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## Patentability of Synthetic Creativity: A Transatlantic Revisit in Light of AI Laws?

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## General Note about the Content



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**Abstract**

As artificial intelligence ("AI") increasingly contributes to invention, the traditional human-centered patent regime faces challenges in recognizing and rewarding inventions generated by synthetic creativity, which is with reduced human input and interaction with machine learning technologies. How should patent law adapt to synthetic creativity, and what role should AI regulations play in complementing or constraining patent protection for AI-assisted inventions? This paper contends that both the inclusion and exclusion of synthetic creativity from patent protection can be justified. However, patent law alone is insufficient to govern synthetic creativity. A policy alignment is required between patent regimes and AI regulations. By analyzing AI governance frameworks in some transatlantic countries, this paper shows how AI laws may supplement patent law by imposing compliance costs, guiding ethical use, and preserving human creativity. It advocates for a balanced legal ecosystem that accommodates synthetic creativity, suggesting that compatibility between patent law and AI regulation is essential for promoting sustainable innovation.

## I. INTRODUCTION

Many industries are increasingly investing in artificial intelligence ("AI") to enhance efficiency in invention, creation, and management. The New York Times is an example of a company that extensively embraces generative AI technologies, including its use in creative work, such as generating interview questions, creating paper titles, and developing web products and editorial ideas.[1] Beyond the applications in art, media, and social sciences, these

[1] Max Tani, *New York Times Goes All-In on Internal AI Tools*, SEMAFOR (Feb. 18, 2025, 12:24 AM), https://www.semafor.com/article/02/16/2025/new-york-times-goes-all-in-on-internal-ai-tools.

technologies can generate research ideas in laboratories, code for programmers, and molecular designs for drug discovery.[2] According to McKinsey's report, "the potential annual economic value that could be unlocked by using AI to accelerate R&D innovation is about $360 billion to $560 billion."[3]

A powerful component of generative AI technologies is the use of machine learning ("ML") models and big data, which support the development and improvement of these models. As a critical subset of AI technologies, ML challenges traditional paradigms of creativity.[4] It enables computers to perform tasks without explicit programming, thereby surpassing the limitations of human programmers in terms of their knowledge, ability, and efficiency.[5] Users can rely on its output for innovation and creation, thereby reducing the time or creative effort required to develop comparable inventions. This form of creativity is distinct from human creativity and has been termed "synthetic creativity" by Dan Burk.[6]

How does synthetic creativity adapt a patent regime centered on human creativity? Reducing human contributions in innovation may enhance efficiency and productivity in research and development ("R&D").[7] Conversely, insufficient human contributions may undermine the legal foundation for establishing patent inventorship. A prevailing consensus among patent offices at this stage about human inventorship is that machines, including ML technologies, cannot be recognized as patent inventors.[8] In addition to this formal requirement, however, some jurisdictions impose stricter requirements of patent inventorship, known as true

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[2] Alex Singla et al., *The Next Innovation Revolution—Powered by AI*, QUANTUMBLACK AI BY MCKINSEY (June 20, 2025), https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-next-innovation-revolution-powered-by-ai.
[3] *See id.*
[4] *See*, *e.g.*, Viktor Bogdanov, *Neuroism—AI Art as a New Paradigm of Creativity*, MEDIUM (April 6, 2025), https://medium.com/@ViktorBogdanov/neuroism-ai-art-as-a-new-paradigm-of-creativity-e03a5dc32543.
[5] *See* A. L. Samuel, *Some Studies in Machine Learning Using the Game of Checkers*, 3 IBM J. 211, 211 (1959).
[6] *See* Dan L. Burk, *Cheap Creativity and What It Will Do*, 57 GA. L. REV. 1669, 1680 (2023).
[7] *See* Singla et al., *supra* note 2.
[8] Diego Black, *AI Inventorship – A Victory for Common Sense (for Now)*, THE GLOBAL LEGAL POST (Jan. 31, 2024), https://www.globallegalpost.com/news/ai-inventorship-a-victory-for-common-sense-for-now-447822863.

inventorship. For example, patent laws in the United States ("U.S.") and the United Kingdom ("U.K.") require sufficient contributions to the inventive concept or conception to establish true inventorship.[9] Although true inventorship is also addressed by the European Patent Convention ("EPC") and German patent law, these frameworks lack mechanisms to enforce this requirement. Thus, synthetic creativity, which may involve varying degrees of human contribution, could lead to divergent patent application outcomes across jurisdictions, and AI-driven R&D investments may not be recoverable through patents.

A paradox arises when AI technologies and patent policies, which are fundamentally different paths to the same goal of promoting innovation, may be incompatible. On the one hand, compatibility may be unnecessary, as synthetic creativity can be sufficiently powerful to confer competitive advantages and enhance R&D efficiency.[10] Moreover, synthetic creativity need not be additionally bolstered by patents.[11] The patent regime has inherent limitations, which may be exacerbated if patents were granted to protect the output of synthetic creativity. On the other hand, inventors who utilize ML technologies continue to value patents, and synthetic creativity itself is not inherently harmful to human creativity.[12] These contrasting rationales suggest that transatlantic standards on patent inventorship are defensible and justifiable in the context of AI-assisted inventions, despite their differences.

Therefore, instead of recommending that patent policymakers revise patent laws to guide the use of ML technologies in invention, this Article proposes an approach that aligns AI policies and regulations with patent law. Both granting and withholding patent protection for synthetic creativity could be justifiable. The key is to ensure synthetic creativity is not excluded from the broader legal framework, where patent law is complemented by AI policies and

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[9] *See infra* Part III. A.
[10] *See infra* Part IV. A.
[11] *See infra* Part IV. B.
[12] *See infra* Part IV. C.

regulations. The U.S., the European Union ("E.U."), and the U.K. currently maintain a delicate balance between patent law and AI regulations with respect to synthetic creativity. When synthetic creativity is not significantly constrained by the patent regime, inventors are more likely to satisfy inventorship requirements for AI-assisted inventions, but they may simultaneously face high compliance costs and regulatory uncertainty under AI laws, even though synthetic creativity is not considered a threat to fundamental rights nor are inventive activities classified as high-risk AI applications. By contrast, U.S. inventors, who face a high threshold for establishing patent inventorship, have not been subject to compliance costs for using AI in inventive processes. Although these jurisdictions share fundamental principles in AI governance and patent law,[13] they do not need to construct harmonized standards for true inventorship or AI regulations, as the underlying rationales for their respective frameworks differ. Nevertheless, as both AI regulations and patent laws evolve in response to AI, these regulatory approaches should be aligned to accommodate synthetic creativity.

This Article makes several key contributions. First, it introduces a nuanced definition of synthetic creativity, emphasizing its role in enhancing innovation efficiency through ML models that support decision-making and idea generation. Second, it provides a comparative analysis of patent inventorship requirements in the U.S., the U.K., and the E.U., revealing divergent approaches to human inventorship and the legal recognition of AI-assisted contributions. Third, it explores the paradoxes and economic consequences of patenting synthetic creativity, including cost-shifting, diminished incentives for radical innovation, and the potential for excessive patenting to create artificial scarcity as well as deadweight losses.

The Article is organized as follows. Part II explains the definition of synthetic creativity and its impact on innovation. Part III discusses the patentability of synthetic creativity across

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[13] *See infra* Part V. A.

various jurisdictions. Part IV explores the economic rationales for excluding synthetic creativity from patent protection, as well as ethical concerns regarding its potential impact on human creativity. Part V presents arguments in favor of recognizing synthetic creativity within the patent system and examines the potential for human creativity to be enhanced through applying synthetic creativity. Part VI reviews international treaties on AI governance and key AI policies or regulations in the E.U., U.K., and U.S. This part evaluates these policies and regulations in light of their corresponding inventorship requirements. It finds that these jurisdictions maintain a balance between patent law and AI regulations.

## II. SYNTHETIC CREATIVITY

### *A. Basic Definitions*

Different ML techniques are applied in diverse ways across various industries to drive innovation. For example, in biotechnology, ML is applied in functional protein design,[14] drug discovery,[15] functional genomics,[16] and other critical domains.[17] In manufacturing, ML is widely used for quality control, fault diagnosis, process optimization, and cloud computing.[18] In software engineering, ML is effectively employed to enhance coding productivity and quality.[19]

A common feature of these applications is their ability to enhance decision-making efficiency for scientists and engineers by leveraging historical data amid uncertainties.[20]

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[14] Pascal Notin et al., *Machine Learning for Functional Protein Design*, 42 NATURE BIOTECHNOLOGY 216, 216 (2014).

[15] Laurianne David et al., *Molecular Representations in AI-Driven Drug Discovery: A Review and Practical Guide*, 12 J. CHEMINFORMATICS 1, 2 (2020).

[16] Claudia Caudai et al., *AI Applications in Functional Genomics*, 19 COMPUTATIONAL & STRUCTURAL BIOTECHNOLOGY J. 5762, 5761 (2021).

[17] *See* Andreas Holzinger et al., *AI for Life: Trends in Artificial Intelligence for Biotechnology*, 74 NEW BIOTECHNOLOGY 16, 16 (2023); *see also* Malik Yousef & Jens Allmer, *Deep Learning in Bioinformatics*, 47 TURKISH J. BIOLOGY 366, 372-73 (2023).

[18] Ziqiu Kang et al., *Machine Learning Applications in Production Lines: A Systematic Literature Review*, 149 COMPUTERS & INDUSTRIAL ENGINEERING 106773, at 6 (2020); Rahul Rai et al., *Machine Learning in Manufacturing and Industry 4.0 Applications*, 59 INT'L J. PRODUCTION RES. 4773, 4775-77 (2021).

[19] Mamdouh Alenezi & Mohammed Akour, *AI-Driven Innovations in Software Engineering: A Review of Current Practices and Future Directions*, 15 APPLIED SCI. 1344, 1344 (2025).

[20] Machine learning models include interpretable ones and uninterpretable ones. Regardless of the selection of

Although computers can independently execute the decision-making process, it remains a collaborative effort because the process is preconfigured and authorized by scientists and engineers. In other words, scientists and engineers typically do not scrutinize the underlying rationale of data-driven process that rely on historical data and known knowledge. They may repeat the process until they obtain satisfactory results. During repetition, they may adjust the design of ML models to obtain improved results from their perspective. Such adjustments may be either deliberate or experimental. While either type of adjustment typically requires prior diagnosis and sufficient domain knowledge in R&D, neither condition is strictly necessary, as satisfactory outcomes may occasionally arise by chance.

Synthetic creativity aptly characterizes the above scenarios, where ML model outputs are involved in decision-making in innovation activities.[21] When Burk coined this term, he did not specify the degree of machine involvement. His description was anthropomorphic, in which he referred to ML models as an intelligent labor and portrayed their uses as a substitute for human creativity.[22] His primary concern was the replacement of human creative input with the output of various ML models.[23] Accordingly, a technical articulation of synthetic creativity may be defined as a process in which ML models are used in decision-making, producing outputs that may exceed the user's predictions.

### *B. Innovation by Synthetic Creativity*

Synthetic creativity can be integrated throughout the entire process of product

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models, scientists cannot completely control the process of decision-making. This process may also be referred as knowledge discovery. *See* Cynthia Rudin, *Stop Explaining Black Box Machine Learning Models for High Stakes Decisions and Use Interpretable Models Instead*, 1 NATURE MACHINE INTELLIGENCE 206, 206-07 (2019); Christoph Molnar et al., *Interpretable Machine Learning – A Brief History, State-of-the-Art and Challenges*, *in* ECML PKDD 2020 WORKSHOPS 417, 417 (Irena Koprinska et al. ed., 2020) ("[M]any important challenges remain for [interpretable machine learning], such as dealing with dependent features, causal interpretation, and uncertainty estimation, which need to be resolved for its successful application to scientific problems.").

21 *See* Burk, *supra* note 6, at 1680.

22 *Id*.

23 *Id*.

development. The essence of product development lies in problem-solving.[24] This is precisely what ML technologies are designed to facilitate. Kim Clark and Takahiro Fujimoto propose a four-step roadmap to describe the process of product development, which includes concept study, product planning, product engineering, and process engineering.[25] At each stage, ML models can be introduced to enhance operational efficiency. In specific, concept study involves creating and articulating the basic conception of the product,[26] where ML models may serve as idea generators to expand options of the inventors.[27] Product planning builds on the initial conception to specify product designs and determine business strategies for financing and marketing,[28] where ML models may act as business consultants to process technological, financing, and market data. Product engineering aims to realize the product plans by creating detailed prototypes that are consistent with the original conception.[29] In this process, ML models can follow instructions from the conception and the plans, further translating abstract ideas into tangible designs. Process engineering focuses on improving the effectiveness of the plans,[30] where ML models perform similar functions as in previous stages, but with inputs and outputs centered on operational efficiency. The breakdown of the product development process affects synthetic creativity by requiring human input for data selection and model adjustment.

Synthetic creativity is inherently innovative because of its ability to enhance the efficiency of innovation. When innovation activities are streamlined through ML technologies, the need for human effort is reduced. This is precisely the intent behind integrating ML technologies into innovation processes. Burk argued that ML involvement in the initial creation

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[24] Kim Clark & Takahiro Fujimoto, *Lead Time in Automobile Product Development Explaining the Japanese Advantage*, 6 J. ENGINEERING & TECH. MGMT. 25, 28-29 (1989).
[25] *Id.* at 27-28.
[26] *Id.*
[27] Generative AI is critical tool to assist in brainstorming. *See* Fujitsu, *AI Powered Brainstorming: Enhanced Brainstorming with Fenerative AI,* FUJITSU BLOG (Mar. 4, 2025), https://corporate-blog.global.fujitsu.com/fgb/2025-03-04/01/.
[28] Clark & Fujimoto, *supra* note 24, at 27-28.
[29] *Id.*
[30] *Id.*

reduces creation costs while expanding access to the creation processes.[31] The involvement of machine-generated output in innovation, substituting for certain human efforts, primarily reflects efficiency and cost considerations, indicating an industrialized approach to innovation.[32] In other words, synthetic creativity represents a new form of innovation, carried out partly or entirely through an industrialized process.

This industrialized form of creation or invention does not directly result in a higher or lower degree of innovation compared to human creativity, even though its enhanced efficiency may yield greater productivity.[33] Unlike mechanical reproduction or industrialized production, which is standardized to lower manufacturing costs,[34] the output of ML models exhibits greater variety. The output may follow certain patterns,[35] but standardization is not required. However, neither standardized nor varied output of machines employed in innovation necessarily indicates a higher degree of creativity. Replacing or reducing human involvement in innovation does not necessarily diminish creativity, but it may instead enhance the

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[31] *See* Burk, *supra* note 6, at 1680.

[32] *See id*. at 1690 (arguing that industrialization is the opposite of individualism by citing the authenticity theory).

[33] The degree of innovation only addresses creativity in science and engineering, rather than in art. The degree of creativity in art is measured by the value of the works in human culture (*e.g.*, subjective ratings) or some measures that are only meaningful to humans (*e.g.*, divergent thinking). It is a historical belief that only humans have creativity, but anthropologists have extended the subject of creativity to nonhuman animals, which evolve to use tools in problem-solving. It is also an undeniable fact that AI can generate creative artworks. However, it is less meaningful to address the creative capacity of machines than how AI can enhance human creativity as a tool because machines and humans proceed knowledge differently and creativity has several measures based on the thinking path of humans. Moreover, without distinguishing between computing and creativity, Margaret Boden argued that novel or valuable output of machines is insufficient to name them with creativity. Without human intervention, programs can produce works that have not shown before and may suggest originality. She argued that while the works appear to be creative, they are not radical and could have shown before. *See* Agustín Fuentes, *The Evolution of a Human Imagination*, *in* THE CAMBRIDGE HANDBOOK OF THE IMAGINATION 13, 14-23 (2020) (addressing the value of creativity and expanding discussions from human creativity to nonhuman creativity); ARTHUR I. MILLER, THE ARTIST IN THE MACHINE: THE WORLD OF AI-POWERED CREATIVITY 6-8 (2019) (updating definitions on creativity from "[c]reativity is the production of new knowledge from already existing knowledge and is accomplished by problem solving" to characteristics of creativity capabilities); Mika Koivisto & Simone Grassini, *Best Humans Still Outperform Artificial Intelligence in a Creative Divergent Thinking Task*, 13:13601 SCI. REPORTS 1, 1 (2023); MARGARET A. BODEN, THE CREATIVE MIND: MYTHS AND MECHANISMS 135 (1990); *But see* Leonardo Arriagada, CG-Art: *Demystifying the Anthropocentric Bias of Artistic Creativity*, 32 CONNECTION SCI. 398, 398-402 (2020) (arguing that machines have artistic creativity and models like creative adversarial networks, a modification of generative adversarial networks, have creative autonomy).

[34] *Cf. id.* at 1682-83.

[35] *See id*. at 1674 (describing machine learning models as "pattern recognition systems" or "statistical optimization systems").

innovative capacity of the remaining scientists and engineers.[36] From this perspective, ML models are indistinguishable from other tools employed in innovation. In other words, this perspective assumes that ML models are merely tools rather than collaborators or partners with humans in scientific or engineering endeavors.[37]

With tools that lower the thresholds for accessing creative works or discoveries,[38] patents serve as a critical metric for inventions arising from synthetic creativity, both economically and technologically. While R&D costs are commonly deployed as a measure of innovation,[39] the reduction in R&D costs due to the employment of advanced tools, such as ML technologies, undermines their effectiveness as an economic indicator of an invention's degree of innovation. This is because the invention results from the use of the tools and is not necessarily correlated with the costs incurred in their application. The reduced R&D costs reflect innovation in the process of producing the invention, specifically the contributions made by the tools and their application, rather than the invention itself. By contrast, reduced R&D costs may serve as an indicator of innovation in the development of tools and their exploratory applications. Compared to R&D costs, patents provide a more reliable measure of an invention's degree of innovation, with their quantity and quality serving as key economic indicators of technological creativity and value.[40] The development and deployment of advanced tools may also be subject to and filed for patent protection, providing an additional metric for innovation. However, a paradox arises in that, although patents are a critical measure

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[36] *See, e.g.*, Jonathan H. Choi et al., *ChatGPT Goes to Law School*, 71 J. LEGAL EDUC. 382, 391-92 (2022) (taking law students as an example and finding that the use of generative artificial intelligence enhances the performance of the students on or below the average in logical reasoning and analyzing skills but reduces the performance of the students above the average); Koivisto & Grassini, *supra* note 33, at 8 ("[I]nstead of generating new ideas, humans were overrepresented in producing common or low-quality responses.").

[37] *But see* Arriagada, *supra* note 33, at 403 (arguing that programmers and algorithms are the artists and act "as a kind oof creative agent or a colleague").

[38] Burk, *supra* note 6, at 1680.

[39] *See e.g.*, Runhua Wang & Jay Kesan, *Do Tax Policies Drive Innovation by SMEs in China?*, 60 J. SMALL BUSS. MGMT. 309 (2022).

[40] *Id.*

for evaluating synthetic creativity's degree of innovation, the patent regime may exclude many of its resulting outputs. It remains a challenging question whether the manifestations and outputs of synthetic creativity are patentable.

## III. PATENT REQUIREMENTS ON SYNTHETIC CREATIVITY

The primary barrier to the patentability of inventions involving synthetic creativity is the inventorship requirement. While human inventorship is a common requirement across transatlantic jurisdictions, this barrier poses the greatest challenge in the U.S. and remains largely formal in Germany and other E.U. countries. In the U.S., inventorship is not an isolated requirement but is inherently interconnected with other substantive patent requirements. By contrast, in Germany and the E.U., it is merely a formal requirement. This Part reviews the patent requirements applicable to inventors who employ ML technologies in invention.

### *A. Patentability of Synthetic Creativity in the U.S.*

The U.S. Patent and Trademark Office ("USPTO") does not prohibit AI-related or AI-assisted inventions from being patented,[41] but the requirements of inventorship, subject matter eligibility, novelty, non-obviousness, and description and enablement may pose barriers to effectively evaluating synthetic creativity through patents. These requirements are formally independent, but the inventorship requirement is inherently related to the others. In light of their relationships, the inventorship requirement is relatively straightforward to apply to inventions developed using synthetic creativity. However, a normative question of whether merely constructing or deploying ML technologies is sufficient to establish inventorship remains a paradoxical issue that continues to challenge legal interpretation.

#### 1. Human Inventorship

The patent regime is specifically designed to reward human inventors. The textual

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[41] Inventorship Guidance for AI-Assisted Inventions, 89 Fed. Reg. 100,043 (Feb. 13, 2024).

meaning of "inventor" under the Patent Act refers to an individual, taking its ordinary meaning of a natural person.[42] Moreover, the legislative origin of U.S. patent law derives from the U.S. Constitution.[43] Its purpose is to incentivize human creativity by granting exclusive rights to inventors. The rationale is that the exclusive rights enable inventors to recoup their R&D investments that generate new knowledge, either directly from the market or from those implementing the inventions.[44] While inventors may not recover their investments immediately, their prospect of collecting royalties from downstream inventors or implementers serves as an incentive to promote innovation.[45] These rationales also explain why ML technologies cannot be deemed inventors. They lack incentives to invent, and the rewards or prospects offered by the patent regime do little to stimulate their autonomous creative activities.

In *Thaler v. Vidal*, the Federal Circuit explained the reasons why DABUS, a self-learning machine, cannot be deemed the inventor of its output.[46] First, the court interpreted the term "individual," which indicates an inventor, joint inventor, or coinventor in the statutory text of the Patent Act, as unambiguous and referring to its ordinary meaning—a human being.[47] Second, the court explained that the law does not permit an oath or declaration to be submitted on behalf of an original inventor or joint inventor.[48] In this case, Thaler submitted the declaration on behalf of DABUS. Setting aside the question of whether an AI system can make an oath, no valid oath or declaration was submitted to the USPTO. Third, the court rejected the argument that excluding DABUS from inventorship depends on the manner in which the invention was produced.[49] The court emphasized that inventorship is an independent

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42 *See* Thaler v. Vidal, 43 F.4th 1207, 1210 (Fed. Cir. 2022), cert denied, 143 S.Ct. 1783 (2023).
43 U.S. CONST. art. 1, § 8, cl. 8.
44 Reward theory. *See* Graham v. John Deere Co., 383 U.S. 1, 9 (1966).
45 Prospect theory.
46 *Thaler*, 43 F.4th.
47 *Id*. 1210-11. Neither a corporation or a sovereign can be deemed as an inventor and only natural persons can be inventors. Univ. of Utah v. Max-Planck-Gesellschaft zur Forderung der Wissenschaften E.V., 734 F.3d 1315 (Fed. Cir. 2013).
48 *Id*. 1211-12.
49 *Id*. 1212.

requirement, parallel to other statutory requirements such as non-obviousness.[50] Whether the employment of an AI system in inventive processes satisfies other statutory thresholds, and whether a non-human can qualify as an inventor, are distinct legal questions.

Therefore, it is meaningless to assert inventorship for ML technologies under the Patent Act. In the context of synthetic creativity, the relevant question is whether developers of ML technologies employed in facilitating an invention and users who originally explored the invention may be considered inventors. In other words, can inventorship be claimed for an invention developed through synthetic creativity, and who qualifies as the inventor? Nevertheless, excluding non-human entities is insufficient to determine true inventorship in the context of synthetic creativity.

### 2. True Inventorship and Other Patent Requirements

The Federal Circuit addressed the question of true inventorship in *Pannu v. Iolab Corp*.[51] In this case, the court set three factors to determine who may be claimed as a joint inventor:

> "[People] (1) contribute in some significant manner to the conception or reduction to practice of the invention, (2) make a contribution to the claimed invention that is not insignificant in quality, when that contribution is measured against the dimension of the full invention, and (3) do more than merely explain to the real inventors well-known concepts and/or the current state of the art."[52]

While these requirements were intended to interpret Sec. 116(a),[53] which defines a joint inventor, the court's interpretation of the threshold of contribution in Sec. 116 indicates true inventorship. This is because what matters to a joint inventorship is the contribution made to

[50] 35 U.S.C. §103.
[51] 155 F.3d 1344 (Fed. Cir. 1998).
[52] *Id*. at 1351.
[53] 35 U.S.C. § 116(a).

the invention rather than how the inventors are coordinated or collaborated.[54]

The *Pannu* factors, however, are not self-interpreting with respect to the required level of contribution. Under the second and third factors, the Federal Circuit excluded two scenarios from true inventorship—making an insignificant contribution in quality compared to the overall invention, and merely explaining well-known concepts or the current state of the art. The measure of the quality of contribution remains undefined. The quality of contribution becomes relevant only when a claimed inventor's contribution is not acknowledged by other co-inventors. In the absence of challenges raised by those co-inventors, the USPTO or courts typically do not scrutinize or evaluate the claimed contribution. In addition to these two exclusionary factors, the first *Pannu* factor requires a true inventor to demonstrate a sufficient contribution to the conception or reduction to practice of the invention. These two requirements are likewise not clearly defined in *Pannu*.

Among the factors, conception is the most fundamental element in establishing a sufficient contribution to inventorship.[55] Justice Stevens referred to an inventor's conception when interpreting the term "invention."[56] Conception is a term that encompasses, but goes beyond, a mere idea. Conception is formed in the mind of an inventor,[57] referring to the mental process of reaching a complete and operative invention with a "definite and permanent" idea.[58] It requires both an idea concerning the content or structure of the invention and a plausible

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[54] *See* Fina Oil & Chem. Co. v. Ewen, 123 F.3d 1466, 1473 (Fed. Cir. 1997) ("[A] joint invention is simply the product of a collaboration between two or more persons working together to solve the problem addressed.").
[55] *Id.* ("Conception is the touchstone to determining inventorship.").
[56] Pfaff v. Wells Elecs., Inc., 525 U.S. 33, 60 (1998). Justice Stevens, who is usually believed as a maverick judge, makes particular contributions on interpretating of federal statutes. His rhetoric shows commitment to individual dignity and interests in protecting individual rights. William D. Popkin, *A Common Law Lawyer on the Supreme Court: The Opinions of Justice Stevens*, 1989 DUKE L. J. 1087, 1088-89 & 1094.
[57] Mergenthaler v. Scudder, 11 App. D.C. 264, 276 (1897) ("The conception of the invention consists in the complete performance of the mental part of the inventive act.").
[58] *Id*. at 276 ("[Conception] is therefore the formation, in the mind of the inventor, of a definite and permanent idea of the complete and operative invention, as it is thereafter to be applied in practice, that constitutes an available conception, within the meaning of the patent law."); Hybritech, Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1376 (Fed. Cir. 1986).

method for operating the idea.[59] The idea should be specific and settled, and a general goal or research plan to be pursued is insufficient to constitute conception.[60]

As the core element of inventorship, however, conception is embedded in patent statutes outside of the explicit inventorship provisions. This also contributes to the ambiguity surrounding the inventorship requirement. Rather than directly defining the identity of inventors,[61] conception functions as a requirement embedded within other patent requirements. One relevant requirement is novelty under Secs. 102(f) and 102(g), which address the issue of invention priority.[62] The priority date of a patent application depends on the completion of conception, which is applied to trace the first and true inventor.[63] Without a complete conception, an invention is considered incomplete.[64] An indication of conception may be the recognition and appreciation of the invention.[65] This means that an inventor must recognize and appreciate what has been created.[66]

Other relevant requirements include contemporaneous disclosure or description and enablement addressed in Sec. 112(a),[67] as well as patent-eligible subject matter governed by Sec. 101,[68] which are inherently interconnected.[69] Completion of conception is established

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[59] *See* Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200, 1206 (Fed. Cir. 1991) ("Conception requires both the idea of the invention's structure and possession of an operative method of making it."); *see*, *e.g*., Oka v. Youssefyeh, 849 F.2d 581, 583 (Fed. Cir. 1988) ("Conception requires (1) the idea of the structure of the chemical compound, and (2) possession of an operative method of making it.").
[60] Burroughs Wellcome Co. v. Barr Labs., Inc., 40 F.3d 1223, 1228 (Fed. Cir. 1994) ("An idea is definite and permanent when the inventor has a specific, settled idea, a particular solution to the problem at hand, not just a general goal or research plan he hopes to pursue.").
[61] *I.e.*, 35 U.S.C. §§100, 101, 115(a), and 256.
[62] 35 U.S.C. §§ 102(f) & 102(g) (pre-AIA).
[63] *Id*.
[64] Mergenthaler v. Scudder, 11 App. D.C. 264, 277-78 (1897) ("As long as there is a missing ingredient, in the absence of which the means utilized is a failure, the desired result unattainable, the invention is incomplete.") (*citing* Voelker v. Gray, 30 O. G. 1091).
[65] Heard v. Burton, 333 F.2d 239, 244 (CCPA 1964).
[66] Dow Chem. Co. v. Astro-Valcour, Inc., 267 F.3d 1334, 1341 (Fed. Cir. 2001).
[67] *See* Burroughs Wellcome Co., 40 F.3d, at 1228; Coleman v. Dines, 754 F.2d 353, 356 (Fed. Cir. 1985); 35 U.S.C. §112.
[68] 35 U.S.C. §101.
[69] *See* Jay Kesan & Runhua Wang, *Eligible Subject Matter at the Patent Office: An Empirical Study of the Influence of Alice on Patent Examiners and Patent Applicants*, 105 MINN. L. REV. 527, 539-41 & 598 (2020) (reminding that preemption issues are both addressed by Sec. 101 and Sec. 112).

when a person of ordinary skill in the art can understand or construct the invention, without extensive research or experimentation.[70] This is because conception, as a mental process, requires objective evidence to substantiate its veracity and accuracy.[71] A lack of adequate description that fails to lead to promising performance within a reasonable time using routine skills suggests a failure to conceive.[72] An alternative way to understand this rationale is that the description and enablement requirement may serve as preconditions for establishing conception and determining priority in inventorship competitions.

The counterpart to the description and enablement requirement is reduction to practice. This is an element addressed in the first *Pannu* factor. However, while the Federal Circuit in *Pannu* listed conception and reduction to practice in parallel, they are not substitutes for each other. Superficially, they appear as paired requirements: Failure to establish either reduction to practice or conception indicates insufficient evidence of priority.[73] In substance, reduction to practice *per se* is generally unable to establish inventorship.[74] It is subsidiary to the requirement for complete conception.[75] Complete conception requires transparency in an invention's content and some certainty in the process of its construction.[76] In some circumstances, reduction to practice through a successful experiment is both necessary and sufficient to establish conception, which is known as the doctrine of simultaneous conception

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[70] *See* Mergenthaler, 11 App. D.C., at 276 (*citing* Machine Co. v. Harvester Works, 42 Fed. Rep. 152); McCormick Harvesting Mach. Co. v. Minneapolis Harvester Works, 42 F. 152, 155 (1890); Coleman, 754 F.2d, at 360; Burroughs Wellcome Co. v. Barr Labs., Inc., 40 F.3d 1223, 1228 (Fed. Cir. 1994).
[71] *See* Burroughs Wellcome Co. v. 40 F.3d at 1228.
[72] *See* Falkner v. Inglis, 448 F.3d 1357, 1367, n.13 (Fed. Cir. 2006).
[73] *See* Heard v. Burton, 333 F.2d 239, 240 (CCPA 1964).
[74] *See* Ethicon, Inc. v. United States Surgical Corp., 135 F.3d 1456, 1460 (Fed.Cir.1998) (ruling that the fulfillment of the requirement of specification and enablement is insufficient to establish joint inventorship when lacking a contribution to conception).
[75] *See* Pfaff v. Wells Elecs., 525 U.S. 55, 66, 119 S. Ct. 304, 311 (1998) ("[R]eduction to practice ordinarily provides the best evidence that an invention is complete.").
[76] *See* Mergenthaler, 11 App. D.C., at 277 (*citing* Voelker v. Gray, 30 O. G. 1091) ("[An inventor has] been first to conceive the thing in controversy; not merely to conceive it possible to construct a device which would produce the result sought … The conception must not be the result to be obtained, but the means (which is the patentable thing) to produce that result.").

and reduction to practice.[77] Nevertheless, more commonly, reduction to practice serves to complement conception in maintaining priority but alone does not necessarily confer priority if a preceding conception has been established by another.[78] Absent such complementation, a mental process remains merely an expectation or a problem statement, falling far short of conception.[79] Such a process may also constitute an abstract idea,[80] which is excluded from patent-eligible subject matter under Sec. 101.[81]

The foregoing elements of true inventorship indicate that it may serve only as a supplementary basis for rejecting patent applications involving synthetic creativity. An inherent reason is that complete conception, the core element of true inventorship, inevitably interacts with other patent requirements. Those requirements function to measure contributions of the named inventors in a patent application, thereby articulating the requirement of true inventorship. Moreover, synthetic creativity renders the measurement of contribution distinct from the joint inventorship outlined in *Pannu*. Joint inventorship evaluates the relative contributions of multiple inventors. In contrast, by excluding machines from inventorship, true inventorship in synthetic creativity evaluates the absolute contributions made by human inventors. ML technologies applied in the invention do not constitute joint inventors alongside human inventors, even though their application may empower human inventors to complete exploration and experimentation successfully. Regardless of the extent of the contributions made by the technologies, conception can only be established and completed through human

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[77] Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200, 1206 (Fed. Cir. 1991) ("In some instances, an inventor is unable to establish a conception until he has reduced the invention to practice through a successful experiment. This situation results in a simultaneous conception and reduction to practice.").

[78] McCormick Harvesting Mach. Co., 42 F., at 154-55 (*citing* Hunter v. Miller, 50 O.G. 1766).

[79] Alpert v. Slatin, 305 F.2d 891, 894 (CCPA 1962) ("If after the claimed conception date extensive research was found necessary before achieving minimum satisfactory performance obviously the mental embodiment of that date was a mere hope or expectation, a statement of a problem, but not an inventive conception."); 35 U.S.C. §101.

[80] MPEP § 2106.04(a)(2).

[81] *See* O'Reilly v. Morse, 56 U.S. 62 (1854) (excluding an abstract idea from being eligible for patenting); Alice Corp. Pty. Ltd. v. CLS Bank Int'l, 134 S. Ct. 2347, 2357 (2014) (holding that a patent claim that contains an "inventive concept" may enable an abstract idea to be transformed into patent eligible).

contributions at any stage of the inventive process—whether at the beginning, middle, or end. This implies that some degree of human effort is required to construct a complete conception. Therefore, absent proper measurement through other patent requirements, true inventorship is purely theoretical and legally irrelevant in the context of synthetic creativity.

Those other patent requirements also reduce the likelihood of securing patent protection for inventions involving synthetic creativity. This is because those requirements amplify the notion that the "first-to-conceive" rule is inherent in the true inventorship standard. It is undisputed that synthetic creativity enhances the productivity of innovation by human inventors, enabling greater output with less human effort.[82] However, neither increased productivity nor reduced human effort directly indicates complete conception. Even if a human inventor enhances innovation efficiency through synthetic creativity, patent priority cannot be established if another inventor conceived the invention earlier. Despite disparities in innovation capabilities resulting from the use of ML technologies, the earliest conception by a human inventor determines true inventorship and the right to patent priority, unless the doctrine of simultaneous conception and reduction to practice applies.

The doctrine of simultaneous conception and reduction to practice, however, reveals the problem of connecting the true inventorship requirement with other patent requirements. When this doctrine applies, synthetic creativity reduces the patent game to competitions among ML technologies. This is because reduction to practice, which constructs conception and further inventorship, can be entirely achieved by machines without human intervention. The human inventorship requirement precludes such inventions from patentability, but satisfying other requirements can simultaneously fulfill sub-elements of true inventorship, creating a conflict with the human inventorship requirement. This conflict produces a paradox: Although

[82] *Supra* Part II.A.

true inventorship is intended to support human inventorship, it may not necessarily reflect human inventorship. The true inventorship requirement fails to respond to the normative question of whether the mere use or development of ML technologies *per se* is sufficient to establish inventorship.

### *B. Patentability of Synthetic Creativity in Europe*

In the U.K. and European countries, human inventorship remains the central requirement for synthetic creativity that ML supports, mirroring the approach taken in the U.S. AI-assisted inventions are not excluded from patentability, but patent laws bar non-humans from being named as inventors. Aside from this inventorship requirement, other patent requirements are substantially equivalent across these jurisdictions, with only minor variations.

The EPC and national patent laws are commonly interpreted to permit only natural persons to be named as inventors, even though this is not explicitly stated in the statutes. A striking example is the experiences of Stephen Thaler, the owner and inventor of DABUS. His patent applications, which listed DABUS as the sole inventor and himself as the assignee, were broadly rejected by the U.K. Intellectual Property Office ("UKIPO"), the German Patent and Trademark Office (Deutsches Patent- und Markenamt, "DPMA"), and the European Patent Office ("EPO"). Moreover, when Thaler appealed the rejections, both national courts and the EPO's Legal Board of Appeal hearing the appeals consistently upheld the interpretations adopted by the respective patent offices.

#### 1. The EPC

The EPC codifies the human inventorship requirement through the requirements of inventor designation (*i.e.*, Art. 81) and origin of rights (*i.e.*, Art. 60(1)).[83] In rejecting Thaler's application, the EPO stated that a designated inventor must be a natural person and refused to

[83] Convention on the Grant of European Patents (European Patent Convention), arts. 81 & 60(1), Oct. 5, 1973, 1065 U.N.T.S. 197.

recognize patent applicants as successors in title to a machine.[84] The Legal Board of Appeal affirmed this rationale and offered further interpretations. The natural person indication is presumed from the drafting of the EPC and is consistent with the ordinary meaning of the term "inventor," as defined in the Oxford English Dictionary.[85] Moreover, from the purposes of legislation and enforcement at the country level, potential compensation mechanisms under patent law are ineffective if inventors were machines.[86] The Board's interpretation is independent of, and need not align with, the positions of domestic courts (*e.g.*, the German Federal Court of Justice).[87] While the Board hesitated about its interpretation of the origin of rights in the context of AI-generated inventions,[88] the EPO continues to refine its interpretation of inventorship under the EPC.

In the EPO's latest interpretation in the DABUS case, inventorship requires conception. The individual who conceives an invention is deemed to have "made" the invention.[89] If a patent applicant claims to have "caused" an AI system to conceive an invention, such causation is insufficient to establish inventorship.[90] The deficiency lies not in the causation itself, but in the ambiguity surrounding the nature of the contribution.[91] To claim inventorship, conception must not be solely generated by an AI system, and a person's contribution to the inventive concept cannot be ambiguous and must be clearly identifiable.

The rationale underlying this interpretation, however, is problematic. The EPO failed to clarify the distinction between an invention conceived by an AI system under human

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[84] Case J 0008/20, Designation of inventor/DABUS, ECLI:EP:BA:2021:J000820.20211221, 11 (Dec. 21, 2021).
[85] Case J 0008/20, Designation of inventor/DABUS, ECLI:EP:BA:2021:J000820.20211221, 20-21 (Dec. 21, 2021).
[86] *See id*. at para 4.3.3.
[87] *See* EPO Patent No. 21216024, para 33.2-33.3 (filed Oct. 17, 2018) (rejected Nov. 25, 2024).
[88] *See id*. at para 4.6.6 ("The Board is not aware of any case law which would prevent the user or the owner of a device involved in an inventive activity to designate himself as inventor under European patent law.").
[89] EPO Patent No. 21216024, para 33.4 (filed Oct. 17, 2018) (rejected Nov. 25, 2024).
[90] *See id*.
[91] *See id*.

influence and one conceived by a human using an AI system. The inherent assumption in the EPO's reasoning is that machines are capable of generating conception. If the EPO adopted the U.S. view of conception,[92] it would raise the question of how machines could possess self-consciousness to recognize and appreciate an invention, and to establish conception.

Moreover, unlike in the U.S., it is unclear what conception means according to the EPO. The examiners and the Board have not addressed how an AI-generated conception can be supplemented by human efforts, or whether conception itself may be attributed to an AI system. Conception is not a criterion for recognizing true inventorship at the EPO because the EPO is not responsible for the accuracy of inventor designatios.[93] In addition, no indication suggests any overlap between the conception requirement and other patent requirements, such as novelty or disclosure. Thus, other patent requirements cannot be applied to infer the threshold for establishing conception. The European patent system is a first-to-file system,[94] where priority is competed by the speed of filing rather than showing the first to conceive the invention. Moreover, it is unclear how the positions of the EPO and the Board on the construction of conception by AI-generated inventions relate to disclosure and specification requirements. A reasonable inference is that all patent requirements are assessed independently, even though this may not reflect actual practice.[95]

The ambiguous connections between conception and other patent requirements may lead the EU patent regime to tolerate inventions involving synthetic creativity at a higher level than the U.S. The priority requirement is straightforward to satisfy upon the filing of a patent

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[92] *See* Heard v. Burton, 333 F.2d 239, 244 (CCPA 1964); Dow Chem. Co. v. Astro-Valcour, Inc., 267 F.3d 1334, 1341 (Fed. Cir. 2001).

[93] *See* Case J 0008/20, Designation of inventor/DABUS, ECLI:EP:BA:2021:J000820.20211221, 10 & 19 (Dec. 21, 2021); Convention on the Grant of European Patents (European Patent Convention), art. 19(2), Oct. 5, 1973, 1065 U.N.T.S. 197.

[94] Convention on the Grant of European Patents (European Patent Convention), arts. 75 & 78, Oct. 5, 1973, 1065 U.N.T.S. 197.

[95] *See* Kesan & Wang, *supra* note 69, at 568-573 (showing that Sec. 101 rejections are correlated with rejections under Secs. 102, 103, and 112).

application. Then, if the application fulfills the disclosure requirement,[96] conception is presumed to have been established. This is because a hypothetical skilled person in the art can only replicate the invention if it has first been conceived by the inventor. Even though the EPO does not recognize an AI system's independent conception construction, without sufficient transparency regarding it, there is no clue to distinguish synthetic creativity from human creativity. The EPC does not require disclosure of AI deployment in an invention or the specific human contribution to conception. Thus, the use of ML technologies does not substantively preclude patentability in the EPO.

### 2. The UK Patent Law

The core of the inventorship requirement under UK patent law is true inventorship. The statutory language of Sec. 7(3) provides that patent inventors and co-inventors should be actual devisers of the invention.[97] To identify an actual inventor, Justice Robert Walker proposed a two-step method: The first step is to define the inventive concept, and the second step is to determine who contributed to it.[98] Judge Laddie at the Patents Court later applied the test with further specifications.[99] The relevant contribution should be the formation of the inventive concept,[100] as distinguished from those who merely contributed to the claims. Contributions limited to the inclusion of prior art in the claims do not qualify a person as an actual inventor.[101]

Human inventorship is an inherent component of the true inventorship requirement. In elaborating on Judge Laddie's rationale regarding contributions by actual inventors, Lord Hoffmann further specified that inventors must be natural persons.[102] This marks the origin of

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[96] EUROPEAN PATENT OFFICE, GUIDELINES FOR EXAMINATION IN THE EUROPEAN PATENT OFFICE Part F. Ch. III.1 (2025) ("[T]he description must disclose any feature essential for carrying out the invention in sufficient detail to make it apparent to the skilled person how to put the invention into practice.").
[97] Patents Act 1977, c. 37, §7(3) (Eng.)
[98] Henry Bros (Magherafelt) Ltd v. Ministry of Defence, [1998] All ER (D) 545 (Eng.).
[99] University of Southampton's Applications, [2004] EWHC 2107 (Pat) (Eng.).
[100] *See id.*
[101] Yeda Research and Development Company Ltd. v. Rhone-Poulenc Rorer Int'l Holdings Inc, [2007] UKHL 43, para. 20 (appeal taken from Eng.).
[102] *See id.*

the link between inventors and natural persons in UK precedents, even though Lord Hoffmann's specification is arguably flawed because it remains unclear whether it was independently derived by him or based on a misreading of Judge Laddie's reasoning.[103]

However, human inventorship is not intended to serve as an ambiguous barrier to AI-generated inventions. In supporting the UKIPO's response to Thaler, Lord Kitchin of the UK Supreme Court addressed the ambiguity. He adopted this interpretation and explained that the term "inventor" in UK patent law, particularly Sec. 7, refers to its ordinary meaning, which is a person who devises an invention.[104] A supplementary rationale is the absence of conflicting interpretations of the term in other statutory provisions.[105] For example, under the novelty requirement in Sec. 2(4), the party owing a duty of confidentiality to the inventor is presumed to be a natural or legal person, thereby implying that an inventor is a natural person.[106] Patent entitlement under Secs. 8 and 37 cannot be granted to, nor transferred to, entities lacking legal personality, such as AI systems.[107]

The nexus between true inventorship and human inventorship precludes Thaler from being named as the inventor. Thaler does not acquire the entitlement of inventorship by virtue of his ownership of DABUS.[108] Intellectual property ("IP") is distinguished from tangible property. Under the doctrine of accession, the owner of tangible property may succeed to the title to newly produced tangible property. However, the doctrine of accession has not been extended to patent law.[109] The inventorship requirement under Sec. 7(2)(b) does not authorize

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[103] *See* Joshua Jowitt, *Tomorrow You Shall Cease to Be a Marionette, and You Shall Become an Inventor*, 83 CAMBRIDGE L.J. 226, 227 (2024) (challenging the source of defining inventors as natural persons after tracing back to Laddie J.'s language).
[104] Thaler v. Comptroller-General of Patents, Designs and Trade Marks, [2023] UKSC 49, para 57 (appeal taken from Eng.).
[105] *See id*. para 62-65.
[106] *See id*. para 67-68. Lord Kichin believed that this legal relationship under the duty of confidentiality does not detract his interpretation that an inventor is a natural person.
[107] *See id*. para 70-71.
[108] *See id*. para 84-85.
[109] *See id*. para 87.

individuals to claim inventorship as successors in title to a machine.[110]

Although human inventorship precludes DABUS's production from being patented, it does not determine the patentability of AI-generated inventions. Whether such inventions are patentable is ultimately a policy issue.[111] This issue implicates human inventorship, and the possibility of adopting an expansive interpretation of the term "inventor" depends on policy considerations.[112] Meanwhile, this issue inevitably interacts with other patent requirements, including, but not limited to novelty, non-obviousness, and disclosure.[113] These requirements serve as critical policy measures for regulating the pace of innovation in AI technologies.[114] However, unlike in the U.S., neither the UKIPO nor the UK courts have articulated a clear position on the use of AI systems for invention.

While UK policymakers have not released any formal guidance on the use of AI in patenting, the UK patent system appears more likely to accommodate synthetic creativity, particularly more so than in the U.S. It may result in similar outcomes before the UKIPO and EPO due to the coherent positions on inventorship and the nexus between inventorship and other patent requirements. Again, absent a clear link between true inventorship, novelty, and disclosure, the true inventorship requirement is superficial and can rely solely on the assertions made by patent applicants. Without red flags raised by other requirements, it is implausible to identify or realize any contribution made by machines. Moreover, in the absence of a specific disclosure requirement concerning the use of AI, patent examiners are unlikely to trace the process of conception construction and disentangle the machine's role in synthetic creativity.

### 3. German Patent Law

The role of human inventorship within the German patent system remains unclear. On

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[110] *See id*. para 85.
[111] *See id*. para 49.
[112] *See id*. para 48.
[113] *See id*. para 49.
[114] *See id*.

its face, German patent law aligns with the EPC and permits only natural persons to be designated as inventors. The German Federal Court of Justice's interpretation in its decision on DABUS's patentability was straightforward, emphasizing the impossibility of naming machine systems as patent inventors or co-inventors.[115] However, the court did not provide thorough explanations of how it reached the perception or conclusion. It cited case law that excludes organizations and inferred that inventorship is limited to natural persons.[116] The absence of a detailed explanation diminishes the interpretive weight of the decision.

The court's rationale is problematic in that it permitted Thaler to revise the application and designate himself as the inventor of the AI-generated invention. It stated that "a substantial contribution [made by AI systems] to the discovery of a technical teaching does not contradict the assumption that there is at least one natural person who is to be regarded as the inventor on the basis of his contribution."[117] This implies that individuals may be listed as inventors of AI-created inventions. The court appears to interpret patent law as intended to accommodate inventions developed through AI uses.[118]

This rationale renders the German patent system both inconsistent with other countries and vulnerable to critique. The standards and consequences of true inventorship differ from those in the U.S. First, inaccurate inventor designation does not automatically result in the rejection of a patent application.[119] The German Patent Office is not responsible for verifying the identity of the true inventor, even though the applicant has the duty to make truthful declarations to the Office, and the true inventor is permitted to request the reassignment of the patent.[120] Second, inventor designation is reviewed prior to substantive examination and

[115] Bundesgerichtshof [BGH] [Federal Court of Justice] June 11, 2024, X ZB 5/22, at para 21 (Ger.); Patentgesetz [PatG] [Patent Law], Dec. 16, 1980, §37(1) (Ger.).
[116] *See* Bundesgerichtshof [BGH] [Federal Court of Justice] June 11, 2024, X ZB 5/22, at paras 41 & 42 (Ger.).
[117] *See id*. para 44.
[118] *See id*. para 47.
[119] *See id*. para 46 (interpretating §7(1) of the Patent Law).
[120] *See id*. paras 45 & 46.

independently of novelty and other patent requirements.[121] A person's contribution to novelty or non-obviousness does not affect his or her status as being named as an inventor or co-inventor.[122] The Federal Court of Justice may not have realized that its inherent logic behind the reasoning dismissed the critical role of conception in establishing inventorship.

Moreover, the Federal Court of Justice's rationale stands in contrast to the EPO's Legal Board of Appeal and the UK Supreme Court, both of which accepted Thaler's revision. The Federal Court of Justice reasoned that it is unfounded to reject the designation of an individual as inventor merely because he or she caused an AI system to generate or discover an invention.[123] A possible presumption underlying this reasoning is that the entitlement to patent inventorship constitutes a natural right. This right may only be deprived where expressly prohibited by law—an approach that differs from the rationale that inventorship must be affirmatively authorized by law. This raises a critical problem: What is the legal foundation for treating patent inventorship as a natural right? The court did not address this issue. What is known, however, is that conception is not required to establish or assert inventorship rights.

Given the diminished role of conception and true inventorship in patenting, synthetic creativity does not alter the Federal Court of Justice's interpretation of German patent law. AI systems are considered conventional tools employed by natural persons, regardless of whether some systems possess self-learning capabilities or produce outputs beyond regular predictions made by their users. Patent applications involving synthetic creativity may be rejected based on other patent requirements, but inventorship is not viewed as a substantive barrier.[124] Inventorship becomes a barrier only when multiple AI users assert competing claims to inventorship.[125]

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[121] *See id*. paras 34 & 35.
[122] *See id*. paras 36 & 37.
[123] *See id*. paras 32 & 62.
[124] *See id*. para 34.
[125] *See id*. para 46.

## IV. LIMITATIONS OF PATENTS FOR SYNTHETIC CREATIVITY

This Part explores the evolving dynamics of innovation and competition in the age of synthetic creativity, particularly focusing on how ML technologies and synthetic creativity reshape traditional mechanisms, such as lead-time advantages, learning curves, and patents. It examines how synthetic creativity can both empower and undermine competitive advantages, accelerate innovation, and challenge the effectiveness of legal protections. The Part also delves into the dual role of synthetic creativity in reducing production costs and enhancing labor productivity while simultaneously complicating the patent landscape and raising concerns about the erosion of human creativity. Through a revisit of theoretical frameworks of patents and some empirical studies on creativity, it argues that, dispute various limitations, the patent regime is still important to synthetic creativity and AI-driven innovation.

### *A. Competition Twisted Under Synthetic Creativity*

Lead time and learning curves are two mechanisms that complement patents and other legal mechanisms in providing competitive advantages.[126] Synthetic creativity may produce lead time and can reduce learning curves due to its impetus to innovation or an innovative environment. Correspondingly, firms gain competitive advantages through synthetic creativity, thereby reordering their market positions.

#### 1. Lead-Time Advantages

Lead-time advantages are also known as first-mover advantages for whom being the first to introduce a particular invention to the market.[127] Time is sensitive to competition.[128] Firms try to obtain lead time through product and progress innovation and management

[126] See Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* 3 (Nat'l Bureau Econ. Research, Working Paper No. 7552, 2000).
[127] *See* Petra Moser, *Innovation Without Patents: Evidence from World's Fairs*, 55 J.L. & ECON. 43, 46, n.5 (2012).
[128] Richard J. Tersine & Edward A. Hummingbird, *Lead-Time Reduction: The Search for Competitive Advantage*, 15 INT'L J. OPERATIONS & PRODUCTION MGMT. 8, 8 (1995) ("Just like labour and capital, time is a critical resource.").

skills.[129] The reduced time in the chain from creation to production and consumption allows them to be superior to competitors.[130] Moreover, pioneer inventors enjoy a cost advantage until fundamental changes in technology.[131] Thus, it is common to view lead time as a critical mechanism to protect profits based on innovation, particularly in the industries with time-based competition, such as manufacturing industries.[132] Due to the potential speed of imitation by competitors, other mechanisms are also important to maintain or even enhance these advantages.[133]

Legal mechanisms, such as patents and trade secrets, can further create, maintain, and complement the advantages.[134] These mechanisms allow for exclusive use of an invention, enabling the user to enjoy monopoly benefits in the market. Moreover, even though others can intrude the market due to the disclosure of trade secrets or the expiration of patents and offer similar or identical products with a lower price, consumers still prefer the first producers.[135] Sometimes firms prefer trade secrets to patents for the lead-time advantages, particularly when

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[129] *See* Clark & Fujimoto, *supra* note 24, at 25 ("[P]roduct innovation and project scope affect planning lead time, while process innovation and organizational capability affect engineering lead time."); Rochelle Cooper Dreyfuss, *Dethroning Lear: Licensee Estoppel and the Incentive to Innovate*, 72 VA. L. REV. 677, 698 (1986) ("[E]ven though [an] invention was not patentable, [its stakeholder] had received a valuable commodity—lead time.").

[130] Tersine & Hummingbird, *supra* note 128, at 9.

[131] *See* Marvin B. Lieberman, *The Learning Curve, Diffusion, and Competitive Strategy*, 8 STRATEGIC MGMT. J. 441, 449 (1987) ("With proprietary learning and a long head start, a pioneering firm can carve out an insurmountable cost advantage. The pioneer firm's profits are sustainable as long as there are no fundamental changes in technology.").

[132] *See* Cohen et al., *supra* note 126, at 6 & 10 ("[F]irms typically protect the profits due to invention with a range of mechanisms, including patents, secrecy, lead time advantages and the use of complementary marketing and manufacturing capabilities.").

[133] *See* FREDERIC M. SCHERER, INDUSTRIAL MARKET STRUCTURE AND ECONOMIC PERFORMANCE 445 (2d ed. 1980) ("6, at 445 ("[T]he speed of imitation depends upon the innovator's pricing policy. Companies pricing their new products to make a quick killing will encourage rapid imitation, while those pursuing a limited pricing strategy will experience slow imitation. Depending upon the circumstances, either strategy may suffice to yield substantial profit.").

[134] David S. Levine & Ted Sichelman, *Why Do Startups Use Trade Secrets?*, 94 NOTRE DAME L. REV. 751, 765 & 783-84 (2019); Marcus Holgersson, *Patent Management in Entrepreneurial SMEs: A Literature Review and an Empirical Study of Innovation Appropriation, Patent Propensity, and Motives*, 43 R&D MGMT. 21, 25 (2013); Cohen et al., *supra* note 126, at 6 & 10 (arguing the importance of mechanisms of lead time, secrecy, and patents to particular industries). There are also studies showing the lead-time advantages without patent or trade secret protection. *See e.g.*, EDWIN MANSFIELD, INDUSTRIAL RESEARCH AND TECHNOLOGICAL INNOVATION: AN ECONOMETRIC ANALYSIS 134-35 (1968).

[135] *See* Dreyfuss, *supra* note 129, at 698 (*citing* RONALD S. BOND & DAVID F. LEAN, SALES, PROMOTIONS, AND PRODUCT DIFFERENTIATION IN TWO DRUG MARKETS, FEDERAL TRADE COMM'N STAFF REPORT (1977)).

patents are too costly or the secrets are not easily explored and reverse-engineered.[136] For technologies with lower threshold to be reverse-engineered or even self-explained when being published, patents reserve the monopoly rights and lead-time advantages for the owners.[137]

Synthetic creativity is a two-edged sword with respect to lead-time advantages. On the one hand, AI technologies, in theory, are effective tools to assist their users in obtaining lead time. Clark and Fujimoto broke down overall lead time into product planning and engineering lead time.[138] Their empirical findings showed that project scope affects planning time, and product content affects both planning and engineering time.[139] As creativity is pivotal in earning lead time in general,[140] synthetic creativity can contribute to both stages. The use of ML technologies reduces the workload in developing the project and corresponding products by simplifying tasks, inspiring users, and providing plausible solutions.[141] The user then earns lead time by the saved effective R&D time. This is also the direct return of innovation involving synthetic creativity and makes it different from simple AI use or total reliance on human creativity. However, synthetic creativity does not necessarily result in lead time. Among various predictable and unpredictable outcomes of industrialized decision-making processes, selection takes time, the length of which depends on knowledge, experience, and cost.[142]

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[136] *Id.*; *e.g.*, Aija Leiponen & Justin Byma, *If You Cannot Block, You Better Run: Small Firms, Cooperative Innovation, and Appropriation Strategies*, 38 RES. POL'Y 1478, 1486 (2009) ("[S]mall firms are likely to attempt to speed up market launch rather than rely on secrecy or patents for protection.").

[137] *See* Petra Moser, *Patents and Innovation: Evidence from Economic History*, 27 J. ECON. PERSP. 23, 30 (2013); *but see* Anthony Arundel & Isabelle Kabl, *What Percentage of Innovations Are Patented? Empirical Estimates for European Firms*, 27 RES POL'Y 127, 129 (1998) ("[G]iven the importance of lead time advantages and concern over disclosure, we would expect many innovations not to be patented.").

[138] Clark & Fujimoto, *supra* note 24, at 28 & 41 ("[P]roduct planning lead time extends from the beginning of concept generation to the end of product planning …, and engineering lead time begins with the first engineering activity … and ends with market introduction.").

[139] *Id*. at 29 & 51 (defining product content as "the degree of innovation, complexity, and sophistication of design" and product scope as "the amount of development work done inside the project").

[140] Tersine & Hummingbird, *supra* note 128, at 8 ("Eliminating delays and improving product flows involves creativity, specialized skills, capital investments and behavioural changes that challenge the status quo.").

[141] *See generally* Tejal K Gandhi et al., *How Can Artificial Intelligence Decrease Cognitive and Work Burden for Front Line Practitioners?*, 6: ooad079, JAMIA OPEN 1 (2023).

[142] *See e.g*., Joel Becker et al., *Measuring the Impact of Early-2025 AI on Experienced Open-Source Developer Productivity*, ARXIV (July, 12, 2025), https://arxiv.org/abs/2507.09089 (experimentally showing that experienced programmers slowed down their work efficiency after using machine learning technologies due to reasons of

While total reliance on optimization by machines saves time, without human selection, lead time is more likely to be achieved in process innovation rather than product innovation.[143] This is because the optimized outcome produced by machines sometimes do not directly match consumer preferences.[144]

On the other hand, AI technologies are critical tools for competitors to reduce lead time. AI empowers reverse engineering and simplifies the process of reduction to practice in invention. Taking the manufacturing industries as an example, when a first mover makes a product available in the market, its content is transparent, and the scope of the project to develop and market it can be pictured, while the process to develop it may not be immediately clear. With the established and disclosed conception, replicators do not need to explore it. Synthetic creativity can effectively reduce the time needed to produce it or develop substitutes. This means that lead-time advantages are limited under the intrusion of synthetic creativity, and the legal mechanisms like patents and trade secrets are powerless against it. It neither means that substitutes for the output of synthetic creativity are easily created, nor does it suggest that access to synthetic creativity is easy. Rather, synthetic creativity provides an approach that allows competitors to catch up and circumvent competitive advantages obtained through innovation, law, and policy.[145]

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being over optimistic about the use of AI, high familiarity regarding the working area by the programmers, the incompetence of AI for complex tasks, low AI reliability, inconsistent knowledge between the programmers and AI).

[143] The difference is that consumers do not have direct contact with the former one.

[144] *See, e.g.*, Yaqi Chen et al., *Consumer Attitudes Toward AI-Generated Ads: Appeal Types, Self-Efficacy and AI's Social Role*, 185: 114867 J. BUSS. RES. 1, 2 (2024) ("[C]onsumers are more likely to have positive attitudes toward AI-generated ads with agentic appeals than those created by human … consumers are more likely to have positive attitudes toward human-created ads with communal appeals than those AI-generated ads with the same appeals."); Fei Jin & Xiaodan Zhang, *Artificial Intelligence or Human: When and Why Consumers Prefer AI Recommendations*, 38 INFO. TECH. & PEOPLE 279, (2025) (empirically showing that "people prefer AI (vs human) recommendations when purchasing material products, but
prefer human (vs AI) recommendations when purchasing experiential products").

[145] Lead-time advantages obtained through management skills are not an exception. Management innovation is a category of innovation and the application of AI in management also allows its users to be empowered with synthetic creativity and catch up or even surpass their competitors. Clark & Fujimoto, *supra* note 24, at 25 (arguing that organizational capabilities are the other factor in addition to product content and project scope).

### 2. Reducing Learning Curves

Learning curves are functions showing the trend of declining costs with the increase in production.[146] They are applied to describe the role of knowledge, experience, and innovation in reducing production costs.[147] Kenneth Arrow explained the inherent rationale of considering the curves, which is composed of a series of generalizations from empirical studies.[148] For example, "[l]earning is the product of experience," and "learning associated with repetition of essentially the same problem is subject to sharply diminishing returns."[149] Under the hypothesis that learning can enhance productivity,[150] it is common to visualize learning efficiency in production through the curves. High or steep learning curves suggest high production costs and low efficiency in deploying resources and experience. By contrast, low learning curves indicate competitive advantages. Thus, firms consciously move down their learning curves, which further intensifies competition.[151]

Learning curves are deployed as indicators of various economic factors based on their relationships. Among the various estimated learning curves, most address labor as a factor.[152] The close relationship between the curves and labor makes a learning curve a plausible

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[146] *See* A. Michael Spence, *The Learning Curve and Competition*, 12 BELL J. ECON. 49, 49 (1981).
[147] *See* Kenneth J. Arrow, *The Economic Implications of Learning by Doing*, 29 REV. ECON. STUD. 155, 156 (1962) ("The role of experience in increasing productivity has not gone unobserved.").
[148] *Id*. at 155.
[149] *Id*.
[150] *See id*. at 156 ("[T]echnical change in general can be ascribed to experience...profits are the result of technical change."); *see also* Norman Keith Womer, *Learning Curves, Production Rate, and Program Costs*, 25 MGMT. SCI. 312, 312 (1979); Luis M. B. Cabral & Michael H. Riordan, *The Learning Curve, Market Dominance, and Predatory Pricing*, 62 ECONOMETRICA 1115, 1115 (1994) ("[A] firm's unit cost declines with its cumulative production.").
[151] Cabral & Riordan, *supra* note 150, at 1115.
[152] Womer, *supra* note 150, at 316; Tooraj Jamasb, *Technical Change Theory and Learning Curves: Patterns of Progress in Electricity Generation Technologies*, 28 ENERGY J. 51, 54 (2007); Nayibe Guerrero Moreno et al., *Approaches to Polymer Electrolyte Membrane Fuel Cells (PEMFCs) and Their Cost*, 52 RENEWABLE & SUSTAINABLE ENERGY REV. 897, 899 (2015) ("A learning curve describes the empirical relationships between output quantities and quantities of certain inputs (mainly direct-labor hours) where learning induced improvement is present."); Michel Jose Anzanello & Flavio Sanson Fogliatto, *Learning Curve Models and Applications: Literature Review and Research Directions*, 41 INT'L J. INDUS. ERGONOMICS 573, 574 (2011) ("A learning curve is a mathematical description of workers' performance in repetitive tasks").

alternative way to represent labor productivity.[153] Labor productivity is also deployed to tell technological efficiency through learning curves.[154] This efficiency indicates the results of learning, particularly under technical changes.[155] While technical changes are often exogenous to the economy,[156] they can generally be captured by knowledge and experience, allowing problems to be resolved over time.[157] After empirically comparing various learning approaches and technology categories, Tooraj Jamasb showed that R&D efficiency is higher through strengthened research than through accumulated experience, particularly in industries with mature or emerging technologies.[158]

Synthetic creativity changes learning curves, at least through the factors of labor and technical changes. How synthetic creativity adjusts learning curves remains an empirical question. While direct empirical evidence is lacking, as an innovation element, it is reasonable to imply that it reduces the curves, disregarding the development costs of various AI systems. First, AI systems enhance labor productivity both extrinsically and intrinsically, which is primarily attributed to the application of synthetic creativity. The extrinsic effect is manifest and straightforward. The industrialized decision-making process enhances work efficiency in general, even though quality control still matters. Moreover, AI systems expand the access of employees to knowledge and skills.[159] Intrinsically, synthetic creativity increases job satisfaction and motivation of employees.[160] The introduction of computer and automation

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[153] *See* Arrow, *supra* note 147, at 156 (*citing* P. J. Verdoorn, *Complementarity and Long-Range Projections*, 24 ECONOMETRICA 429, 433-34 (1956)).
[154] *Id*. at 160 (*citing* Nicholas Kaldor, *Capital Accumulation and Economic Growth*, *in* THE THEORY OF CAPITAL 177 (F.A. Lutz & D.C. Hague ed., 1961)).
[155] *See* Tooraj Jamasb & Jonathan Kőhler, *Learning Curves for Energy Technology: A Critical Assessment*, *in* DELIVERING A LOW CARBON ELECTRICITY SYSTEM: TECHNOLOGIES, ECONOMICS AND POLICY 314, 317 (Michael Grubb et al. ed., 2008).
[156] *Id*. at 315-16 ("The learning effect is measured in terms of reduction in the unit cost (or price) of a product as a function of experience gained from an increase in its cumulative capacity or output").
[157] *See* Arrow, *supra* note 147, at 156.
[158] *See* Jamasb, *supra* note 152, at 69 ("We find higher learning by research than learning by doing rates.").
[159] Luísa Nazareno & Daniel S. Schiff, *The Impact of Automation and Artificial Intelligence on Worker Well-Being*, 67: 101679 TECH. IN SOC. 1, 5 (2021).
[160] Belayneh Yitayew Kassa & Eyob Ketema Worku, *The Impact of Artificial Intelligence on Organizational Performance: The Mediating Role of Employee Productivity*, 11: 100474 J. OPEN INNOVATION: TECH. MARKET

systems aggregates occupational stress and production safety risks.[161] However, even though the effect of high-efficiency tools on job satisfaction is diverse, synthetic creativity contributes to positive effects. The reduced workload indicates lower work stress, allowing employees to devote themselves to what they excel at.[162] Meanwhile, the enhanced capabilities in problem-resolving and the expanded access to knowledge make the use of machines a source of reward and enhance job satisfaction.[163]

Second, technical changes associated with the evolution of AI technologies may induce higher R&D efficiency and reduce learning curves. The application of these technologies empowers R&D activities with extensive datasets, rapid calculation, and expanded knowledge. People can solve scientific or technical issues with new ideas and methodologies, assisted by these technologies.[164] Nevertheless, enhanced R&D efficiency is not guaranteed, not only because it is an empirical question, but also because the effective and efficient adoption of AI technologies is expensive. As these technologies are applied to optimize resource allocation,[165] compatible management skills and effective transitions to adapt AI usage are also required to leverage them to their full potential.[166] For example, in innovation management, it is critical to reallocate resources to tailor innovation using AI.[167]

Synthetic creativity is key to reducing learning curves. AI is a broad concept. Using AI

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& COMPLEXITY 1, 1-2 (2025).

161 *See* Nazareno & Schiff, *supra* note 159, at 4-5.

162 Kassa & Worku, *supra* note 160, at 1.

163 Nazareno & Schiff, *supra* note 159, at 4-5.

164 *See* Muhammad Ali et al., *Synergizing AI and Business: Maximizing Innovation, Creativity, Decision Precision, and Operational Efficiency in High-Tech Enterprises*, 10: 100352 J. OPEN INNOVATION: TECH, MARKET & COMPLEXITY 1, 2 (2024) ("AI technologies that give advanced analytics and decision support systems let firms test new ideas and methodologies…AI facilitates learning and adaptation, creating an ever-changing environment that supports creativity.").

165 *Id.* at 3.

166 *See* Johann Füller et al., *How AI Revolutionizes Innovation Management – Perceptions and Implementation Preferences of AI-Based Innovators*, 178:121589 TECH. FORECASTING & SOC. CHANGE 1, 2 (2022) ("AI based innovation management requires substantial technical and organizational changes to cope with the associated challenge.").

167 *See id.* at 4 ("[O]rganizations must determine the resources they need and how much they want to allocate to AI-based
innovation management to reach their ambition.").

technologies does not suggest production of synthetic creativity, which is a result of applying ML technologies. The models allow machines to learn independently and are a subset of AI technologies.[168] The AI technologies, absent ML models, do not learn from data or improve through experience without specified instructions from programmers.[169] With their self-optimizing characteristics, adopting the models deepens experience rather than requiring experience from their users. This makes learning by doing more effective.[170] Moreover, an end-to-end optimization process under the assistance of ML models is more efficient than stepwise optimization followed by integration. Synthetic creativity, inclusive of obtained experience and enhanced efficiency, is capable of reducing learning curves on its own. It should be able to reduce the curves further if applied to R&D activities, rather than serving as the end point of problem solving.[171]

### *B. Problems of Patent Protection for Synthetic Creativity*

Synthetic creativity poses critical challenges to the traditional patent regime. In specific, the intervention of ML technologies in innovation shifts innovation costs to investors and the market, complicates reward mechanisms, undermines the foundational theories of patent law, such as incentive and prospect, and diminishes public benefits through artificial scarcity. There are also institutional burdens, such as expanded prior art searches and the erosion of human creativity, raising concerns about the long-term viability of patents in an AI-driven innovation landscape.

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[168] *See* Mohsen Soori et al., *Artificial Intelligence, Machine Learning and Deep Learning in Advanced Robotics, a Review*, 3 COGNITIVE ROBOTICS 54, 55 (2023) ("The relationship between [artificial intelligence, machine learning, and deep learning] are inclusive in terms of analysis and modification of advanced robotic systems.").

[169] *See* Iqbal H. Sarker, *Machine Learning: Algorithms, Real-World Applications and Research Directions*, 2:160 SN COMPUTER SCI. 1, 2 (2021) ("ML usually provides systems with the ability to learn and enhance from experience automatically without being specifically programmed.").

[170] *See*, *e.g.*, Amr M. Mohamed et al., *Empowering the Faculty of Education Students: Applying AI's Potential for Motivating and Enhancing Learning*, 50 INNOVATION HIGHER EDUC. 587, 601 (2025) (showing that the assistance of AI tools promotes students' problem-solving skills and collaboration in learning).

[171] *See* Jamasb, *supra* note 152, at 69.

### 1. Cost Shifting

The patent regime has multiple aims. The traditional aim is to reward inventors. Monopoly power allows inventors to charge a higher price, which not only covers their R&D costs but also creates a surplus to motivate further innovation.[172] A supplemental aim is explained by the prospect theory that Edmund Kitch proposed.[173] Inventors have the prospect of collecting royalties with the support of the patent regime, based on the technological possibilities they create.[174] Regardless of how inventors are encouraged under the two theories, the public also benefits from the disclosed technologies through the patent regime.[175]

These aims, however, may all be unattainable when the patent regime embraces output generated by synthetic creativity. At first glance, synthetic creativity saves *ex ante* R&D expenses for users of ML technologies.[176] In substance, inventors and their investors face higher *ex post* selection costs to explore valuable patents produced with the assistance of these technologies. The public also receives the same knowledge at higher costs due to patents, which create limited consumer surplus but deadweight losses for both consumers and producers.

First, the reward theory fails by itself in certain circumstances, which synthetic creativity cannot avoid but rather inevitably encounters. Recall the presumed economic rationale explaining how patents function as rewards to promote R&D investment. Patentees may not be able to generate profits from the market solely from the monopoly power granted by patents. One reason is insufficient innovation because what enhances market shares or reduces production costs is the innovation embodied in the patents rather than the patents themselves.[177] Insufficient innovation can easily be circumvented by other patentable

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172 *See* Arnold Plant, *The Economic Theory Concerning Patents for Inventions*, 1 ECONOMICA 30, 38 (1934).
173 Edmund Kitch, *The Nature and Function of the Patent System*, 20 J. L & ECON. 265 (1977).
174 *See id.* at 266.
175 *See generally* John F. Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. L. REV. 439 (2004) (complementing the prospect theory by addressing the arguments of social costs and the public welfare).
176 *See* Burk, *supra* note 6.
177 *See* Runhua Wang, *How Do Patent Subsidies Drive SMEs to Patent? Evidence from China*, 16 J. DEV.

substitutes. Moreover, despite positive marginal profits attributed to patents, patent rewards may be ineffective in motivating additional R&D investment. The effectiveness of patent rewards remains an empirical question. What is known, however, is that machines, the use and intelligent ability of which are critical variables in synthetic creativity, cannot be motivated by such rewards. R&D investors. Only AI users and R&D investors can be incentivized by such rewards.

R&D investors, however, may obtain innovation incentives only at high transaction costs resulting from undeserved patents.[178] They face higher search costs in deal sourcing, particularly given their preference for radical innovation rather than incremental innovation or exploitation innovation.[179] These challenges are more likely to arise when synthetic creativity enables inventors to generate numerous minor improvements easily. It is challenging for ML technologies empowered by existing data to break through the existing knowledge, particularly when they are constrained by computational power, algorithm size, an absence of intent to transcend the limits of incremental innovation.[180]

Second, the bedrock of the prospect of coordination under the patent regime is fragile and can easily be undermined by the application of synthetic creativity. As John Duffy criticizes, the prospect theory overlooks the inherent rivalry embedded in the patent regime.[181] The patent

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EFFECTIVENESS 408, 413 (2024) (empirically showing the existence of inframarginal patent applications that are not driven by increased R&D investment but purely reacts to patent subsidies).

[178] *See* Stephen Yelderman, *The Value of Accuracy in the Patent System*, 84 U. CHI. L. REV. 1217, 1220-21 (2017) (highlighting the problem of erroneous patent awards that impose unjustified costs and undermine the incentives to create "ambitious, disruptive technology").

[179] *See* Massimo G. Colombo et al., *The Dark Side of Signals: Patents Protecting Radical Inventions and Venture Capital Investments*, 52: 104741 RES. POL'Y 1, 1-3 (2023) ("[T]he quality signal of patents protecting radical inventions is stronger than that of patents protecting incremental inventions since radical inventions are more costly to develop and have particularly high earnings potential."); *but see* Mathias Beck et al., *Radical or incremental: Where Does R&D Policy Hit?*, 45 RES. POL'Y 869, 870 (2016) ("Privately financed R&D… is significant for both [radical and incremental] innovation."); Richard T. Thakor, *Explore or Exploit? Labor Market Frictions and the Innovation Choice*, SSRN 3 (April 9, 2025), ("Exploitation is simply an extension of what the firm is currently doing, so it involves neither the value of learning nor project quality uncertainty.").

[180] *See* Zeljko Tekic & Johann Füller, *Managing Innovation in the Era of AI*, 73: 102254 TECH. IN SOC. 1, 8 (2023).

[181] *See* John Duffy, *Rethinking the Prospect Theory of Patents*, 71 U. CHI. REV. 438, 442-43 (2004) (reviewing the reasons why rivalry matters to the patent system).

race is fierce among inventors when they seek the prospect right, which is the original and broadly scoped patents.[182] While access to AI tools that enhance R&D efficiency provides an advantage in the race, their widespread use intensifies the race to an even higher level. The patent race never stops, and synthetic creativity's output and efficiency have become key determinants of success. Moreover, the patented inventions with flourishing improvements through synthetic creativity not only block each other but also undermine the original inventor's prospect. ML tools enable competitors to develop around existing knowledge that has been disclosed in a broad patent. ML technologies thus become solutions to the barriers created by the exclusive right of the prospective patent, suggesting the failure of the prospect theory. The original inventor can easily be besieged by follow-on patents or displaced by substitute patents.

Third, instead of creating public benefits, the accumulated knowledge disclosure through the growing number of patents that are developed by synthetic creativity unnecessarily erodes both consumer and producer surplus. Industrialized innovation certainly produces an increased number of patents regardless of the constraints on inventor identity and disclosure. Among these patents, undeserved ones generate higher deadweight losses that neither patentees nor consumers can capture.[183] These deadweight losses also impose transaction costs on investors. Investors need to distinguish the deadweight losses from producer surplus, which refers to profits created through innovation or extracted from consumers. Moreover, such patents may mislead follow-on inventors who design around the patents or are blocked by the prior arts established by the patents.[184] Patents are neither the sole means of access to new knowledge for the public nor an efficient mechanism for knowledge sharing.[185] Access to ML

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182 *Id.*
183 *See* Yelderman, *supra* note 178, at 1126.
184 *Id*.
185 *See e.g.*, Lisa Larrimore Ouellette, *Do Patents Disclose Useful Information?*, 25 HARV. J.L. & TECH. 545, 544 (2012) (surveying among the nanotechnology area and showing the insignificance of patents on technology

technologies enables users to perceive and extend knowledge through iterative experimentation, which is not necessarily embedded in the training data. The search cost of obtaining such knowledge may not exceed the licensing fees for the patents that prevail in the race and have been filed for protection.

Therefore, patenting the productive output of synthetic creativity as regular R&D output may not be profitable or even rarely cost-saving. It is a process of cost shifting from inventors to investors, producers, follow-on inventors, competitors, and consumers. The saved R&D expenses due to the use of ML technologies are postponed and spent after patenting, reducing social surplus in some circumstances. It would be particularly problematic for small firms. Synthetic creativity is not cheap and requires compatible management skills to be effectively applied in innovation and productivity, which poses more challenges to small firms than to large firms.[186] Moreover, small firms do not receive equivalent benefits from the technologies as those received by large firms. Empirical evidence shows that AI-powered growth in product innovation, sales, employment, and market valuations clusters among large firms.[187] ML technologies allow small firms to enhance productivity, but do not enable them to catch up.[188] Instead, large latecomer firms can catch up to the frontiers with the positive effect of the technologies on innovation.[189]

#### 2. Flourishing Ideas

AI is not the first shock to creativity and IP laws from technological changes. The Internet is another example.[190] It represents the power of digital technologies and has reformed

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disclosure); *cf.* Robert P. Merges, *Commercial Success and Patent Standards: Economic Perspectives on Innovation*, 76 CALIF. L. REV. 803, 808 n.9 (1988) ("There is a significant amount of evidence showing that inventors in many fields rely on published patents for technical information.").

[186] *See infra* Part IV.C.1.

[187] Tania Babina et al., *Artificial Intelligence, Firm Growth, and Product Innovation*, 151: 103745 J. FINANCIAL ECON. 1, 1 (2024).

[188] Alexander Kopka & Dirk Fornahl, *Artificial Intelligence and Firm Growth — Catch-Up Processes of SMEs Through Integrating AI into Their Knowledge Bases*, 62 SMALL BUSS. ECON. 63, 63 (2024).

[189] *Id*.

[190] Mark A. Lemley, *IP in a World Without Scarcity*, 90 N.Y.U. L. REV. 460 (2015).

the patterns of products, innovation, production, and business. Products do not have to be physical.[191] For example, information can be an intermediate material that supports the production of physical goods and services.[192] The process of innovation and production can be disseminated rather than centralized.[193] E-commerce provides inventors with both a new marketing channel and more infringing products. Overall, the Internet reduces the costs of creation, reproduction, and distribution.[194] As infringing activities are rampant with the support of the Internet, knowledge spreads faster than ever. Creativity is not harmed but stimulated further by the Internet. In this process, what contributes to flourishing creativity is neither the rewards from the patent regime nor the disclosure encouraged by the regime. Innovation happens naturally, with or without economic rewards from the patent regime.[195] Compared to the limited contribution of the patent regime to innovation or creation, Mark Lemley suggests that it is more important for the regime to reduce the costs of production and distribution.[196] This means that instead of focusing on what is subject to patent protection, it is more important to shield inventors from being sued for infringement by others.[197]

Granting patents is a process of artificially creating scarcity. Knowledge and ideas are not scarce because they are viewed as public goods and are nonrivalrous.[198] Technologies, including AI, that reduce the cost of innovation and creation, could make products and services no longer scarce.[199] However, patents are exclusive rights, transforming the economic nature of the non-scarce products and services into scarce and non-free ones. The artificial scarcity does not guarantee a positive effect in promoting further innovation, but may result in

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191 *Id*. at 469.
192 *E.g., id*. at 471 (explaining 3D printer's principle of operation).
193 *Id*. at 499.
194 *Id*. at 460.
195 *Id*. at 487-96 (discussing the failure of intellectual property as the main reason to incentivize creation).
196 *Id*. at 460.
197 *Id*. at 510.
198 *Id*. at 486 & 504.
199 *Id*. at 482.

deadweight losses that are not beneficial to any parties.

What if the ideas are all covered by patents, making them scarce? This happens if the output of synthetic creativity is utterly accommodated by the patent regime. Ideas by themselves are not patentable, but they can be covered by patents when they are applied in the form of processes and products.[200] ML technologies enable the formalization of new possibilities in R&D without human intervention. In this process, existing knowledge is repetitively produced or delivered in varying forms. The output perceived by human deployers of ML technologies directly becomes their ideas or stimulates their idea generation. The ML-powered supply of ideas is not only inexhaustible but also flourishing. Unless the ideas are abstract and cannot be transformed into patent-eligible inventions, they can be protected by patents.[201] Then, regardless of whether a person obtains the same ideas through the use of ML technologies or not, he or she must examine whether the application of the ideas has been anticipated by a process or product patent.[202] Inventors and the market cannot enjoy the full benefits of the technologies because of the unnecessary scarcity created by excessive patents.[203]

In addition to economic reasons, there is an institutional challenge for patent applicants arising from the influence of ML technologies. That is the anticipation problem. Regardless of minor differences in the novelty requirement across jurisdictions, the common requirement is that the invention addressed in a patent application must be new and not anticipated by existing knowledge. Since ML technologies speed up the process of exploring new ideas and knowledge, patent applicants face the broadest scope of prior art ever.

This challenge also unequally imposes a higher burden on institutions. Patent examiners

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[200] 35 U.S.C. §101.
[201] *See* Alice Corp. Pty. Ltd. v. CLS Bank Intern., 134 S.Ct. 2347, 2350 (2014).
[202] *Cf.* Mark Lemley, *Ignoring Patents*, 2008 MICH. ST. L. REV. 19, 21 ("[B]oth researchers and companies in component industries simply ignore patents.").
[203] *See* Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 624 (1998) (raising the theory of anticommons tragedy, which refers to the failure of coordination to deploy a property with fragmented property rights).

face the same problem as patent applicants, which is the need to expand their search scope of prior art.[204] Some users of ML technologies do not file patent applications for their findings but instead incorporate the findings into their products, production, or research papers. In this scenario, the utility model regime in Germany would be so problematic that prior art outside the country does not anticipate utility model applications.[205] In addition to the enhanced search costs for patent offices, it remains an unsettled policy question how much artificial scarcity is appropriate to effectively promote social innovation through the rewards associated with that scarcity and the accompanying disclosure of technology.

### 3. Eroding Human Creativity

It involves more than moral concerns that ML erodes human learning, and improper use of ML tools cab limit or harm human creativity. The most common argument is that ML technologies contain unavoidable biases.[206] These biases not only misguide the creative thinking of humans but also become entrenched in subsequent cycles of thought. Beyond biases, the flourishing use of ML technologies changes the preference for human creativity. AI shows strong creativity and produces competitive products, artworks, and services, leaving human creativity without any edge.[207] A realistic outcome is that people either follow the paths explored by machines or receive no rewards from the patent regime or the market.[208] On a deeper level, the employment of ML technologies changes the patterns and quality of human

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[204] *See* Zhen Sun & Brain D. Wright, *Citations Backward and Forward: Insights into the Patent Examiner's Role*, 51: 104517 RES. POL'Y 1 (2022) ("Blocking citations. The examiner must, by statute, identify at least one 'backward' citation of prior art to justify rejection of a claim related to patent novelty … or non-obviousness.").
[205] *See Utility Models—Annual Report 2024*, GERMAN PATENT & TRADE MARK OFFICE, https://www.dpma.de/digitaler_jahresbericht/2024/jb24_en/utility-models.html (last visited Aug. 31, 2025) (showing a declining trend of utility models).
[206] Matthew G. Hanna et al., *Ethical and Bias Considerations in Artificial Intelligence/Machine Learning*, 38: 100686 MODERN PATHOLOGY 1, 4 (2025) (listing a series of biases when using machine learning, including data bias, algorithmic bias, sampling bias, measurement bias, labeling bias, prejudice bias, environmental bias, interaction bias, feedback loop bias, representation bias, temporal bias, transfer bias, and confirmation bias).
[207] *See* Madoc Wade, *Is AI a Threat to Human Creativity?*, INSTITUTE FOR ETHICS IN AI (2024), https://www.oxford-aiethics.ox.ac.uk/ai-threat-human-creativity.
[208] *See* Daryl Lim, *AI & IP Innovation & Creativity in an Age of Accelerated Change*, 52 AKRON L. REV. 813, 862 (2019) (arguing that the threshold of non-obviousness is inevitably enhanced if it is reviewed under standards embracing AI).

learning. Scholars have provided various empirical evidence to support this argument. Natarajan Balasubramanian et al. showed that substituting human decision-making with machine learning impairs the quality of organizational decision-making and performance after altering the routines of organizational learning.[209] They defined the problem as the deficiency of human learning, which becomes myopic when relying on sources contributed by ML.[210] Jonathan Choi et al. developed an experiment to explore how large language models affect critical thinking by law students.[211] Their findings suggest that the use of GPT-4 can, on average, effectively help students to improve their legal analysis but cannot surpass the boundaries of the ones with higher ability or work quality.[212] In a similar experiment, Choi and Daniel Schwarcz showed that the use of GPT-4 had a negative effect on top students, even though it effectively improved the performance of the bottom students.[213] Similarly, Erik Brynjolfsson at al. found that the access to GPT-3 brought only a small increase in work efficiency but some declines in work quality among highest-skilled workers, even though it improved both work efficiency and quality among lower-skilled workers.[214] In a survey conducted by Sabrina Habib at al., students criticized AI for constraining their learning abilities, even though they admitted that AI can assist in brainstorming.[215] In a survey among university professors, one-third expressed concern that the increasing use of AI technologies leads to

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[209] Natarajan Balasubramanian at al., *Substituting Human Decision-Making with Machine Learning: Implications for Organizational Learning*, 47 ACAD. MGMT. REV. 448, 449 (2022) (arguing that there are several negative impacts of machine learning on human and organizational learning).
[210] *Id*.
[211] Jonathan H. Choi et al., *Lawyering in the Age of Artificial Intelligence*, 109 MINN. L. REV. 147, 170 (2024) ("[W]ithout assistance from GPT-4 received the largest quality benefits, with little quality benefit to participants who were capable of producing high-quality work on their own.").
[212] *Id*. at 170 ("[W]ithout assistance from GPT-4 received the largest quality benefits, with little quality benefit to participants who were capable of producing high-quality work on their own.").
[213] Jonathan H. Choi & Daniel Schwarcz, *AI Assistance in Legal Analysis: An Empirical Study*, 73 J. LEGAL EDUC. 384, 397 (2025) ("GPT4 substantially improved the scores of students at the bottom of the class and negatively impacted the scores of students at the top of the class.").
[214] Erik Brynjolfsson et al., *Generative AI at Work*, 140 Q. J. ECON. 889, 889 (2025).
[215] Sabrina Habib et al., *How Does Generative Artificial Intelligence Impact Student Creativity?*, 34:100072 J. CREATIVITY 1, 4 (2024) (exploring the potential of AI in teaching and learning).

poorer learning experiences and devalues higher education.[216] In Sayed Fayaz Ahmad et al.'s survey, they found that AI results in the absence of human decision-making and human laziness.[217] A further consequence could be that the ideas and judgment of people become dominated by machines, leading them to lose interest in learning new skills and methodologies.[218]

The concerns are not unique to ML technologies or AI in general. They arise from the broader risk that people may become overly reliant on digital technologies in thinking. In Betsy Sparrow et al.'s experiments, people were less likely to recall things on their own but were primed to rely on computers and the Internet as external memory sources, which provide reliable access to information.[219] People tend to bypass thinking processes when they have tools with access to knowledge. The problem of such efficient thinking, especially overreliance on ML tools, is the weakening of core cognitive processes.[220] My personal experience of instructing students confirms that when learning new knowledge under time pressure, some students tend to over-rely on external resources, particularly ML tools, which offer more powerful and rich information than conventional search engines.[221] However, technologies inevitably have limitations, such as the limitations to generate originality compared to what

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[216] Lauren Coffey, *Academics Blame Technology for Increased Burnout*, TIMES HIGHER EDUC. (Aug. 29, 2024), https://www.timeshighereducation.com/news/academics-blame-technology-increased-burnout.
[217] Sayed Fayaz Ahmad et al., *Impact of Artificial Intelligence on Human Loss in Decision Making, Laziness and Safety in Education*, 10:311 HUMAN. & SOC. SCI. COMM. 1, 1 (2023) (surveying students in Pakistan and China).
[218] *See id*. at 4 & 11.
[219] Betsy Sparrow et al., *Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips*, 333 SCI. 776 (2011) (conducting a survey to learn people's routines to find information).
[220] Ismail Dergaa et al., *From Tools to Threats: A Reflection on the Impact of Artificial-Intelligence Chatbots on Cognitive Health*, 15:1259845 FRONTIERS IN PSYCHOL. 1, 2 (2024) (explaining how generative AI tools result in cognitive decline).
[221] One of my research assistants, who was a junior law student whose native language is Chinese, used Kimi, a large language model as ChatGPT to interpret and code the U.S. policy documents in the area of patent law. The student could do the work without the assistance of Kimi, but the tool made her work more efficiently. Finally, she basically gave up her personal judgment, but simply followed Kimi's output. When Kimi provided inconsistent binary output sometimes, the student was confused and tended to rely on the latest output regardless of her original thinking without using Kimi. Another extreme example occurred in my legal writing class. When I showed rules of direct citations on the board and asked the class to apply the rules in an example, a student gave up independent thinking at all and just copied all the rules and asked DeepSeek to produce the answer.

human creativity can capture.[222] Industrialization liberates labors, but liberating people from thinking does not advance society.

The concerns regarding the future of human creativity particularly matter for patent regimes in the U.S. and Europe. The U.S. patent regime was designed to promote human creativity rather than production or commercialization. The latter functions of patents have been further explored through various theoretical frameworks.[223] Although important, the former function is derived from the legislative purpose of patent law, which originates from the U.S. Constitution.[224] The development of democracy is also a process of expanding and sustaining human creativity.[225] If the rise of synthetic creativity overtrumps the development of human creativity under the tolerance of the patent regime, the patent regime becomes dysfunctional and undermines its constitutional justifications.

While the patent laws of the U.K. and E.U. countries do not originate from their own constitutions, their patent regimes nonetheless incorporate constitutional justifications and human rights considerations. The U.K. and E.U. countries are indirectly influenced by the U.S. legislative goals through trade obligations. As members of the Agreement on Trade-Related Aspects of Intellectual Property Rights ("the TRIPS Agreement"), the foundations of modern patent laws were initiated and established by U.S. interest parties.[226] In addition to the economic concerns driving the international negotiations towards the formation of the TRIPS

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222 *See* Koivisto & Grassini, *supra* note 33, 2 (exploring differences between human and machine creativity); *see also* Habib et al., *supra* note 215, at 4 (arguing that AI has negative effects on human creativity from the dimensions of originality, flexibility, fluency, and elaboration).

223 *See e.g.*, Vincenzo Denicolò & Luigi Alberto Franzoni, *The Contract Theory of Patents*, 23 INT'L REV. L. & ECON. 365 (2003) (highlignting the contract theory of patents, which is to publish knowledge to the public); Ted Sichelman, *Commercializing Patents*, 62 STANFORD L. REV. 342 (2010) (emphasizing the commercialization function of the patent regime, which could be decoupled from its invention function).

224 U.S. CONST. art. 1, § 8, cl. 8.

225 *See* Kara W. Swanson, *Race and Selective Legal Memory: Reflections on Invention of a Slave*, 120 COLUM. L. REV. 1077 (2020) (reviewing the history of how black Americans obtained the rights of inventorship in the U.S.).

226 *See e.g.*, Robert Weissman, *A Long, Strange TRIPs: The Pharmaceutical Industry Drive to Harmonize Global Intellectual Property Rules, and the Remaining WTO Legal Alternatives Available to Third World Countries*, 17 U. PA. J. INT'L ECON. L. 1069, 1074-75 (1996) (reviewing the history of the establishment of the TRIPS Agreement contributed by big pharmaceutical companies).

Agreement, human creativity was not only naturally widespread but also held significant value across the countries. Under the influence of the European Convention on Human Rights ("ECHR"), human rights had been inherently important to E.U. countries before the modernization of the patent regime driven by the TRIPS agreement.[227] The ECHR does not directly mention human creativity, but human creativity sustains certain conventional human rights, such as freedom of expression.[228] It is not reasonable to presume that the patent regimes under the effect of the ECHR are intended to sacrifice human creativity to achieve high efficiency of industrialization.[229]

### *C. Problems of Excluding Synthetic Creativity from Patents*

While synthetic creativity may challenge traditional notions of the patent regime, excluding it could stifle innovation. The high costs and technical complexity involved in leveraging ML technologies for invention suggest that denying patent protection would undermine incentives for investment and technological development. Moreover, synthetic creativity can stimulate human creativity, foster interdisciplinary collaboration, and enrich both cultural and scientific progress. Therefore, a more inclusive and adaptive patent regime is needed to accommodate the evolving nature of creativity and invention in the AI era.

#### 1. Synthetic Creativity Is Not Cheap

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[227] *See* Christophe Geiger & Elena Izyumenko, *Shaping Intellectual Property Rights Through Human Rights Adjudication: The Example of the European Court of Human Rights*, 46 MITCHELL HAMLINE L. REV. 527 (2020) (explaining the development of IP laws under the influence of the ECHR); Elena Izyumenko & Christophe Geiger, *Intellectual Property and Human Rights in the Jurisprudence of the CJEU and the ECtHR – An Introduction*, *in* HUMAN RIGHTS AND INTELLECTUAL PROPERTY BEFORE THE EUROPEAN COURTS: A CASE COMMENTARY ON THE COURT OF JUSTICE OF THE EUROPEAN UNION AND THE EUROPEAN COURT OF HUMAN RIGHTS (Edward Elgar, forthcoming 2025) (reviewing the cases addressing the intersection of IP and human rights at the Court of Justice of the European Union and the European Court of Human Rights).

[228] While the fundamental rights discussed in the cases addressing human rights at European courts are freedom of expression, right to property, privacy, freedom to conduct a business, non-discrimination, fair trial, and absence a voice on human creativity, it is a critical factor inherent in those rights. Moral rights that are critical to national copyright laws in Europe are another example.

[229] In practice, some elements in the patent regime could have flaws that are immoral as they are supposed to be. For example, the German patent system presumes patent applicants as inventors without verification requirements, which has been criticized as morally reprehensible. *See* Anthoula Papadopoulou, *Creativity in Crisis: Are the Creations of Artificial Intelligence Worth Protecting?*, 12 J. INTELL. PROP. INFO. TECH. & ELEC. COM. L. 408, 413 (2021).

When updating the core meaning of patent law with the concept of synthetic creativity, Burk based his analysis on the assumption that ML technologies reduce costs at the initial phase of creation and appropriation.[230] Traditional patent theories were built on the assumption that initial creation and production are expensive, whereas reproduction and appropriation are cheap.[231] Synthetic creativity disrupts this imbalance and reduces costs on both sides.[232]

That assumption, however, is not robust. Regardless of the cost of developing original ML models, synthetic creativity is much more than a simple framework and can be very expensive. Techniques for the efficient employment of the models for invention are emerging disciplines to be studied. For example, prompt engineering has become a course not only in engineering schools but also in business schools and other social sciences.[233] In a narrow sense, it concerns efficient employment of generative AI through designing and optimizing prompts, such as constructing clear prompts with context and examples.[234] In a broad sense, advanced techniques, such as retrieval-augmented generation ("RAG") and fine-tuning strategies, also fall within the scope of prompt engineering.[235] RAG allows access to external information during the generation process, expanding the training data used in constructing the original generative AI models.[236] Fine-tuning strategies enable users to individualize models by

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[230] *See* Burk, *supra* note 6, at 1679-80.
[231] *Id.* at 1669.
[232] *Id.* at 1676-78.
[233] For example, Northeastern University, Southern Illinois University, the Ohio State University have opened in-class or online courses of prompt engineering. Nik Bear Brown, *INFO 7375: Prompt Engineering for Generative AI-Course Syllabus*, NE. U., http://newton.neu.edu:8080/syllabusrepo/40483.pdf?t=1731006972412 (last visited Aug. 8, 2025); *Prompt Engineering*, SE. ILL. U., https://continuinged.siu.edu/siu-courses/prompt-engineering.php (last visited Aug. 8, 2025); *Prompt Engineering*, OHIO ST. U. C. EDUC. & HUM., https://cdli.ehe.osu.edu/ai-in-ehe/ai-101/prompt-engineering/ (last visited Aug. 8, 2025).
[234] *See* Palak Jain, *Use LLMs: Pre-Training, Fine-Tuning, RAG and Prompt Engineering*, MEDIUM (May 6, 2024), https://medium.com/@jainpalak9509/use-llms-pre-training-fine-tuning-rag-and-prompt-engineering-564d5670f44d; Xavier Amatriain, *Prompt Design and Engineering: Introduction and Advanced Methods*, ARXIV (May, 5, 2024), https://arxiv.org/html/2401.14423v4.
[235] Golam Md Muktadir, *A Brief History of Prompt: Leveraging Language Models. (Through Advanced Prompting)*, ARXIV (Nov. 28, 2023), https://arxiv.org/pdf/2310.04438 (reviewing the development of various methods in prompt engineering between 2015 and 2023).
[236] *See* Jain, *supra* note 234.

adjusting parameters to meet their particular demands.[237] Advanced techniques are costly due to the skills, time, and data invested in adjusting models for specific tasks to achieve better output from pre-trained models.[238] These advance techniques are continuing to evolve. To further exploit and augment generative AI, prompt engineering has been evolved to include context engineering.[239] Context engineering, which incorporates advanced techniques of prompt engineering, such as RAG, further empowers generative AI models for specific tasks within an individualized environments constructed through context processing and management skills.[240] While these costly techniques are still rare and have not yet been broadly demanded in the labor market,[241] the market shows a growing trend toward practical skills in ML technologies.[242]

While the reward theory of patents may not be fully functional,[243] depriving rewards by excluding synthetic creativity from the patent regime cannot be an optimal policy. There are persistent arguments that patents are overprotected and should be gradually abolished.[244] A primary reason is the lack of direct evidence supporting the success of the reward theory.[245]

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[237] *Id*. Fine-tuning is also considered as a step of training large language models. *See* Bijit Ghosh, *Empowering Language Models: Pre-training, Fine-Tuning, and In-Context Learning*, MEDIUM (June 12, 2023), https://medium.com/@bijit211987/the-evolution-of-language-models-pre-training-fine-tuning-and-in-context-learning-b63d4c161e49.

[238] *See* Justin Muller, *How to Navigate Between Pre-Training, Fine Tuning, and Model Distillation*, MEDIUM (Dec. 19, 2024), https://medium.com/@flux07/how-to-choose-between-pre-training-fine-tuning-and-model-distillation-ed6f5179e29c.

[239] *See* Lingrui Mei et al., *A Survey of Context Engineering for Large Language Models*, ARXIV (July 21, 2025), https://arxiv.org/pdf/2507.13334.

[240] *See id*.; Soumil Jain, *Context Engineering is the 'New' Prompt Engineering (Learn this Now)*, ANALYTICS VIDHYA (July 28, 2025), https://www.analyticsvidhya.com/blog/2025/07/context-engineering/.

[241] *See* Jonas Oppenlaender An Vu, *Prompt Engineer: Analyzing Skill Requirements in the AI Job Market*, ARXIV 1 (May 29, 2025), https://arxiv.org/html/2506.00058v1 ("We found that prompt engineering is still rare (less than 0.5% of sampled job postings) but has a unique skill profile.").

[242] *See* Matthew Bone et al., *Skills or Degree? The Rise of Skill-Based Hiring for AI and Green Jobs*, 214: 124042 TECH. FORECASTING & SOC. CHANGE 1 (2025) (empirically showing a fast-growing demand on AI-skilled labors in the labor market and a trend that employers are lenient with talents with AI skills regarding degree requirements).

[243] *See generally* Steven Shavell & Tanguy van Ypersele, *Rewards Versus Intellectual Property Rights*, 44 J. L. & ECON. 525 (2001) (arguing that patents are not superior to a reward system in terms of efficiently promoting innovation).

[244] *See* Michele Boldrin & David K. Levine, *The Case Against Patents*, 27 J. ECON. PERSP. 3, 3 (2013).

[245] *Id.* at 5 (*citing* MICHELE BOLDRIN & DAVID K. LEVINE, AGAINST INTELLECTUAL MONOPOLY (2008)) (reviewing empirical findings in the literature).

What has increased under the patent regime is the number of patents rather than the level of innovation.[246] Another reason, evident throughout the European history, is the disagreement on the principle of rewards for patents.[247] The only consensus established over centuries of debate was that patents should be granted only for significant inventions.[248] However, regardless of how effective rewards are in promoting innovation, a policy shift from an easy entry to patents toward their abolition daunts inventors.[249] Instead of abolition, Mark Schankerman and Florian Schuett proposed a four-dimensional governance strategies to adjust the patent thresholds, including examination, application fees, renewal fees, and invalidation procedures.[250] Using game theory analysis, they argued that after fee-driven decisions to file patent applications, invalidation procedures are effective in excluding patents that do not need incentives to invent and preserving the patents filed primarily because of patent rewards.[251] The patent system still generates positive welfare by embracing both types of patents.[252] In the case of costly synthetic creativity, while innovation towards it is driven more by competition than by patent rewards,[253] filing patent applications remains a critical strategy before any complete abolition of the patent system. Otherwise, inventors using synthetic creativity would always bear the opportunity costs of losing potential rewards from the patent system. If inventors decide to bear high filing costs, the patent system can always adjust the effects of these inventions on public good through *ex post* mechanisms, such as invalidation or

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[246] *Id.*
[247] *See* ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT 87-88 (2024) (reviewing anti-patent movement debates in mid-1800s).
[248] *Id.* at 80.
[249] *Id.* at 95; *see also* Kesan & Wang, *supra* note 69 (showing that patent applicants in the areas of business methods, bioinformatics, and software filed fewer patent applications after *Alice*).
[250] *See* Mark Schankerman & Florian Schuett, *Patent Screening, Innovation, and Welfare*, 89 REV. ECON. STUD. 2101, 2102 (2022).
[251] *See id.*
[252] *See id.* at 2103.
[253] *See supra* Part IV. A.1.

court enforcement.[254] It is unnecessary for the patent regime to block them at the entry stage. Otherwise, before any harm to the public good arises from overprotection, increased patenting costs would first burden human inventors as they pursue patents amid uncertainties.[255]

### 2. Stimulate Human Creativity

Compared with concerns about the negative influences of ML technologies on human creativity,[256] scholars in general are more optimistic about employing these technologies to promote human creativity. In an experiment conducted by Anil Doshi and Oliver Hauser, people were found to be more creative, and better-written stories were produced with the assistance of generative AI, suggesting that their individual creativity was better off.[257] Mirko Farina et al. see the potential of synthetic creativity to expand human creativity based on how it strengthens multidisciplinary research, particularly by linking various natural sciences to the humanities.[258] In Sebastian Bouschery et al.'s experiment, the employment of the technologies results in more ideas and a faster process of idea generation in brainstorming productivity and creativity, compare with the lack of access to ML technologies.[259] Regarding learning abilities, Hsin Huang's experiment showed that students improved their creative thinking after using ML technologies.[260] Even though the performance of some top students may not have broken through their own limits after using ML tools, students on average improved their critical

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[254] *See* Runhua Wang, *New Private Law? Intellectual Property "Common-Law Precedents" in China*, 89 UMKC L. REV. 353, 374-77 (2020) (discussing the utilitarianism considerations of courts in patent enforcement).
[255] *See e.g.*, Kesan & Wang, *supra* note 69 (reviewing the uncertainties and increased transaction costs in patent prosecution caused by *Alice*).
[256] *See supra* Part IV.B.3.
[257] Anil R. Doshi & Oliver P. Hauser, *Generative AI Enhances Individual Creativity but Reduces the Collective Diversity of Novel Content*, 10: eadn5290 SCI. ADVANCES 1, 1 (2024).
[258] *See* Mirko Farina et al., *Machine Learning in Human Creativity: Status and Perspectives*, 39 AI & SOC. 3017, 3024 (2024).
[259] *See* Sebastian G. Bouschery et al., *Artificial Intelligence-Augmented Brainstorming: How Humans and AI Beat Humans Alone*, SSRN 2-3 (Mar. 1, 2024), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4724068.
[260] Hsin Huang, *Promoting Students' Creative and Design Thinking with Generative AI Supported Co-Regulated Learning: Evidence from Digital Game Development Projects in Healthcare Courses*, 27 EDU. TECH. & SOC. 487, 487 (2024).

thinking and legal analysis with these tools.[261]

Instead of being concerned that AI will swallow human creativity, it is a perception problem whether the success of synthetic creativity signifies the same value as human creativity or threatens it. For example, Bouschery et al.'s experiment found that computers alone, without human intervention, were more efficient in generating ideas than when people used them to generate ideas.[262] They did not magnify this finding or view in their implications. Instead, they viewed ML technologies as critical tools to patch the holes of traditional brainstorming done only by humans.[263] Manuel Garcia argues that ML technologies have launched a cultural shift alongside technological improvements, enriching human creativity.[264] While the cultural shift may not occur smoothly, anthropocentrism persists and continues to defend the standing of human creativity. The defense could represent a type of cognitive bias. Through experiments, Kobe Millet et al. found that people preferred artworks labeled as AI-generated less than those labeled as human-created.[265] This is particularly true among people who tend to be anthropocentric and insist that only humans possess creativity.[266] Anthropocentrism was also observed in Doshi and Hauser's experiment.[267] Inventions produced through pure human creativity may not be as competitive as those developed under synthetic creativity in terms of cost and efficiency. Nevertheless, they could contribute more to realm of art rather than industrialization, such as fine crafts or artisanal goods. Thus, regardless of whether industrialized innovation can be further promoted under the mechanism of utility patents, other

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[261] *See* Choi et al., *Lawyering in the Age of Artificial Intelligence*, *supra* note 211, at 170; Choi & Schwarcz, *supra* note 213, at 397.
[262] Bouschery et al., *supra* note 259, at 2-3.
[263] *Id*. at 3 ("AI-augmented brainstorming can help overcome the productivity loss in traditional brainstorming groups and could play an important role in creative idea-generation practices").
[264] Manuel Garcia, *The Paradox of Artificial Creativity: Challenges and Opportunities of Generative AI Artistry*, CREATIVITY RES. J. (May 30, 2024), https://doi.org/10.1080/10400419.2024.2354622 (reviewing the challenges of generative AI on authenticity, ethics, and IP).
[265] Kobe Millet et al., *Defending Humankind: Anthropocentric Bias in the Appreciation of AI Art*, 143: 107707 COMPUTERS IN HUMAN BEHAV. 1, 6 (2023).
[266] *Id*. at 1.
[267] Doshi & Hauser, *supra* note 257, at 6.

IP regimes, such as design, copyright, and trademark protection, still preserve space for human creativity in line with consumer preferences. The bottom line is that there will always be consumers who value human creativity.

To move beyond this bottom line and exploit ML models to enhance human creativity, patent policymakers play a critical role in facilitating the culture shift by ensuring that synthetic creativity is not excluded from the patent regime. Their perceptions of the effect of synthetic creativity influence its presence within the patent regime and shape the progression of this cultural shift. In the preliminary stage, these perceptions can be observed through the positions taken by patent offices and judges on AI-generated inventions. In the U.S. patent system, the nexus between synthetic creativity and human creativity lies in the concept of complete conception. Because only human inventors can establish complete conceptions, which entail more than mere information, synthetic creativity at least does not erode human creativity. Instead, human inventors are entitled to the economic benefits of patents developed through synthetic creativity following the establishment of complete conceptions. Compared to the U.S., the German judicial system's perception is more AI-friendly. Neither its willingness to recognize Thaler as the inventor of DABUS's results nor the German patent system's absence of a true inventorship requirement indicates any concerns about harm to human creativity arising from the patenting of synthetic creativity.[268] The U.K.'s position is less clear, although it has explicitly precluded the doctrine of accession from its patent system. Synthetic creativity is not produced solely by machines but rather reflects the endeavor of their users. However, since the U.K. patent system lacks a mechanism to recognize true inventorship among various forms of synthetic creativity, it at least does not applaud all forms of synthetic creativity.

As the cultural shift progresses, patents safeguard the interests of human inventors

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[268] Even though there are multiple frameworks of synthetic creativity, having findings that autonomous generated by AI is an extreme situation, which demands the minimum human intervention in the process of the generation.

engaged in synthetic creativity. The rise of AI technologies enhances work efficiency but neither liberates workers or substantially increases their income.[269] If workers cannot pursue greater personal benefits from their enhanced abilities aided by AI, they will have little motivation to disclose such improvements.[270] In other words, if workers cannot obtain greater personal benefits from the enhanced productivity generated by synthetic creativity, they may withhold part of that productivity as deadweight losses, reclaiming personal time at the expense of overall efficiency.[271] Patents serve as an important mechanism for scientific and technical workers to disclose new inventions first to their employers and then to the public.[272]

## V. BALANCE PATENT LAW WITH AI LAW

Imbalanced patent application requirements regarding human efforts in synthetic creativity may trigger policy competition across jurisdictions. For example, when abstract ideas were increasingly excluded from the U.S. patent system, U.S. policymakers expressed concerns that China was improperly granting patents for abstract ideas, resulting in a superseding increase in AI-related patents.[273] Moreover, in standard-essential patent disputes, patentees may readily obtain injunctions in Germany or secure a global license in the U.K., although their applications might be abandoned or invalidated elsewhere.[274] Introducing synthetic creativity into the patent regime involves more than merely adjusting inventorship requirement. It

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[269] *See* Irina Ivanova, *Study Looking at AI Chatbots In 7,000 Workplaces Finds 'No Significant Impact on Earnings or Recorded Hours in Any Occupation'*, FORTUNE (May 19, 2025, 4:26 PM), https://fortune.com/2025/05/18/ai-chatbots-study-impact-earnings-hours-worked-any-occupation/ ("Workers in the study allocated more than 80% of their saved time to other work tasks (less than 10% said they took more breaks or leisure time)."); Callum Borchers, *Your Prize for Saving Time at Work With AI: More Work*, WALL STREET J. (July 9, 2025, 8:00 PM), https://www.wsj.com/lifestyle/careers/ai-work-free-time-51c8c92a.

[270] *See* Borchers, *supra* note 269 (showing that workers prefer to hide their enhanced efficiency for reserving the saved time).

[271] *Id*; Runhua Wang, *Information Asymmetry and the Inefficiency of Informal IP Strategies Within Employment Relationships*, 162: 120335 TECH. FORECASTING & SOC. CHANGE (2021) (arguing information asymmetry exist between employers and employees due to insufficient incentives from employers and policies).

[272] *See* Wang, *Information Asymmetry and the Inefficiency of Informal IP Strategies Within Employment Relationships*, *supra* note 271, at 1.

[273] *See* Gene Quinn, *Director Iancu Worries Current State of Section 101 "Weakens the Robustness of Our IP System,"* IPWATCHDOG (May 15, 2018, 11:15 AM), https://ipwatchdog.com/2018/05/15/iancu-part-2/id=97191/.

[274] *See* Runhua Wang, *Irrational Unwillingness in SEP Licensing*, 34 TEXAS INTELL. PROP. L. J. 1, 8-12 (forthcoming 2025).

requires dynamically constructing a harmonious system of patents integrating patents with other policies. This Part discusses how AI regulations are important to complement the patent regime in safeguarding human creativity and promoting the public good.

### *A. International Treaties*

The Bletchley Declaration is an agreement on AI safety and had been signed by the E.U., the U.S., the U.K., and another 27 countries as of 2024.[275] The underlying motivation that drives international agreements on AI issues is that AI's risks are international in nature, which requires international cooperation.[276] The Bletchley Declaration addresses concerns over general-purpose models, which could be functional across a wide range of applications and enabled by ML, while predicting "the transformative positive potential" of these models in science and education.[277] It particularly identifies risks of relating to "human rights, transparency and explainability, fairness, accountability, regulation, safety, appropriate human oversight, ethics, bias mitigation, privacy and data protection."[278] The goal of the Bletchley Declaration is to establish an framework for countries to communicate and collectively manage these risks. It contains neither substantive requirements nor enforcement schemes, but aims instead to ensure international cooperation through communication and consensus in advancing AI governance.

Prior to the Bletchley Declaration, the Organization for Economic Co-operation and Development ("OECD") initiated the AI principles, which were endorsed by the E.U. and 48 other countries.[279] Similar to the Bletchley Declaration, the OECD AI principles emphasize

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[275] Danielle Keen, *Bletchley Declaration on AI safety cooperation signed by 28 countries at UK summit*, CHARTERED INSTITUTE OF EXPORT & INT'L TRADE (Nov. 2, 2023), https://www.export.org.uk/insights/trade-news/bletchley-declaration-on-ai-safety-cooperation-signed-by-28-countries-at-uk-summit/.
[276] THE BLETCHLEY DECLARATION BY COUNTRIES ATTENDING THE AI SAFETY SUMMIT, 1-2 NOVEMBER 2023 (Feb. 13, 2025), https://www.gov.uk/government/publications/ai-safety-summit-2023-the-bletchley-declaration/the-bletchley-declaration-by-countries-attending-the-ai-safety-summit-1-2-november-2023.
[277] *Id.*
[278] *Id.*
[279] *See Recommendation of the Council on Artificial Intelligence*, OECD LEGAL INSTRUMENTS, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449#adherents (last visited Aug. 13, 2025).

international cooperation but are unenforceable.[280] Nevertheless, the principles are instructive and influential, articulating the conception of governing AI risks and offering a preliminary framework for policymakers to design and construct national policies and regulations. The core consensus is to adopt a pro-AI, human-centered approach to sustainable development rather than an anti-AI stance.[281] These values include "non-discrimination and equality, freedom, dignity, autonomy of individuals, privacy and data protection, diversity, fairness, social justice, and internationally recognised labour rights,"[282] broader and more specific than the risks identified in the Bletchley Declaration. According to the principles, while AI stakeholders and actors should bear the burden on upholding these values, governments play a pivotal role in the cultural shift and should assist them to protect the values.[283] Among the various contested values in the cultural transformation, the principles further suggest that governments should support individuals to obtain and enhance synthetic creativity while preserving human creativity.[284] Beyond adopting AI regulations and policies, governments are also expected to provide more direct support. To promote synthetic creativity in technical innovation, the principles encourage a tendency to conduct AI infrastructure through government investment.[285]

Echoing the OECD principles, the E.U. has initiated hybrid funds and infrastructures as well as regulatory measures to govern AI-related activities and support their development. In February 2025, the E.U. launched InvestAI, a fund designed to support the development of "trustworthy AI."[286] The European Commission ("E.C.") provided initial capital for InvestAI,

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[280] *AI Principles*, OECD, https://www.oecd.org/en/topics/ai-principles.html (last visited Aug. 14, 2025).
[281] *Id.*
[282] *Id.*
[283] *Id.*
[284] *See id.* (suggesting "[b]uilding human capacity and preparing for labour market transformation.").
[285] *See id.* ("Governments should consider long-term public investment, and encourage private investment, in research and development, including interdisciplinary efforts, to spur innovation in trustworthy AI that focus on challenging technical issues and on AI-related social, legal and ethical implications and policy issues.").
[286] *EU launches InvestAI Initiative to Mobilise €200 Billion of Investment in Artificial Intelligence*, EUROPEAN COMMISSION (Feb. 11, 2025), https://ec.europa.eu/commission/presscorner/detail/en/ip_25_467.

which will leverage risks of other investors, such as member states or private investors.[287] A primary and specific goal of InvestAI is to facilitate the establishment of AI Factories. Before establishing InvestAI, the E.U. had already collaborated with national funds and invested in AI Factories.[288] The E.U. aims to build ecosystems that support AI development by gathering key resources, including computing power, data, and talent.[289] Accordingly, AI Factories are located at various technology hubs across Europe, such as the University of Linköping in Sweden and LuxProvide in Luxembourg, and they continue to expand.[290] Supported by InvestAI and its leveraged private funds, the E.U. moves forward with the construction of AI Gigafactories, including hardware infrastructure for AI processors and operational support, such as supply chains and networking.[291] By 2025, thirteen AI Factories had been established.[292] All the investments in infrastructure and further ecosystems are critical elements to constructing synthetic creativity. With strengthened infrastructure and ecosystems, the hybrid fund launched by the E.U. will further support small AI firms, particularly those developing and applying generative AI in areas such as robotics, health, biotechnology, manufacturing, mobility, and climate and virtual worlds.[293]

The other side of the support is the legal constraint under the EU AI Act ("AIA"). The AIA is a milestone piece of legislation on AI—machine-based systems enabling autonomy.[294] It is the most comprehensive legislation on AI. Compared to other international treaties that lack an enforcement mechanism, the EC established the AI Office to oversee the

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[287] *Id.*
[288] *Seven Consortia Selected to Establish AI Factories Which Will Boost AI Innovation in the EU*, EUROPEAN COMMISSION (Dec. 10, 2025), https://ec.europa.eu/commission/presscorner/detail/en/ip_24_6302.
[289] *Id.*
[290] *Id.*
[291] *AI Factories*, EUROPEAN COMMISSION (June 19, 2025), https://digital-strategy.ec.europa.eu/en/policies/ai-factories.
[292] *Id.*
[293] *Commission Launches AI Innovation Package to Support Artificial Intelligence Startups and SMEs*, EUROPEAN COMMISSION (Jan. 24, 2025), https://ec.europa.eu/commission/presscorner/detail/en/ip_24_383.
[294] Regulation (EU) 2024/1689 of the European Parliament and of the Council No. 2024/1689 of 13 June 2024, art.3, 2024 O.J. (L 2024/1689, 12.7.2024), ELI: http://data.europa.eu/eli/reg/2024/1689/oj [hereinafter *AI Act*].

implementation of the AIA by member states and to supervise the compliance of general-purpose AI providers.[295] The next subsection explains how it has the potential to supplement patent law in addressing the effect of synthetic creativity.

### *B. The EU AI Act*

The AIA imposes various obligations depending on how it categorizes AI systems and their interactors. The AIA layers the risk threshold for AI systems as unacceptable, high, limited, and minimal, with levels of restrictions and scrutiny from high to low. Unacceptable risk is prohibited.[296] For other AI systems, AI deployers bear lighter obligations than do other stakeholders (*i.e.*, importers, distributors, and developers). Deployers refer to AI users.[297] Their obligations when using high-risk AI systems are primarily compliance, monitoring, and notification.[298] High-risk systems are primarily defined by their application cases,[299] some of which overlap with the areas promoted by EC-led investments, such as biotech. For general-purpose AI systems, which are considered the most powerful models with systemic risks, the obligations for AI developers and deployers are imposed slightly more lightly than for high-risk systems.[300] AI deployers sometimes bear the obligations of disclosure and notification when using general-purpose AI systems.[301] The scope of the obligations depends on the application of AI models. The notification obligation is imposed when deploying models that can process emotional or biometric information.[302] The disclosure obligation is imposed when

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[295] *High-Level Summary of the AI Act*, EU ARTIFICIAL INTELLIGENCE ACT (Feb. 27, 2024), https://artificialintelligenceact.eu/high-level-summary/.
[296] *AI Act*, art 5.
[297] *Id.* art 3.
[298] *Id.* arts 16-27.
[299] *Id.* art 6. Specific cases include (1) biometrics, (2) critical infrastructure, (3) education and vocational training, (4) employment, workers management, and access to self-employment, (5) access to and enjoyment of essential private services and essential public services and benefits, (6) law enforcement, (7) migration, asylum and border control management, and (8) administration of justice and democratic processes. A general case refers to the AI systems that are applied for the safety component of a product.
[300] *Id*. arts 51 & 53-55.
[301] *Id*. art 50.
[302] *Id*.

models are deployed for deepfakes or for producing information for the public on matters of public interest.[303]

As many companies expressed concerns about the high compliance cost of the AIA,[304] synthetic creativity may also impose the costs. Synthetic creativity arises through AI use, which forces inventors to pay attention at least to the obligations of disclosure and notification, since deploying general-purpose ML models is the easiest way to obtain synthetic creativity. Inventors may bear more obligations due to the sources and applications of the models that they deploy. For inventors who not only deploy but also develop ML models themselves, they may not bear higher obligations as AI developers if the AI systems are not on the market or open to third parties for services.[305] The obligations are only imposed when the models trigger high-risk or general-purpose AI systems. It is unlikely that a company would invest in a general-purpose AI system only for internal use, but some self-developed business models deployed in employment or supported by personal data may trigger high-risk models and result in compliance costs. For inventors who pursue customized models from independent contractors, while they do not bear the same obligations as AI developers, the high obligations for developers of high-risk or general-purpose systems are transformed into their procurement costs.

While there are possibilities for inventors to bear compliance costs for synthetic creativity, the cost is unlikely to increase further. The AIA disregards synthetic creativity from threats to human society. The protected fundamental rights in the AIA do not include human

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303 *Id*.
304 *See* Andreas Liebl et al., *AI Act Impact Survey Exploring the Impact of the AI Act on Startups in Europe*, APPLIEDAI INSTITUTE FOR EUROPE (Dec. 12, 2022), https://aai.frb.io/assets/files/AI-Act-Impact-Survey_Report_Dec12.2022.pdf; *see also EU AI Act Delay Officially Ruled Out: Timeline Confirmed for Full Implementation*, NEMKO DIGITAL (July 31, 2025, 8:40 AM), https://digital.nemko.com/news/eu-ai-act-delay-officially-ruled-out (listing concerns from various industries for enhancing their costs, which were ineffective to convince the EU to postpone the adoption of the AI Act as the General-Purpose AI Code of Practice was released on time).
305 *Id*. art 3.

creativity.[306] Even though AI systems that are applied in education and vocational training are considered high risk, the high-risk applications of AI systems only cover situations in which the systems are deployed to create decisive effects (*i.e.*, admission, grading, tracking, and invigilating).[307] It seems that the application of general-purpose AI systems in innovation is not required to be disclosed to the public, since it is too far to conclude that innovation activities themselves matter to the public interest unless there are particular restrictions.[308] The list of high-risk AI systems may be amended by the EC.[309] Nevertheless, as long as inventors have complete control over the application of the output of ML models during inventing, the autonomy of the models should not subject them to high obligations under high-risk AI systems merely because of synthetic creativity.[310] Trivial human contributions in synthetic creativity do not increase the risks that the AIA aims to govern, because the activities of innovation and patenting, where synthetic creativity is intermediately applied, are not harmful in themselves.

Instead, synthetic creativity may reduce the compliance cost. The key is to enhance human participation and control in synthetic creativity. Even though some application cases fall into the scope of high-risk AI systems, the obligations could be waived with the EC's approval if the systems are deployed to develop synthetic creativity. In specific,

> "(a) the AI system is intended to perform a narrow procedural task;
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> (b) the AI system is intended to improve the result of a previously completed human activity;
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> (c) the AI system is intended to detect decision-making patterns or deviations from prior decision-making patterns and is not meant to replace or influence the

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[306] *See e.g.*, *id.* recital 58 (listing "the right to social protection, non-discrimination, human dignity" as examples of fundamental rights).
[307] *Id*. annex III.
[308] For example, the goal of the innovation or the ultimate inventions from the innovation is particularly to harm the public interest.
[309] *AI Act*, art 7.
[310] *Id*.

previously completed human assessment, without proper human review; or

(d) the AI system is intended to perform a preparatory task to an assessment relevant for the purposes of the use cases [causing high risk of harms]."[311]

This list is open to expansion or revision by the EC.[312] As human inventors have strict control over decision-making outcomes in innovation, the output of ML models cannot be decisive or substantial. Then, inventors may convince the EC that their inventions applied in high-risk cases are exempt them from the obligations under high-risk AI systems.

The compliance cost mechanism makes the AIA a useful framework for instructing human involvement in synthetic creativity. Instead of depriving inventors of the possibility of being rewarded with patents, the AIA allows reduced or waived compliance costs for human inventors who primarily contribute to synthetic creativity. It has been criticized for the absence of patent matters, resulting in unfairness and harm to innovation as synthetic creativity is permitted in patenting.[313] Nevertheless, the AIA leaves space for innovation that applies synthetic creativity and, at very least, does not decelerate the expansion of synthetic creativity in human society by classifying it to be risky. While it imposes high obligations on patent offices and courts that determine on patent examination, validity, and enforcement,[314] as the authorities overcome the costs of compliance, there is a trend toward inventions being examined and reviewed by AI systems with relatively high standards of novelty and non-obviousness.[315] Under this trend, it is unrealistic to exclude synthetic creativity from the patent regime, regardless of the human contributions within it.

### *C. The UK AI Regulation White Paper*

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[311] *Id*. art 6.3.
[312] *Id*. arts 6.6-6.7.
[313] *See* John Hillman, *Smart Regulation: Lessons from the Artificial Intelligence Act*, 37 EMORY INT'L L. REV. 775, 788-93 (2023).
[314] AI systems that support law enforcement refer to high-risk AI systems. *AI Act*, annex III.
[315] *See* Lim, *supra* note 208, at 863.

Instead of having a comprehensive regulation like the AIA, the UK State for Science, Innovation and Technology proposed principles for governing AI-related activities in its AI Regulation White Paper in 2023.[316] When defining AI systems, the White Paper particularly addresses their autonomous characteristics, thereby bringing ML models enabling synthetic creativity within the regulated scope.[317] It set out cross-sector principles that instruct UK regulators to pursue a "pro-innovation, proportionate, trustworthy, adaptable, clear and collaborative" regulatory framework for AI.[318] On the one hand, the White Paper sets out the standing of the UK government and instructs AI stakeholders to follow in a general sense. The principles define the elements for AI stakeholders to be within the scope of responsible AI design, development, and use.[319] On the other hand, the White Paper draws a framework for regulators based on these characteristics. The trustworthiness characteristic suggests a consensus with the AIA, instructing regulators to address risks created by AI technologies and their uses.[320] With the proportionality characteristic, future UK AI regulations are not meant to impose excessive burdens on AI stakeholders and regulators.[321]

However, it is too early to conclude that the U.K. will have more permissive or lenient regulations than the AIA because the principles are vague and broad, which may lead to contradictory stances in detail. For example, to avoid opportunity costs in innovation and financing, the White Paper opposes prohibiting AI from entering safety-critical operations.[322] This does not suggest a narrower definition or scope of high-risk AI systems compared to the AIA. Regulators still need to weigh the risks when designing AI regulations.[323] The White

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316 A Pro-Innovation Approach to AI Regulation 2023 (Eng.).
317 *Id.* ¶ 39.
318 *Id.* ¶ 37.
319 *Id.* ¶ 49.
320 *Id.*
321 *Id.*
322 *Id.* ¶ 46.
323 *Id.* ¶ 47.

Paper particularly reminds regulators that risks extend beyond certain domains, such as health or critical infrastructure.[324] It is still uncertain for both regulators and industries which areas are affected by high-risk AI systems.

Under such a regulatory framework, inventors may face high compliance costs for synthetic creativity. Compared to the compliance costs, the obstacles to patent inventorship could be slight. Unlike the AIA, which provides greater certainty, the UK government seems to be pro-AI, but as it is still early to evaluate its new regulations based on the White Paper, the regulations could nonetheless be inherently restrictive. When the government systematically implements the framework proposed in the White Paper, new regulations that impose monitoring or supervision obligations will enhance costs not only for inventors who deploy ML models but also for all AI users, regardless of the practical risks arising from their uses. By then, inventors could be responsible for the safety of AI output, including potential biases.[325] In addition, the principle of "appropriate transparency and explainability" requires that users of AI systems should be able to access sufficient information about the systems when enforcing their rights.[326] It is unclear how much information is sufficient for inventors to obtain or maintain patents that are developed through the use of ML technologies. If the agency implementing the principle is the UKIPO, which further requires transparency based on the existing disclosure requirement, inventors would bear dual costs of understanding ML models and explaining them to the UKIPO.[327] The principle least likely to impose additional costs on inventors is fairness because the application of synthetic creativity does not necessarily result

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[324] *Id.* ¶ 52.
[325] *Id.*
[326] *Id.*
[327] *See* Davide Castelvecchi, *Can We Open the Black Box of AI?*, NATURE.COM (Oct. 5, 2016), https://www.nature.com/news/can-we-open-the-black-box-of-ai-1.20731 (discussing black box issues of AI); *but see* Bartosz Brożek et al., *The Black Box Problem Revisited. Real and Imaginary Challenges for Automated Legal Decision Making*, 32 ARTIFICIAL INTELLIGENCE & L. 427, 427 (2024) (challenging that the opacity issue of AI is not a genuine problem).

in unfair competition or contravene the principle, even though synthetic creativity may be more efficient than human creativity.[328] However, the government always has a role in defining AI risks and adjusting their definitions, particularly with agile regulations and ample funding for proposing and updating those regulations.[329]

One argument could be that the UK government is actively funding the development of safe, responsible, and trustworthy AI systems, such as general-purpose ones.[330] Nevertheless, having government-certified AI systems is insufficient to alleviate concerns of inventors. They need to balance the low risks associated with using uniform AI models and limited synthetic creativity. To develop competitive inventions, they may rely on multiple ML models or technologies in innovation, which may incur high compliance costs due to high risks. However, the bottom line is that as the government offers general-purpose AI systems, synthetic creativity itself becomes widespread rather than exclusive. The patent race will inevitably be primarily between applications of synthetic creativity.

### *D. AI Regulations in the U.S.*

While the U.S. has signed several international treaties on AI governance and Congress has received many bills to push federal framework on this issue,[331] the U.S. is still at the stage of having only a few state AI regulations.[332] With disparate areas of legislative emphasis and inconsistent legislative agendas among states, the whole picture of AI regulations in the U.S.

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[328] A Pro-Innovation Approach to AI Regulation 2023, ¶ 52 (Eng.).
[329] Department for Science, Innovation and Technology et al., *UK Signals Step Change for Regulators to Strengthen AI Leadership*, GOV.UK (Feb. 6, 2024), https://www.gov.uk/government/news/uk-signals-step-change-for-regulators-to-strengthen-ai-leadership.
[330] *Id.* ("The UK further commits to this approach today with an investment of £9 million through the government's International Science Partnerships Fund, bringing together researchers and innovators in the UK and the United States to focus on developing safe, responsible, and trustworthy AI.").
[331] *See, e.g.*, LAURIE HARRIS, CONG. RESEARCH. SERV., R48555, REGULATING ARTIFICIAL INTELLIGENCE: U.S. AND INTERNATIONAL APPROACHES AND CONSIDERATIONS FOR CONGRESS (2025); Chuck Schumer et al., *Majority Leader Schumer Delivers Remarks to Launch SAFE Innovation Framework for Artificial Intelligence At CSIS*, SENATE DEMOCRATS (June 21, 2023), https://www.democrats.senate.gov/news/press-releases/majority-leader-schumer-delivers-remarks-to-launch-safe-innovation-framework-for-artificial-intelligence-at-csis.
[332] *See Artificial Intelligence 2025 Legislation*, NCSL (July 10, 2025), https://www.ncsl.org/technology-and-communication/artificial-intelligence-2025-legislation (updating latest legislation AI in the U.S.).

remains unclear.[333] It is possibility that there would not be specific AI regulations or AI laws in addition to the existing legal framework. The limited certainty is that critical elements recognized in the E.U. and the U.K., such as public safety, critical infrastructures, transparency, and accountability, are also the key matters addressed in state legislation.[334] However, most states did not address them through a risk-oriented framework. Instead, they commonly began with specific issues or requirements, which set obligations for the government or AI stakeholders.[335] There are also general compliance requirements proposed by legislators in some states accommodating many technology companies, such as Illinois and California.[336] While most of the proposals were rejected, in the absence of federal laws that systematically address the issues or provide an instructive framework, diverse state regulations impose high compliance transaction costs on AI stakeholders.[337]

It is, nevertheless, unreasonable to expect that most states will specifically address synthetic creativity through restrictive regulations. One reason is the lack of authority over patents. Patent issues are exclusively governed by federal law and federal courts.[338] Even though the use of ML technologies may affect human creativity or competitive advantages, state legislators cannot address concerns about these factors through patentability. Another reason is that states may compete with their AI regulations or policies.[339] It is unknown what

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[333] *See* Harris, *supra* note 331 ("Congressional actions might focus on leveraging federal agencies' existing authorities without enacting additional AI-specific laws or on creating new cross-sector authorities or broad regulations to address potential risks from AI, such as transparency and accountability requirements.").
[334] *Id.*; *see also* Sorelle Friedler & Andrew D. Selbst, *5 Points of Bipartisan Agreement on How to Regulate AI*, BROOKINGS (Aug. 15, 2025), https://www.brookings.edu/articles/five-points-of-bipartisan-agreement-on-how-to-regulate-ai/ (listing a few values embedded in AI development with bipartisan agreement).
[335] *See e.g.*, H.B. 3720, 104th Gen. Assemb. (Ill. 2025) (requiring agencies to have human review after utilizing any automated decision-making system).
[336] *See Artificial Intelligence 2025 Legislation*, *supra* note 332.
[337] *See* Harris, *supra* note 331.
[338] *See* 28 U.S.C. § 1338; U.S. CONST. art. 1, § 8, cl. 8.
[339] *See* Jonathan H. Adler, *Interstate Competition and the Race to the Top*, 35 HARV. J. L. & PUB. PO'LY 89, 97 (2012) ("States certainly compete with each other to create a more favorable climate for business investment."); *see generally* Mark Carl Rom et al., *Interstate Competition and Welfare Policy*, 28 PUBLIU 17 (1998) (empirically showing that states compete with welfare policies); *but see* Mark J. Roe, *Delaware's Competition*, 117 HARV. L. REV. 588 (2003) (challenging interstate competition and arguing that the success of Delaware company law was under the pressure of federal government rather than the competition with other states).

the ultimate design of the regulations or policies will be in this competition. At least, it is inefficient for state legislators to constrain AI uses to uphold patent law, an exclusive federal issue, for defending human creativity, especially before the theory that human creativity is harmed by AI uses has been consistently proved. Moreover, restrictions on the private sector are costly and may cause spillovers or other unexpected outcomes in the regulation race.[340] The economic loss will not be subsidized by the federal government. The federal government does not plan to financially support any state legislative activities, but rather plans to review them.[341] The only legislation that directly addresses synthetic creativity is an affirmative regulation. Arkansas passed a bill that grants ownership of the AI-generated content to AI users if the content does not infringe copyright or other IP rights.[342] However, it is very unlikely that federal courts will set aside the inventorship requirement and adopt a similar rationale in the context of patents.

The overall trend of governing AI in the U.S. is to promote innovation, particularly through synthetic creativity, rather than restrict innovation or AI use in innovation.[343] The private sector has not been imposed new obligations regarding AI, while AI use remains under federal scrutiny.[344] Even the documentation requirement for AI use was only imposed only on government agencies rather than the public.[345] As Congress has not approved any restrictive regulation, America's AI Action Plan ("AIAP"), the latest policy document from the federal

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[340] *See* Chokri Zehri, *Restrictive Policy Impacts in Emerging Economies*, 8: 1815979 COGENT ECON. & FIN. 1, 1 (2020).

[341] OFFICE OF SCIENCE AND TECHNOLOGY POLICY, AMERICA'S AI ACTION PLAN 3 (2025) (recommending the Federal Communications Commission to evaluate whether state AI regulations interfere with its authority).

[342] H.B. 1876, 95th Gen. Assemb. (Ark. 2025).

[343] *See generally* Memorandum from Russell T. Vought, the director, Executive Office of the President Office of Management and Budget, to the Heads of Executive Departments and Agencies (April 3, 2025), https://www.whitehouse.gov/wp-content/uploads/2025/02/M-25-21-Accelerating-Federal-Use-of-AI-through-Innovation-Governance-and-Public-Trust.pdf.

[344] *See Policy Overview*, CIO.GOV, https://www.cio.gov/policies-and-priorities/Executive-Order-13960-AI-Use-Case-Inventories-Reference/ (last visited Aug. 28, 2025).

[345] *Id*. The federal government constructs a Federal AI Use Case Inventory, collecting and disclosing AI use cases from federal agencies.

government, has outlined its strategic arrangement of AI governance.[346] It provides several policy directions and suggestions for promoting innovation in AI technologies and innovation through AI, as well as protecting fundamental human rights, such as free speech.[347] Instead of imposing restrictive regulations, government agencies were encouraged to reflect their preferences in the requirements for federal procurement or funding.[348] However, it is difficult to foresee which suggestions will be adopted and implemented by the agencies.

The problem is that before the federal government provides or imposes any substantive financial support or compliance cost, patent applicants face increased application costs when applying synthetic creativity.[349] The optimistic part is that there is no indication that AI users will bear any compliance costs for applying synthetic creativity. By contrast, there is potential that AI users may receive government funding to support their AI-assisted innovation activities.[350] Thus, the increased application costs may be offset by the government support. A critical gap in the AIAP is the absence of a documentation system for synthetic creativity. While it encourages open-source data,[351] the AIAP is silent on open-source models or their uses. If the USPTO only reviews AI uses to determine human contributions, this would not be an effective means of disclosing and sharing the development of synthetic creativity. In addition to the AI use case inventory library that collects AI uses in the federal government,[352] it is valuable to disclose and share the use of various ML models in innovation activities in the private sector. After the initial step of full disclosure, if the theory that synthetic creativity

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[346] *See* OFFICE OF SCIENCE AND TECHNOLOGY POLICY, AMERICA'S AI ACTION PLAN (2025).
[347] *Id.*
[348] *E.g.*, *id.* at 4 (suggesting to "[u]pdate Federal procurement guidelines to ensure that the government only contracts with frontier large language model (LLM) developers who ensure that their systems are objective and free from top-down ideological bias.").
[349] *See* Inventorship Guidance for AI-Assisted Inventions, 89 Fed. Reg. 100,043 (Feb. 13, 2024) (noticing that patent applicants may need to submit additional information requested by patent examiners regarding evaluation of the sufficiency of human contribution to an AI-assisted invention).
[350] *See* OFFICE OF SCIENCE AND TECHNOLOGY POLICY, AMERICA'S AI ACTION PLAN 8 (2025).
[351] *Id.*
[352] *Artificial Intelligence Use Case Inventory Library*, HOMELAND SECURITY, https://www.dhs.gov/publication/ai-use-case-inventory-library.

threatens human creativity is broadly upheld, the documented information could provide a solid foundation for designing ethical review processes and establishing requirements for assessing the risks of synthetic creativity.

## VI. CONCLUSIONS

Deploying machine learning technologies in innovation is a way to harness synthetic creativity. It enables the inventive process to be more efficient than when it relies solely based on human creativity. However, it faces challenges related to patent inventorship and the compliance burdens introduced by artificial intelligence regulations, which vary across the United States, the European Union, and the United Kingdom. The various standards on patent inventorship may each be justifiable and could be adopted in designing an optimal framework that either includes or excludes synthetic creativity within the patent regime. Instead of relying solely on patent law to adjust the innovation patterns and the competition distorted by synthetic creativity, the inventorship requirement should be evaluated in conjunction with AI regulations and policies. The overall policy framework should accommodate synthetic creativity in the inventive process, rather than impose obligations without adequate rewards for it.