understand animals and other non-human living organisms as objects within this paper. In some jurisdictions, animals are defined as not being objects but governed by provisions that apply to objects (cf s 90a of the German Civil Code).

5. Sufficient disclosure

It seems natural to adjust the requirement of sufficient disclosure in line with the foregoing amendments.[153] At present, Art. 83 EPC requires the European patent application to disclose the invention in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art. An amended version would be similar to the modified Art. 56 EPC and accept a disclosure that allows an 'object skilled in the art' to carry out the invention.

However, such a standard will result in applications which enable only AI systems but not human persons skilled in the art to carry out the invention.[154] Patent offices might be able to verify the disclosure as sufficient by using state of the art AI systems themselves but it seems questionable whether a reform acknowledging AI inventorship will need to take such a step. It would risk excluding human inventors from future R&D processes.

Currently, patent offices and IP institutes worldwide are examining the issue of sufficient disclosure, also known as enablement, with regard to AI involvement, particularly AI inventions.[155] This issue is not associated with AI-generated inventions in general. Various AI-generated claims – think of the food container allegedly invented by DABUS – can be sufficiently disclosed without any amendments to the law, but there might be problems – not specific to AI inventorship but to AI involvement in general – with regard to certain process claims or pharmaceutical inventions. Nevertheless, before further research demonstrates the need to include a machine perspective in Art. 83 EPC to mitigate problems, it seems reasonable to keep the current standard to avoid the risk of excluding humans from future R&D processes by virtue of patent law.

6. Inventor's rights

a) Implementation agenda

As a final core feature, such a reform would need to ensure that non-human inventors will not be entitled to other inventor's rights, particularly the right to be mentioned as inventor (Art. 62, 81, Rule 20(1) EPC) unless national laws assign legal personality to AI. Granting (moral) rights to an object without legal capacity would neither be consistent with the dogmatic foundations of the national laws nor with the European patent system.

Denying this right to a machine inventor would be in line with Art. 4ter PC, which ensures the right of the inventor to be mentioned as such in the patent application. As explained above, the provision does not require the attribution of inventor's rights to non-human inventors.

Although AI inventors – lacking legal personality – must not be entitled to inventor's rights, the amendment could give the AI operator the right to have the artificial agent mentioned as inventor. This right would not comprise any moral character but serve as a measure to correct false information in the registry, since the AI system itself will not be able to have wrongful designations corrected.

b) Implementation measures

A machine lacking legal capacity will not be entitled to any rights. Legal capacity is a prerequisite for every entitlement. Thus, the law can remain unchanged in this regard.

However, establishing a right of the operator to have the non-human inventor mentioned requires changes to Art. 62 EPC. The current wording could be amended with a second sentence: 'In the case of an inventor without legal capacity, its operator shall have the right to have the inventor mentioned.'

VI. Problems associated with a reform implementing AI inventorship

As we have seen at the beginning of this study, the general arguments raised within scholarship and practice against AI inventorship are mostly unfounded. However, a reform such as the one outlined to acknowledge non-human inventorship will involve various rather specific problems. In this part we will touch on some of them and hope that this will initiate a more concrete discussion in the future.

1. Complexity of the inventorship assessment

In general, the assessment of inventorship will be extremely complex if non-human inventors are admitted. At present, the contributions of all humans involved in the R&D process need to be analysed in order to evaluate their potential (co-)inventorship. As shown, acknowledging machines as potential inventors might even lead to acknowledging all other non-humans like animals or living organisms. In the end, everything could be considered an inventor. Thus, in principle, the contribution of each machine and potentially of each and every other object within the R&D process will need to be assessed in order to get a clear picture of inventorship.

2. Complex delineation between non-human inventors

Allowing for non-human inventorship entails a complex delineation between potential non-human inventors in order to identify the actual inventor.[156] This will be onerous in a complex R&D process involving multiple computer systems. The identification of human inventors in the existing system might already be difficult, but natural

153 See Cubert and Bone (n 127) 421 regarding a change of the standard.

154 cf Vertinsky (n 97) 503.

155 cf EPO, 'Legal aspects of patenting inventions involving artificial intelligence (AI): Summary of feedback by EPC contracting states' (*EPO*, 20 February 2019) <http://documents.epo.org/projects/babylon/eponet.nsf/0/3918F57B010A3540C125841900280653/$File/AI_inventorship_summary_of_answers_en.pdf> accessed 27 July 2020; Department of Commerce, Patent and Trademark Office, 'Request for Comments on Patenting Artificial Intelligence Inventions' 84 Fed. Reg. 44,889 (22 August 2019); WIPO (n 100) para 67 ff. See also Heinze and Engel (n 99) § 10 para 64 ff.

156 cf France, 'INPI's contribution to the public consultation on the draft position paper on artificial intelligence and intellectual property policies prepared by the WIPO Secretariat (document WIPO/IP/AI/2/GE/20/1)' (14 February 2020) 2 <https://www.wipo.int/export/sites/www/about-ip/en/artificial_intelligence/call_for_comments/pdf/ms_france_inpi.pdf> accessed 27 July 2020; Finland, 'Draft issues paper on Intellectual Property Policy and artificial intelligence' (14 February 2020) 1 <https://www.wipo.int/export/sites/www/about-ip/en/artificial_intelligence/call_for_comments/pdf/ms_finland.pdf> accessed 27 July 2020.

persons can at least be distinguished clearly. Identifying human inventors appears to be much easier than singling out a single system within an R&D network, since the transitions between humans are not artificial.

If the operator is in charge of all potential systems involved, the decision on the identification of the AI inventor might not have a perceptible effect. He (or his employer) will be entitled to the right to the European patent in any case. Moreover, he will be able to name the segment in the network which he identifies as being the inventor with a specific machine name for the designation. In such cases, it might not even be necessary to indicate all non-human inventors separately but rather give a name for their combination. However, if various systems with different operators from different companies are part of this process, the right delineation will be decisive for the right to the patent. The patent system might require a database for upfront registration of AI systems and courts would need to develop criteria to delineate between different non-human inventors, which would be a difficult task.

3. Complexity of non-obviousness assessment

Extending the concept of inventorship to non-human inventors would make the assessment of inventive step extremely complex. Patent examiners would need to assess not only whether the claimed subject matter was obvious for a person skilled in the art but also whether it was obvious for a machine (or potentially even other non-human inventors).[157] The standard will be based on the full knowledge of all potential human and non-human inventors and will include everything obvious to them. It is hard to imagine that a patent office will be able to make such assessments once AI systems reach or outrank the level of human intelligence in a specific field – not to mention the timeframe required for such assessment.[158] Given the cumulated state of the art and the cumulated capacity, nearly everything might be obvious at one point.[159]

However, considering the legitimate concerns of practice and scholarship about the capacity to invent of the present machines and those AI systems coming on line in the next few decades,[160] this complexity appears to be manageable at least in the foreseeable future. Patent policy makers could therefore keep the issue in mind and prepare for it but handle the designation of AI systems as inventor for the present. Nevertheless, there is still an urgent need to reflect on the capacity of human patent examiners to examine obviousness under the new standard, even if using AI in the examining process.

4. The low standard for co-inventorship

The EPC does not define standards for the concept of joint inventorship. Even if the better arguments appear to weigh in favour of an EPC-autonomous concept,[161] the contracting member states developed the relevant criteria de facto and the European system just follows the outcome of national assessment (cf. Art. 60(3), Art. 61, Rule 20(2) EPC).[162]

The standard to constitute co-inventorship appears to be lower than the threshold for regular inventorship.[163] Although the pure implementation of concrete technical specifications provided by an inventor might not be sufficient, case law does not require a full inventive act for joint inventorship.[164] As a result, AI systems with a low level of autonomy might be able to qualify for co-inventorship. This low standard for co-inventorship entails a high risk of having multiple artificial co-inventors for each invention, although they should more aptly be considered as mere tools, given their lack of autonomy.

Further analysis will need to examine whether the law should ask for a higher threshold for AI co-inventorship. A second solution involves raising the bar for co-inventorship in general – even for human inventors. Although there might be reasons to remunerate co-inventors who only contributed to the invention at a low level under today's standard, it seems questionable that such co-inventors are entitled to the full set of inventor's moral rights.

5. Conclusion

The analysis touched upon four issues associated with a reform of the European patent system to allow the designation of AI systems as inventor. Although the more general, rather abstract reservations against AI inventorship are somewhat unfounded as demonstrated above, these more concrete problems might hinder such a reform. If further research does not find convincing solutions to these issues, they appear to argue substantially against the acknowledgment of AI inventorship.

VII. Alternative approaches *de lege ferenda*

In the light of the specific problems associated with the outlined reform, it appears to be worth reflecting on solutions that avoid AI becoming an inventor. Thus, the last part of this study will take a brief look at alternative approaches to the acknowledgment of AI inventorship.

1. Inventorship of the human user

Some experts emphasize the possibility of understanding AI as a tool, even in the case of autonomous inventions.[165] Although machines might work independently of humans, they could be treated as devices. The human user of the machine would be considered the inventor, not the machine itself. Following this approach, patents could be granted for solutions produced by means of AI but only if the person skilled in the art could not come up with these solutions using the same AI system or because it was not obvious to use such a system.[166] This appears to be in line with the current approach to computer-

157 See for such standard Cubert and Bone (n 127) 421.
158 cf Hetmank and Lauber-Rönsberg (n 55) 580 f (patent offices might not be able to assess the average capacity of state-of-the-art AI systems).
159 Abbott (n 73) 34.
160 See n 18.
161 See Stierle (n 4) 924.
162 See EPO (n 18) 3 f.
163 See references in n 33.
164 See for example Federal Supreme Court, [2004] GRUR 50, 51 – *Verkranzungsverfahren*; Federal Supreme Court, decision of 18 June 2013, X ZR 103/11 – *Zuerkennung des Miterfinderstatus*, para 8.
165 cf Blok (n 18) 73.
166 cf Shemtov (n 18) 21; Blok (n 18) 73; Tochtermann (n 18) 7.3 para 33.

assisted inventions by some,[167] as already mentioned above. It could be backed up by an amendment to statutory law implementing a legal fiction. An example for a model can be found in UK copyright law: pursuant to Sec. 9(3) of the UK Copyright Designs and Patent Act 1988, the author of a computer-generated work is the person who undertakes the arrangements necessary for the creation of the work. A similar but modified approach consists in bestowing inventorship upon the first human who recognizes and assesses the AI-generated subject matter.[168]

However, such concepts are not a solution but at best a temporary workaround.[169] Human inventorship by legal fiction would trigger some of the arguments against the status quo of the current paradigm of human inventorship already considered above. Such an approach would result in the assignment of inventorship to a natural person for machine-generated inventions. The assignment would entail *moral* inventor's rights, even though the human might not have been involved at all in the core inventive process.[170] Moreover, this 'inventor' might be able to claim remuneration from his or her employer in the case of an employee invention, even though he or she used the employer's AI that made the whole R&D process possible.

Since these alternative solutions result in granting inappropriate employee remuneration and moral rights, one might consider abolishing both rights in the case of non-human-generated inventions.[171] The contracting member states might be able to revoke employee remuneration in the case of such inventorship in their national laws depending on the scope of protection of such inventors granted by fundamental rights,[172] but international law will prevent both the European Patent Organisation and national laws from denying moral rights. Article 4ter of the Paris Convention guarantees the right of the inventor to be mentioned as such. Given its genesis in the 1930s, one might argue along historical and teleological lines that Art. 4ter of the Paris Convention does not protect human inventorship established by legal fiction. Following this approach, the EPC and national laws would be required to grant such rights only to persons who are inventors on the basis of their own inventive act. However, this argument appears to be highly problematic. The wording of Art. 4ter does not refer to the way inventorship was established and does not hint at a distinction between 'actual' inventorship and inventorship established by a legal fiction.

Furthermore, the legal fictions would involve issues comparable to the problems of the outlined reform. The complex assessment of inventorship and delineation of potential inventors would arise in a similar manner. Every machine or (in the case of a general concept of non-human inventorship)[173] object might trigger the legal fiction, and objects would need to be delineated, in particular if different humans used different machines or other objects as tools. The only difference would be that the applicant would not necessarily need to state the name of the object for the registry.[174] However, this is not a major advantage over the reform outlined above, since this reform might allow the applicant to indicate and name a group of non-human inventors as the inventor in order to avoid complexity, as already discussed above.

Moreover, the non-obviousness assessment will be of a similar complexity. If the standard continues to be the 'person skilled in the art', the yardstick will be too low. It will not include subject matter known or obvious to AI if the invention is not known or non-obvious to the person skilled in the art himself. However, AI systems would de facto be an extension to the human inventor, since everything they invent is considered to be a human outcome by virtue of the legal fiction. As a result, the standards of Art. 54 and 56 EPC on the one side and the full natural knowledge and obviousness of the inventor on the other side would be incongruent. This entails the risk of a flood of useless and trivial patents in particular in AI-driven industries. A human could patent subject matter that is state of the art to the actual and predominant innovators in this industry: AI systems. It might be information that is used within this industry on a day-to-day basis – just not directly by humans. The unchanged application of the 'person skilled in the art' standard would therefore risk significantly hindering innovation and technological progress. The problem will not be solved by assessing what the person skilled in the art considers non-obvious using the potential of an average AI system,[175] since human assessment of the knowledge and capacity of AI might lag behind its actual knowledge and capacity. Thus, a non-obviousness assessment in a system working with human inventorship by legal fiction will need to include knowledge and non-obvious assessment of the average AI skilled in the art. As a result, such a standard will entail the same complex non-obviousness assessment as the reform outlined above.

Furthermore, unlike the acknowledgment of AI inventorship, an approach based on inventorship by usage will emphasise a predominant role played by humans within R&D processes, which might not mirror reality. If a non-human invented, it plainly seems to be more honest to designate such systems as inventor. Stressing a major human contribution by labelling a natural person as inventor while non-human inventors drive technological

167 See n 119.
168 cf Melullis (n 31) para 32; Abbott (n 119) 194 f; Meitinger (n 47) 50.
169 cf Li and Koay (n 18) 403 (arguing that attributing inventorship to the first person to 'appreciate' or 'discover' an AI's invention is not a solution but rather a temporary workaround); Hetmank and Lauber-Rönsberg (n 55) 576 (given the capacity of present and future autonomic AI systems, a classification as a tool does not correspond with reality).
170 cf Abbott (n 119) 194 f; Banterle (n 52) sub 6. (ii).
171 cf Erich Zipse, 'Computer oder nachvollziehender Mensch als Erfinder?' [1972] Mitt. 41, 44 (doubting the justification of inventor's moral rights for computer-generated inventions).
172 See for example German Federal Constitutional Court (BVerfG), [1998] NJW 3704 (the employee-inventor is protected by the right to property of the German Constitution).
173 As outlined above, a general concept of non-human inventorship would also acknowledge other objects beside machines as (potential) inventors.
174 Such a statement might be conducive to tracking the applicant's entitlement.
175 For such a standard see EPO (n 18) 7 f; William Samore, 'Artificial intelligence and the patent system: can a new tool render a once patentable idea obvious?' in Woodrow Barfield and Ugo Pagallo (eds), *Research Handbook on the Law of Artificial Intelligence* (Edward Elgar 2018) 471, 480 f; Ralph D Clifford, 'Creativity Revisited', (2018) 59 IDEA 25, 36; Herbert Zech, 'Artificial Intelligence: Impact of Current Developments in IT on Intellectual Property' [2019] GRUR Int 1145, 1147. See also Cubert and Bone (n 127) 421 (defining such an approach as an intermediate step before including the skills of AI directly in the non-obviousness assessment).

progress bears the risk of misleading society and endangers the integrity of the patent system as a whole.

2. Inventorship of the owner of the AI system

Human inventorship could also be based on other legal fictions in the case of AI-generated subject matter. The High Court suggested most recently that the owner of the AI system that invented the subject matter could be considered as the inventor under the UK Patent Act.[176] Since AI systems are as a rule owned by companies, the law would require endowing inventorship on legal persons. Such an approach would come close to the concept of company inventions ('*Betriebserfindungen*') as implemented in the German Patent Act until 1936.[177] As already mentioned above, such an understanding would not work under the current European framework, which does not allow the designation of a legal person as inventor.[178]

Nevertheless, consideration might be given to making the owner of the AI system the inventor *de lege ferenda*.[179] Such a reform would, however, share most of the problems which were already demonstrated with regard to the concept that establishes human inventorship through the use of the inventing AI.[180] In particular, it will need to assess non-obviousness by the standard of an average R&D company in its entirety, including the average skills of its AI systems.[181] Moreover, such an approach will de facto entail the risk that applicants will always state the company as sole-inventor even where human inventorship is involved. It appears that there are no major advantages over a reform implementing AI inventorship, but further research will be necessary.

3. Abolition of inventorship within the current patent system

Considering the downside of the approaches analysed, one might also consider the abolition of the concept of inventorship in the long term.[182] An alternative mechanism for the assignment of the right to the European patent could focus even more on the incentive-to-invent or the incentive-to-disclose theory. It could entitle the entity which invested in the creation of the invention (investment protection system) or which was the first to file the patent application (first-to-file system).

The abolition of inventorship would change the patent system even more dramatically than the outlined reform proposal to acknowledge machine inventors. Such an approach would avoid some of the specific problems of the outlined reform but would share the complexity of the necessary non-obviousness assessment. Moreover, it would entail the specific problems associated with a system which does not work with the concept of inventorship, such as the lack of incentives to disclose a useful invention which did not require major investments (disadvantage of an investment protection system) or the entitlement of a person who has not been involved in the inventive process but was the first to file a patent (disadvantage of a first-to-file system).

Furthermore, the Paris Convention argues against the general abolition of inventorship. Although, as already pointed out, it seems to be unclear whether the protection of Art. 4[ter] PC extends to inventorship established by legal fiction, the PC requires the implementation of a concept of inventorship in general by safeguarding the right of the inventor to be mentioned as such. Therefore, such an approach would need to require an amendment of the international legal framework.

The designation requirement is inspired by a general idea of fairness to human inventors as a counterbalance to the investment-centred incentive structure of patent law. The increased involvement of AI gives no reason to deprive human inventors of this reward. Some critics even fear that removing the concept of inventorship would weaken public support of the patent system in general.[183] However, given the well-established shift of the patent system towards inventions by teams of employees and corporate-owned patents that serve primarily as impersonal business assets, removing inventorship might de facto not constitute such a fundamental change.[184] Moreover, the abolition of the concept of inventorship within patent law could initiate a discussion on national labour law legislation compensating for the withdrawal of (employee) inventor's rights and might even lead to such a reform. Thus, strangely, the unambiguous abolition of inventorship might be better for employee inventors than the implementation of company inventions, which risks abolishing the designation of human inventors only de facto without any legislative compensation.

In any event, the abolition of inventorship in general should be the subject of further discussion in the future, particularly if the acknowledgment of AI inventorship proves to be unworkable due to the problems set out above.

4. *Sui generis* protection of AI-generated inventions in a parallel system

As already discussed within the patent community, another possibility might be a *sui generis* protection of AI-generated subject matter outside patent law instead of AI inventorship.[185] This approach would lead to the existence of two parallel IP protection systems: the patent systems for inventions generated by humans as it stands and a pure investment protection right for inventions created by AI.

176 *Thaler v The Comptroller-General of Patents, Designs and Trade Marks* [2020] EWHC 2412 (Pat) at 49(3)(d) (referring to s 7(2)(a) of the UK Patents Act 1977).
177 For references to this concept and its abolition see n 64.
178 See references in n 114. See also n 119 ff.
179 Some scholars are currently advancing the idea of 'company inventions'. See Lauber-Rönsberg and Hetmank (n 23) 647 and Engel (n 10) 1129, sub V.4.).
180 It would not share the problem of inappropriate employee remuneration, nor would it emphasise a major human contribution.
181 As demonstrated above, this consequence follows from the idea that all potential categories of inventors must be represented in the assessment of inventive step in order to avoid bad patents.
182 See Fraser (n 14) 331; cf Meitinger (n 47) 51.
183 Banterle (n 52) sub 6. (iv).
184 Fraser (n 14) 328 ff, but see also 331. See also Meitinger (n 47) 51 (arguing with regard to the German system that such a change might be less revolutionary than it appears, since German utility models do not require the indication of an inventor either).
185 WIPO (n 40) 4 (sub 11); Zech (n 175) 1147; Hetmank and Lauber-Rönsberg (n 55) 576, 579 ff; cf Tim W Dornis, 'Der Schutz künstlicher Kreativität im Immaterialgüterrecht' [2019] GRUR 1252, 1260 ff (proposing *sui generis* protection for creative works generated by AI which cannot be protected by copyright law).

The idea is tempting. The traditional patent system would stay untouched, and a modern IP right tailored to incentivize the creation of machine-realized inventions would deal with the various issues of AI inventorship. However, the negative effects of a dual system would prevail. Firstly, dealing with AI inventions outside the patent system eliminates the possibility of using the framework of international patent law treaties for AI inventions. This might not be a decisive argument against *sui generis* protection but would need to be considered carefully. The international legal framework appears to be of benefit in particular with regard to priority rights. Secondly, keeping the patent system unchanged entails various negative effects as already referred to above, e.g. the incentive to provide false statements to the patent office as well as the inappropriate remuneration and granting of inventor's rights to the wrong person. Humans might still be designated as patent inventors for AI-generated subject matter. Thirdly, creating two parallel IP regimes would lead to dependencies and uncertainties that would involve high transaction costs for the applicant[186] as well as the implementer of technologies. Such effects endanger the ultimate objective of stimulating innovation. Fourthly, a double-track system would not be able to protect subject matter co-invented by humans and autonomous AI. Considering the intermingling of human and AI contributions within research, mixed human and AI co-inventorship will occur regularly.

5. Innovation patents replacing the current system

A far-reaching reform alternative to address the intensified deployment of AI systems in the R&D processes has been proposed by Meitinger.[187] He advances the idea of replacing the current patent system for the protection of inventions by a system protecting innovation in the sense of the actual product or service offered on the market. According to this approach, the creation of inventions is no longer society's concern, now that AI systems generate inventions. A patent system must focus rather on the development and commercialization of the invention.[188] Similar innovation protection systems[189] have been put forward in patent history by Kronz[190] and Sichelman.[191]

Such an innovation protection system might be able to create sufficient indirect incentives for investments in AI systems. However, the present law does not only provide incentives for investment in the inventive process. It also sets incentives for the disclosure of an invention and allows patentees to transfer technology as mentioned above. A pure innovation protection system would not provide such incentives and would result in the information holder keeping the invention secret until he commercializes it himself – a result inconsistent with a society based on the division of labour.[192]

VIII. Conclusion

Against the backdrop of today's paradigm of human inventorship underlying the present European patent system, this study has analysed the issue of AI systems designated as inventor from a *de lege ferenda* perspective. Although the capacity of present AI systems might still be limited, the patent community needs to discuss a potential admission of AI inventorship now. This paper has shown that major general reservations against the admission of AI as inventor are unfounded and risk leading the discussion in the wrong direction. Acknowledging AI as inventor will not require the patent system to grant machines legal personality or entitle AI to patent ownership or inventor's (moral) rights. Allowing such systems to be the inventor will not depart from the current functions of the system or substantive patentability requirements. Moreover, neither the international dimension of patent law nor the risk of intensified patent thickets argues against AI inventorship.

As demonstrated, there are various arguments which establish a need to consider the possibility of designating AI systems as inventors. Such a step would increase incentives to invest in AI systems, particularly when needed in the future. It would avoid false statements to the EPO and reduce the consequences of legal uncertainty associated with patent applications deriving from AI-driven R&D processes. Most notably, a possible designation of AI as inventor would help to prevent the designation of non-inventing humans in order to fulfil the paradigm of human inventorship, thereby avoiding the unjustified attribution of inventor's moral and economic rights to such alleged inventors.

This study then outlined a potential reform intended to allow the designation of AI inventors within the European patent system in order to lay the groundwork for a more concrete discussion. It explained that such a reform allowing for the designation of AI systems or machines as inventors might need to consider also opening access to inventorship to non-humans in general, e.g. animals, living organisms or viruses. The core characteristic of the outlined amendment is the entitlement of the operator of such an inventor or its employer analogous to the regular concept of employee-inventor constellations. The operator has the closest link to the R&D process and their entitlement would guarantee a fair allocation of remuneration and reduce uncertainties regarding ownership. The reform proposal, put forward as an example, suggested granting non-human inventors access to joint inventorship and including the perspective of 'objects skilled in the art' in the standards for the novelty and

186 Where there are uncertainties as to whether the AI invented autonomously or was deployed as a mere tool to support a human inventor, the applicant might struggle in deciding between the two IP regimes. Choosing the wrong system for an application for an IP right will raise novelty issues with regard to a later application in the correct system. For this reason, an earlier application in the wrong system would need to establish a priority right which the applicant can use later within the parallel system.

187 Meitinger (n 47) 51.

188 Meitinger (n 47) 51.

189 Such a system must not be confused with second-tier patent rights like Australia's innovation patent, the successor to Australia's petty patent.

190 Hermann Kronz, 'Patentschutz für die Innovation. Ein Modell' [1976] Mitt. 178; Hermann Kronz, 'Innovationspatentschutz – ein Instrument der Wirtschaftspolitik' [1983] Mitt. 128; Hermann Kronz, 'Patent Protection for Innovations: A Model' (1983) 5 E.I.P.R. 178 and 206; Hermann Kronz, 'Response in Defence of the Innovation Patent Concept' in William Kingston (ed), *Direct Protection of Innovation* (Springer 1987) 257.

191 Ted Sichelmann, 'Commercializing Patents' (2010) 62 Stan. L. Rev. 341.

192 For an analysis of a system of innovation patents see Stierle (n 60) 422 ff.

inventive step assessment but not in the sufficient disclosure requirement. It would deny inventor's rights to non-human inventors but suggested granting its operator a (non-moral) right to have the inventor mentioned in the register. This would allow the correction of false inventorship designations. Such a reform would require amendments to the EPC (Arts. 56, 60 and 62 EPC) itself as well as to the Implementing Regulations (Rule 19 EPC).

Although the prominent general arguments against granting AI access to inventorship are not convincing, such a reform would involve various more specific problems. The paper touched upon some of them: Allowing for non-human inventorship would render the inventorship and non-obviousness assessment extremely complex and practically unworkable, would entail an extremely difficult delineation between certain non-human inventors, and might require a change to the standard of co-inventorship. These issues are serious and argue substantially against the acknowledgment of AI inventorship. Further research will need to analyse whether these difficulties can be avoided or managed.

Finally, this paper examined alternative approaches to such a reform. Establishing a legal fiction which would allow a human user to be considered the inventor of AI-generated content would raise various concerns already discussed as general arguments in favour of allowing the designation of an AI system as inventor, particularly the unjustified entitlement of the human user to inventor's economic and moral rights in the current framework. Moreover, this approach would involve the same problems as the outlined reform acknowledging AI as inventor. A legal fiction attributing inventorship to the owner and not the user of the machine would share similar problems and does not appear to bring any substantial advantages. A further alternative, a *sui generis* protection of machine-generated inventions parallel to the current patent system, would not resolve patent-internal problems arising from the deployment of AI within R&D processes. An innovation protection system replacing the current protection of inventions through the patent system as suggested in the literature would deprive technology law of its beneficial structures for technology transfer. The most promising alternative to the outlined reform appears to be the abolition of inventorship in the long term. From today's point of view, this might be throwing the baby out with the bathwater, but given the well-established practice of employed research teams and joint corporate R&D endeavours, further analysis should be conducted in this regard.

This study is not intended as a call for an immediate reform but should rather be seen as laying the foundations for a more concrete, critical and fruitful discussion on non-human inventorship and its alternatives. Further legal research might investigate the level of autonomy required for AI systems to actually invent, whether the concrete and severe problems associated with the outlined reform would be manageable somehow, and whether the abolition of inventorship in general is a feasible and fruitful alternative.