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THE RISE OF MACHINES: PATENTING INVENTIONS GENERATED BY ARTIFICIAL INTELLIGENCE IN CANADA

by

Morris Odeh

Submitted in partial fulfilment of the requirements
for the degree of Master of Laws

at

Dalhousie University
Halifax, Nova Scotia
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Dedication

- To God almighty, whose grace and mercy made the completion of this LLM program possible.

- To Schulich Law School, Dalhousie University for constantly providing a conducive environment for graduate legal research and scholarship.

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Abstract

"The rise of machines is here," but they did not come as "rogue robots" to terminate humankind as some fictional writers predicted. Rather, they have come as inventors of human-like creativity. Therefore, this thesis examines the question of the patentability of inventions generated by artificial intelligence (AI) machines within the context of the Canadian patent system. Applying the modern principle of statutory interpretation, utilitarianism, and economic theoretical framework, this research determines whether AI-generated inventions can constitute patentable subject matter, AI systems can be inventors, and AI technology can own and exercise patent rights under the Canadian *Patent Act*. The thesis concludes that patent protection should not be extended to AI-generated inventions as it would not yield the greatest social net benefit. This is because AI systems cannot be incentivized, there is no "public goods problem," other incentives already exist for their human initiators, and it may create avoidable transaction costs.

List of Abbreviations Used

AI	Artificial Intelligence
ANN	Artificial Neural Networks
CIPC	South Africa Companies and Intellectual Property Commission
CIPO	Canadian Intellectual Property Office
DABUS	Device for the Autonomous Bootstrapping of Unified Sentience
EPO	European Patent Office
GDP	Gross Domestic Product
GP	Genetic Programming
IPIC	Intellectual Property Institute of Canada
IPONZ	Intellectual Property Office of New Zealand
ML	Machine Learning
NASA	National Aeronautics and Space Administration
NNBPSM	Neural Network-Based Prototyping System and Method
OECD	Organization for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
R&D	Research and development
UKIPO	United Kingdom Intellectual Property Office
USPTO	United States Patents and Trademarks Office
WEF	World Economic Forum
WIPO	World Intellectual Property Organization
WTO	World Trade Organization.

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Chapter One: Introduction

1.1. Deus Ex Machina: "a god from a machine."

We are witnessing another tumultuous phase of patent law and policy discourse that demands a rethink of old assumptions and conventional principles. Once the fantasies of science fiction writers and philosophers, artificial intelligence (AI) technologies have, in recent years, become capable of generating inventions indistinguishable from works of human creativity.[1] This development has not only disrupted the technological environment but has also given rise to new doctrinal and policy dilemmas under patent law, such as (a) can AI-generated inventions be considered protectable subject matters? (b) can AI systems be named inventors and/or owners of patent rights? And (c) can the human initiators of AI systems patent AI-generated inventions? This thesis discusses these issues and attempts to provide answers within the context of the Canadian patent system.

AI technology, which can emulate human-like functioning and abilities, is not new to our collective consciousness. Indeed, works of literature and movies have familiarized us with

[1] See Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law," (2016) 57 B.C. L. Rev. 1079, 1083-91; Nick Li and Tzeyi Koay, "Artificial intelligence and inventorship: an Australian perspective" (2020) 15:5 J of Intell Prop L & Practice, at 400. ('The question is no longer 'can AI invent'– the answer to that must be a resounding yes.'); Aleksandra Bar, "Machina Ex Machina Artificially Intelligent Systems as Inventors under Polish Legal Framework" (2020) 10:1 Wroclaw Review of Law, Administration & Economics at 17 ("AI systems are already capable of autonomously generating 'real world inventions"); Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, 'When Artificial Intelligence Systems Produce Inventions: The 3A era and an alternative model for patent law" (2018) 39 Cardozo L. Rev. 2215("AI advanced systems are becoming capable of creating unpredictable, innovative outcomes independently, rather than merely by following digital orders… [AI systems can] "produce innovative and unexpected products and processes which, had they been developed by humans, might qualify as patentable inventions."); Robert Plotkin, *The Genie in the Machine: How Computer-automated inventing is revolutionizing Law and Business* (Stanford, California: Standard University Press, 2009) 1 ("AI is not a science fiction movie, it is "already here, and we're already buying and using its creations"); The World Economic Forum (WEF), 'Artificial Intelligence Collides with Patent Law' (April 2018), online(pdf): *WEF* <http://www3.weforum.org/docs/WEF_ > at 6 (The WEF noted in 2018 that AI is no longer "just crunching numbers" but is generating or co-generating works of a sort that have historically been protected as "inventive" or as requiring human ingenuity); Morris Kingsley Odeh, "Patenting Inventions Generated by Artificial Intelligence: The Way Forward" (2020), 11:2 The Gravitas Review of Business & Property Law at 18.

the idea of human-like machines walking among us and relating with us.[2] In these works, some people have explored the possibility of a "robot revolution," "Robopocalypse," or an "Apocalyptic AI," where AI systems pose an existential threat to humanity as we know it.[3] While the discourse on the existential and social risks of AI systems can be deeply fascinating (and disturbing), the social value of AI systems cannot be ignored.[4] For instance, the operations of AI are transforming how we live, work, and interact, an indeed, many of us live with an array of invisible algorithms that control our internet searches, bus schedules, traffic lights, security cameras, and smart phones.[5]

A prominent feature of AI's remarkable progress is its influence in the innovation industry. This influence occurs at different levels, but for the purpose of this study, it can be best described as a "vast spectrum" with three crucial points.[6] On one end of the spectrum are humans inventing on their own without AI applications; in the middle are humans increasingly using AI technology to generate inventions;[7] on the other end are AI systems

[2] See Karel Čapek, R.U.R. (Rossum's Universal Robots), Epilogue (Paul Selver & Nigel Playfair trans. 2014) (1920), Surrogates (Touchstone Pictures 2009), H.A.L. 9000 from 2001: A Space Odyssey (Metro Goldwyn-Mayer 1968), HER (Warner Bros. Pictures 2013), Tomorrowland (Walt Disney Pictures 2015), The Terminator (Orion Pictures 1984) and its sequels, Robocop (Orion Pictures 1987) and its sequels, and I, Robot (Twentieth Century Fox 2004)

[3] Robert M. Geraci, *Apocalyptic AI: Visions of Heaven in Robotics, Artificial Intelligence, And Virtual Reality*, (Oxford University Press, 2010); and Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2220 and 2221.

[4] However, Tim Dornis argued that at the moment, we need not fear our own extinction. The idea of a robot revolution remains a sci-fi thrill at most. Similarly, there is no promise or threat of a brave new world of costless manufacture and endless consumption." See Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," (2020) 23 Yale J. L. & Tech. 97 at 101

[5] See Florian Martin-Bariteau & Marina Pavlović, "Introduction" in Florian Martin-Bariteau & Teresa Scassa, eds., Artificial Intelligence and the Law in Canada (Toronto: LexisNexis Canada, 2021) at 2; and Amir H Khoury, "Intellectual Property Rights for Hubots: On the Legal Implications of Human-like Robots as Innovators and Creators" (2017) 35:3 Cardozo Arts & Ent LJ 635 at 636 ("Robots are playing a growing part of everyday life-from autonomous vacuum cleaners to autonomous cars, hospital robotic nurses, and robots in factories, in the workplace, at home, and obviously as Internet search engines."); Craig S. Smith, "A.I. Here, There, Everywhere" (March 9, 2021), online: *The New York Times* <https://www.nytimes.com/2021/02/23/technology/ai-innovation-privacy-seniors-education.html>

[6] See Tabrez Y. Ebrahim, "Artificial Intelligence Inventions & Patent Disclosure," (2020) 125 Penn St. L. Rev. 147, 151; and Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 110-11

[7] Olga Gurgula, "AI-Assisted Inventions in the Field of Drug Discovery: Readjusting the Inventive Step Analysis" (August 29, 2020). International Journal of Social Science and Public Policy, Forthcoming, Available at SSRN: https://ssrn.com/abstract=3683127 at 1

independently developing "real world inventions" without human guidance.[8] In these instances, AI systems may be incorporated into a physical embodiment as used in robotics to increase their ability to operate independently.[9] However, the analysis in this thesis is concerned with the end of the spectrum where AI systems are generating inventions independently without the direct contribution of natural persons and seeks to determine the patentability of those new types of inventions.

Anytime a new technological invention emerges, there are "always debates and calls" for it to be recognized and protected under the patent regime.[10] The popular examples of such discussions relate to computer software, semiconductors, and gene-related inventions.[11] The usual speculation or general estimation is that if such innovations are not protected, they might stifle the development of the industry and create sub-optimal investments in valuable research and development (R&D). And sometimes, the arguments are based on rewarding the inventors for their intellectual labour or creative geniuses.[12]

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[8] Ryan Abbott, "I Think, Therefore I Invent: Creative Computers And The Future Of Patent Law" *supra* note 1; and Amir H Khoury, *supra* note 5 at 635. A system is described as possessing autonomous intelligence if it has the ability to compute information, learn, and reason. See Matthew L. Ginsberg, "Multivalued Logics: A Uniform Approach to Reasoning in Artificial Intelligence" (1988) 4 Computational Intelligence 265

[9] Ross Donald King et al, "The Robot Scientist Adam" (2009) 42 Computer 46-54 at 47

[10] Wissam Aoun, Professor at Windsor Law made this comment during an interview with CBA National Magazine on "Do we need to rethink our intellectual property rights?" See online: <https://www.nationalmagazine.ca/en-ca/articles/law/in-depth/2022/do-we-need-to-rethink-our-intellectual-property-rights>

[11] Andres Guadamuz, "The Software Patent Debate" (2006) 1:3 JIPLP at196-206, 2006; and Rafael A Corredoira, Rafael & Preeta Banerjee, "Measuring Patent's Influence on Technological Evolution: A Study of Knowledge Spanning as Driver of Inventive Activity" (March 31, 2014). Robert H. Smith School Research Paper No. RHS 2428452, Available at SSRN: https://ssrn.com/abstract=2428452 or http://dx.doi.org/10.2139/ssrn.2428452; and Arsenio M Fialho & Ananda M Chakrabarty "Patent controversies and court cases: cancer diagnosis, therapy and prevention" (2012) 13:13 Cancer biology & therapy 1229-34. doi:10.4161/cbt.21958

[12] *See generally* Emir Aly Crowne-Mohammad, *"*The EPC Exceptions to Patentable Subject Matter in the United Kingdom*,"* (2010) 92 J. Pat. & Trademark Off. Soc'y 435; and Emir Aly Crowne-Mohammad*, "*A Review of the 'as such' Exclusions to Patentable Subject Matter in the United Kingdom: Lessons for Canadian and American Courts*,"* (2010) 20 Alb. L.J. Sci. & Tech. 457

It is true that in certain situations, the competitive economy cannot support efficient levels of innovation because rivals could easily enter the market, copy, and sell the essential elements of an invention before the inventors can recoup their R&D costs.[13] And this has the potential to discourage many rational firms from investing the necessary resources to develop new technologies. Economists call this situation - "the public goods problem," which is the inability of firms to internalize the benefits of their investment costs due to competition. This problem creates the need for a state-sanctioned monopoly in the form of patent rights that empowers inventors to prevent free-riding by competitors and consumers and enable them to recoup their fixed costs.[14]

While the state-sanctioned monopoly or patent rights may incentivize investors and inventors to produce new inventions, they can result in social costs such as "deadweight loss," where certain consumers are excluded from the market due to the supra-competitive pricing or scarcity of patented goods.[15] This situation reflects two competing interests, the interests of the patent rightsholders in seeking to maximize the exploitation of the monopoly, and society's interests of increased access to inventions.

Accordingly, the dominant theoretical objective of the global patent system (which is also applicable in Canada) is to maximize social welfare by seeking to strike a delicate balance

[13] See Peter S. Mennell & Suzanne Scotchmer, *Intellectual Property* in A. Mitchell Polinsky and Steven Shavell *Handbook Of Law And Economics*, Forthcoming, UC Berkeley Public Law Research Paper No. 741724, available at SSRN: https://ssrn.com/abstract=741424 at 3

[14] See Bhaven Sampat & Heidi L Williams, "How Do Patents Affect Follow-On Innovation? Evidence from the Human Genome (2019) 109(1) American Economic Review 203 – 204. Countries such as Eritrea, Somalia, East Timor, Suriname, and Maldives do not have local patent laws. See João Francisco Sá, "Which Countries Do Not Belong To The International Patent System?" (24 June 2020), online: *Mondaq* <https://www.mondaq.com/patent/956862/which-countries-do-not-belong-to-the-international-patent-system#:~:text=Countries%20such%20as%20East%20Timor,granting%20or%20enforcement%20of%20patents.>

[15] Mark A Lemley, "Faith-Based Intellectual Property," (2015) 62 UCLA L. Rev. 1328

between solving the "public goods problem" on the one hand, and minimizing the social costs of patent rights on the other hand.[16] To achieve the optimal balance, the social discount rate derived from a patented invention ought to exceed the private monopoly gains attributable to the inventor.[17] For instance, if the scope or length of the monopoly is broader than necessary, it would create a sub-optimal balance from the unjustifiable deadweight loss and decreased Gross Domestic Product (GDP).[18]

Therefore, the patent system is designed to grant property rights only where it is needed to incentivize inventions, the social costs is minimal, and to the degree, the inventor needs to commercialize the invention and recoup their R&D costs.[19] If this is the philosophy of the patent system, the critical question is whether extending patent protection to AI-generated inventions would advance this objective.

There is a vigorous disagreement concerning whether AI-generated inventions should be patentable or excluded from the patent system. On the one hand, some commentators have argued that patenting AI-generated inventions would boost innovation in the AI industry and produce more sophisticated AI systems.[20] On the contrary, some authors have argued that patenting AI-generated inventions may lead to an unwarranted surge of monopolies in

[16] See William M Landes & Richard A. Posner, *supra* note 16 at 21
[17] Mark A Lemley, "Property, Intellectual Property, and Free Riding," (2005) 83 Tex. L. Rev. 1031, 1031
[18] Ibid
[19] David S Olson. "Taking the Utilitarian Basis for Patent Law Seriously: The Case for Restricting Patentable Subject Matter." (2006) Temple Law Review 93
[20] David L. Schwartz and Max Rogers, "Inventorless Inventions? The Constitutional Conundrum of AI-Produced Inventions" (2022) 35 Harv. J of Law & Tech, (Forthcoming), Northwestern Public Law Research Paper No. 22-05, Available at SSRN: https://ssrn.com/abstract=4025434 or http://dx.doi.org/10.2139/ssrn.4025434 at 564 ("As a matter of pure common sense, granting patents on AI-produced inventions would arguably incentivize the further development and ongoing deployment of inventive AI systems.")

the marketplace: worsening the current problem of too many patents[21] and "squeezing humans out of the inventor marketplace."[22] This argument is based on the high inventive capacity of AI systems vis-à-vis the relatively low non-obviousness standard.

Additionally, like other inventions, there are concerns that patenting AI innovations could give rise to social harms such as deadweight loss from monopoly pricing, excessive rent-seeking from "patent trolls," and restriction of secondary inventions.[23] "Patent troll" here refers to companies that are not in the business of producing or manufacturing but acquire patents to "lay traps for producers,"[24] while the restriction of secondary inventions could occur by raising the cost of creating new works and blocking others from exploring the patent's scope.[25] On the other hand, it has been argued that social costs should not be the reason to deny patent protection to new inventions because society is expected to pay for increased inventions temporarily through limited monopoly rights.[26]

This thesis establishes that the above controversies could be resolved in Canada by considering the patent system's overarching social welfare policy. As it would become clearer in later parts of this research, the Canadian patent regime seeks to promote social

[21] *See, e.g., Too Many Patents*, Patent Progress, (26 June 2022), online: <https://www.patentprogress.org/systemic-problems/too-manypatents/>; *see also* Richard A Posner, "Why There are Too Many Patents In America*," supra* note 21 (explaining problems associated with the recent increase in granted patents).
[22] See Pressley Nietering, "Why Artificial Intelligence Shouldn't be a Patent Inventor" (2022) Ariz. L. J. Emerging Technologies 1 at 9
[23] See generally Robert P Merges, "The Trouble with Trolls: Innovation, Rent-Seeking, and Patent Law Reform" (2010) 24 Berkeley Technology Law Journal 1583
[24] Ibid at 1587; Richard A Posner, "Why There are Too Many Patents In America*," supra* note 21
[25] See Ruth Eisenberg, "Bargaining over the transfer of proprietary research tools: Is this market failing or emerging?" RC Dreyfuss, DL Zimmerman, & H First, ed., *In Expanding the Boundaries of Intellectual Property: Innovation Policy for the Knowledge Society*, ed. (Oxford, UK: Oxford Univ. Press, 2001) pp. 223–50.
[26] See *Harvard College v. Canada (Commissioner of Patents)*, [2002] 4 S.C.R. 45 at 69 ("The Patent Act embodies the public policy that those who directly benefit from an invention should be asked, through the patent system, to pay for it, at least in part."); see also Amir H Khoury, *supra* note 5 at 660

prosperity by bringing new inventions to the public, not to compensate natural entitlements or advance the wealth accumulation or private gains of the inventors.[27]

Therefore, this thesis contends that before any invention (including AI-generated inventions) is admitted into the patent regime, specific fundamental questions ought to be answered, including: (a) can they be accommodated under the existing patent framework (b) are they subject to the public goods problem? (c) is it efficient (that is, the allocation of resources that yield the greatest net benefit) to extend patent protection to them? And (d) how should the initial ownership rights be allocated?

These questions are best answered through the analysis of industry-specific empirical data.[28] Indeed, there exist certain empirical findings on AI innovation that would be helpful to the evaluations contained in this thesis.[29] While there may be a need for more experiential evidence on patenting AI-generated inventions, the existing data provides practical insights into the social net benefit of protecting such inventions.

On the other hand, the failure to ask these questions and demand concrete answers can lead to unnecessary social costs from increased patent monopolies. As noted earlier, the

[27] See *Apotex v. Wellcome Foundation* 2002 SCC 77 ("[a] patent is not intended as an accolade or civic award for ingenuity. It is a method by which inventive solutions to practical problems are coaxed into the public domain by the promise of a limited monopoly for a limited time."); and *Free World Trust v Électro Santé Inc* 2000 SCC 66 at para 42

[28] Jeremy De Beer, "Evidence-Based Intellectual Property Policymaking: An Integrated Review of Methods and Conclusions" (2016) 19:5-6 The Journal of World Intellectual Property at p. 150-177.

[29] World Intellectual Property Organization (WIPO), "WIPO Technology Trends 2019: Artificial Intelligence" (accessed on July 19, 2022), online(pdf) at 4: < https://www.wipo.int/publications/en/details.jsp?id=4386>; European Patent Office, "Patents and the Fourth Industrial Revolution" (December 2020), online(pdf) at 29: < https://www.epo.org/service-support/publications.html?pubid=222#tab3>; and Canadian Intellectual Property Office (CIPO), "Processing Artificial Intelligence: Highlighting the Canadian Patent Landscape" (2019), online (pdf) at 8 <Canada.ca/intellectualproperty>

negative impacts of patent monopolies can only be cost-justified from a public interest viewpoint if they are granted in necessary circumstances – where the social benefits are maximized.[30] For example, abstract theorems, scientific principles, and mathematical formulas have been excluded from the *Patent Act* despite their social gains because of their enormous social costs. Specifically, patenting such inventions is likely to stifle technological progress as they are essential tools of scientific and technology research.

Therefore, this thesis asserts that the Canadian patent system is not designed to protect every class of potentially patentable inventions. In other words, patents should not be extended to fields where the social costs resulting from the protection are enormous, there is no evidence to show that the invention is susceptible to the "public goods problem," it may create unwarranted transaction costs, or other incentives exist outside patent law to spur innovation in the industry. It is through these lenses that this thesis examines the patentability of AI-generated inventions in Canada.

1.2. Research Question.

The central question of this thesis is whether AI-generated inventions are protectable under the Canadian patent regime. This question is based on two perspectives: "can" and "should" AI inventions be patentable? The first part involves a positive and descriptive analysis of the existing law. It aims to explain three patent concepts: (a) statutory subject matter, (b) inventorship, and (c) ownership within the context of AI-generated inventions.

[30] See William M Landes & Richard A. Posner, *supra* note 16 at 21

These concepts are critical because they constitute the material framework of the patent system. The first concept represents the "object" of the patent system: what subject matter the law seeks to incentivize its production. The second concept constitutes the "subject" of the patent system: what type of entities the law aims to incentivize their behaviour, while the third concept represents the benefits the patent system grants: how the law seeks to incentivize the development of the subject matter and the behaviour of the inventors.

The second part of the research question is normative and examines the “should” element of the question. It identifies the theoretical underpinnings of the Canadian patent system to determine if extending patent protection to AI-generated inventions supports the objective of the *Patent Act*. It explains the economic structure of the Canadian patent system, the "public goods problem," social costs, social utility balance, and how AI-generated inventions should be dealt with in Canada.

1.3. Research Significance and Contribution

The intersection of AI systems and patent law has been the subject of significant legal scholarship. However, much of the scholarship has been focused on other jurisdictions.[31]

[31] See Ryan Abbott, “I Think, Therefore I Invent: Creative Computers and the Future of Patent Law” *supra* note 1 at 1083-91; W. Michael Schuster, ‘Artificial Intelligence and Patent Ownership’ (2018) 75 Washington and Lee Law Review 194; Tim W. Dornis, “Artificial Intelligence and Innovation: The End of Patent Law As We Know It,” *supra* note 1 at 137; Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2215, 2215; Ben Hattenbach & Joshua Glucoft, Patents in an Era of Infinite Monkeys and Artificial Intelligence, 19 Stan. Tech. L. Rev. 32, 44 (2015), at 50; Ralph D. Clifford, "Intellectual Property in the Era of the Creative Computer Program: Will the True Creator Please Stand Up " (1997) 71:6 Tul L Rev 1675 at 1696 – 1702, 1703; Manny W. Schecter & Jennifer M. Anda, “IBM Corporation Comments in Response to ‘Request for Comments on Patenting Artificial Intelligence Inventions’, 84 Fed. Reg. 44889 (August 27, 2019)” (November 8, 2019) at 3, online: *United States Patent and Trademark Office* https://www.uspto.gov/sites/default/files/documents/IBM_RFC-84-FR044889.pdf.; Daria Kim, “AI-Generated

There has been little attention concerning the intersection of AI and patent law in Canada. At the time of writing this thesis and to the best of the author's knowledge, only Anna Morrish,[32] Gregory Hagen,[33] Aviv Gaon and Ian Stedman[34] have written peer-reviewed works on AI and patents relating to the Canadian patent regime.

The central question of Morrish's work was whether AI technology could be considered an inventor where they assist in developing a drug. She concluded that it "may be possible to define AI as a co-inventor in drug development (because they contributed to the production of the invention), although it is unlikely at this juncture that an AI could be considered a sole inventor (because of they cannot conduct the required experimentation and testing to satisfy the "utility" standard)."[35] She also analyzed how the concepts of "utility" and "non-obviousness" might pose some difficulties relating to the patentability of AI outputs in the pharmaceutical industry.[36]

Hagen's research focused on how the uncertainties around the patentability of AI-generated subject matter would affect the disclosure of information about their inventions and administrative decisions. He concluded that if AI-generated artifacts are not patentable,

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Inventions': Time to Get the Record Straight?" GRUR International, 69(5), 2020, 443–456; Daria Kim, et al, "Ten Assumptions About Artificial Intelligence That Can Mislead Patent Law Analysis," Max Planck Institute for Innovation and Competition Research Paper No. 21-18; Dan L Burk, "AI Patents and the Self-Assembling Machine'" (2021) 105 Minn. L. Rev. Headnotes 301, 317; and Peter Blok, 'The Inventor's New Tool: Artificial Intelligence – How Does It Fit in the European Patent System?' 39(2) E.I.P.R. 69, 73 (2017); and Ryan Abbott, *The Reasonable Robot: Artificial Intelligence and the Law* (Cambridge, UK: Cambridge University Press, 2020) 11

[32] See Anna Morrish, "AI and Patents: Finding Harmony between Protection of Intellectual Property Rights and Innovation" (2021) 33 I.P.J. 253 - 278 at 274

[33] Gregory Hagen, "AI and Patents and Trade Secrets" in Florian Martin-Bariteau & Teresa Scassa, eds., *Artificial Intelligence and the Law in Canada* (Toronto: LexisNexis Canada, 2021) 57

[34] See Aviv Gaon & Ian Stedman, "A Call to Action: Moving Forward with the Governance of Artificial Intelligence in Canada," (2019) 56:4 Alta L Rev 1137 - 1165

[35] See Anna Morrish, *supra* note 32 at 274

[36] Ibid at 273

"then disclosure of information about them might not occur."[37] He recommended ways to ensure the disclosure of the trade secrets of AI outputs, including submitting the information in confidence to a regulatory body. Lastly, Goan and Stedman analyzed the various impacts of AI on Canadian law, including the patent implications of outputs generated by AI. They concluded that since a "patentee" means person, it implicitly suggests that an "inventor" must be a person in Canada.[38]

While these authors provide valuable insights on the interaction between patent law and AI-generated artifacts, they did not categorically answer certain relevant and important questions. First, whether AI-generated inventions can qualify as "statutory subject matters" under the Canadian *Patent Act*? This question is particularly critical because an invention must qualify as a “statutory subject matter” to be patentable, but as chapter five of this research project shows “AI-generated invention” does not entirely fit within the conventional class of patentable inventions. Second, whether AI systems can be an inventor or own and exercise patent rights? The significance of this question would become clearer in chapter four, which established that a patent application must disclose a recognizable inventor and patentee (i.e., owner of the patent rights) for it to be competent. Finally, whether it is theoretically justifiable in Canada to recognize AI as inventors or AI-generated inventions as statutory subject matters, and who should own the initial proprietary rights of the AI-generated inventions? This question has to do with the philosophical underpinnings of the patent system to determine if patenting AI-generated inventions is consistent with the rationale of the patent regime.

[37] Gregory Hagen, “AI and Patents and Trade Secrets,” *supra* note 33 at 41
[38] See Aviv Gaon & Ian Stedman, *supra* note 34 at 1149

Furthermore, the authors did not seem to rely on Driedger's modern principle of statutory interpretation nor the normative utilitarian (and its derivative law and economics) theory to conduct their research analysis. In other words, they did not answer their research questions considering the textual, contextual, and economic structure of the Canadian patent system.

Accordingly, based on my review of existing literature, this thesis is the first attempt to comprehensively analyze the concepts of statutory subject matter, inventorship and ownership using the modern principle, utilitarian, and economics approaches within the context of the Canadian patent regime.

1.4. Research Methodology

A methodology has been described as "a systematic procedure that a scholar applies as part of an intellectual enterprise" and "a way to systematically solve a research problem … various steps … adopted by a researcher in studying his research problem along with the logic behind them."[39] In this regard, this thesis applies the doctrinal, theoretical, and empirical research methods to examine the research question – whether AI-generated inventions are protectable under the Canadian patent regime.

[39] See Elizabeth Fisher et al, eds., "Maturity and Methodology: Starting a Debate about Environmental Law Scholarship" (2009) 21:2 Journal of Environmental Law 213 at 214, 218; and C.R. Kothari, *Research Methodology: Methods and Techniques,* 2nd edn (New Delhi: New Age, 2004) 8. I understand that there are divergent views on what constitutes methodology, in this work, methodology has been used as a collective term to refer to methods, approaches, and theories

Before expatiating on the methods, it is important to highlight that in considering and exploring the research question, this thesis relies on the following sub-research questions (which are based on the “can” and “should” approaches):[40]

1. Can AI systems generate inventions autonomously?
2. Can AI-generated inventions qualify as "statutory subject matters"?
3. Can AI systems be named inventors?
4. Can AI systems own and exercise patent rights?
5. Should AI-generated inventions be patentable? (i.e., are AI-generated inventions subject to the public goods problem? And is it efficient to extend patent protection to AI-generated innovations?)
6. Who should own the initial rights of AI-generated inventions?

These sub-research questions seek to highlight the major themes that I will be considering in the analysis of the research question; the focus of each chapter, and the applicable research methods.

1.4.1. Doctrinal Research

A significant portion of this thesis involves doctrinal research. Doctrinal research is commonly referred to as the foundational tool of most legal studies. It consists of analyzing the sources of law, the connection between legal rules, clarifying areas of difficulty and,

[40] See sections 1.2 of this chapter

perhaps, predicting future legal developments.[41] This method relates directly to research questions that seek to determine whether AI-generated inventions can be protected under the Canadian patent system. To answer this question, chapters three and four undertake an extensive review of the provisions of the Canadian *Patent Act* and relevant jurisprudence.

Chapter three uses the doctrinal research method to describe the legal framework of the Canadian patent system and explain the concept of "statutory subject matter" and how it applies to AI-generated inventions. It begins by examining the meaning of an "invention" under the *Patent Act,* which includes art, process, machines, composition of matter, and manufacture, as well as the "statutory exclusions," which cover abstract theorem and scientific principles, to determine whether AI-generated inventions can be protected. Similarly, chapter four applies doctrinal analysis to discuss the concepts of an "inventorship," "patent ownership," "patentee," and "personhood" under the *Patent Act* in order to determine if AI systems can qualify as "inventors" or "patent owners" and whether AI systems can own and exercise patent rights.

These chapters show that the concepts of statutory subject matter, inventorship, and ownership could be ambiguous as they can be interpreted either broadly or narrowly. Engaging the doctrinal method assists the author in properly construing the three concepts by directing the research to relevant primary and secondary sources of law. Also, the method serves as a vital prequel to the philosophical analysis contained in chapter five. Meanwhile, due to the limited Canadian scholarship on the research questions (in section

[41] Terry Hutchinson & Nigel Duncan. "Defining and Describing What We Do: Doctrinal Legal Research" (2012) 17:1 Deakin Law Review 83-119 at 101

1.3), this thesis partially relies on works relating to foreign jurisdictions in determining the questions while noting the particularities of the different legal systems.

1.4.2. Theoretical Approach

In my opinion, the theoretical underpinnings of the Canadian patent system should be the basis for determining whether patent protection or recognition should be extended to AI-generated inventions and/or AI technology. Thus, this thesis engages normative theories to critically explain how the patent system should respond to AI innovation. There are four main substantive theories that jurists rely on to justify intellectual property protection, and a lot has been written on them already.[42] In the following pages, I will provide a brief overview of the theories: (1) Lockean labour theory; (2) personality theory; (3) the utilitarian; (4) law and economics approach and put forward the normative framework that is relevant to this thesis.

1.4.2.1. Lockean Labour Theory

According to Lockean labour theory, an inventor is entitled to intellectual property rights because of their inherent right to the fruits of their intellectual labour.[43] This philosophical conception is inspired by John Locke's 1690 *Second Treatise of Civil Government: "*every man has a 'property' in his own person."[44] However, I will explain in the thesis (in chapter

[42] See Robert P Merges, *Justifying Intellectual Property* (Cambridge: Harvard University Press, 2011) at 32–33; Justin Hughes, "The Philosophy of Intellectual Property," (1988) 77 Geo. L.J. 287, 288–89, and William Fisher, "Theories of Intellectual Property," in *New Essays in The Legal And Political Theory of Property* 168 (Stephen Munzer, ed. 2001)
[43] John Locke, "Second Treatise of Civil Government" in Peter Laslett, ed., *Locke: Two Treatises of Government*, 3rd ed. (Cambridge, U.K.: Cambridge University Press, 1988); Robert P. Merges, *supra* note 42 at 32-33
[44] Ibid

five) why the labour theory is incompatible with the Canadian patent regime and cannot be used to determine whether patent protection should be extended to AI-generated inventions.

1.4.2.2. Hegelian Personality Theory

Personality theory is often credited to German philosopher Friedrich Hegel who believes that property rights are mediums by which people develop and realize their personalities.[45] Hegel argues that the core of a person's existence is her internal will which constantly seeks to find expression in the external world through her personality.[46] Therefore, private property rights enable an entity to become a person and express its actual will. However, I will describe in later parts of this thesis (precisely, in chapter five) why this theory cannot be used to determine the question of patenting AI-generated inventions in Canada.

1.4.2.3. Utilitarian

The third approach is utilitarian theory, which seeks to promote social good by encouraging the creation and dissemination of new inventions to the public.[47] The theory is grounded in social welfare, not some form of natural law entitlement or fruits of creations as posited by the Lockean labour or Hegelian-personality values. As would become more evident in

[45] Georg. W.F. Hegel, *Philosophy of Right* translated by Thomas Malcolm Knox (Oxford: The Clarendon Press, 1957) Beyond Hegel, many other scholars have advocated similar personality-based justifications of property rights such as Wilhelm von Humboldt and Immanuel Kant. See Tom G. Palmer, "Are Patents and Copyright Morally Justified? The Philosophy of Property Rights and Ideal Objects" (1990) 13 Harv. J.L. & Pub. Pol'y 817 at 821827 at 835843; and Margaret Radin, "Property and Personhood" (1982) 34 Stan. L. Rev. 957

[46] Justin Hughes, *supra* note 42 at 331 ("[f]or Hegel, the individual's will is the core of the individual's existence, constantly seeking actuality and effectiveness in the world" and personality is "the will's struggle to actualize itself")

[47] Ibid

chapter five, the utilitarian theory is public-interest driven and seeks to maximize social welfare by bringing more inventions to the public.[48]

The law is settled in Canada that the patent regime is based on the utilitarian objective of pursuing social good.[49] Consequently, this thesis employs the normative values of utilitarianism to determine if patent protection should be extended to AI-generated inventions.[50] The focus here is to establish whether the common good is best served by recognizing AI-generated inventions as patentable subject matter or AI systems as inventors or owners of patent rights. If the goal of patent law is to encourage innovation and dissemination of new works to the public, this thesis examines whether recognizing AI technologies as inventors or AI-generated inventions as patentable subject matter would advance that goal. Specifically, chapter five of this thesis employs the "incentive principle" in the utilitarian theory to consider whether AI systems can be incentivized to generate inventions and whether non-recognition of AI-generated inventions would lead to a decline in AI investments.

1.4.2.4. Law and Economics

The law and economics theory complements utilitarianism by providing useful theoretical perspectives for measuring and analyzing the goals of the utilitarian model. This thesis engages two of such perspectives: (a) incentives to produce public goods, and (b) allocation

[48] *AstraZeneca Canada Inc. v. Apotex In*., [2017] S.C.J.. No. 36, 2017 SCC 36 at para. 39 (S.C.C.)
[49] See *Free World Trust v Électro Santé Inc* 2000 SCC 66 at para 42
[50] The fifth and sixth questions are: are AI-generated inventions subject to the public goods problem - lack of incentives to innovate? And is it efficient to extend patent protection to AI-generated inventions? respectively

of rights, to determine if AI-generated inventions are subject to the public goods problem - lack of incentives to innovate, is it efficient to extend patent protection to AI-generated inventions, and who should own the initial rights of AI-generated inventions.

a. Incentives to Produce Public Goods

This perspective postulates that patent law seeks to maximize efficiency by solving the "public goods" problem.[51] According to this theory, intellectual property assets are public goods: typically described as nonrivalrous and nonexclusive. Nonrivalrous because the goods can be enjoyed by more than one person at a time, while nonexclusive because they cannot be physically sequestered from consumption.[52] Given these characteristics, rational consumers and producers would likely free-ride such assets because there is no obvious way of enforcing payment.

Patent law solves this "public goods problem" by granting inventors the legal medium to exclude others from copying their inventions, thus encouraging innovations for the benefit of society.[53] However, these exclusion rights also entail social costs such as "deadweight loss" that needs to be balanced against the need for increased inventions. Therefore, extending patent protections to any new technology field, such as AI-generated inventions, must be cost-justified from a social standpoint.

[51] William M Landes & Richard A. Posner, *supra* note 16 at 39-40; Richard A Posner, *Economic Analysis of Law* 6th ed. (Wolters Kluwer Law & Business, 2014)
[52] Pamela Samuelson., "The pure theory of public expenditures" (1954) 36 Rev. Econ. Stat. 387—89
[53] Ibid

This thesis employs the systematic tools of the law and economics approach, including "efficiency," "public goods problem," "social costs," "transaction costs," and "social utility" (as a complement to the utilitarian theory) to determine if AI-generated inventions suffer from the "public goods problem" and identify the inefficiencies of patenting AI-generated inventions and how to address them.

b. Allocation of Rights

This perspective is based on the Coase theorem (a component of the law and economics theory) and seeks to determine the last research sub-question concerning who should be entitled to the initial rights of AI-generated inventions. According to the Coase theorem, in a perfect marketplace, allocation of initial rights is unimportant because they would eventually be transferred to the actor with the highest utility through private bargains.[54] However, the existence of transaction costs makes things complex and complicated.[55] Transaction costs refer to the "costs involved in market exchange," including the costs of discovering market prices, the costs of negotiations, the costs of entering into and enforcing contracts.[56] Given this, the theory recommends that the initial rights be awarded to the party who will derive the most value from the property in order to avoid or minimize transaction costs and advance efficiency.

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[54] Ronald Coase, "The Problem of Social Cost," (1960) 3 J. Law & Econ. 1

[55] Ibid at 8. See also Robert P. Merges, "Of Property Rules, Coase, and Intellectual Proeperty" (1994) 94 Colum. L. Rev. 2655 at 2664; and Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 156

[56] See R.S. Khemani & D.M. Shapiro, "Glossary of Industrial Organisation Economics and Competition Law" (March 14, 2003), online(pdf): *Directorate for Financial, Fiscal and Enterprise Affairs, OECD* < http://www.oecd.org/dataoecd/8/61/2376087.pdf>

As noted above, this thesis employs the Coase theorem to determine who should be entitled to the initial rights of AI-generated inventions (i.e., the party likely to benefit the most from the ownership of AI-generated artifacts).[57] Resolving this issue is problematic because several parties are involved in the spectrum of the AI invention process, such as the developer, programmer, operator, investor, data supplier, trainer, user, and the public, and commentators have suggested different entities as being entitled to claim the benefits of AI-generated inventions.[58] Chapter four engages the Coase theorem to examine which of these parties would value the invention the most from a "transaction costs" and "efficiency" point of view.

1.4.3. Empirical Research

Empiricism refers to any research where the conclusion of the study is drawn from empirical evidence: knowledge from actual observation or experience rather than from theory or belief.[59] As Epstein and King explains: "empirical" denotes evidence about the world based on observation or experience."[60] Therefore, empirical legal scholars take "the law" … as a social construction to be explained by empirically testing causal and non-causal hypotheses." The generally accepted goal of empirical legal research is to compare

[57] See W Michael Schuster, *supra* note 31 at 1978-81
[58] See Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law," *supra* note 1 at 1114–15 ("Ownership rights to computational inventions should vest in a computer's owner because it would be most consistent with the way personal property . . . is treated in the United States and it would most incentivize computational invention."); W Michael Schuster, *supra* note 31 at 1985 (the patent rights should be allocated to the AI user); and Jan Phillip Rektorschek & Tobias Baus, 'Protectability and Enforceability of AIGenerated Inventions' in Kai Jacob, Dierk Schindler & Roger Strathausen (eds), Liquid Legal. Towards a Common Legal Platform (Springer 2020) 459, 475 (the patent rights should be allocated to the employer of the patent system)
[59] Felicity Bell, "Empirical research in law" (2016) 25:2 Griffith Law Review 262-282
[60] Lee Epstein & Gary King. "The rules of inference" (2002) The University of Chicago Law Review 1-133.

the "law in books" with the "law in action" (reference to the applicability of the law in the "real world").[61]

This thesis has some empirical component in the analysis of the research question – should AI-generated inventions be patentable? Although I did not personally conduct any independent empirical research to determine the social welfare balance of patenting AI-generated inventions, this research work relies on several existing empirical data to conduct the determination, including studies conducted by the World Intellectual Property Organization (WIPO),[62] the European Patent Office (EPO),[63] the Canadian Intellectual Property Office (CIPO),[64] and Organisation for Economic Co-operation and Development (OECD) on patenting AI applications and techniques.[65]

1.5. The Structure of the Thesis

The thesis is divided into six chapters. Following the introduction, chapter two focuses on AI's definition, operations, and development. It seeks to explain the technical assumptions in the research questions and determine whether AI systems can independently generate inventions. Chapters three and four examine the intersection of AI-generated inventions and Canadian patent law. They discuss the concepts of statutory subject matter,

[61] Roscoe Pound, "Law in Books and Law in Action" (1910) 44 American Law Review 12.
[62] World Intellectual Property Organization (WIPO), "WIPO Technology Trends 2019: Artificial Intelligence" (accessed on July 19, 2022), online(pdf) at 4: < https://www.wipo.int/publications/en/details.jsp?id=4386>
[63] European Patent Office, "Patents and the Fourth Industrial Revolution" (December 2020), online(pdf) at 29: < https://www.epo.org/service-support/publications.html?pubid=222#tab3>
[64] See Canadian Intellectual Property Office (CIPO), "Processing Artificial Intelligence: Highlighting the Canadian Patent Landscape" (2019), online (pdf) at 8 <Canada.ca/intellectualproperty>
[65] See OECD, "Patents and Innovation: Trends and Policy Challenges" (Paris: OECD publications, 2004) 24.

inventorship, and ownership of patent rights vis-à-vis AI innovation under the Canadian *Patent Act.* Precisely, the chapters aim to discover the Parliament's intention on patenting inventions independently generated by AI technology.

Chapter five examines the economic structure of the patent system and determines whether patent protection should be extended to AI-generated inventions. It addresses several theoretical and practical concerns of patenting AI creativity and suggests a way forward concerning the recognition of such inventions under the Canadian patent system. Lastly, chapter six contains the summary of the thesis' arguments and general conclusions.

1.6. Scope and Limitations

Although interesting and relevant, certain questions remain outside the scope of this thesis. First, this thesis did not empirically study if AI systems can truly invent independently and the range of their inventive enterprise. Instead, it relies on several existing publications and patent applications to presume that AI systems can create human-like inventions. Second, this thesis reviews specific court decisions arising from the United Kingdom, United States and Australia on AI inventorship vis-à-vis the Canadian patent system to appreciate the international scope of the research problem, but it did not undertake an in-depth comparative analysis. Finally, issues relating to electronic personhood for AI systems and the patentability criteria of novelty, non-obviousness, and utility, are mentioned only in passing and are not examined in full detail because of time and length constraints.

Chapter Two: Understanding Artificial Intelligence (AI)

AI has become an indispensable part of how we live and work. More and more of our daily lives involve interacting with AI to render services, communicate, complete school tasks, conduct businesses, and store information.[66] For instance, AI technologies underlie many Internet tools, chess-playing machines,[67] face and speech recognition,[68] autonomous driving,[69] research assistants,[70] translation and even autonomous writing such as sports news and stock exchange reports.[71] As Amir Khoury pointed out, "humanity is at the doorstep of a world full of Al robots" and Al systems are set to become a "possibly dominant part of the way we live, interact, communicate, travel, and do business."[72]

Given the rapid development of robotics, nanotechnology, bioinformatics, and computers, the social value of AI is taking a new dimension as there are now reports of AI systems independently generating inventions. In fact, some scholars have expressed concerns about "the *substitution* of human creativity, innovation, and productivity by AI."[73] While this thesis aims to determine whether such inventions can be protected under the Canadian

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[66] Nick Heath, "What is AI? Here's everything you need to know about artificial intelligence" (July 23, 2021), online: *ZD Net* <https://www.zdnet.com/article/what-is-ai-heres-everything-you-need-to-know-about-artificial-intelligence/>

[67] See Steven Strogatz, One Giant Step for a Chess-Playing Machine, N.Y. TIMES (July 17, 2019), <https://www.nytimes.com/2018/12/26/science/chessartificial-intelligence.html.>

[68] Thomas Smith, "The AI That Knows Your Face — From Your Voice" (November 20, 2019) <https://medium.com/swlh/the-ai-that-knows-your-face-from-your-voice-90772b352f2a>

[69] See, e.g., Suhasini Gadam, Artificial Intelligence and Autonomous Vehicles, MEDIUM (Apr. 19, 2019), https://medium.com/datadriveninvestor/artificialintelligence-and-autonomous-vehicles-ae877feb6cd2.

[70] See Anne Gulland, "Scientists Claim to Have Developed World's First Vaccine with Artificial Intelligence" (3 July 2019), online: *The Telegraph* <www.telegraph.co.uk/global-health/science -and-disease/scientists-claim-have-developed-worlds-first-vaccine-artificial/> [In 2019, a group of AI researchers at Flinders University in Australia reportedly used AI to make a flu vaccine approved for human trials. The AI reportedly sped up the development process and substantially reduced costs].

[71] See, e.g., Jaclyn Peiser, The Rise of the Robot Reporter, N.Y. TIMES (Feb. 5, 2019) https://www.nytimes.com/2019/02/05/business/media/artificialintelligence-journalism-robots.html

[72] Amir H Khoury, *supra* note 5 at 637

[73] Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 101

patent regime, it is important to understand the meaning and operations of this new digital frontier – AI.

Accordingly, this chapter tackles three questions: what is AI? How does it function? And can AI systems develop inventions? These questions aim to explain the technical assumptions in this research and discuss how reported advancements in computing power are paving the way for robust and autonomous AI systems.

The analysis in this chapter is divided into three main parts. Part 1 discusses the meaning of AI and the theoretical challenges raised by the definition of AI. Part 2 briefly examines the two key subfields of AI: machine learning and evolutionary algorithms. Part 3 discusses whether AI systems can invent independently and provides examples of AI-generated inventions.

2.1. What is Artificial Intelligence? And how does it function?

There is no universally accepted definition of AI, even amongst experts and after sixty decades of the term being in existence.[74] Instead, what we have is a collection of descriptions that emphasize different areas of AI.[75] Basically, AI consists of two linguistic constituents: "artificial" and "intelligence."

[74] See Matthew U. Scherer, "Regulating Artificial Intelligent Systems: Risks, Challenges, Competencies, and Strategies," (2016) 29 Harv. J.L. & Tech. 353, 354-55 at 360 (definitions tend to focus on human functions such as the ability to learn, consciousness, and self-awareness, all of which are difficult to classify)

[75] See Mathew U Scherer, *supra* note 74 at 359 (AI are "[m]achines that are capable of performing tasks that, if performed by a human, would be said to require intelligence"); Josef Drexl et al. "Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective,"(October 2019), online: *SSRN* <https://ssrn.com/abstract=3465577> (AI are "computer based systems that are developed to mimic human behaviour."); Nils J Nilsson, *The Quest for Artificial Intelligence: A History of Ideas and Achievements* (Cambridge, UK: Cambridge

"Artificial" refers to something made by humankind other than nature; caused or produced by a human, or humanly contrived,[76] and it is usually used in contrast to "natural" –created by, existing in, or caused by nature.[77] Today, it is not difficult to distinguish "natural" from "artificial" in the field of technology, although the difference is becoming blurring given the prospects of biological computers.[78]

Intelligence, on the other hand, is harder to define. As Mathew Scherer stated, the difficulty in defining AI "lies not in the concept of artificiality but rather in the conceptual ambiguity of intelligence."[79] The late AI pioneer John McCarthy, commonly known for coining the term "artificial intelligence," acknowledged the difficulty and concluded that "we cannot yet characterize in general what kinds of computational procedures we want to call intelligent."[80]

University Press, 2010) 13 (AI is the "activity devoted to making machines intelligent, and intelligence is that quality that enables an entity to function appropriately and with foresight in its environment."); Ryan Abbott, *The Reasonable Robot, supra* note 31 at 22 (AI is "an algorithm or machine capable of completing tasks that would otherwise require cognition. Cognition refers to mental capabilities and the process of acquiring knowledge and understanding through thought"); John McCarthy, "What is Artificial Intelligence?",(12 Nov. 2007), online (pdf) at 2-3: John Mccarthy's Home Page <http://www-formal.stanford.edu/jmc/whatisai.pdf> [https://perma.cc/ U3RT-Q7JK]. (McCarthy defined AI as "the science and engineering of making intelligent machines, especially intelligent computer programs); Similarly, Marvin Minsky, an American computer and cognitive scientist, defined AI as software and technological instruments that "behave in ways that probably everyone would agree seem to show intelligence." See Marvin Minsky, "Artificial Intelligence," (1966) 215 SCI. AM. 246, 247

[76] Merriam-Webster Dictionary, "artificial," (Merriam-Webster Incorporated, 2022), online: <https://www.merriam-webster.com/dictionary/artificial>

[77] Ibid

[78] These are computers that use "natural proteins and DNA to store, retrieve and process data .See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 22, 86 ("Functioning biological computers do not yet exist, but all the necessary building blocks have been created. In 2013, a team of Stanford University engineers created a biological version of an electrical transistor.")

[79] See Mathew U Scherer, *supra* note 74 at at 359; Shane Legg & Marcus Hutter, "Universal intelligence: A definition of machine intelligence" (2007) 17:4 Minds and Machines 391 ("A fundamental problem in artificial intelligence is that nobody really knows what intelligence is. The problem is especially acute when we need to consider artificial systems which are significantly different to humans")

[80] See John McCarthy, "What is Artificial Intelligence?",(12 Nov. 2007), online (pdf) at 2-3: John Mccarthy's Home Page <http://www-formal.stanford.edu/jmc/whatisai.pdf> [https://perma.cc/ U3RT-Q7JK].

Some commentators have attempted to define intelligence in various ways.[81] However, Stuart Russell and Peter Norvig, perhaps the most popular authors on the subject, examined the common definitions of AI and grouped them into four categories: thinking rationally, acting rationally, thinking humanly, and acting humanly.[82] Thereafter, they defined AI as "the designing and building of intelligent agents that receive precepts from the environment and take actions that affect that environment."[83]

Although there is no one-size-fits-all definition of AI, given its multifaceted and dynamic nature, a research project on the legal implications of AI artifacts, like this thesis, should have a working definition. Therefore, this project considers AI systems as a spectrum of techniques or smart machines capable of performing tasks that typically require mental capabilities or cognition or capable of making decisions that affect the real or virtual environment.[84] The prominent feature of the definition is that AI is a general concept that exhibits capabilities and cognition like that of a rational being.

The range of AI's intelligent functions is vast. It includes problem-solving, dynamism and ever-changing, testing hypotheses, pattern recognition and detection, decision-making,

[81] See Shane Legg & Marcus Hutter, "Universal intelligence: A definition of machine intelligence" (2007) 17:4 Minds and Machines 411. (Shane Legg and Marcus Hutter, in a bid to define intelligence, surveyed several prominent informal definitions of intelligence and concluded that intelligence is measured in terms of "an agent's ability to achieve goals in a wide range of environments."); Colin McIntosh, "Intelligence"(14 February 2022), online: Cambridge Advanced Learner's Dictionary <https://dictionary.cambridge.org/dictionary/english/intelligence> (in common parlance, intelligence is "the ability to learn, understand, and make judgments or have opinions that are based on reason.)

[82] See Stuart J. Russell & Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd Ed (New Jersey: Pearson Education, Inc, 2010) at 1 -5.

[83] Ibid

[84] See Organization for Economic Cooperation and Development, *Artificial Intelligence in Society* (Paris: OECD Publishing, 2019) at 23, online: <https://doi.org/10.2760/382730>

natural language processing and translation, optimization, and prediction.[85] These AI's intelligent functions aim to have machines that can emulate human-like functioning and abilities or are capable of actions that ordinarily require intelligence.[86] Indeed, most AI research draws inspiration from human mental skills and behaviours.[87] Nonetheless, the seeming relationship between AI and human intelligence should not be seen as equating human intelligence to AI. At least for now, unlike humans, AI is not conscious, self-aware, comprehensible, and capable of general thinking.[88]

2.2. Subfields of Artificial Intelligence: Machine Learning and Evolutionary Algorithms

While it may be difficult to define AI, it is commonly understood that AI is a broad spectrum that covers several subfields, and the two most prominent subfields are: machine learning (ML) and evolutionary algorithms.

The first subfield - ML, has been the driving force of AI.[89] It trains a computer program to use algorithms to automatically identify, analyze, and extract useful patterns and

[85] Emelia Gomez, Giuditta De Prato, Fernando Marti'nez-Plumed & Blagoj Delipetrev, *AI Watch-Defining Artificial Intelligence: Towards an Operational Definition and Taxonomy of Artificial Intelligence* (Luxembourg: Publications Office of the European Union, 2020) at 11, 17, online: <https://doi/org/10.2760/382730>; and Bryan Casey & Mark A. Lemley, "You Might Be a Robot" (2019) 105 Corn. L. Rev. 287 at 294

[86] See Florian Martin-Bariteau & Marina Pavlović, "Introduction" in Florian Martin-Bariteau & Teresa Scassa, eds., Artificial Intelligence and the Law in Canada (Toronto: LexisNexis Canada, 2021) at 2

[87] Ethem Alpaydin, *Machine Learning* (Cambridge, MA: M.I.T. Press, 2016) at 19

[88] Abdullah A. Abonamah, Muhammad Usman Tariq, & Samar Shilbayeh, "On the Commoditization of Artificial Intelligence" (30 September 2021), 12: 696346 Frontiers in psychology, doi:10.3389/fpsyg.2021.696346; Ryan Abbott, "Everything is Obvious," UCLA Law Review, 66(1), 2 – 53, 25; Ryan Abbott, *The Reasonable Robot, supra* note 31 at 33.

[89] John D. Kelleher, *Deep Learning* (Cambridge, MA: M.I.T. Press, 2019) at 5.

correlations from large data sets.[90] The ML process enables machines to learn from patterns and "think" through neural networks and entails several steps.[91]

The first step is developing or programming the model architecture and then subjecting it to a training process, which involves using algorithms to analyze a large data set.[92] Thereafter, a trained model is developed that would be applied to new data or circumstances to get certain results. The result of a machine learning process (i.e. the ML model) depends on the analysis of the data sets and the detection of existing correlations and patterns within the data.[93]

The data set (i.e. the training data) is the most treasurable element of the machine learning process. The better the training data in terms of variety, quality, and quantity, the more accurate and precise the trainable parameters and the model.[94] AI systems continue to evolve according to new data.[95]

Another essential element of the machine learning process is "algorithms." Algorithms do the data analysis. Generally, algorithms are designed as software to facilitate their readability by computers.[96] Many well-known training algorithms are available online in

[90] European Commission, "Artificial Intelligence for Europe," COM (2018) 237 final, p. 10
[91] John D. Kelleher, *Deep Learning* (Cambridge, MA: M.I.T. Press, 2019) at 5.
[92] Ibid
[93] See David Lehr & Paul Ohm, Playing with the Data: What Legal Scholars Should Learn About Machine Learning, 51 U.C. Davis L. Rev. 653, 670-71 (2017); Cf. Peter Flach, Machine Learning: The Art And Science Of Algorithms That Make Sense Of Data 3 (2012) ("Machine learning is the systematic study of algorithms and systems that improve their knowledge or performance with experience.").
[94] See Josef Drexl et al., "Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective," (October 2019), online(pdf) at 4 *SSRN* <https://ssrn.com/abstract=3465577>.
[95] Ibid
[96] Ibid

open-source collections in the form of pre-written software.[97] However, new algorithms may need to be generated in certain situations, requiring human and financial commitments.

There is also the "ML model," which is the immediate output of the training process. One type of model is artificial neural networks (ANN), which imitate the functioning of a human brain.[98] The artificial neural networks evaluate data "by applying a series of mathematical transformations and thereby execute processes resembling human learning experiences."[99]

Finally, another prominent feature of machine learning is the "model architecture," typically created by the programmer before the training process and composed of stratums of neurons connected by weights.[100]

In practical terms, all these features interact to complete the machine learning process; the training data is 'fed' into the model architecture. After that, the training algorithm analyzes the training data, leading to optimizing the trainable parameters and generating an ML model.[101]

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[97] Ibid
[98] John D. Kelleher, *Deep Learning* (Cambridge, MA: M.I.T. Press, 2019) at 5.
[99] See Robin C. Feldman, "Artificial Intelligence" (2018) 21 Green Bag 2d 201, 202–203; Madeleine de Cock Buning, "Autonomous Intelligent Systems as Creative Agents under the EU Framework for Intellectual Property" (2016) 7 European Journal of Risk Regulation 310, 312.
[100] See Josef Drexl et al., "Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective," (October 2019), online(pdf) at 4 *SSRN* <https://ssrn.com/abstract=3465577≥ 5. ("Each neuron is a mathematical function that transforms inputs (the numeric value of the upstream weights) into an output (the numeric value of the downstream weights). The model is composed of the sum of all the functions entailed in the neurons")
[101] Ibid at 7

There are two forms of machine learning: supervised and unsupervised learning. The model is "instructed" during the optimization process on what the training data represents for supervised learning. Here, the training data is labelled and it is currently the most prevalent form of machine learning.[102] In the case of unsupervised learning, the training data is unlabelled and the training involves less human participation and a more rigorous human interpretation of the output.[103]

Machine learning is a rapidly evolving field and can be applied in all segments of society to optimize decision-making and promote innovation.[104] It accounts for many functions of AI and is widely regarded as the compelling energy for the entire technological development in the future.[105] The current prevalent penetration of machine learning is attributed chiefly to advanced software, the growth of big data (that can be used for the training process), and the upsurge in computing power.[106]

On the other hand, an evolutionary algorithm is an AI-based application that solves problems by identifying the best solution for a given problem out of several alternatives.[107] This optimization process relies on Darwinian principles and has proven to be powerful.

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[102] Ibid
[103] Ibid at 10
[104] Ethem Alpaydin, *Machine Learning* (Cambridge, MA: M.I.T. Press, 2016) at 17
[105] See for example European Parliament, P8_TA(2017)0051, 'Civil Law Rules on Robotics, European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL))' sub B; Peter Stone and others, 'Artificial Intelligence and Life in 2030, One Hundred Year Study on Artificial Intelligence: Report of the 2015-2016 Study Panel, Stanford University' accessed 27 July 2020; Ekkehard Ernst, Rossana Merola and Daniel Samaan, 'The economics of artificial intelligence: Implications for the future of work' (ILO 2018) accessed 27 July 2020.
[106] Economic literature argues that breakthroughs in relation to machine learning techniques and hence the technological side are the reason for widespread application and technology diffusion. See Jason Furman & Robert Seamans, "AI and the Economy," (June 2018), online(pdf) at p.4: *National Bureau of Economic Research* <https://www.nber.org/papers/w24689> 'performance increases are due to breakthroughs in various machine learning techniques' or 'these scientific breakthroughs are starting to find their way to commercial applications'.
[107] Ibid at 10

The fragile solutions are removed while stronger and more worthwhile options are retained and re-evaluated in the subsequent evolution.

An evolutionary algorithm does not require training data, as in the case of ANN.[108] Instead, it evaluates the quality of possible solutions (already generated) and selects the best-suited ones. Then, the best-suited ones are improved using reproduction, recombination, and mutation mechanisms. This process produces a new population which is again assessed. The procedure continues until an optimal solution is found. The adaptive process of selecting the best available solutions to a problem is similar to Darwin's survival of the fittest.[109] Evolutionary algorithms can be applied to find the best model developed by the machine learning.[110]

Evolutionary Algorithms are composed of three main categories: evolution strategies, evolutionary programming, and genetic algorithms.[111] They use the same conceptual framework and only differ in the "representations of individuals and schemes for implementing fitness evaluation, selection and search operators."[112] In the case of evolution strategies, an individual is taken "as a vector of real numbers;"[113] while in the case of evolutionary programming, each individual is represented "as a pair of real-valued

[108] Ibid at 11.

[109] Techtarget, "evolutionary algorithm" (2018), online: *Techtarget* <https://whatis.techtarget.com/definition/evolutionary-algorithm>

[110] See Josef Drexl et al., "Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective," (October 2019), online(pdf) at 4 *SSRN* <https://ssrn.com/abstract=3465577>. 11.

[111] Xin Yao, 'Evolutionary Computation. A Gentle Introduction' in Ruhul Sarker, Masoud Mohammadian and Xin Yao (eds), Evolutionary Optimization. International Series in Operations Research & Management Science, vol 48 (Springer 2003) 27, 29-34; Daria Kim, et al, "Ten Assumptions About Artificial Intelligence That Can Mislead Patent Law Analysis," *supra* note 31 at 6.

[112] Ibid

[113] Ibid

vectors."[114] On the other hand, genetic algorithms use 'binary representation [whereby] each individual will be represented by several binary bits, 0 or 1.'[115]

2.3. AI Autonomy: Can Artificial Intelligence invent?

The goal of AI research is to build agents that are increasingly better at mimicking and even surpassing human intelligence.[116] Indeed, in certain aspects like speed, organization, and efficiency, AI systems have since gone beyond human intelligence. The development of AI technology fast-tracked exponentially in the 2010s.[117] In December 2015, Bloomberg Tech Journalist Jack Clark observed that "[c]omputers are smarter and learning faster than ever."[118] This phenomenal progress has been credited to improved computing power, large data sets, cloud computing, and advanced software like evolutionary algorithms and ANNs,[119] leading to reports of AI systems being able to generate inventions independently.[120]

Even the World Intellectual Property Organization (WIPO) acknowledged these reports by stating that "it would now seem clear that inventions can be autonomously generated by AI…."[121] Robert Plotkin noted that modern AI systems have genie's capabilities to solve

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[114] Ibid
[115] Ibid
[116] Stuart Russell, *Human Compatible: Artificial Intelligence and the Problem of Control* (New York: Viking 2019) at 9 – 11.
[117] See Erik Brynjolfsson & Andrew Mcafee, *The Second Machine Age: Work, Progress, And Prosperity In A Time Of Brilliant Technologies (*W.W. Norton & Co., 1st ed. 2014) at 20.
[118] See Jack Clark, "Why 2015 Was a Breakthrough Year in Artificial Intelligence," (8 December 2015) *Bloomberg Tech*. <https://www.bloomberg.com/news/articles/2015-12-08/why-2015-was-a-breakthrough-yearin-artificial-intelligence.
[119] See Aleksandra Bar, *supra* note 1 at 73
[120] Ibid, and Ryan Abbott, 'I Think, Therefore I Invent: Creative computers and the future of patent law' (2016) 57(4) B.C.L. Rev. 1079, 1081.
[121] World Intellectual Property Organization Secretariat, *WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI): Draft Issues Paper on Intellectual Property Policy and Artificial Intelligence* (December 13, 19), online

technical problems. According to him, a human only needs to make a wish, and an AI system would develop it.[122] This is quite impressive, suggesting that the mere statement of a goal is sufficient for an AI system to solve a problem "on its own."

However, before analyzing the reported cases, it is important to highlight that some scholars have expressed reservations regarding the ability of AI systems to invent autonomously.[123] They argue that it seems "premature to conclude that AI can autonomously generate inventions" and that AI is "currently and will remain a tool for a human inventor" for the foreseeable future.[124] Donald Clark, an AI expert, warned that "we must be careful" about anthropomorphizing AI, usually involved in "math, statistical analysis and pattern matching."[125] Similarly, other commentators have stated that the prevalent use of anthropomorphic language to describe AI "inadvertently promotes misleading interpretations" of AI's capacities.[126]

According to other skeptics like Daria Kim, Senior Research Fellow in the Department of Intellectual Property and Competition Law at the Max Planck Institute for Innovation and Competition, human guidance and decision-making are central to ML systems outcomes

(pdf) at 3: *World Intellectual Property Organization* https://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ip_ai_2_ge_20/wipo_ip_ai_2_ge_20_1.

[122] See Robert Plotkin, *supra* note 1 at 2-3.

[123] See James Grimmelmann, "There's No Such Thing As A Computer-Authored Work-and It's A Good Thing, Too," (2016) 39 Colum. J. L. & Arts 403, 408.

[124] See e.g. Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight," *supra* note 31 at 6, 116

[125] See Donald Clark, *Artificial Intelligence for Learning: How to Use AI to Support Employee Developmen*t (Kogan Page 2020) 30-31 (referring to the anthropomorphisation of AI as a 'dangerous tendency' and 'a type of category mistake') at 231.

[126] See Arleen Salles, Kathinka Evers & Michele Farisco, "Anthropomorphism in AI" (2020) 11 AJOB Neuroscience 88, 93. See also 'Open Letter of to the European Commission. Artificial Intelligence and Robotics' para 2 (accessed 21 Jul 2021) (warning that an understanding of AI as 'selflearning' is 'superficial' and reflects 'an overvaluation of the actual capabilities' of AI systems). See generally David Watson, "The Rhetoric and Reality of Anthropomorphism in Artificial Intelligence" (2019) 29 Minds and Machines 417.

because humans' overall computational set-up shape the ML processes.[127] Therefore, AI characteristics such as "autonomy" or "self-learning" are "based on an overvaluation of the actual capabilities of even the most advanced robots."[128] In other words, AI's creativity is the mere "outputs of a process whose steps are precise and explicit."[129] In response to these skeptics, Russ Pearlman, a computer scientist and lawyer, stated, "…those that detract from the potential for AI creativity fail to distinguish between deep-learning approaches that mimic human mental process versus general purpose algorithms that merely automate pre-defined rules and steps."[130]

Due to the significant difference in opinions concerning the status of AI's creativity, it may be challenging to assert categorically whether AI systems can create inventions. This may require further empirical studies to resolve the controversies, which is beyond the scope of this study. However, prominent scholars, organizations, and corporations have cited and relied on reported cases of "AI-generated inventions" (rightly or wrongly).[131] For instance,

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[127] See Daria Kim et al. "Clarifying Assumptions About Artificial Intelligence Before Revolutionising Patent Law" (2022) 71(4) GRUR International at 310

[128] Daria Kim, "AI – Generated Inventions: Time to Get the Record Straight," *supra* note 31 at 443 – 456, 444; Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 317 (pointing out that, '[a]sserting that AI tools are either inventors or infringers is equally absurd and can only be based on ignoring the human hand at work behind the AI'). See also Rose Hughes, 'Is It Time to Move On from the AI Inventor Debate?' (IPKat, 2 Dec 2020) (accessed 21 May 2021); and Kaelyn R Knutson, 'Anything You Can Do, AI Can Do Better: An Analysis of Conception as a Requirement for Patent Inventorship and a Rationale for Excluding AI Inventors', Cybaris, Vol 11, Issue 2, Art 2, p24 (There has to be strong empirical evidence to underpin any assertion that AI could replicate human cognition when one looks at the weight of cognitive neuroscience and evolutionary anthropology).

[129] See James Grimmelmann, "There's No Such Thing As A Computer-Authored Work-and It's A Good Thing, Too," (2016) 39 Colum. J. L. & Arts 403, 408.

[130] Russ Pearlman, "Recognizing Artificial Intelligence (AI) As Authors and Inventors Under U.S. Intellectual Property Law," (2018) 24 Rich. J. L. & Tech., no. 2 at 27.

[131] See Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law," (2016) 57 B.C. L. REv. 1079, 1083-91; Nick Li & Tzeyi Koay, *supra* note 1 at 400. ('The question is no longer 'can AI invent'– the answer to that must be a resounding yes.'); Aleksandra Bar, *supra* note 1 at 17 ("AI systems are already capable of autonomously generating 'real world inventions"); Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2215, 2221 ("AI advanced systems are becoming capable of creating unpredictable, innovative outcomes independently, rather than merely by following digital orders"); Robert Plotkin, *supra* note at 1 ("AI is not a science fiction movie, it is "already here, and we're already buying and using its creations"); and Ernest Fok, Challenging the International Trend: The Case for Artificial Intelligence Inventorship in the United States, (2021)19 Santa Clara J. of Inter'l Law 51, 62.

the World Economic Forum (WEF) noted in 2018 that AI is no longer "just crunching numbers" but is generating works of a sort that have historically been protected as "inventive" or as requiring human ingenuity.[132] Also, while requesting comments on the intersection between AI and patents, WIPO acknowledged that "it would now seem clear that inventions can be autonomously generated by AI…."[133]

Furthermore, concerning whether AI can independently generate inventions, in 2019, during one of the sessions held by WIPO on the intersection between AI and IP, a Fortune 100 company, Siemens, claimed that it had several AI-generated inventions within its custody.[134] However, according to Siemens, it did not file for patent protection for the AI-generated inventions because it could not identify a human being eligible as the inventor of those inventions.[135] Similarly, Ryan Abbott, Professor of Law at the University of Surrey, states, "[c]omputers have been autonomously creating inventions since the twentieth century."[136] Some examples of the well-known inventive AI systems include the creativity machine,[137] the genetic programming software,[138] AI applications in drug

[132] The World Economic Forum (WEF), *supra* note 1 at 6
[133] World Intellectual Property Organization Secretariat, *WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI): Draft Issues Paper on Intellectual Property Policy and Artificial Intelligence* (December 13, 19), online (pdf) at 3: *World Intellectual Property Organization* https://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ip_ai_2_ge_20/wipo_ip_ai_2_ge_20_1.
[134] See Beat Weibel, "AI Created Inventions – Digital Inventor Computer-Implemented Simulations – Digital Twin," (September 30, 2019), www WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI) <wipo.int/meetings/en/doc_details.jsp? doc_id=454861>.
[135] Ibid
[136] Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law," *supra* note 1 at 1083.
[137] Stephen L Thaler, 'Creativity MachineVR Paradigm' in Elias G Carayannis (ed), Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship (Springer 2013) 447, 451. 34.
[138] Homepage of John R Koza accessed 3 March 2020 (stating that 'genetic programming may produce a result that is equivalent to an invention that was patented in the past or that is patentable today as a new invention'). See generally John R Koza, 'Human-competitive Results Produced by Genetic Programming' 11 Genet. Program. Evolvable Mach. 251 (2010); Matthew J Streeter, Martin A Keane and John R Koza, 'Routine Duplication of Post-2000 Patented Inventions by Means of Genetic Programming' in James A Foster and others (eds), Genetic Programming 5th European Conference, EuroGP 2002, Kinsale, Ireland, April 2002 Proceedings (Springer 2002) 26.

discovery and development,[139] the invention machine,[140] the DABUS connectionist system,[141] and innovative devices and methods for generating enhanced solutions.[142] The next section will examine some of these inventions.

2.3.1. Creativity Machine

As far back as 1994, computer scientist and technologist Stephen Thaler disclosed that an AI system called a "Creativity Machine" could generate novel ideas using ANN.[143] Thaler likened the Creativity Machine to a human brain because it could mimic the interconnections and interactions among neurons in the brain.[144] Like the brain, the Creativity Machine can adapt to new scenarios and produce original patterns of information without extra human input, not just simply associating patterns.[145]

Thaler patented the "Creativity Machine" under the title: "Device for the Autonomous Generation of Useful Information."[146] Subsequently, he claimed that the patented Creativity Machine developed an invention titled "Neural Network-Based Prototyping

[139] Robert Plotkin, *supra* note at 61 (providing few other examples).
[140] ANN are essentially the combinations of on/off switches that automatically connect themselves to produce software without human involvement. See Stephen L. Thaler, Synaptic Perturbation and Consciousness, (2014) 6 Int'l J. Machine Consciousness 75.
[141] See Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" *supra* note 1 at 1079, 1085.
[142] For further examples, see Robert Plotkin, *supra* note 1 at 60; Peter M. Kohlhepp, "When the Invention Is an Inventor: Revitalizing Patentable Subject Matter to Exclude Unpredictable Processes," (2008) 93 Minn. L. Rev. 779, 786; Hattenbach & Glucoft, *supra* note 31 at 35. Finally, see the patent "Computer designed stabilized proteins and method for producing same," U.S. Patent No 4,908,773 (filed Apr. 6, 1987). (examples of such autonomously innovative AI solutions include the design of the front cover of a Japanese high-speed train, an aircraft motor and other kinds of engines, and numerous pharmaceutical and medicinal substances)
[143] See Jeremy Hadfield, "Imagination and Creativity in Artificial Neural Networks" (accessed on 8 June 2022), online: *Darmouth Comp Neuro* <http://brainengineering.dartmouth.edu/psyc40wiki/index.php/Imagination_and_Creativity_in_Artificial_Neural_Networks>.
[144] Ryan Abbott, *The Reasonable Robot, supra* note 31 at 73
[145] Ibid
[146] See U.S. Patent No. 5,659,666 (filed Oct. 13, 1994).

System and Method (NNBPSM)," which was the subject of a second patent application filed on January 26, 1996.[147] The USPTO granted the patent on December 22, 1998.[148] On the advice of his attorneys, Thaler listed himself as the inventor in the patent application and did not disclose the role of the Creativity Machine to the patent office. If Thaler's claims are accurate, it means the USPTO granted a patent for an AI-generated invention as early as 1998, although the Patent Office had no idea it did.[149] Beyond NNBPSM, the Creativity Machine has been credited with several inventions, including the cross-bristle design of the Oral-B CrossAction toothbrush, internet search devices, and new super-strong materials.[150]

2.3.2. Genetic Programming (GP) Software

GP software is another example of an Inventive AI.[151] It is a system that facilitates a computer to write computer programs automatically.[152] The genetic programmer provides the initial specifications, parameters and rules for the algorithmic approach, but the system evolves without further human intervention.[153] After some time, the algorithmic system develops its internal architecture for problem-solving and inventing, which may vary

[147] See U.S. Patent No. 5,852,815 (filed May 15, 1998).
[148] See U.S. Patent & Trademark Office, Manual of Patent Examining Procedure § 2164 (9th ed. Rev 7, Nov. 2015) [hereinafter MPEP]; and Ryan Abbott, I think, therefore I invent at page 1085.
[149] Ryan Abbott, *The Reasonable Robot, supra* note 31 at 73
[150] See, e.g., U.S. Patent No. 7,117,186 (filed Jan. 30, 2003) (issued Oct. 3, 2006); U.S. Patent No. 6,532,453 (filed Apr. 12, 1999) (issued Mar. 11, 2003); U.S. Patent No. 6,360,191 (filed Jan. 5, 1999) (issued Mar. 19, 2002); Ryan Abbott, I think therefore I invent," *supra* note 1 at page 1085; See Robert Plotkin, *The Genie in the Machine: How Computer-automated inventing is revolutionizing Law and Business* (Stanford, California: Standard University Press, 2009) 1.
[151] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 75
[152] See Robert Plotkin, *supra* note 1 at 55.
[153] See Riccardo Poli & John Koza, Genetic Programming, *Search Methodologies: Introductory Tutorials In Optimization And Decision Support Techniques* 143, 147 (Edmund K. Burke & Graham Kendall eds., 2014).

significantly from its initial programming.[154] The process can thus be termed emancipation or child development.[155]

The GP software emulates evolutionary processes like mutation, natural selection, and sexual recombination to attain human-competitive intelligence and generate patentable results.[156] John Koza, a computer scientist and AI genetic algorithms pioneer, noted that since 1996 the GP software had been independently generating patentable results.[157] Koza developed a GP software called "The Invention Machine,"[158] modelled after the process of biological evolution.[159]

On January 25, 2005, Koza claimed that the USPTO granted a patent for an invention independently generated by the "Invention Machine."[160] The Patent was for an enhanced version of a notable controller developed in 1995,[161] which a 2006 article referred to as "Apparatus for Improved General-Purpose PID and non-PID Controllers" (the "Invention

[154] See also, e.g., Liza Vertinsky & Todd M. Rice, "Thinking About Thinking Machines: Implications of Machine Inventors for Patent Law," (2002) 8 B.U. J. Sci. & Tech. L. at 581; Ryan Abbott, "I think therefore I invent: Creative Computers and the future of patent law," *supra* note 1 at 1094-95; and Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 108.
[155] Ibid
[156] Ibid
[157] See John R. Koza, "Human-Competitive Results Produced by Genetic Programming," in 11 *Genetic Programming & Evolvable Machines* 251, 251 (2010) at 255–56, 265. John Koza was also the inventor of the scratch-off lottery ticket in the 1970s. See Home Page of John R. Koza, Genetic Programming, http://www.genetic-programming.com/johnkoza.html [https://perma.cc/H77Y-XM4T] (last visited May 8, 2022).
[158] Ibid
[159] See Ryan Abbott, "I think therefore I invent: Creative Computers and the future of patent law," *supra* note 1 at 1084 – 1085.
[160] Jonathon Keats, "John Koza Has Built an Invention Machine," POPULAR SCI. (Apr. 18, 2006), http://www.popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine [https://web.archive.org/web/20150218225133/http://www.popsci.com/scitech/article/2006-04/john-koza-hasbuilt-invention-machine]
[161] See generally Karl J. Astrom & Tore Hagglund, *Pid Controllers: Theory, Design, And Tuning* (2d ed.) (NC, US: Instrument Society of America, 1995) (detailing original version of the controller for which the Invention Machine created an improved, patentable version).

Machine's Patent")."[162] The controller is a device found in everything from thermostats to automobile cruise control systems."[163] The Invention Machine created the content of the patent without human intervention, a database of expert knowledge or any knowledge about existing controllers.[164] Again, the patent office had no idea that an AI system had developed the invention because Koza was listed as the inventor.

Like in the case of the Creativity Machine, Koza did not disclose the Invention Machine's role in the generation of the invention further to his legal counsel's advice.[165] Koza further claimed that the Invention Machine had generated several "patentable new invention[s]" in response to critics who believe that computers cannot produce something valuable [166] Beyond Koza, other entities have utilized GP for invention purposes. Hitachi used genetic algorithms to develop a quieter bullet train nose case.[167] General Electric (GE) used the technology to design jet engines that outclass existing units.[168] Similarly, genetic algorithms have generated novel communications systems, pharmaceuticals, diesel engines, and power plant turbines.[169]

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[162] Jonathon Keats, "John Koza Has Built an Invention Machine," POPULAR SCI. (Apr. 18, 2006), http://www.popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine [https://web.archive.org/web/20150218225133/http://www.popsci.com/scitech/article/2006-04/john-koza-hasbuilt-invention-machine].

[163] Ibid

[164] John R. Koza Et Al., "Genetic Programming Iv: Routing Human Competitive machine intelligence" 102–04 (2003)at102 - 104

[165] See Pedro Domingos, *The Master Algorithm: How The Quest For The Ultimate Learning Machine Will Remake Our World* (New York Basic Books, 2015) at 133– 34.

[166] See John R. Koza, "Human-Competitive Results Produced by Genetic Programming" (2010) 11 Genetic Programming & Evolvable Machines 251, 251 at 265; See Ryan Abbott, "I think therefore I invent: Creative Computers and the future of patent law," *supra* note 1 at 1079 – 1126, 1088.

[167] See Robert Plotkin, *supra* note 1 at 60 (explaining how genetic algorithms optimized the design and performance of the bullet train).

[168] See id. ("General Electric also uses genetic algorithms, in the design of jet engines . . . .").

[169] See Peter M. Kohlhepp, "When the Invention is an Inventor: Revitalizing Patentable Subject Matter to Exclude Unpredictable Processes," (2008) 93 Minn. L. Rev. 779, 786–87 ("Virginia engineers designed a novel and effective satellite communications antenna)." (citing Anne Eisenberg, When a Gizmo Can Invent a Gizmo (November 25, 1999) N.Y. Times at G9); Robert Plotkin, *supra* note 1 at 60 (explaining that a genetic algorithm "produced such a significant improvement in the efficiency of the drug discovery process that it has become the most-used software by 1,500 computational chemists at Pfizer" (citing Interview by Robert Plotkin with David Fogel (Sept. 20, 2007); Liza Vertinsky

2.3.3. Evolutionary Software and Eurisko

Evolutionary algorithms are progressing from tools supporting architects and designers to devices capable of creating their designs.[170] For instance, Gregory Hornby of the National Aeronautics and Space Administration (NASA) Ames Research Center developed an evolutionary software, which later designed an antenna for NASA's Space Technology 5 (ST5) mission.[171] Hornby claimed that no human engineer would have thought of such an antenna design because it looked crazy, yet it works better than earlier human designs.[172] According to Robert Plotkin, it was the first computer-generated "antenna" and computer-evolved antenna deployed in space.[173]

Furthermore, another inventive AI system is "Eurisko," encoded with basic microchips, which empowered it to discover new information and develop several novel designs independently and works in line with a series of rules and evaluations known as heuristics.[174] Eurisko was reported to have "invent[ed] new kinds of three-dimensional microelectronic devices ... novel designs and design rules."[175] It was further reported that in 1980, Standford University filed a patent for one of the Eurisko designs but abandoned

& Todd M. Rice, *supra* note 155 at 574, 581 (discussing how genetic algorithms increased the efficiency of turbines by five percent).
[170] NASA, "Overview," (22 May 2022), online: <https://ti.arc.nasa.gov/m/pub-archive/1175h/1175%20(Hornby).pdf>
[171] See Robert Plotkin, *supra* note 1 at 2, 10.
[172] Ibid at 1.
[173] Ibid
[174] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 75.
[175] See Telephone Interview with John Koza, President, Genetic Programming Inc. (Jan. 22, 2016) (on file with author); John R. Koza, "Human-Competitive Results Produced by Genetic Programming" (2010) 11 Genetic Programming & Evolvable Machines 251, 251 at 265.

it in 1984 for unknown reasons.[176] Like the other AI-generated inventions, the applicants did not disclose the role of the AI system to the Patent Office.[177]

2.3.4. IBM AI-Generated Inventions

IBM's Watson is another example of an inventive AI. It was invented to compete on a game show – Jeopardy! It proceeded to beat the former winners (Brad Rutter and Ken Jennings), earning a huge amount of money in the process.[178] The champions could not match the 200 million pages of data fed to Watson for the game.[179] IBM describes Watson as a phenomenal machine capable of "computational creativity" because it "generates millions of ideas out of the quintillions of possibilities, and then predicts which ones are [best]." [180] According to Ryan Abbott, Watson is "capable of generating novel, nonobvious, and useful ideas."[181] IBM has made Watson publicly available, enabling software application providers to create services with Watson's capabilities. Accordingly, Watson is helping to develop medical treatment, financial, research, and travel plans and solutions.[182]

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[176] See Douglas B. Lenat & William R. Sutherland, "Heuristic Search for New Microcircuit Structures: An Application of Artificial Intelligence," (1982) 3 AI Magazine, 17; and U.S. provisional patent application SN 144,960 (filed Apr. 29, 1980).
[177] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 75.
[178] See Jo Best, "IBM Watson," (accessed on May 22, 2022) online: *Techrepublic,* <http://www.techrepublic.com/article/ibm-watson-theinside-story-of-how-the-jeopardy-winning-supercomputer-was-born-and-what-it-wants-to-do-next/>[https://perma.cc/BQ4V-Q48F]
[179] Ibid
[180] IBM Research, "Computational Creativity," (accessed on May 22, 2022), online: *IBM* <http://www.research.ibm.com/cognitive-computing/computational-creativity.shtml#fbid=kwG0oXrjBHY> [https://perma.cc/6FK4-WTL3].
[181] See Ryan Abbott, "I think therefore I invent: Creative Computers and the future of patent law," *supra* note 1 at 1091.
[182] Anna Edney, "Doctor Watson Will See You Now, if IBM Wins in Congress," Bloomberg Bna Health It Law & Industry Report (January 29, 2015), online: <http://www.post-gazette.com/ frontpage/2015/01/29/Doctor-Watson-will-see-you-now-if-IBM-wins-in-Congress/stories/201501290332> [https://perma.cc/4BHU-VJXU]; Thor Olavsrud, "10 IBM Watson-Powered Apps That Are Changing Our World, CIO" (November 6, 2014), <http://www.cio.com/article/2843710/big-data/10-ibm-watson-powered-appsthat-are-changing-our-world.html#slide11> [https://perma.cc/NPY7-DDMA]

2.3.5. Device for the Autonomous Bootstrapping of Unified Sentience (DABUS)

DABUS is another example of an AI system that has been reported to have generated inventions. It was created by Stephen Thaler and trained to mimic certain aspects of the human brain's function.[183] DABUS has been described as a "system of many neural networks that generate new ideas by altering the network interconnections."[184]

Between 2018 and 2019, Thaler filed two patent applications at several national patent offices[185] and under the Patent Cooperation Treaty (PCT) at the WIPO.[186] The applications were in respect of two main inventions – a "light beacon that flashes in a new and inventive manner to attract attention ('Neural Flame')" and a "beverage container based on fractal geometry ('Fractal Container')."[187] The applications claim that DABUS independently generated the inventions as the output of its functionality, which made it the first time that a patent application has listed an AI system as the inventor.[188]

The DABUS applications have been considered by six (6) patent offices so far: the United Kingdom Intellectual Property Office (UKIPO), European Patent Office (EPO), United

[183] Jackie O'Brien & Isobel Taylor, "The year that was for DABUS, the world's first AI 'inventor" (13 December 2021), online: *Norton Rose Fulbright* <https://www.insidetechlaw.com/blog/the-year-that-was-for-dabus-the-worlds-first-ai-inventor>
[184] Matt Hamblen, "Team seeks patents for inventions created by DABUS, an AI" (August 1, 2019), online: *Fierce Electronics* <https://www.fierceelectronics.com/electronics/team-seeks-patents-for-inventions-created-by-dabus-ai#:~:text=DABUS%20was%20created%20by%20Dr,Charles%2C%20Missouri.>
[185] The UK - GB18116909.4 (October 17, 2018) and GB1818161.0 (November 7, 2018); The US - U.S. Application Serial No. 16/524, 350 and 16/524, 532 (July 29, 2019).
[186] International Application No. PCT/IB2019/057809 (September 17, 2019). The PCT facilitates the process of obtaining patent protection in over 150 countries. The patent applications have now entered the national phase of processing.
[187] See Ryan Abbott, "Patents and Applications" (visited on 23 February 2022), online: *Artificial Inventor Project (AIP)* <https://artificialinventor.com/patent-applications/>.
[188] Ibid

States Patents and Trademarks Office (USPTO), Australian Patent Office, South Africa Companies and Intellectual Property Commission (CIPC) and The Intellectual Property Office of New Zealand (IPONZ).[189]

On December 4, 2019, the UKIPO was the first country to determine the validity of the DABUS applications. However, it rejected them because there had been "no indications from the courts or legislature that a 'person' should be construed as anything other than a natural person."[190] However, somewhat optimistically, the Hearing Officer stated as follows:

> I have found that the present system does not cater for such inventions and it was never anticipated that it would, but times have changed and technology has moved on. It is right that this is debated more widely and that any changes to the law be considered in the context of such a debate, and not shoehorned arbitrarily into existing legislation.[191]

The second decision came on January 27, 2020; this time, it was the EPO. The European office rejected the DABUS patent applications because, according to the European Patent Convention (EPC), an inventor must be a human being, not a machine.[192] The EPO also noted that "AI systems or machines cannot have rights that come from being an inventor,

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[189] The patent applications is pending before Canada, China, India, Israel, Japan, Republic of Korea, Saudi Arabia, Switzerland, and Taiwan. See Ryan Abbott, "Patents and Applications" (visited on 23 February 2022), online: *Artificial Inventor Project (AIP)* <https://artificialinventor.com/patent-applications/>.

[190] United Kingdom patent applications GB1816909.4 and GB1818161.0 were filed in the name of Stephen Thaler ("the applicant") on 17 October 2018 and 7 November 2018 respectively. The decision was delivered by Huw Jones, Deputy Director, acting for the Comptroller (Patent Decision BL O/741/19).

[191] See paragraph 29 of the Patent Decision.

[192] The DABUS applications were filed in autumn 2018: EP 18 275 163 and EP 18 275 174. The applications were refused by the EPO following oral proceedings with the applicant in November 2019. See EPO, "EPO publishes grounds for its decision to refuse two patent applications naming a machine as inventor" (28 January 2020), online: *European Patent Office* <https://www.epo.org/news-events/news/2020/20200128.html>.

such as the right to be mentioned as the inventor or designated as an inventor in the patent application."[193] Moreover, according to the EPO, the internationally recognized standard is that only a natural person can be considered an inventor. Specifically, the EPO held as follows:

> The legislative framework of the EPC provides for natural persons, legal persons and bodies equivalent to legal persons (see e.g. Article 58 EPC) acting in certain capacities. The EPC does not provide for non-persons i.e. neither natural nor legal persons, as applicant, inventor or in any other role in the patent grant proceedings. In the context of inventorship reference is made only to natural persons. This indicates a clear legislative understanding that the inventor is a natural person.[194]

On February 17, 2020, the USPTO also rejected the DABUS applications because "interpreting 'inventor' broadly to encompass machines would contradict the plain reading of the patent statutes that refer to persons and individuals as inventors.[195] According to the USPTO, the US patent law limit inventorship to natural persons and "does not permit a machine to be named as the inventor in a patent application."[196] Furthermore, the "plain language of the patent laws as passed by the Congress and as interpreted by the courts" did not allow for the same.

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[193] Ibid
[194] Paragraph 23 of the Patent EPO Decision.
[195] The application for patents in the US was filed on 29 July 2019 with application no. 16/524,350. The patent decision was delivered by Robert W. Bahr, Deputy Commission for Patent Examination Policy. See USPTO, "Decision on Petition" <https://www.uspto.gov/sites/default/files/documents/16524350_22apr2020.pdf>.
[196] Ibid

The Australian Patent Office handed down the fourth decision in February 2021. It rejected the DABUS applications because the plain language of the *Australian Patents Act* does not permit an AI system to be named the inventor of a patent.[197] However, the Federal High Court, per Justice Beach, reversed the Patent Office's decision. The court held that the PCT, the *Patent Act* and the *Regulations* did not preclude a non-human such as DABUS from being named an inventor. The court considered "inventor" as an agent noun that applies to any entity that invents regardless of whether the entity is a natural person.

Not surprisingly, the High Court's decision was appealed by the Patent Commissioner to the Full Federal Court of Australia.[198] In April 2022, the Full Court reversed the decision of Australia's Federal Court, which held that AI could legally be an inventor. The Full Court found that an "inventor" within the meaning of the legislation must refer to a human or natural person.[199]

In July 2021, the South African Patent Office became the first patent office in the world to grant the DABUS patent applications.[200] The significance of this decision is debatable because South Africa only operates formal patent examinations, which involves merely examining for "compliance with the requisite formalities deemed necessary for the grant of a patent (i.e., consideration as to whether the correct official forms and fees)."[201] The

[197] *Stephen L. Thaler* [2021] APO 5
[198] Adam Liberman, "One small step for 'artificial intelligence' and a giant leap for the Australian patent system? The Federal Court decision in Thaler v Commissioner of Patents," (2022) 17:2 JIPLP, Pages 164–178.
[199] *Commissioner of Patents v Thaler*, [2022] FCAFC 62.
[200] Utkarsh Patil, "South Africa Grants A Patent With An Artificial Intelligence (AI) System As The Inventor – World's First!!" (19 October 2021), online: *Mondaq < https://www.mondaq.com/india/patent/1122790/south-africa-grants-a-patent-with-an-artificial-intelligence-ai-system-as-the-inventor-world39s-first#:~:text=In%20July%202021%2C%20the%20South,Sentience)%20listed%20as%20an%20inventor>*.
[201] Caroline B. Ncube, "The draft national Intellectual Property Policy proposals for improving South Africa's patent registration system: A review" (2014) 9:10 JIPLP 822-829; and Robyn-Leigh Merry, "The Intention to Become a

South African patent office does not substantively verify that the claimed inventions satisfy the requirements of inventorship, non-obviousness and industrial applicability before granting the patents. The validity of such patents can only be challenged after the patents are granted via the court system.[202] Nonetheless, the DABUS team celebrated the decision. The Thaler's lawyers stated as follows:

> Today, the Artificial Inventor Project successfully obtained the world's first patent, in South Africa, for an AI-generated invention without a traditional human inventor. The patent is owned by the AI's owner and the patent names the AI which devised the invention as the inventor. This is an important milestone for ensuring that we appropriately encourage people to make, develop, and use AI to generate socially valuable innovation.[203]

The Intellectual Property Office of New Zealand (IPONZ) handed down the sixth and latest patent office decision on 31 January 2022.[204] The patent office rejected the patent applications because DABUS is not a legal person and incapable of being an inventor. The Assistant Commissioner of Patents, Mark Luiten, held as follows:

> The artificial intelligence, being the machine identified as DABUS, is not a natural person or what amounts to the same thing, an individual. The term "inventor" as used in and as in the scheme of the Patents Act 2013 (the Act) refers only to a natural person, an individual. That inventors fall within the class of natural human persons is intrinsic to the proper construction of the Act. If the legislators had intended to allow granting of patents in New Zealand for

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Substantive Search and Examination Office" (October 16, 2017), online: *Dennemeyer* < https://www.dennemeyer.com/ip-blog/news/the-intention-to-become-a-substantive-search-and-examination-office/>

[202] Ibid

[203] Ryan Abbott, "First Patent Granted to the Artificial Inventor Project" (28 July 2021), online: *Artificial Inventor Project (AIP)* <https://artificialinventor.com/patent-applications/>.

[204] Stephen L. Thaler [2022] NZIPOPAT 2

> inventions devised solely by non-humans such as artificial intelligence, or life forms other than human beings they would have drafted the Act to accommodate these possibilities specifically and explicitly. They did not do so. It is not appropriate for the Commissioner to ignore this fact and decide a case as though they should have done so.

In conclusion, although the international trend has been to refuse patent protections for AI-generated inventions, the scope of the foreign decisions has been limited to the question of inventorship and based on the frameworks of their respective patent systems. The decisions did not consider whether AI-generated inventions can constitute statutory subject matter or if they can own and exercise patent rights. Also, they did not analyze whether patenting AI-generated inventions align with the theoretical basis of the patent system or the allocation of ownership rights of such inventions (i.e., should AI-generated inventions be patentable?). This thesis attempts to address these issues and provides a deeper analysis of the patentability of AI-generated inventions, particularly in Canada, where neither the Canadian Intellectual Property Office (CIPO) nor the courts have expressly determined the issues.

Chapter Three: Statutory Subject Matter Eligibility of Artificial Intelligence Inventions

The eligibility of AI-generated inventions for patent protection has been the subject of international debate and controversies.[205] Some scholars have argued that patenting such inventions is in line with the text and objective of the patent system.[206] On the contrary, others have argued that recognizing AI-generated inventions is inconsistent with the patent system and that there should be "a clear-cut line between human and nonhuman [inventions]."[207] While the previous chapter discusses the meaning of artificial intelligence (AI), how it functions, and whether AI systems can autonomously create inventions, this chapter attempts to weigh in on the debate by examining whether AI-generated inventions qualify as a statutory subject matter under the Canadian patent regime.

In exploring and examining the question, this chapter applies the doctrinal research method, precisely, Elmer Driedger's modern principle of statutory interpretation (which is the most recognized method of interpreting statutes in Canada and has also been applied in

[205] See Ryan Abbott, "I Think, Therefore I Invent," *supra* note 1 at 1079, 1080; Daria Kim, *supra* note 30 at 443–456; Nick Li and Tzeyi Koay, *supra* note 1 at 400; Aleksandra Bar, *supra* note 1 at 17; Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2215; Robert Plotkin, *supra* note 1; The World Economic Forum (WEF), *supra* note 1 at 6; Daria Kim, et al, "Ten Assumptions About Artificial Intelligence That Can Mislead Patent Law Analysis," *supra* note 31; Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 301, 317.

[206] See Ryan Abbott, "I Think, Therefore I Invent," *supra* note 1 at 1083-91; W. Michael Schuster, *supra* note 31 at 194; Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 137; Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 (arguing the current patent system is "outdated, inapplicable, and irrelevant with respect to inventions created by AI systems"); Ben Hattenbach & Joshua Glucoft, *supra* note at 53 (arguing that if a computer-generated claim meets all the requirements for a patentable invention, then those types of inventions should be patentable).

[207] See Ben Hattenbach & Joshua Glucoft, *supra* note at 47; Ralph D. Clifford, *supra* note 31 at 1696 – 1702, 1703; Manny W Schecter & Jennifer M. Anda, *supra* note 31 at 6; Daria Kim, *supra* note 31 at 443–456; Daria Kim, et al, "Ten Assumptions About Artificial Intelligence That Can Mislead Patent Law Analysis," *supra* note 31; Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 301, 317; Peter Blok, *supra* note 31 at 69, 73, and Amir H Khoury, *supra* note 6 at 652.

patent law).[208] The method is employed to analyze the provisions of the *Patent Act* to determine if they contemplate AI-generated inventions as statutory subject matter.[209]

The analysis in this chapter is organized in three parts: the first part focuses on the statutory meaning of an "invention" and examines the meaning of an "art," "process," and "machine" under the provisions of s. 2 of the *Patent Act*. The second part discusses the statutory exclusions under s 27(8) of the *Patent Act* and the various phases of protecting computer-related technologies in Canada, while the third part focuses on the patentability criteria and examines the intersection of AI-generated inventions and the concepts of novelty, non-obviousness, and utility.

3.1. Statutory Subject matter and AI-generated inventions

It is well-settled law that for an invention to qualify for patent protection, it must not only be *novel*, *useful*, and *nonobvious*, but it must also constitute a statutory subject matter.[210] Statutory (or patentable) subject matter is fundamentally similar worldwide because of the World Trade Organization (WTO) Agreement on Trade-Related Aspects of Intellectual

[208] See *Havard College v. Canada (Commissioner of Patents)* [2002] S.C.C. 76; [(2002), 21 C.P.R. (4th), 417 (S.C.C.)]; *Apotex Inc v Merck & Co*, [2008] FCJ No 1465, 2008 FC 1185, [2009] 3 FCR 234, [2009] 3 RCF 234, 70 CPR (4th) 297, 335 FTR 255, 172 ACWS (3d) 484, 2010EXP-2738; *Apotex Inc v Syntex Pharmaceuticals International Ltd*, [2009] FCJ No 977, 2009 FC 494, [2009] ACF no 977, 76 CPR (4th) 325, 352 FTR 124, 180 ACWS (3d) 488; *Bristol-Myers Squibb Co v Canada (Attorney General),* [2005] SCJ No 26, 2005 SCC 26, 2005 CSC 26, [2005] ACS no 26, [2005] 1 SCR 533, [2005] 1 RCS 533, 253 DLR (4th) 1, 334 NR 55, JE 2005-996, 39 CPR (4th) 449, 139 ACWS (3d) 552.

[209] The "Canadian patent law is entirely statutory in nature." See *Farbwerke Hoechst A.G. vormals Meister Lucius & Bruning v. Canada (Commissioner of Patents)* (1963), [1964] S.C.R. 49 (S.C.C.), Sanofi, para. 12; Flexi-Coil, para. 31; *DBC Marine Safety Systems Ltd. v. Canada (Commissioner of Patents),* 2007 FC 1142, [2008] 2 F.C.R. 563 (F.C.), aff'd 2008 FCA 256, 69 C.P.R. (4th) 189 (F.C.A.), at para. 2; and *Weatherford Canada Ltd. v. Corlac Inc.* 2011 CarswellNat 2835, 2011 CarswellNat 3714, 2011 CAF 228, 2011 FCA 228, [2011] F.C.J. No. 1090, 204 A.C.W.S. (3d) 888, 422 N.R. 49, 95 C.P.R. (4th) 101 at 141.

[210] The requirements of novelty and usefulness (or utility) are bases on s 2 of the *Patent Act,* while non-obviousness (or inventiveness) is based on s 28.3 of the *Act.*

Property Rights (TRIPs Agreement), which requires patents to be available for "products and processes" and "in all fields of technology.'[211]

However, the availability of patents in all fields of technology does not eliminate the right of states to exclude certain subject matter from their patent system.[212] In Canada, the *Patent Act* defines a statutory subject matter as covering only five categories of inventions: art, process, machine, manufacture or composition of matter.[213] Correspondingly, the Act explicitly excludes mere scientific principles and abstract theorems from the subject matter paradigm.[214]

The limited scope of subject matter in Canada was noted in *Harvard College v Canada (Commissioner of Patents).*[215] In that case, the Supreme Court of Canada held that the Parliament's choice of an exhaustive definition of invention signifies its intention to include specific subject matters as patentable and exclude certain subject matters from the definition.[216] Similarly, the Supreme Court commented in *Monsanto Canada Inc. v. Schmeiser* that "[c]laims that would otherwise be valid may be limited by statutory

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[211] *Agreement on Trade-Related Aspects of Intellectual Property Rights*, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994) [hereinafter TRIPS Agreement]. Article 27.1 of the TRIPS Agreement

[212] Gregory Hagen, et al, *Canadian Intellectual Property Law Cases and Materials* (Toronto, Canada: Emond Montgomery Publications, 2013) 642; and *Harvard College v. Canada (Commissioner of Patents)*, [2002] 4 S.C.R. 45 at 117

[213] R.S.C. 1985, c. P-4, s. 2. (*"*invention" as "any new and useful art, process, machine, manufacture or composition of matter, or any new and useful improvement in any art, process, machine, manufacture or composition of matter."). See also *Public Servants Inventions Act,* R.S.C. 1985, c. P-32, s. 2

[214] *Patent Act*, s. 27(8)

[215] [2002] S.C.C. 76; [(2002), 21 C.P.R. (4th), 417 (S.C.C.)] at para. 158

[216] *Harvard College v. Canada (Commissioner of Patents)* [2002] S.C.C. 76; [(2002), 21 C.P.R. (4th), 417 (S.C.C.)] at para. 158 ["Harvard College"]

provisions or by jurisprudence."[217] These decisions clearly established that the *Patent Act* does not intend to protect every kind of invention.

Having established the limited scope of the statutory subject matter under the *Patent Act*, it is important to highlight that it is the language of the patent claims that define the subject matter of the invention.[218] When a patent application is filed, the patent examiner is expected to assess the claims to ascertain if it discloses a recognized invention.[219] These claims can contain essential and non-essential elements of an invention.

In identifying the essential elements of an invention, the recognized method is a purposive construction of the claims.[220] Under this construction, whether an element of a claim is essential is based on two factors: (a) does it make a difference to the way the invention works? or (b) did the inventor intend for the element to be essential regardless of whether it affects how the invention works?[221]

Having established the method of identifying the essential elements of an invention, the next step is assessing whether they constitute statutory subject matter. Conducting the assessment requires a determination as to whether the invention: (a) falls within the statutory meaning of an "invention"*;* (b) is not within a class of statutory exclusions; (c) is

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[217] *Monsanto Canada Inc. v. Schmeiser*, 2004 SCC 34, [2004] 1 S.C.R. 902 at para. 132, 239 D.L.R. (4th) 271 [Schmeiser].
[218] See *Free World Trust v. Électro Santé Inc* (2000) SCC 66; *Canada (Attorney General) v. Amazon.com, Inc* [2011] F.C.J. No. 1621 at para. 63.
[219] Section 27(4) of the *Patent Act* provides that: "The specification must end with a claim or claims defining distinctly and in explicit terms the subject-matter of the invention for which an exclusive privilege or property is claimed."
[220] M*onsanto Canada Inc. v. Schmeiser* 2004 CarswellNat 1391, 2004 CarswellNat 1392, 2004 SCC 34, 2004 CSC 34, [2004] 1 S.C.R. 902, [2004] S.C.J. No. 29, 130 A.C.W.S. (3d) 1195, 239 D.L.R. (4th) 271, 31 C.P.R. (4th) 161, 320 N.R. 201, J.E. 2004-1126, REJB 2004-62104
[221] See See *Free World Trust v. Électro Santé Inc* (2000) SCC 66 at para. 68

not otherwise excluded by judicial interpretation of the Act ("judicial exclusion").[222] Of the three factors, only judicial exclusion is irrelevant to this thesis because no court in Canada has expressly excluded AI-generated inventions as a statutory subject matter. Therefore, the next sections discuss the two relevant factors: statutory meaning and statutory exclusions.

3.1.2. The Statutory Meaning of an "Invention"

The *Patent Act* only recognizes five categories of inventions (i.e., statutory subject matter): art, process, machine, manufacture, or composition of matter. But it appears only the first three inventions are relevant to this thesis. An AI system is unlikely to be able to conduct a "mixture of substances" to qualify as a composition of matter or make something to constitute "manufacture." In essence, if an AI system is to generate an invention, it will likely be either art, process, or machine.[223]

The majority decision in *Harvard College*[224] also supports the conclusion that AI systems cannot produce "composition of matter" and "manufacture." In that case, the issue before the Supreme Court was the patentability of a "transgenic animal." In defining the meaning of an invention, the court in a 5 to 4 majority held that "composition of matter" is the mixture of the substances engineered by a human being.[225] Similarly, the Court interpreted the term "manufacture" to mean "something made by the hands of man."[226]

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[222] See Stephen J. Perry & T. Andrew Currier, *Canadian Patent Law,* 4th Ed (Toronto, Canada: LexisNexis Canada Inc., 2021) at 104.
[223] See the examples of AI-generated inventions provided in chapter two.
[224] 2002 SCC 76, [2002] 4 SCR 45
[225] Supra, (p. 479).
[226] *Harvard College,* Ibid para. 159

Harvard College's rationale for the meaning of "composition of matter" and "manufacture" appears to be factually driven, which means they are also applicable in the context of AI-generated invention. Thus, this thesis assumes that AI systems cannot independently and legally create a "composition of matter" or "manufacture." Moreover, even if it is possible that AI systems can mix substances to create a "composition of matter" or produce a 'manufacture,' as we will see later in this chapter, most AI-generated inventions are likely to fall within the paradigm of "art, process, and machine."

Having excluded "composition of matter" and "manufacture" from the analysis, the specific meaning of "art," "process," and "machine" will be addressed below.

3.1.2.1. Art

The origin of the term "art" in the *Patent Act* can be traced to the English *Statute of Monopolies.*[227] The term was developed from the English courts' interpretation of the concept of "manufacture," which was the overarching term for statutory subject matter under the *Statute of Monopolies.* The early British courts interpreted "manufacture" to include methods of manufacturing new substances,[228] new processes,[229] and new uses of doing things.[230] For instance, in *Refrigerating Equipment Ltd. v. Waltham System Inc.,*[231] the Honourable Justice Maclean wrote as follows:

[227] (U.K.), 21 Jac. I, c. 3 (1623), s. 6(a).
[228] *Boulton & Watt v. Bull* (1795), 2 H. B1. 463.
[229] *Crane v. Price* (1842), 1 W.P.C. 409.
[230] *Losh v. Hague* (1888), 1 W.P.C. 208
[231] [1930] Ex. C.R. 154 (Can. Ex. Ct.), at page 166

> The Patent Act recognizes a method or process as having the same title to protection as a machine or article of manufacture; I conceive method and process to be one and the same thing, but in any event that "art" may include a method or process patent is well settled.

The above historical context suggests that "art" means a method or process of achieving a certain result as separate from the result.[232] In later parts of this chapter, it would be evident that the Canadian courts have since adopted this "historical" meaning of the term "art."[233] Before examining the judicial interpretations, it is important to highlight the legislative development in Canada.

The term "art" was included in the *Patent Act* before 1867 Confederation. The Legislature of Lower Canada enacted the first patent statute of Canada in 1824,[234] which had the term "art" in the preamble setting out its object: "WHEREAS it is expedient for the encouragement of Genius and of Arts in this Province to secure an exclusive right to the Inventor of any New and Useful Art, Machine, Manufacture, or Composition of Matter ...." In 1826, the Act was replicated in Upper Canada.[235] Upon the amalgamation of the Upper and Lower Canada into the province of Canada, a new patent Act was passed in 1849 to consolidate the patent laws.[236]

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[232] Harold Fox, *Canadian Patent Law and Practice,* 4th ed. (Toronto: Carswell, 1969) at 16 (Emphasis mine).
[233] See *Shell Oil Co. v. Canada (Commissioner of Patents)* [1982] S.C.J. No. 82, [1982] 2 S.C.R. 536 (S.C.C.)
[234] *An Act to promote the progress of useful Arts in this Provinc*e, 4 Geo. 4, c. 25; H.G. Fox, *The Canadian Law and Practice Relating to Letters Patent for Inventions,* vol. 1 (Toronto: Carswell, 1947) at 26.
[235] *An Act to Encourage the Progress of Useful Arts within this Province, 7 Geo. 4, c. 5;* See Roberts G. Howell, Linda Vincent & Michael D. Manson, *Intellectual Property Law Cases and Materials* (Toronto, Canada: Emond Montgomery Publications Limited, 2010) 874;
[236] (U.K.), 12 Vict. C. 24 (1849). This Act underwent several amendments: *Patent Act* (U.K.) , 14 & 15 Vict., c. 79 (1851); *An Act respecting the Practice and Procedure in Suits Instituted on behalf of the Crown in Matters Relating to the Revenue and the Repeal of Letter Patent,* C.S.U.C. 1859, C. 21 (U.K.), 22 Vict., c. 21 (1859); *An Act respecting*

In 1867, the *British North America Act* granted the Parliament of Canada exclusive power to legislate on all matters relating to patents.[237] The first post-Confederation *Patent Act* was enacted in 1869[238] and was modelled after the US patent statute of 1836.[239] The Act defined a statutory subject matter as follows:

> Any person having invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvement on any art, machine, manufacture or composition of matter, not known or used by others before his invention or discovery thereof, or not being at the time of his application for a patent in public use or on sale in any of the Provinces of the Dominion with the consent or allowance of the inventor or discoverer thereof.[240]

The *Patent Act* has been amended several times, but the wording of a "statutory subject matter" has remained substantially the same in the intervening years.[241] Indeed, "art" has been part of the Canadian patent statutory regime since its inception.

Although the term "art" is not defined in the *Patent Act,* "art" in the context of patent law is commonly understood as a "method of applying skill or knowledge."[242] The leading case

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Patents of Invention, C.S.C. 1859, c. 34; *An Act Respecting Writ of Mandamus and Injunction,* C.S.U.C. 1859, c. 23, s. 12 (1859).

[237] (U.K.), 30 & 31 Vict., c. 3 (1867), s. 91(22).

[238] (U.K.), 32 & 33 Vict., c. 11 (1869).

[239] *Patents for Useful Invention Act,* c. 357, 5 Stat. 117 (1836). The Act underwent several revisions to introduce new provisions to comply with international conventions including *Paris Convention for the Protection of Industrial Property (1883),* the *Patent Cooperation Treaty* (PCT) (1970), *North American Free Trade Agreement* (*NAFTA) (1992),* the *Agreement on Trade-Related Aspects of Intellectual Property Rights* (TRIPS Agreement) (1994), the *Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure (1996)*, and the *Patent Law Treaty* (PLT) (2000); see Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 37 – 48.

[240] *Act respecting Patents of Invention,* S.C. 1869, c. 11, s. 6

[241] R.S.C. 1985, c. P-4, s. 2.

[242] *Progressive Games, Inc. v. Canada (Commissioner of Patents)* [1999] F.C.J. No. 1623 at para. 16, C.P.R. (4th) 517 (F.C.T.D.), affd [2000] F.C.J. No. 1829, 9 C.P.R. (4th) 476 (F.C.A.).

law in Canada on the meaning of "art" is the decision in *Shell Oil Co. v. Canada (Commissioner of Patents)*.[243] In the case, the Appellant sought to patent a "discovery" of a new use of mixing certain chemical compounds with adjuvants. The main issue before the court was whether such "discovery" was an "art." The Supreme Court held that a new use for a known compound is an "art" because it is a method of practical application and patentable. The Honourable Justice Wilson, for the Court, stated as follows: "A disembodied idea is not *per se* patentable. But it will be patentable if it has a method of practical application."[244] Wilson J referred to the court's decision in *Tennessee Eastman Co. v. Commissioner of Patents,*[245] which held as follows:

> …that "art" was a word of very wide connotation and was not to be confined to new processes or products or manufacturing techniques but extended as well to new and innovative methods of applying skill or knowledge provided they produced effects or results commercially useful to the public.[246]

The above judicial pronouncements establish that "art" has a broad meaning to include every method of applying new knowledge or skill to achieve the desired result and has a "method of practical application," subject to the exclusions under s. 27(8) of the *Patent Act.*[247] The broad scope of "art" was further confirmed by the Federal Court in *Amazon.com Inc. v Canada (Attorney General)*[248] to include "business methods" and the term "practical application" to incorporate discernable effects (not just physical changes).

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[243] [1982] S.C.J. No. 82, [1982] 2 S.C.R. 536 (S.C.C.)
[244] Ibid at page 554:
[245] [1972] S.C.J. No. 112, [1974] S.C.R. 111 (S.C.C.), affg [1970] Ex. C.J. No. 14, 62 C.P.R. 117 (Ex. Ct.)
[246] Supra (at 544 (S.C.C.) [as paraphrased by Wilson J.]. (emphasis mine)
[247] I discuss the exclusionary provision of s. 27(8) of the *Patent Act* in full detail under section 3.1.3 of this thesis.
[248] *Canada (Attorney General) v. Amazon.com, Inc* [2011] F.C.J. No. 1621 at para. 63.

The net implication of the various judicial decisions is that "art" refers to a method of applying knowledge or skill to produce physical or discernable effects.

In *Progressive Games Inc. v Canada (Commissioner of Patents),*[249] the Federal Court surprisingly adopted a different approach. The sole issue before the court was whether changes in the method of playing poker fall within the definition of "art" or "process." The Court agreed that the changes were not simply a disembodied idea because they involved physical manipulation of cards. The court further held that the method reaches a result that may be commercially useful. However, the Court took the view that the changes were not an "art' or "process" because they do not add to the cumulative wisdom on the subject of games.[250] It further defined the test of a statutory subject matter as "whether the subject-matter was "new" (i.e., novel) and "innovative" (i.e., non-obvious) and "commercially useful."[251]

The court in the *Progressive Games case* conflated the meaning of statutory subject matter with the patentability criteria: novelty, non-obviousness, and utility.[252] The problem with mixing up statutory subject matter with patentability criteria is that the concept of statutory subject matter becomes redundant.[253] An invention can be a statutory subject matter even though it does meet the patentability criteria and *vice versa.* The two patent concepts – subject matter and patentability criteria - should not be fused. The Commissioner of Patents

[249] 1999 CarswellNat 2186, 1999 CarswellNat 5762, [1999] F.C.J. No. 1623, 177 F.T.R. 241, 3 C.P.R. (4th) 517.
[250] Ibid at para. 20.
[251] Ibid
[252] *Intercontinental Exchange Holdings, Inc.,* Re 2018 CarswellNat 5500, 2018 CarswellNat 5501
[253] Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 104

recognized this distinction in the *Harvard case* by acknowledging that the invention met the usual patentability criteria, even though it failed the subject matter test. [254]

An analogy can be drawn from the copyright regime with respect to the distinction between copyrightable work and originality. The standard for determining a copyrightable work (i.e., protectable subject matter) is different from the originality requirements. While copyrightable works refer to literary, artistic, dramatic, and musical works, originality contemplates the exercise of skill and judgment.[255] Likewise, what constitutes patentable subject matter should be distinguished from patentability criteria. Thus, the Court in the *Progressive Games case* ought to have limited its definition of "art" to a method of applying skill or knowledge with practical or discernable effects, instead of merging it with the concepts of non-obviousness and utility.

Having established the textual meaning of "art," can AI-generated inventions qualify as a method or process of applying knowledge or skill? Chapter two of this thesis provided several examples of AI-generated inventions and some of them can *arguably* qualify as "art" in appropriate circumstances.[256] First, the AI system called the "Creativity Machine" developed an invention titled "Neural Network-Based Prototyping System and Method (NNBPSM)," which was the subject of a patent grant filed on January 26, 1996.[257] The

[254] See para. 51 of the Commissioner of Patents' Factum
[255] *CCH Canadian Ltd. v Law Society of Upper Canada*, 2004 SCC 13
[256] See section 2.3 of chapter two.
[257] See U.S. Patent No. 5,852,815 (filed May 15, 1998) (The role of the AI system in developing the invention was not mentioned to the patent office)

patent claims of NNBPSM suggest that the invention relates to artificial neural networks (ANN) implemented in a non-algorithmic fashion in a data space, such as a spreadsheet.[258]

The essential elements of the patent claims described the invention as a method of facilitating such artificial neural networks. The patent claims disclosed five (5) objects of the invention:

> A principal object of the present invention is to provide a user-friendly System of implementing or simulating neural networks in which movement of such networks and cascading of such networks is facilitated.
>
> Another object of the present invention is to provide self-training artificial neural networks.
>
> A further object of the present invention is to provide artificial neural networks capable of analyzing data within a data Space.
>
> Yet another object of the present invention is to provide artificial neural networks which are mobile within a data Space.
>
> Still another object of the present invention is to provide artificial neural networks which can be easily duplicated within a data space and which can be easily interconnected to facilitate the construction of more complex artificial neural network systems.[259]

Based on the patent claims, NNBPSM is not a disembodied idea but a mode or method of implementing or stimulating an artificial neural network to self-train or provide an artificial

[258] United States Patent and Trade Marks Office (USPTO) registry: online https://patentimages.storage.googleapis.com/88/e2/bb/46f32c12f7de0d/US5852815.pdf
[259] Ibid, Paras. 10 - 25 of the Specification

network capable of analyzing or duplicating data within a data space. The knowledge or skill may presumably have been derived from the large data set used to train the AI system.[260] Therefore, it *arguably* fits within the textual meaning of an "art" under the Canadian *Patent Act* subject to the statutory exclusions.

Another example is the "Apparatus for Improved General-Purpose PID and non-PID Controllers" (Improved PID Controller)[261] developed by an AI system called "Invention Machine." The improved PID Controllers patent claims disclosed that the AI-generated invention relates to the field of controllers and, more particularly, an enhanced version of "general-purpose proportional-integrative-derivative (PID) and improved non-PID general-purpose controllers."[262] The controller's purpose was to force, in a commendable way, the response of a system (conventionally called the plant) to achieve a specified reaction (the reference signal).[263] The PID controller is typically constructed from various signal-processing blocks that process time domain Signals and each processing block has one or more inputs and a single output.[264]

According to the patent claims, the Improved PID Controller is a method of improving control performance in electronic or mechanical systems. Similarly, the skill or knowledge to apply the method may have been derived from the training data set. Since the PID

[260] See section 2.2 of chapter two.
[261] Jonathon Keats, "John Koza Has Built an Invention Machine," (Apr. 18, 2006), online: *Popular Sci.* <http://www.popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine> (This invention was also patented without disclosing the role of the AI systems.)
[262] USPTO's Registry – U.S. Patent No. 6, 847, 851 (filed July 12, 2002), accessed from <https://patentimages.storage.googleapis.com/8a/5b/e9/b69e6415df8fe1/US6847851.pdf>
[263] Ibid
[264] Ibid

Controller is a method of applying knowledge or skill with discernable effects, it may qualify as an "art" under the Canadian *Patent Act.*

The NNBPSM and Improved PID Controller inventions suggest that AI-generated inventions can fall within the textual meaning of "art" if they constitute a method of applying skill or knowledge with discernable effects. Notably, the United States Patents and Trademarks Office (USPTO) granted patents for NNBPSM and the Improved PID Controller in 1998 and 2002, respectively.[265] The owners claim they did not disclose the role of the AI systems in generating the inventions to the patent office.[266] This further confirms that AI-generated inventions can *arguably* satisfy the textual meaning of "art."

3.1.2.2. Process

The term "process" like "art" was not originally in the patent statutes. The English courts developed it as part of the definition of "manufacture" set forth in the *Statute of Monopolies.* In interpreting the term, the English courts usually connect "process" to vendible products or commercial or economic value, which has also been the preferred approach of Canadian courts.[267] The recognition of "process" as a distinct statutory subject matter first appeared in s. 7 of the *U.K. Patent Act* of 1923[268] and has been exported to other countries like Canada.[269]

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[265] See U.S. Patent No. 5,852,815 (filed May 15, 1998) (The role of the AI system in developing the invention was not mentioned to the patent office); and USPTO's Registry – U.S. Patent No. 6, 847, 851 (filed July 12, 2002), accessed from <https://patentimages.storage.googleapis.com/8a/5b/e9/b69e6415df8fe1/US6847851.pdf>

[266] See section 2.2 of chapter two.

[267] *Hospira Healthcare Corporation v. Kennedy Trust for Rheumatology Research,* [2020 FCA 30]; *Tennessee Eastman Co. v. Commissioner of Patents,* [1970] Ex. C.J. No. 14 at para. 28, 62 C.P.R. 117 (Ex. Ct.), affd [1972] S.C.J. No. 112, [1974] S.C.R. 111 (S.C.C.); and Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 117.

[268] (U.K.), 13 & 14 Geo. V, c. 23 (1923)

[269] See *Patent Act,* s. 2

The term "process" has been judicially interpreted in Canada in several cases and commonly refers to a method directed at achieving a particular result. For instance, in *Tennessee Eastman Co. v Commissioner of Patents,*[270] the issue before the court was whether a method of medical treatment qualifies as an "art" or "process." The Court held that word "process" was "a particular method of operation in any manufacture."[271] It used the word "method" to describe "process," similar to the term "art." A more comprehensive definition was given by Martland J. of the Supreme Court in *Canada (Commissioner of Patents) v Ciba Ltd,*[272] where he held as follows:

> A process implies the application of a method to material or materials. The method may be known, and the materials may be known. Still, the idea of making the application of the one to the other to produce a new and useful compound may be new [resulting in a patentable process]…[273]

Based on the *Tennessee* and *Ciba* judicial pronouncements, process means much the same as "art" or "method," a mode or series of actions directed to do something. Some prominent intellectual property scholars have also tried to explain the concept of "process." Harold Fox defined "process" as the procedure adopted, the method or the performance of an operation used to produce a result.[274] David Vaver described a "process" as "a systematic series of interdependent actions or steps directed to some useful end."[275] These definitions

[270] [1970] Ex. C.J. No. 14 at para. 28, 62 C.P.R. 117 (Ex. Ct.), affd [1972] S.C.J. No. 112, [1974] S.C.R. 111 (S.C.C.).
[271] Ibid
[272] [1959] S.C.J. No. 16, [1959] S.C.R. 378 at para. 15 (S.C.C.).
[273] Ibid, at para. 15 (S.C.C.)
[274] Harold Fox, *Canadian Patent Law and Practice,* 4th ed. (Toronto: Carswell, 1969) at 17.
[275] David Vaver, *Intellectual Property Law: Copyright, Patents, Trademarks*. 2nd ed. (Toronto: Irwin Law, 2011) at 292.

clarify the ordinary meaning of "process" as a method or series of steps to produce the desired result. Synthesizing the various interpretations, the Canadian Intellectual Property Office (CIPO) described a process as "a mode or method of operation by which a result or effect is produced by physical or chemical action, the operation or application of some element or power of nature or one substance to another."[276] Having established that "process" refers to a method directed at producing a particular result, can an AI-generated invention qualify as a process?

As mentioned in chapter two, an AI system called DABUS developed several inventions, including a device called "Neural flame" to attract attention during emergencies. The owner and developer of DABUS sought to patent the DABUS inventions.[277] Specifically, the patent application claimed the method of producing the "Neural flame."[278] The patent claims describe the "method" as comprising the following steps:

> (a) Generating a lacunar pulse train having characteristics of a pulse frequency of approximately four Hertz and a pulse-train fractual dimension of approximately one-half; (b) Transmitting said input signal to at least one controllable light source; and; (c) Pulsatingly operating said at least one controllable light source to **produce a neural flame emitted** from said at least one controllable light source as a result of the said lacunar pulse train is adapted to serve as a uniquely-identifiable signal beacon over potentially-competing attention sources by selectively triggering human or artificial anomaly-detection filters, thereby attracting attention.[279]

[276] S. 17.01.02 of MOPOP (emphasis mine)
[277] The patent applications were unsuccessful in many countries for failing to name a human inventor.
[278] South Africa's Patent Journal (July 2021) at page 255.
[279] European patent Register, EP 3563896, <https://register.epo.org/application?documentId=E2K6JSZI4333DSU&number=EP18275174&lng=en&npl=false>

The DABUS patent claims describe a series of steps or actions of producing a "neutral flame," which involves generating a lacunar pulse train and transmitting the input signal to at least one controllable light source. This invention appears to be a method of producing a neural flame, which means an AI-generated invention can fall within the textual scope of a "process."

3.1.2.3. Machine

Machines have benefited from patent protection since the beginning of the patent system.[280] The English courts' definition of a "manufacture" under the *Statute of Monopolies* has always included "machine when completed."[281] Early Canadian cases followed this broad definition of "manufacture" to have machines and mechanical contrivances as patentable inventions.[282] But what is a machine?

The Canadian courts have not interpreted the meaning of the word "machine," perhaps because the meaning is obvious or hardly contested. The CIPO has described a machine as a "mechanical and/or physical embodiment of any function or mode of operation designed to accomplish a particular effect, wherein the parts of the machine cooperate to accomplish the effect."[283] The *Oxford English Dictionary* defined "machine" as a "piece of equipment

[280] See generally D. Prager & G. Scaglia, *Brunelleschi: Studies of his Technology and Inventions* (Cambridge, MA: M.I.T. Press, 1970)
[281] *Morgan v. Seaward* (1837) 1 W.P.C. 187 at 193.
[282] *Yates v. Great Western R.W. Co.,* [1877] O.J. No. 76 (Onc. C.A.); and *Waterous v. Bishop* [1869] O.J. No. 161, 20 U.C.C.P. 29 (U.C. Ct. C.P.).
[283] MOPOP, s. 17.01.03

with many parts that work together to do a particular task,"[284] "any device that transmits a force or directs its application," or "a device that enables energy from one source to be modified and transmitted as energy in a different form or for a different purpose."[285] These definitions suggest that a machine is a piece of equipment, device, appliance, instrument, or other mechanical embodiments of any mode of operation to undertake a specific task.

Some intellectual property scholars have commented on the meaning of "machine." David Vaver described a machine as "an apparatus of interrelated parts (today often electron) with separate functions" or "a mechanism or other device that modifies force or motion and that, by itself or combined with other elements, can achieve some useful end. A system comprising a set of components that enable a process to be carried out may also qualify."[286] Vaver's definition is comprehensive as it covers apparatus, a mechanism that modifies force, and a set of components. Similarly, Gregory Hagen noted that often a machine "embodies many 'machines' in terms of its components, parts, and processes."[287]

Based on the various definitions provided above, machines include devices, equipment, systems, apparatuses, and a set of components that embodies any function to accomplish a particular task. Unlike "art" and "process," the meaning of a "machine" involves a physical or mechanical embodiment. Can AI-generated inventions qualify as machines?

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[284] Oxford Learners Dictionary, (Oxford University Press, 20222), online: <https://www.oxfordlearnersdictionaries.com/definition/english/machine_1#:~:text=(often%20in%20compounds)%20a%20piece,human%20labour%20in%20many%20industries.>

[285] *The Oxford Dictionary of English (revised edition)*, Oxford University Press 2005; "machine" *The Concise Oxford Dictionary of Mathematics*, Oxford University Press 2005

[286] Ibid, 293

[287] Gregory Hagen, et al, *Canadian Intellectual Property Law Cases and Materials, supra* note 213 at 644

AI systems have been credited with generating several machine-like inventions like internet search devices, antennas, new super-strong materials, and three-dimensional microelectronic devices.[288] Specifically, two of the DABUS inventions can qualify as machines.[289] The first is a "beverage container based on fractal geometry ('Fractal Container')," a mechanical product that enables multiple containers to be coupled by inter-engagement of pits and bulges. The patent claims described the invention as follows:

> "A container for use, for example, for beverages, has a wall with an external surface and an internal wall of substantially uniform thickness. The wall has a fractal profile which provides a series of fractal elements on the interior and exterior surfaces, forming pits and bulges in the profile of the wall and in which a pit as seen from one of the exterior or interior surfaces forms a bulge on the other of the exterior or interior surfaces. The profile enables multiple containers to be coupled together by inter-engagement of pits and bulges on corresponding ones of the containers. The profile also improves grip, as well as heat transfer into and out of the container."[290]

The second invention is a "light beacon that flashes in a new and inventive manner to attract attention ("Neural Flame")."[291] The patent claims described the invention as a "device" for attracting enhanced attention with a controllable light source. The essential elements of the invention are as follows:

> A device for attracting enhanced attention, the device comprising:

[288] See section 2.2 of chapter two.
[289] See Ryan Abbott, "Patents and Applications" (visited on 23 February 2022), online: *Artificial Inventor Project (AIP)* <https://artificialinventor.com/patent-applications/>.
[290] South Africa's Patent Journal (July 2021) at page 255
[291] See Ryan Abbott, "Patents and Applications" (visited on 23 February 2022), online: *Artificial Inventor Project (AIP)* <https://artificialinventor.com/patent-applications/>.

(a) An input signal of a lacunar pulse train having characteristics of a pulse frequency of approximately four Hertz and a pulse-train fractal dimension of approximately one-half; and

(b) At least one controllable light source configured to be pulsatingly operated by said input signal;

Wherein a neural flame emitted from said at least one controllable light source as a result of said lacunar pulse train is adapted to serve as a uniquely-identifiable signal beacon over potentially-competing attention sources by selectively triggering human or artificial anomaly-detection filters, thereby attracting enhanced attention.[292]

According to the patent claims of the DABUS patent applications, the inventions can be described as devices, apparatuses, or equipment. They physically embodied modes of operation to achieve different tasks. In other words, they constitute mechanical and/or physical embodiment of a function to accomplish a particular effect. This suggests that AI-generated inventions can be "machines" based on their textual meaning.

There is another unique definition of a machine. If a software program is incorporated into a computer and it improves the computer's functionality or processing, the computer and the program would together form a "single actual invention," and the subject matter defined by the claim would be a machine.[293] "Computer software" *per se* is usually considered an abstract or mathematical principle, but when it is incorporated into computer hardware, it

[292] European patent Register, EP 3563896, online:<https://register.epo.org/application?number=EP18275174&lng=en&tab=doclist>

[293] *Canada (Attorney General) v. Amazon.com, Inc* [2011] F.C.J. No. 1621 at para. 63; *Chouefaty v. Canada (Attorney General),* [2020] F.C.J. No. 874 at para. 62, 2008 FC 608 (F.C.); and Optuminsight, Inc (Re), 2022 CACP 5 (Commissioner's Decision #1612) at para. 19.

ceases to be "mere scientific principles or theorem. It becomes a "machine" as it satisfies the tangible object requirement.[294]

In the *2022 Novomatic AG (Re) case*,[295] the applicant sought to patent a method and system for conducting a lottery game using the point-of-sale system. The patent examiner rejected the application on the grounds that it was directed to an abstract and non-statutory subject matter. The Patent Appeal Board disagreed because the rules of calculating change and playing the lottery game cooperate with the point of the system and therefore have a physical existence. The Board explained that:

> "In particular, the cash register and point of sale systems, including an item scanner, serve as inputs to the computer calculations, which are then further used to provide input to the lottery game. They thus form a single actual invention that has physical existence. Therefore, I believe that the subject matter of claims 1-16 is directed to patentable subject matters as they fall within the definition of "invention" in section 2 of the *Patent Act*. They are also not prohibited under subsection 27(8) of the *Patent Act*."[296]

In *Re Application for Pat. of Batelle Memorial Institute*,[297] the patent examiner rejected a patent application directed to means for signal enhancement because of the calculations involved. But the Patent Appeal Board disagreed by holding that the applicant's "disclosure

[294] See Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 129.

[295] 2022 CACP7 (Commissioner's Decision #1614)

[296] Ibid at paras. 29, 30. See also Brett Eisenlohr (Re), 2021 CACP 50 (Commissioner's Decision #1603)

[297] Re Application for Pat. of Batelle Memorial Institute. (1984), 8 C.P.R. (3d) 133 (Pat. App. Bd. & Pat. Commr.).

of apparatus amounts to more than merely making calculations. We are satisfied that applicant's discovery amounts to the embodiment of an idea in a means to carry it out."[298]

In the context of AI-generated invention, one of the inventions in the DABUS patent applications is an incorporation of a "Neural Flame" scientific method into a device to enable it to attract enhanced attention.[299] The "Neural Flame" scientific method improves the functionality or processing of the device. Therefore, the device and the scientific method can together form a single machine invention and may be regarded as machines.

3.1.3. Statutory Exclusions: The Problem of Abstraction and Scientific Principles

The *Patent Act,* as previously noted (in section 3.1), explicitly excludes "mere scientific principle or abstract theorem" from the paradigm of statutory subject matter.[300] This exclusion has been interpreted as covering mathematical formulae, mathematical calculation,[301] mental processes, schemes, plans, rules, and abstract intellectual concepts.[302] The rationale for the exclusion is that the inventions are the basic elements of

[298] Ibid at 136.
[299] See Ryan Abbott, "Patents and Applications" (visited on 23 February 2022), online: *Artificial Inventor Project (AIP)* <https://artificialinventor.com/patent-applications/>.
[300] *Patent Act,* s 27(8)
[301] *Schlumberger Ltd. v. Canada (Patent Commissioner),* [1981] F.C.J. No. 176, 56 C.P.R. (2d) 204 (F.C.A.), leave to appeal refused [1981] S.C.C.A. No. 56 (S.C.C.)
[302] *Schlumberger Can. Ltd. v. Commr. of Patents* (1981), 56 C.P.R.(2d) 204 (Fed. C.A.), leave to appeal to S.C.C. refused (1981), 63 C.P.R. (2d) 261(note) (S.C.C.); *Optuminsight, Inc (Re),* 2022 CACP 5 (Commissioner's Decision #1612), Re Application for Pat. No. 178,570 (1983), 2 C.P.R. (3d) 483 (Pat. App. Bd. & Pat. Commr.). See In Re Maucorps, 609 F.2d 481 (C.C.P.A. 1979); *Re Application for Pat. No.* 178,570 (1983), 2 C.P.R. (3d) 483 (Pat. App. Bd. & Pat. Commr.); Re Application No. 096,284 (1978), 52 C.P.R. (2d) 96 (Pat. App. Bd. & Pat. Commr.). See also Re Slee and Harris' Application, [1966] R.P.C. 194; Canadian Intellectual Property Office, "Manual of Patent Office Practice (MOPOP)" (October 2019) at s. 22.080.4, online: *Government of Canada* https://manuels-manuals.opic-cipo.gc.ca/w/ic/MOPOP-en.; *Schlumberger Canada Ltd v. Commissioner of Patents* (1981) F.C.J. No. 176, 56 C.P.R. (2d) 204 (F.C.A.), leave to appeal refused [1981] S.C.C.A. No. 56 (S.C.C.);

scientific and technological work, thus patenting them might stifle further inventions.[303] Since computer-related technologies usually rely on mathematics, algorithms, models, and abstract rules, the exclusions constitute a significant obstacle for such inventions.[304]

A study of the Patent Appeal Board decisions from June 2021 and March 2022 reveals a high rejection rate of computer programs. The Board considered thirty patent applications involving computer programs within the period.[305] It affirmed the rejections of twenty-three of the applications on the grounds of non-statutory subject matter (that is over 75%), recommended necessary amendments in five applications, and allowed only two. Specifically, in *Wasmund (Re) case*,[306] the Applicant sought to patent a new type of nested quiz game and system for one or multiple players, with claims directed to computer implementations. The Patent Examiner found the application directed to rules for playing a quiz game and non-statutory subject matter. The Patent Appeal Board agreed with the Patent Examiner that the actual invention is a set of abstract rules and algorithms for a

[303] Gottschalk v. Benson, 409 U.S. 63 at 67; In re Comiskey, 499 F.3d 1365, 1371 (Fed. Cir. 2007), at 1378–79 (holding that "mental processes," "processes of human thinking," and "systems that depend for their operation on human intelligence alone" are not patent-eligible subject matter under *Benson).*

[304] Barry B. Sookman, *Sookman: Computer, Internet and Electronic Commerce Law* (Scarborough, Ont: Carswell, 2022) at § 6:2.

[305] See *Wasmund (Re),* 2022 CACP 9; *BROLLEY, KATHERINE J. (Re),* 2022 CACP 8; *Novomatic AG (Re*), 2022 CACP7; *The Dun and Bradstreet Corporation (Re),* 2022 CACP 6; *Optuminsight, Inc* (Re), 2022 CACP 5; *BIO-RAD LABORATORIES,* INC. (Re), 2022 CACP4; *NYSE GROUP, INC. (Re),* 2022 CACP 1; Brett Eisenlohr (Re), 2021 CACP 50; *Landmark Graphics Corporation (Re), 2021* CACP 51; *Novomatic AG (Re),* 2021 CACP52; *PEPSICO, INC. (Re),* 2021 CACP 49; *BGC Partners, Inc* (Re), 2021 CACP 48; *Google LLC (Re),* 2021 CACP47; *Becton, Dickinson and Company (Re),* 2021 CACP 46; Teletracking *Technologies, INC. (Re),* 2021 CACP 45; Stukanov, Igor (Re), 2021 CACP 44; *Worldgaming Network LP. (Re),* 2021 CACP 43; Landmark Graphics Corporation (Re), 2021 CACP 42; *Smart Technologies ULC (Re),* 2021 CACP 40; *Acoustic L.P. (Re),* 2021 CACP 39; *BIO-RAD LABORATORIES, INC. (Re),* 2021 CACP 37; *Ticketmaster (Re),* 2021 CACP 36; *TILTON (Re),* 2021 CACP 34; *Home Depot International, Inc. (Re*), 2021 CACP 33; *Landmark Graphics Corporation (Re),* 2021 CACP 31; *Liffe Administration and Management (Re),* 2021 CACP 28; *Ontario Lottery and Gaming Corporation (Re),* 2021 CACP 32; *Qiagen Redwood City, Inc. (Re),* 2021 CACP 30; *Ticketmaster, LLC (Re),* 2021 CACP 27; and *United Parcel Service of America, Inc (Re),* 2021 CACP 29.

[306] Wasmund (Re), 2022 CACP 9 (Commissioner's Decision #1616)

nested quiz game and a non-statutory subject matter. The Board specifically concluded as follows:

> "…the actual invention of representative claim 1 is a set of abstract rules and an algorithm for a nested quiz game, because, while computer components are essential elements of the claim, the computer components are not part of the actual invention…There is no improvement to the computer's functionality; that is, no discernible physical effect on the computer. Absent the computer components, there is no physical component or discernible physical effect produced. The output is of intellectual significance only and has no physicality. Similarly, the actual invention of all the other claims on file is a set of abstract rules for nested quiz games."[307]

The Patent Appeal Board's decision is a source of concern because an AI system is a form of computer technology and is often described in abstract mathematical functions that consider perceptions as inputs and actions as outputs.[308] The European Patent Office described AI as follows:

> Artificial intelligence and machine learning are based on computational models and algorithms for classification, clustering, regression and dimensionality reduction, such as neural networks, genetic algorithms, support vector machines, k-means, kernel regression and discriminant analysis. Such computational models and algorithms are *per se* of an abstract mathematical nature, irrespective of whether they can be "trained" based on training data.[309]

[307] Ibid at 23-24.
[308] Stuart Russel & Peter Norvig, *supra* note 82 at 35
[309] European Patent Office, "Guidelines for Examination" (2018) at s. 3.3.1, online: <https://www.epo.org/law-practice/legal-texts/html/guidelines/e/g_ii_3_3_1.htm>

Considering that AI systems are *mathematical functions* or *computational models,* there is the risk that such systems will likely produce "mathematical methods or applications," which may be construed as non-statutory scientific principles or abstract theorems. For instance, the NNBPSM invention, the improved PID controller, and the DABUS "Neural Flame" are all based on computational models and algorithms, exposing them to being regarded as mere scientific principles or abstract theorems.

The patentability of computer-related inventions in Canada has been defined by four landmark decisions: *Waldbaum Application,*[310] *Schlumberger Ltd. v. Canada (Patent Commissioner)*,[311] *Canada (Attorney General) v. Amazon.com, Inc,*[312] and *Benjamin Moore & Co. v. The Attorney General of Canada and Intellectual Property Institute of Canada.*[313] Therefore, the development of the patent law concerning computer-related technology in Canada has been through six phases: the *pre-Waldbaum* phase (prior to 1971), the *Waldbaum* phase (1971–1978), the *Pre-Schlumberger* phase (1978–1981), the *Schlumberger* phase (1981-2011), the *Amazon.com* phase (2011 – 2022), and *Benjamin Moore* phase (2022 till present). This chapter examines the significant developments in the respective phases in the following pages to provide some historical context to the current position of law.

[310] Re Applicaton No. 961,392 (1911), 5 C.P.R. (2d) 162 at 166 (Pat. App. Bd. & Pat. Commr.).
[311] [1981] F.C.J. No. 176, 56 C.P.R. (2d) 204 (F.C.A.), leave to appeal refused [1981] S.C.C.A. No. 56 (S.C.C.)
[312] (2011) FCA 328
[313] *Benjamin Moore & Co.* (Re), 2020 CACP 15 ["Benjamin Moore"]

3.1.3.1. Pre-Waldbaum Phase (prior to 1971)

Computer programs entered the market in the mid-1960s and there were debates concerning whether they should be patentable.[314] Therefore, in 1970, Canadian Patent Office issued the first regulation on computer programs via an *Official Notice* explaining what constitutes non-statutory subject matters under section 2(*d*) (now s. 2) of the *Patent Act*.[315] In the notice, the patent office considered a computer program, an algorithm, or a set of instructions to operate a computer in whatever form as mathematical information and not allowable under the *Patent Act.*[316] Also, the *Notice* stated that a method, process or scheme that is merely intellectual, literary, or artistic was not permissible under the Act.[317]

The provisions of the *Official Notice* were far-reaching. They even excluded some computer hardware from patent protection.[318] The basis for the exclusions is that the computer invention must be evident to other skilled and competent programmers, and they are essentially mathematical information. Within a short period, the scope of the *Notice* was tested in *Waldbaum's patent application,* which was the first case on computer program patentability by the Patent Appeal Board.[319]

[314] Martin Campbell-Kelly, "Not all bad: An historical perspective on software patents" (2004) 191 Mich. Telecomm. & Tech. L. Rev. 11
[315] *Re Application No. 862,758* (1970), 4 C.P.R. (2d) 24 (Pat. Commr.).
[316] Ibid at para. d
[317] Ibid at para. c
[318] Ibid
[319] See Barry B. Sookman, *supra* note 305 at § 6:11.

3.1.*3*.2. Waldbaum Phase: 1971–1978

In *Waldbaum's Application*, the Commissioner of Patents refused sixteen patent claims because they were abstract non-statutory subject matters. The invention described in the patent claims referred to a method of determining telephone traffic density by associating a known data processor (the computer) and a telephone system. Specifically, the claims were mainly (i) directed to a method for controlling the operation of a data processor, (ii) directed to a process for conditioning the operation of a data processor, and (iv) directed to a new use of a data processor.

Dissatisfied with the Commissioner's decision, the applicant applied for judicial review at the Patent Appeal Board. After reviewing the existing cases in the United States[320] and Britain[321] that had dealt with a similar issue, the Board narrowly construed the *Official Notice* and decided that the claims were directed to a method for controlling a computer's operation and constituted a statutory subject matter.

The *Waldaum* decision was significant because it allowed claims to new methods of programming a computer as well as claims to a computer that is programmed in a novel manner to be statutory subject matters under the *Patent Act*.[322] Nonetheless, the general rule remained that claims to a computer program *per se* were not statutory subject matters.

[320] In *Re Bernhardt*, 417 F.2d 1395 (C.C.P.A. 1969).; In Re Prater, 415 F.2d 1393 (C.C.P.A. 1969); In *Re Musgrave,* 167.S.P.Q. 280 (1910).
[321] *Re Slee and Harris' Application*, [1966] R.P.C. 194; Badger Co. Inc.'s Application, [1910] R.P.C. 36; and *Gevers' Application*, [1910] R.P.C. 91.
[322] See Barry B. Sookman, *supra* note 305 at § 6:13.

3.1.3.3. Pre-Schlumberger Phase: 1978–1981

The victory caused by the *Waldbaum Application* was short-lived. In *Re Application No. 096,284*, the applicant sought to patent a seismic exploration method. The patent examiner refused the application as being directed to a non-statutory subject matter because the substance of the claims "merely set forth a routine of standard computational operations for solving a mathematical problem and outputting the data in the desired format."[323] The Patent Appeal Board affirmed the position of the patent examiner. After reviewing the decisions in the United States and Britain after *Waldbaum's Application*, it concluded, contrary to what had been decided in *Waldbaum's Application,* that claims to a new method of programming and a computer programmed in a novel manner are not statutory subject matters under the Act.[324]

While overruling the decision in *Waldbaum's Application,* the Board recommended a new framework to the Commissioner of Patents for determining the patentability of computer-related technology, which was later adopted by the Patent Office and published on August 1, 1978.[325] The framework provides as follows: (1) claims to a computer program *per se* are not patentable; (2) claims of a new method of programming a computer are not patentable; (3) claims to a computer programmed in a novel manner, where the novelty lies solely in the program or algorithm, are not patentable subject matters; (4) claims to a computing apparatus programmed in a novel manner, where the patentable advance is in

[323] Application No. 096,284, Re 1978 CarswellNat 784, 52 C.P.R. (2d) 96.
[324] Re Application No. 096,284 (1978), 52 C.P.R. (2d) 96 (Pat. App. Bd. & Pat. Commr.), pp. 109–110.
[325] Ibid

the apparatus itself, are patentable; and (5) claims to a method or process carried out with specific novel apparatus devised to implement a newly discovered idea are patentable.[326]

3.1.3.4. Schlumberger Phase: 1981 to 2011

Prior to 1981, only the Patent Appeal Board had considered the patentability of claims involving computer programs. The Federal Court of Appeal's opportunity came in *Schlumberger Ltd. v Canada (Patent Commissioner)*,[327] an appeal against the decision in *Application No. 096,284.* After reviewing the case, the Court affirmed the conclusion of the Patent Appeal Board that the seismic exploration method was a non-statutory subject matter because the claim merely presented and solved mathematical formulae, and the fact that a computer was used to implement the discovery did not change its nature. The Court per Pratte J. specifically held: "What the appellant claims as an invention here is merely the discovery that by making certain calculations according to certain formulae, useful information could be extracted from certain measurements. This is not an invention within the meaning of section 2."[328]

Schlumberger's decision is well known for its three principles. First, it integrated the concept of "mathematical formula" into the "mere scientific principle" or "abstract

[326] Re Application No. 096,284 (1978), 52 C.P.R. (2d) 96 (Pat. App. Bd. & Pat. Commr.), p. 112.
[327] [1981] F.C.J. No. 176, 56 C.P.R. (2d) 204 (F.C.A.), leave to appeal refused [1981] S.C.C.A. No. 56 (S.C.C.)
[328] Ibid, para. 5 ["Now, it is obvious, I think, that there is nothing new in using computers to make calculations of the kind that are prescribed by the specifications. It is precisely in order to make those kinds of calculations that computers were invented. What is new here is the discovery of the various calculations to be made and of the mathematical formulae to be used in making those calculations. If those calculations were not to be effected by computers but by men, the subject-matter of the application would clearly be mathematical formulae and a series of purely mental operations; as such, in my view, it would not be patentable. A mathematical formula must be assimilated to a "mere scientific principle or abstract theorem" for which subsection 28(3) of the Act prescribes that "no patent shall issue"].

theorem" exclusionary statutory provisions.[329] Second, a computer used to implement a discovery does not change the nature of the discovery. Third, it prescribed the first step for determining a statutory subject matter: "what, according to the application, has been discovered."[330]

The Federal Court of Appeal did not prescribe comprehensive guidelines for determining the patentability of computer software-related technology. However, W. Charles Kent and Edward Cheung pointed out that following the *Schlumberger* decision, the Patent Appeal Board recognized certain types of applications, such as data manipulation or information enhancement systems and control systems, as statutory subject matters.[331] For instance, in *Re Application for Pat. of Gerber Garment Technology Inc.,*[332] the Applicant sought to patent a computer program for advancing an automatically controlled sheet-cutting machine. The patent examiner rejected the application because the claims were directed to a method of programming a computer. The Patent Appeal Board disagreed because the result of the invention was not merely a resolution of an algorithm by a computer program but "an improved cutting result over and above the programmed changes in blade orientation."[333]

[329] Ibid, ["I am of opinion that the fact that a computer is or should be used to implement discovery does not change the nature of that discovery.]
[330] Ibid, para. 5.
[331] See W. Charles Kent and Edward Cheung, "Patent Protection in Canada for Computer Related Technology" (1987) 3 Intellectual Property Rev. 23.
[332] Re Application for Pat. of Gerber Garment Technology Inc. (1984), 3 C.P.R. (3d) 563 (Pat. App. Bd. & Pat. Commr.).
[333] Ibid at p. 573.

3.1.3.5. The *Amazon.com* phase: 2011 – 2022

In the *Amazon 1-Click patent case*, the applicant sought to patent inventions relating to a business method, a 'one-click' method of internet shopping. The Patent Appeal Board ruled that the claimed invention is not a statutory subject matter because it is a business method, and such methods are unpatentable subject matters. The Board also ruled that the claimed invention is not "an act or series of acts performed by some physical agent upon some physical object and producing in such object some change either of character or of condition."[334]

The applicant was dissatisfied with the Board's decision and appealed to the Federal Court, which reversed the conclusion of the Commissioner. The matter was further appealed to the Federal Court of Appeal. After reviewing the case, the Federal Court of Appeal quashed the Commissioner's "tradition" of describing business methods as abstract non-statutory subject matters.[335] However, the court refrained from ruling whether the 'one-click' method of internet shopping constitutes a patentable subject matter. Instead, it remitted the case to the Commissioner of Patents for reassessment.

The court rejected the test put forward by the Commissioner to determine whether an 'art' was a patentable subject matter because they were contextual and non-determinant factors.

[334] *Amazon.com Inc., Re* (2009), 2009 CarswellNat 982, 2009 CarswellNat 983 (Can. Pat. App. Bd. & Pat. Commr.).
[335] *Canada (Attorney General) v. Amazon.com, Inc* (2011) FCA 328

The Commissioner had proposed using a three-step test: (1) whether the invention adds to human knowledge anything technological in nature; (2) whether it is merely a business method, and a business method is not patentable; and (3) whether it does not cause a change in the character or condition of a physical object. Similarly, the court also rejected the test of Phelan J. of the Federal Court, who had proposed asking whether *Amazon.com's* business model had a practical embodiment or practical application. Instead, the Court held that the assessment should be based on a purposive construction of the claims to identify the essential elements of the invention, a method that the Supreme Court had earlier applied to claims construction in the context of determining validity and infringement.[336] The Court also widened the scope of the term "practical application" to mean a "physical existence or something that manifests a discernible effect or change."[337]

Following *Amazon's decision*, the Canadian Intellectual Property Office (CIPO) issued two practice notices on March 8, 2013, providing guidance on examining computer-implemented inventions.[338] As part of the statutory eligibility analysis, the notices require that the claimed elements address a "computer problem" (a problem with the operation of a computer). If the claimed computer solves a problem, the claim is considered a statutory subject matter and *vice versa*.[339] CIPO relied on the "problem-solution" approach to

[336] See *Free World Trust v. Électro Santé Inc* (2000) SCC 66. ("The purposive construction seeks to detect claims expressed in language that is deliberately or mistakeably deceptive. For example, a claim for an "art" or a "process" in which, upon a proper purposive construction, would become a claim for a mathematical formula and therefore unpatentable")
[337] Ibid at paras. 65 – 66.
[338] *Examination Practice Respecting Purposive Construction—PN2013-02*, Gov't Can. (Mar. 8, 2013); *Examination Practice Respecting Computer-Implemented Inventions—PN 2013-03*, Gov't Can. (Mar. 8, 2013) [hereinafter *PN 2013-03*].
[339] Gov't of Can., Manual of Patent Office Practice (MOPOP) § 13.05.02c (2015).

determine the patentability of several computer-related and other patent applications, which resulted in the CIPO's rejection of many such applications.[340]

Applicants attempted to work around the rejections by including physical elements of the computer in the claims.[341] Notwithstanding, CIPO would sometimes adopt a broader problem-solution approach to find an inventor's essential elements abstract and unpatentable.[342] In April 2020, the Federal Court in *Yves Choueifaty v Attorney General of Canada*[343] (*Choueifaty*) rejected CIPO's "problem-solution approach" in favour of the purposive construction of claims.

In *Choueifaty,* the Appellant sought to patent "A computer-implemented method for providing an anti-benchmark portfolio." The patent examiner and the Patent Appeal Board refused to grant the patent because it was directed at a non-statutory subject matter. Specifically, the Board applied the problem-solution approach to establish that "the essential elements of the Appellant's claimed invention was "directed to a scheme or rules involving mere calculations;" the Appellant's claimed invention was, in essence, an abstract algorithm and, therefore patent ineligible.[344] The Court held that CIPO improperly applied the Supreme Court's precedents by disregarding the inventor's intention contrary

[340] Bradley White, Vincent M. de Grandpré, Nathaniel Lipkus & Geoffrey Langen, "Canadian Court again rejects problem-solution approach to subject-matter eligibility of computer-implemented patents" (22 June 2022), online: *Osler* <https://www.osler.com/en/resources/regulations/2022/canadian-court-again-rejects-problem-solution-approach-to-subject-matter-eligibility-of-computer-imp>
[341] Ibid
[342] Roch Ripley & Brian Kingwell, "Federal Court Finds A Problem With Problem-Solution" (9 September 2020), online: <https://gowlingwlg.com/en/insights-resources/articles/2020/federal-court-finds-problem-with-problem-solution/>
[343] 2020 FC 837
[344] *Choueifaty* at paras. [14]-[16].

to purposive claims construction.[345] Accordingly, the Court set aside CIPO's decision and ordered that the Appellant's invention be reconsidered by properly considering the inventor's intention when assessing a claim's essential elements and eligibility.

Choueifaty was the first decision to address the 2013 CIPO's problem-solution approach. Instead of appealing the decision, the Patent Office issued updated guidelines in November 2020 explaining its current understanding of a statutory subject matter. The guidelines emphasized three main points: (a) the claimed invention must have physical existence or manifests a discernable physical effect or change; (b) the determination of the "essential elements of the claim" must be grounded in purposive construction per the principles set out in *Free World Trust* and *Whirlpool*, and finally (c) the actual invention may consist of either a single element that provides a solution to a problem or of a combination of elements that cooperate in providing a solution to a problem, and all the aspects of the combination must be considered in determining whether there is a patentable subject matter.[346]

3.1.3.6. The *Benjamin Moore* phase: 2022 till present

On June 17, 2022, for the second time, the Federal Court disagreed with CIPO's guidelines on determining the eligibility of a statutory subject matter.[347] In *Benjamin Moore & Co. v. The Attorney General of Canada and Intellectual Property Institute of Canada,*[348] the issue

[345] *Free World Trust v Électro Santé Inc*, 2000 SCC 66 and *Whirlpool Corp v Camco Inc,* 2000 SCC 67
[346] CIPO, "Patentable Subject-Matter under the Patent Act," (November 3, 2020) online: <https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr04860.html>
[347] See *Benjamin Moore & Co.* (Re), 2020 CACP 15 and *Benjamin Moore & Co. (Re),* 2020 CACP 16
[348] Ibid

before the court was whether the CIPO was correct in rejecting patent applications for computer-related methods of colour selection. The Patent Office rejected the patent applications based on the problem-solution approach it developed following the *Amazon Case* in 2011. It admitted before the Court that the patent examination was incorrect because of the *Choueifaty* decision in 2020 and asked the Court to remit the matter for reassessment under the post- *Choueifaty* guidelines.

The Court agreed with the Commissioner, but while remitting the case, it took the opportunity to set new guidelines for determining the eligibility of a statutory subject matter. The Court adopted the legal framework proposed by the Intellectual Property Institute of Canada (IPIC).[349] The framework provides that when determining the eligibility of a claim, the Commissioner must: a) Purposively construe the claim; b) Ask whether the construed claim as a whole consists of only a mere scientific principle or abstract theorem or whether it comprises a practical application that employs a scientific principle or abstract theorem; and c) If the construed claim comprises a practical application, assess the construed claim for the remaining patentability criteria: statutory categories and judicial exclusions, as well as novelty, obviousness, and utility.[350]

The Court's rationale for the framework is that it "ensures consistency a) between the law applied to patent applications by CIPO and the law applied to issued patents by the Courts,

[349] Canada's professional association of lawyers, academics, patent agents, and trademark agents practicing in intellectual property, (which intervened in the case).
[350] *Ibid*. at paras. 43 and 52

and b) between the way patent law is applied to computer-implemented inventions and the way patent law is applied to all other types of inventions."[351] The Attorney General has the right to appeal against the decision to the Federal Court of Appeal within 30 days, the timeline excludes the summer recess in July and August. Time will tell if the Attorney General will appeal the decision or if CIPO will commence applying the new framework.

The *Benjamin Moore* decision clarifies the proper test to follow when assessing the subject matter eligibility of patent claims, particularly computer-implemented patent applications. The framework clearly distinguished between statutory subject matter requirements and patentability criteria. The items (a) and (b) of the framework focus on determining whether a computer-related invention qualifies as a statutory subject matter, while item (c) centers on the patentability criteria.

Although *Benjamin Moore* framework mentioned "practical application," it did not define the term. Thus, the decision is not meant to be read in isolation; it complements the Federal Court of Appeal's *Amazon* decision, where the phrase "practical application" was defined to represent something of physical existence or that manifests a discernable effect or changes.

It remains to be seen how CIPO will proceed with this new framework and the impact of the framework on the volume of permissible statutory subject matters. Some IP experts have noted that the *Benjamin Moore* decision has ended any further use of the problem-

[351] *Ibid*. at para. 53.

solution approach by CIPO when assessing the subject-matter eligibility of computer-implemented patent applications.[352] Roch Ripley's commentary on the decision indicates that the new framework is a lower threshold.[353] Ripley stated that the test "reflects the reality that the patent system needs to adapt to protect, and promote investment in, computer-related innovation.[354] Now, how does this affect AI-generated invention?

A holistic and purposive review of the patent claims for the NNBPSM invention shows that the essential elements of the invention are methods of implementing or simulating neural networks and the provision of self-training artificial neural networks that can be easily duplicated within a data space.[355] This claim construction shows that the invention has a practical application, i.e., manifest discernable effects of implementing or stimulating neural networks.

The relevant test in the *Benjamin Moore* framework is that the invention must comprise a practical application that employs a scientific principle or abstract theorem. NNBPSM patent claims do not appear as scientific principles or abstract formulas, but an application of *computational models* and *mathematical functions* that produces discernable effects.[356]

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[352] Bradley White, Vincent M. de Grandpré, Nathaniel Lipkus & Geoffrey Langen, "Canadian Court again rejects problem-solution approach to subject-matter eligibility of computer-implemented patents" (22 June 2022), online: *Osler* <https://www.osler.com/en/resources/regulations/2022/canadian-court-again-rejects-problem-solution-approach-to-subject-matter-eligibility-of-computer-imp>

[353] Roch Ripley, "Canada: Practically Permissible? Canadian Federal Court Adopts New Subject Matter Eligibility Test In The Context Of Computer-Implemented Inventions" (21 June 2012), online: *Mondaq* <https://www.mondaq.com/canada/patent/1204118/practically-permissible-canadian-federal-court-adopts-new-subject-matter-eligibility-test-in-the-context-of-computer-implemented-inventions>

[354] Ibid

[355] Ibid, Paras. 10 - 25 of the Specification

[356] See section 3.1.2.1 of this chapter.

The noticeable impact is the "implementation or stimulation of artificial neural networks." These characteristics can satisfy the *Benjamin Moore* test.

Similarly, the DABUS "Neural Flame" is a method that can enhance attention by "[g]enerating a lacunar pulse train having characteristics of a pulse frequency of approximately four Hertz and a pulse-train fractual dimension of approximately one-half."[357] The practical application of the DABUS invention is the "generation of a lacunar pulse train." The claims do not appear as mere scientific principles and mathematical functions.

The Improved PID controller is a method of improving control performance in PID controllers. The patent claims suggest that the invention forces "in a commendable way, the response of a system (conventionally called the plant) to achieve a specified reaction (the reference signal)."[358] The practical application is the "reference signal" that the invention generates in the plant. This discernable effect can satisfy the *Benjamin Moore* test and solve the abstraction problem.

In addition to the *Benjamin Moore test,* the common theme of the NNBPSM invention, the DABUS "Neural Flame" method, and the Improved PID controller is that they are control and information enhancement systems. The Patent Appeal Board has since recognized such systems as statutory subject matters. In *Re Application for Pat. of General Electric Co.,*[359]

[357] European patent Register, EP 3563896, online:<https://register.epo.org/application?number=EP18275174&lng=en&tab=doclist>
[358] See section 3.1.2.1 of this chapter
[359] In Re Application for Pat. of General Electric Co. (1984), 6 C.P.R. (3d) 191 (Pat. App. Bd. & Pat. Commr.).

the Applicant sought to patent a control system for a gas turbine engine. The invention was a replacement signal for an erroneous input signal from a faulty sensor in the feedback control loop of a gas turbine. The examiner rejected the application because it is a computer program and an unpatentable subject matter. The Patent Appeal Board disagreed with the patent examiner. It held that a system for controlling an engine, i.e., the calculated numbers used within a system of controlling a machine, is a statutory subject matter.[360] Correspondingly, in *Re Application for Pat. by Rockwell International Corp*.,[361] the Board found a method to monitor vibration levels in industrial plants as patentable subject matter, notwithstanding the use of a computer to implement the discovery. These quasi-judicial decisions on "control and information enhancement systems" further confirm that AI-generated inventions can fall within the statutory meaning of a statutory subject matter as provided under the *Patent Act.*

In sum, the tests for determining whether an invention is a statutory subject matter is whether it falls within the meaning of an invention: "art, process, machine, composition of matter, and manufacture," and has physical existence or manifests a discernable physical effect or change to satisfy the "practical application" condition. AI-generated inventions can meet these tests of statutory subject matter.

For instance, the claims in some of the inventions (mentioned in section 2.3 of this thesis) have shown that they can be an "art" (method of applying skill or knowledge), "process" (method of operation used to produce a result"), and a machine (a physical embodiment of

[360] Ibid at p. 194.
[361] Ibid

a mode of operation). Also, AI-generated inventions can manifest "discernable physical effects" in the forms of stimulating neural networks, enhancement, and control to render them patentable subject matters. The "discernable physical effect" implies that AI-generated inventions would not be affected by the statutory exclusions of mere scientific principles and abstract theorem.

Finally, some precedents in the U.S. on patenting AI-generated inventions may be relevant to this discourse. Two computer scientists and AI developers, Stephen Thaler and John Koza (mentioned in section 2.3 of this thesis), have claimed to have patented several AI-generated inventions, including an Improved PID controller and NNBPSM invention at the USPTO, although without disclosing the AI systems' role to the patent office. If the claims of Thaler and Koza are true, it suggests that AI-generated innovations can satisfy the subject matter requirements under the U.S. regime and that many patent offices may have unknowingly granted patents on AI-generated inventions for decades. This is likely to happen in situations where the applicants did not disclose the substantive role of the AI systems to the patent office by simply naming a natural person as the inventor.[362]

The relevancy of the above US circumstances to Canada is grounded on the fact that s 2 of the Canadian *Patent Act* is modelled after s 101 of the *United States Code,*[363] which deals with the statutory subject matter.[364] The two statutory provisions are substantially the same. Thus, in *Re Application for Pat. of Dialog Systems Inc.,* the Patent Appeal Board, after

[362] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 10
[363] 35 U.S.C. Section 101.
[364] See Barry B. Sookman, *supra* note 305 at § 6:3.

relying on decisions of the US Supreme Court, concluded that the "Board views this United States jurisprudence as being not divergent in principle from the interpretation given to s. 2 of the Canadian *Patent Act* in Schlumberger."[365]

Consequently, the fact that AI-generated inventions could satisfy the meaning of a statutory subject in the US and patented supports the view that AI-generated inventions can qualify as a statutory subject matter under Canadian patent law.[366] However, chapter four examines the theoretical underpinnings of this broad understanding of a statutory subject matter to determine if it is legally justifiable.

3.1.4. Patentability Criteria: The Patent Examiner's Nightmare and the Utility Test

As I noted earlier, the mechanism for determining statutory subject matter and patentability criteria under the *Patent Act* are different procedures. Patent examiners and policymakers should not conflate the two processes. However, a discussion on the statutory subject matter would not be complete without examining the patentability criteria, as they are closely intertwined with the concept of statutory subject matter. In the subsequent paragraphs, I briefly discuss the patentability criteria and highlight some challenges AI-generated inventions may face to satisfy them.

[365] See *Re Application for Pat of Dialog Systems Inc.* (1984), 5 C.P.R. (3d) 423 at 428 (Pat. App. Bd. & Pat. Commr.).
[366] However, Barry Sookman has argued that "[US patent decisions] will no doubt be of assistance at the examiner and Patent Appeal Board level, [but] it is still unclear whether the relatively explicit tests being applied currently in the Unites States will be directly applied to any given situation in Canada." See Barry B. Sookman, *supra* note 305 at § 6:3.

Canada has three substantive patentability criteria: novelty, non-obviousness, and utility. For a statutory subject matter to be patentable, it must meet these three requirements. An invention is novel if it has not been disclosed to the public before the filing or claim date.[367] The place to search to determine if an invention is novel is the 'state of the art' or 'prior art.'[368] Anything can be prior art, including prior publications, products, and patent applications anywhere in the world.[369] In *Mylan Pharmaceuticals ULC v Eli Lilly Canada Inc*,[370] the Federal Court of Appeal defined a "Prior art as "the collection of learning in the field of the patent at issue" and "comprises any publicly available teaching, however obscure or not generally accepted." However, for a prior publication or sale to anticipate an invention, it must be an "enabling disclosure."[371]

Generally, determining whether an invention is novel is not a difficult task. Once a prior product, process, or patent contains all the essential elements of a claimed invention, it is not novel. Consequently, the novelty requirement does not appear to raise any concerns for AI-generated inventions.

The second patentability requirement is that the invention must not be obvious to a "person with ordinary skill in the art" (POSITA). The aim is that "[t]he public should not be expected to pay an elevated price in exchange…for the 'discovery' of things that already

[367] Section 28.2 of the *Patent Act;* See Gregory Hagen, et al, *Canadian Intellectual Property Law Cases and Materials, supra* note 213 at 750.
[368] See *Mylan Pharmaceuticals ULC v Eli Lilly Canada Inc*, 2016 FCA 119 (Prior art is "the collection of learning in the field of the patent at issue" and "comprises any publicly available teaching, however obscure or not generally accepted").
[369] For an invention to be novel, it must not have been described or shown in the prior art. However, the prior art (publication or sale) must be such that a skilled person reading or analyzing it would in every case be led to the claimed inventionSee *Canada Ltd. v. Valmet OY* (1986), 8 C.P.R. (3d) 289 (F.C.A.), per Hugessen J.A., at p. 299; *Apotex Inc. v. Sanofi-Synthelabo Canada Inc*., 2008 SCC 61 (para. 37).
[370] 2016 FCA 119
[371] See *Canwell Enviro-Industries Ltd v Baker Petrolite* [2002 FCA 158]

exist or are obvious,"[372] or "knowledge that is effectively already in the 'public domain.'[373] The test for non-obviousness is whether the POSITA would, given the "state of the art" and "common general knowledge" as at the claimed date of invention, have come quickly, easily, directly, and relatively inexpensively, come to the solution described in the patent application,[374] and the obviousness inquiry is usually undertaken on a claim-by-claim basis.[375]

There was no statutory provision on non-obviousness in Canada until 1989. Therefore, the law on non-obviousness before 1989 was shaped by judicial cases.[376] However, the current statutory regime on non-obviousness is not drastically different from the law before 1989.[377] The Supreme Court of Canada laid the latest test for obviousness in the case of *Apotex Inc. v. Sanofi-Synthelabo Canada Inc*,[378] where the Court adopted the British Court of Appeal's four-step approach for the obviousness inquiry outlined by Oliver L.J. in *Windsurfing International Inc. v. Tabur Marine (Great Britain) Ltd*.,[379] and refined by Lord Jacob in *Pozzoli SPA v. BDMO SA,*[380] as follows:

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[372] *Apotex Inc. v. Wellcome Foundation Ltd.* [2002] S.C.J. No. 78 at para. 37, 2002 SCC 77 (S.C.C.).
[373] See Matthew Herder, "Demythologizing PHOSITA - Applying the Non-Obviousness Requirement under Canadian Patent Law to Keep Knowledge in the Public Domain and Foster Innovation." Osgoode Hall LJ 47.4 (2009) : 695-750 at 697.
[374] See *Apotex Inc v Sanofi-Synthelabo Canada Inc* 2008 scc 61
[375] See Lucie Guibault, et al, "Handbook on Canadian Intellectual Property Law" (Creative Commons) at Part IV 20 (stating that if an independent claim is found not to be obvious, then dependent claims therefrom cannot be obvious. By way of contrast, if an independent claim is held to be obvious, the Court must go on to consider each dependent claim for obviousness)
[376] *Smith v. Goldie* [1883] S.C.J. No. 23, 9 S.C.R. 46 (S.C.C.); *Canadian Gypsum Co. v. Gypsum, Lime & Alabastine Canada Ltd* [1931] Ex. C.R. 180 (Ex. Ct.); *C.H. Boehringer Sohn v. Bell-Craig Ltd* [1962] Ex. C.R. 201, 39 C.P.R. 201 at para. 44 (Ex. Ct.), affd [1963] S.C.J. No. 40, [1963] S.C.R. 410 (S.C.C.); *Xerox of Canada Ltd v. IBM Canada Ltd* [1977] F.C.J. No. 603, 33 C.P.R. (2d) 24
[377] Section 28.3 of the *Patent Act*
[378] [2008] S.C.J. No. 63.
[379] [1985] R.P.C. 59 (C.A.).
[380] [2007] F.S.R. 37.

> (1) (a) Identify the notional "person skilled in the art";
> (b) Identify the relevant common general knowledge of that person;
>
> (2) Identify the inventive concept of the claim in question or if that cannot readily be done, construe it;
>
> (3) Identify what, if any, differences exist between the matter cited as forming part of the "state of the art" and the inventive concept of the claim or the claim as construed;
>
> (4) Viewed without any knowledge of the alleged invention as claimed, do those differences constitute steps which would have been obvious to the person skilled in the art or do they require any degree of invention?

Correspondingly, section 28.3 of the *Patent Act* provides that the subject matter claimed in a patent application must not be obvious as of the claim date "to a person skilled in the art or science." The obviousness analysis involves appropriately identifying the 'person skilled in the art (POSITA),' 'common general knowledge,' 'state of the art,' and purposive construction of the applicant's claims.[381]

The crux of the obviousness assessment is whether the POSITA, having regard to state of the art, would have arrived at the invention. This means obviousness is assessed through the eyes of a POSITA, who reflects the characteristics of an average worker in a relevant scientific field.[382] If the POSITA finds the claimed invention obvious, the patent will not

[381] The state of art is "the collection of learning in the field of the patent at issue" and "comprises any publicly available teaching, however obscure or not generally accepted" (See *Mylan Pharmaceuticals ULC v Eli Lilly Canada Inc*, 2016 FCA 119). "The skilled person may use his or her common general knowledge to supplement information contained in the prior patent. Common general knowledge means knowledge generally known by persons skilled in the relevant art at the relevant time" (see *Apotex Inc. v. Sanofi-Synthelabo Canada Inc*., 2008 SCC 61 (para. 37) See Lucie Guibault, et al, "Handbook on Canadian Intellectual Property Law" (Creative Commons) at Part IV 14).
[382] *Apotex Inc. v. Sanofi-Synthelabo Canada Inc* [2008] S.C.J. No. 63.

be issued.[383] Determining the skill of the POSITA is critical in the obviousness inquiry in order not to patent trivial advancements. The knowledge of the POSITA must align with real-world conditions; otherwise, it would be too lenient or harsh a standard of patentability.

With the emergence of AI systems, the real-world conditions of innovation have changed as AI technology amplifies humans' capabilities in developing inventions. Thus, the knowledge of the POSITA ought to evolve, and the "state of the art" ought to be expanded. For instance, given the broad application of machine learning (ML) systems across technology and engineering fields, it is crucial to integrate ML techniques in the "obviousness" inquiry.[384] ML systems need to be factored into the definition of a POSITA for inventions that could or would have been developed by applying ML systems.

Consequently, if ML techniques could have solved the technical problem underlying a claimed invention, the invention should be considered obvious and unpatentable. The fallout of not reflecting the current trend of technological innovation and a low obviousness standard is that society may witness a torrent of patents that would have been otherwise obvious, which may have a stifling effect on innovation.[385]

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[383] *Graham v. John Deere Co.,* 383 U.S. 1 (1966).
[384] See Daria Kim et al., *supra* note 128 at 301
[385] See Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 114 (arguing that "the increasing use of AI support for human inventive activity leads to a rapid transformation of the concept of the PHOSITA"); Robert Plotkin, *supra* note 1 at 112 (arguing that the "ubiquity of artificial invention technology" influences the non-obviousness requirement"); Ryan Abbott, 'Everything Is Obvious' (2018) 66 U.C.L.A. L. Rev. 2, 46 -47.

On the other hand, the impact of a higher standard of patent protection may lead to fewer patents because it is more likely that new inventions may appear obvious.[386] However, the matter becomes complicated in the event of "AI-generated invention." The average inventive AI system has a superior innovative capacity and accesses boundless prior art knowledge.[387] Therefore, how would a patent examiner assess the obviousness of such inventions?

It is doubtful if a human examiner can adequately determine if an AI-generated invention is obvious.[388] As Anna Morrish pointed out, the test of non-obviousness for AI-generated inventions may be too high for humans to be able to reach because "it is possible for an AI to have read every piece of literature, to recall all data related to a particular field and to compare said data to tributary data from other fields."[389]

Some commentators are concerned about determining the appropriate standard of non-obviousness for AI-generated invention.[390] Determining the proper standard may require understanding the "common general knowledge" of machines (and persons) and creating a hypothetical "machine skilled in the art" (MOSITA). The patent examiner may also need to assess the standard of non-obviousness not only from the perspective of a "person skilled in the art" but also "whether it was obvious to machines (or potentially even other non-

[386] Ibid at 8
[387] Ibid
[388] Patent protection is only granted to new, nonobvious, and useful inventions. See Donald Chisum, *Chisum on Patents* (Matthew Bender Elite Products, 1978) § 5.02; John R. Allison and Mark A. Lemley, "Empirical Evidence on the Validity of Litigated Patents" (July 1, 1998) 26 American Intellectual Property Law Association (AIPLA) Quarterly Journal, p. 185.
[389] See Anna Morrish, *supra* note 32 at 265
[390] Jeremy A Cubert and Richard GA Bone, "The Law of Intellectual Property Created by Artificial Intelligence" in Woodrow Barfield and Ugo Pagallo (eds), Research Handbook on the Law of Artificial Intelligence (Edward Elgar 2018) 421.

human inventors)."[391] The examination may be based on full knowledge at the disposal of all potential human and non-human inventors.[392] This adjusted assessment will likely be highly complex, if not impossible, to undertake. As Martin Stierle noted, recognizing AI-generated inventions would make assessing obviousness extremely complex.[393]

Some commentators have predicted a doomsday coming. Ryan Abbott stated that as innovative AI systems become more sophisticated and foresee all potential advances, all inventions would one day seem obvious through the lens of innovative AI systems.[394] Sven Hetmank et al. noted that the patent examination process might break down once AI systems reach or outstrip the level of human intelligence in a particular field.[395] Similarly, Tim W. Dornis argued that with the advent of AI-generated inventions, "the end of patent law is near" because "humans no longer stand at the center of the creative universe—we are no longer the masters of innovation."[396]

On the contrary, some commentators like Dan Burk do not share the view that AI systems would significantly disrupt the non-obviousness framework. He argued that the ease or difficulty of producing an invention has never been a criterion for determining patentable obviousness.[397] Instead, the question of obviousness is whether the invention could have

[391]Ibid
[392] Martin Stierle, "A De Lege Ferenda Perspective on Artificial Systems Designated as Inventors in the European Patent System" (2021) 70:2 *GRUR International* 115 at 129.
[393] Ibid at 128.
[394] See Ryan Abbott, 'Everything Is Obvious', (2018) 66 UCLA L.Rev.2 10, 6
[395] See Sven Hetmank and Anne Lauber-Ro¨nsberg, 'Ku¨nstliche Intelligenz – Herausforderungen fu¨r das Immaterialgu¨terrecht' [2018] GRUR 580 (patent offices might not be able to assess the average capacity of state-of-the-art AI systems) cited in Martin Stierle, *supra* note 393 at 129
[396] Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 98.
[397] Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 312; Sean B. Seymore, "Serendipity," (2009) 88 N.C. L. REV. 185, 190

been predicted, foreseen, or routinely executed by those of ordinary skill in the field of technology. Once the solution is unexpected or unpredictable, the claimed invention is non-obvious, not "whether the method employed to obtain it was widely or routinely available.[398]

The adequacy or otherwise of the current non-obviousness standard would first depend on whether AI-generated inventions are patentable subject matters. In the unlikely event that they are, I believe the Patent Office could clarify the issue with time. Even for other inventions, determining the appropriate standard of "non-obviousness" has been elusive, and courts have devised several imaginative analytical protocols to manage the inquiry.[399] At the moment, it may seem unclear how the patent office would assess the non-obviousness of AI-generated invention, but as the creative space of AI systems continues to expand, it may become more apparent. Indeed, with today's eyes, it is difficult to see how tomorrow's invention would be assessed.

Assuming AI-generated inventions qualify as statutory subject matter, the patent office may resolve to deem an AI-generated invention non-obvious (regardless of the inventive capacity of such AI system) so long as it is not obvious to the notional "person skilled in the art" and adjust the standard with time.

[398] Dan L. Burk, Ibid, at 312.
[399]See Matthew Herder, *supra* note 374 at 695-750; and John R. Allison & Mark A. Lemley, "Empirical Evidence on the Validity of Litigated Patents" (1998) 26 A.I.P.L.A.Q.J. 185 at 209.

The third requirement of patentability is utility; the invention must be useful as of the filing date.[400] The utility does not depend on marketability or commercial acceptance.[401] An invention may be uneconomic, primitive, or commercially useless – yet considered useful in law.[402] In *AstraZeneca Canada Inc. v. Apotex Inc*.,[403] the Justice Rower of the Supreme Court of Canada proposed a two-step test to establish utility: "First, courts must identify the subject matter of the invention as claimed in the patent. Lastly, courts must ask whether that subject matter is useful - is it capable of a practical purpose (i.e., an actual result)?"[404] This test revised the old promise doctrine, which required that every potential use or promise in the patent claims must be realized. In the new test, "a scintilla of utility will do."[405]

The claimed invention need not fulfill all the promises in a patent application to establish utility, a single-use related to the nature of the subject matter is sufficient.[406] The usefulness of the patentable subject matter must be demonstrated or "soundly predicted" at the time of application.[407] The concept of 'sound prediction' only becomes relevant and available when an invention's utility cannot readily be demonstrated by tests or experiments but can nonetheless be successfully predicted.[408]

[400] See s. 2 of the *Patent Act*
[401] See *Laboratories Servier, Adir, Oril Industries, Servier Canada Inc v Apotex Inc,* 2008 FC 825, Snider J.
[402] See David Vaver, *supra* note 276 at 339.
[403] 2017 SCC 36
[404] *Ibid.* at [54].
[405] *Ibid.* at [55]
[406] See *AstraZeneca Canada Inc. v Apotex Inc*. [2017 SCC 36]
[407] See *Apotex v Wellcome Foundation,* [2002] 4 SCR 153.
[408] See AstraZeneca Canada Inc. v Apotex Inc. [2017 SCC 36]

Establishing "sound prediction" or conducting the relevant experimental tests to demonstrate utility may constitute hurdles for AI-generated inventions. This can be seen from the decision in *Apotex Inc. v. Wellcome Foundation Ltd*.[409] In that case, the court set out a three-part test to establish "sound prediction:" (a) "there must be a factual basis for the prediction;" (b) "the inventor must have at the date of the patent application an articulable and 'sound' line of reasoning from which the desired result can be inferred from the factual basis;" and (c) "there must be proper disclosure."[410]

AI systems do not have minds of their own, so they cannot produce an articulable and sound line of reasoning concerning the workings of their inventions as required in the *Apotex case.* Also, in theory, due to the complexities of experimental tests, they are unlikely to be able to conduct the necessary tests (without human intervention), particularly as it relates to the pharmaceutical and chemical industries. This is because "[T]esting often involves more than mere verification linearly. It includes chemical analysis, testing in non-human analogues, *in vitro* testing for interactions, and testing in human subjects."[411] The testing may even require alterations depending on the pre-clinical testing results or the circumstances of each case, which may demand further problem-solving and innovation.[412]

AI systems cannot undertake the above magnitude of testing activities independently. This means in certain circumstances; it may be impossible for AI-generated inventions to satisfy the utility test. However, in practical terms, it is important to highlight that it is unlikely

[409] [2002] SCC 77 at [70]

[410] *Apotex Inc. v. Wellcome Foundation Ltd,* [2002] SCC 77 at [70]
[411] Anna Morrish, *supra* note 32 at 268
[412] Ibid

that AI-generated artifacts would ever be the product of testing or that patent examiners would need to do much testing to determine whether such inventions meet the utility test because these issues do not arise with respect to computer-related inventions.

3.2. Summary

This chapter's analysis establishes that the patentability of AI-generated inventions in Canada, including whether such inventions could qualify as a statutory subject matter, mainly depends on the *Patent Act*'s provisions and the relevant courts' decisions. In this regard, the Act defines a statutory subject matter as an invention that includes "art, process, and machine." A careful review of the meaning of these categories of inventions suggests that AI inventions may qualify as statutory subject matter.

Correspondingly, the Act excludes "mere scientific principles" and "abstract theorem from the realm of patentable subject matter as they do not manifest "discernable physical effects." However, an examination of the patent claims of some AI-generated inventions reveals that they can manifest "discernable physical effect" and may not be affected by the statutory exclusions.

Chapter Four: Inventorship and Ownership of Artificial Intelligence Inventions

As the previous chapter shows, AI-generated inventions may qualify as a statutory subject matter subject in certain circumstances, the next question is whether AI-systems can be inventors or owners of patent rights under the Canadian patent framework. This chapter seeks to answer this question by examining the provisions of the *Patent Act* and relevant judicial decisions.

The analysis in this chapter is organized into two main parts: the first part centers on inventorship and studies the meaning of "conception," the provisions of ss. 2, 27(1) and 31 of the *Patent Act,* the *Paris Convention*, and inventorship in comparable jurisdictions, while the second part focuses on ownership of patent rights and evaluates the meaning of "patentee" and "person" under ss. 2 and 42 of the *Patent Act.*

4.1. Inventorship under the *Patent Act*

Before delving into the provisions of the Act, it is critical to highlight the importance of inventorship in Canada. First, as would become clearer in subsequent parts of this chapter,[413] inventorship plays a vital role in determining the person entitled to apply for and be granted patents.[414] In other words, it is the inventor that has the first right to apply for a patent, which they can transfer to a third party either by contract or other legal mechanisms. As Gregory Hagen pointed out, only an inventor (or their representative) can

[413] See section 3.2.5 of this research project.
[414] *Patent Act,* R.S.C. 1985, c. P-4, s. 27(1

be given a patent.[415] This means inventorship strikes at the root of the title of a patentable invention.

Second, a vital formality requirement under the *Patent Act* is that the inventor's details must be included in the patent application.[416] A patent application is incomplete and liable to be rejected by the patent office if the name and address of a legally recognizable inventor is not included in the application.[417] Thus, even in circumstances where a corporation is the applicant and may own the eventual intellectual property rights, the applicant is still required to mention the details of the actual inventor.[418] In fact, if the inventor's details are not correctly stated, it may affect the validity of a patent grant. In a decided case, the court held that a patent would be declared invalid if an applicant willfully and incorrectly identifies the inventor.[419]

Consequently, it is vital to understand and correctly identify who or what constitutes an "inventor" under the Canadian patent system and examine whether AI systems can be inventors. In determining whether an AI system can be eligible to be an "inventor," this section considers the (a) ordinary meaning of the term inventor, (b) the mental conception requirement, (c) the expectations of the *Patent Act,* (d) inventorship in comparable jurisdictions, and (d) the object of the Act.

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[415] See Gregory Hagen, "AI and Patents and Trade Secrets," *supra* note 33 at 64.
[416] SOR/2019-251, s. 54(1)(2) of the Patent Rules (made pursuant to the Patent Act).
[417] Ibid
[418] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 10
[419] Section 53(1) of the *Patent Act*; See 671905 *Alberta Inc. v. Q'Max Solutions Inc.,* [2003] F.C.J. No. 873 at paras. 26 – 32, page 115 – 116.2003 FCA 241 (F.C.A); *Weatherford Canada Ltd. v. Corlac Inc.* 2011 CarswellNat 2835, 2011 CarswellNat 3714, 2011 CAF 228, 2011 FCA 228, [2011] F.C.J. No. 1090, 204 A.C.W.S. (3d) 888, 422 N.R. 49, 95 C.P.R. (4th) 101 at 142 ("a patent can be found to be void if the conditions of subsection 53(1) are met.. [but] "…the misstatement must be material to the 'public' and in a practical sense material to the Commissioner of Patents.")

4.1.1. The Ordinary Meaning: First Impression Perspective

The Canadian *Patent Act* does not explicitly define the term "inventor" and the relevant court decisions on the subject matter are scanty. In contrast, the United States (U.S.) patent regime expressly suggests that an inventor must be a person. The US Federal Circuit Court held that corporations and sovereigns could not be inventors.[420] Subsequently, the U.S. enacted the *America Invents Act,*[421] which defines an inventor as an individual who invented or discovered the subject matter of an invention. This clearly excluded non-human entities from inventorship by using the word "individual."

In Canada, the position is not that straightforward. The difference between the two jurisdictions may be because since 1989 Canada has operated a first-to-file priority system rather than the first-to-invent system, resulting in little patent jurisprudence on inventorship.[422] The "first-to-file" system grants the patent rights for an invention to the party who first files a patent application, regardless of whether they are the true inventor. The first-to-file system was first implemented by European countries and has increasingly become the international standard.[423] In contrast, the U.S. only recently embraced the idea of the first inventor to file on March 16, 2013, based on *America Invents Act.*[424]

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[420] See *Univ. of Utah v. Max-Planck-Gesellschaft zur Forderung der Wissenschaften e.V*., 734 F.3d 1315, 1323 (Fed. Cir. 2013) (holding that "inventors must be natural persons and cannot be corporations or sovereigns").
[421] *Leahy-Smith America Invent Act* Sept. 16, 2011. [H.R. 1249] 35 U.S.C. § 100(f) (Definitions) ["the individual, or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention"]
[422] Michael C. Jordan, "The Politics of Drug Patenting in Canada, 1965-2005" (2005) MA Thesis, University of Saskatchewan at 29-34.
[423] Shih-tse Lo & Dhanoos Sutthiphisal, "Does It Matter Who Has The Right To Patent: First-To-Invent Or First-To-File? Lessons From Canada" (April 2009), online: *NBER Working Paper Series* < https://www.nber.org/system/files/working_papers/w14926/w14926.pdf>
[424] USPTO, "First Inventor to File (FITF) Resources" (accessed on 28 July 2022), online: <https://www.uspto.gov/patents/first-inventor-file-fitf-resources#:~:text=The%20first%20inventor%20to%20file,effective%20on%20March%2016%2C%202013>

Concerning the ordinary meaning of an "inventor" in Canada, the arguably most relevant decision on the subject was delivered in *Sarnoff Corp v Canada (Attorney General) (FC),*[425] where the Federal Court defined the term "inventor" to mean a natural person. In that case, the central issue before the court was whether the Patent Office could deem a patent application abandoned because an improper person had paid the maintenance fees. The court found the decision of the Commissioner to be incorrect, but while resolving the issue for determination, the court stated that an "inventor" could only be a natural person. Hughes J commented on the meaning of an inventor as follows:

> "In Canada, the language of the jurisprudence assumes that an "inventor" is a natural person as opposed to a juridical person such as a corporation… I note that some European applications for patents are filed naming corporate entities as the inventor. Not so in Canada or the United States. There can, of course, be more than one natural person named as an inventor in a patent application."

However, Hughes J's opinion is an *obiter dictum*, which is not binding,[426] although it is likely to be highly persuasive because it is the only judicial pronouncement in Canada that explicitly defines an "inventor" as a natural person and excluded corporations. The decision is also applicable within the context of AI-generated inventions. If the basis for excluding

[425] [2009] 2 FCR 3, 2008 FC 712, [2009] 2 RCF 3, [2008] FCJ No 895, [2008] ACF no 895 at para. 9
[426] Gerald L. Gall, *The Canadian Legal System* (Carswell, 3rd ed. 1990) 292 ("... The ratio decidendi is the 'part of the case that is said to possess authority' containing 'the rule of law upon which the decision is founded'. On the other hand, an obiter dictum is any statement of law made by a judge that is part of a case but which does not contain the particular rule of law upon which that case is decided. A future judge, of course, is not bound by an obiter dictum, as the doctrine of stare decisis is not applicable to it and it merely has persuasive force at best."); see *Sellars v. R.,* [1980] 1 S.C.R. 527, 20 C.R. (3d) 381, 52 C.C.C. (2d) 345, 110 D.L.R. (3d) 629, 32 N.R. 70; and *Neuman v Canada (Minister of National Revenue - MNR),* [1992] TCJ No 288, [1992] ACI no 288, [1992] 2 CTC 2074, 92 DTC 1652

juridical persons from inventorship is because they are not natural persons, the same principle applies to AI systems. Meanwhile, it is important to note that to the extent that Hughes J's opinion is an *obiter dictum,* the issue of AI inventorship has not been settled by the court.

In addition to *Sarnoff's* pronouncement, the dictionary meaning of an inventor refers to a person who created something, not a computer technology or a machine. For example, the *Oxford English Dictionary* defines an "inventor" as: "a **person** who has invented something or whose job is inventing things."[427] Similarly, *Cambridge English Dictionary* defined an inventor as: "**Someone** who has invented something or whose job is to invent things."[428] These dictionary definitions suggest that an "inventor" must be a person, which means either a natural or artificial person. A natural person refers to a human being, while an artificial person means a legal entity created by law with the ability to exercise rights and perform duties.[429]

It is controversial whether AI systems should be recognized as artificial or "electronic persons."[430] On February 16, 2017, the European Parliament proposed that electronic

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[427] See Oxford Learner's Dictionary (Oxford, UK: Oxford University Press, 2022) retrieved from <https://www.oxfordlearnersdictionaries.com/definition/american_english/inventor#:~:text=%2F%C9%AAn%CB%88v%C9%9Bnt%C9%99r%2F,whose%20job%20is%20inventing%20things>; (emphasis mine).

[428] Cambridge Dictionary (Cambridge, UK: Cambridge University Press, 2022) retrieved from <https://dictionary.cambridge.org/dictionary/english/inventor> (emphasis mine)

[429] Sergio M.C. Avila Negri, "Robot as Legal Person: Electronic Personhood in Robotics and Artificial Intelligence" (23 December 2021), frontiers < https://www.frontiersin.org/articles/10.3389/frobt.2021.789327/full#:~:text=In%202017%2C%20the%20European%20Parliament,(European%20Union%2C%202017).>

[430] Janosch Delcker, "Europe divided over robot 'personhood" (April 11, 2018), online: <https://www.politico.eu/article/europe-divided-over-robot-ai-artificial-intelligence-personhood/>

personhood be created for "intelligent" robotic artefacts.[431] In response, 156 AI experts hailing from 14 European countries warned that granting legal personhood to robots would be "inappropriate" from both a "legal and ethical perspective."[432] In the same year, Saudi Arabia became the first country in world to grant an AI system called Sophia legal personhood and citizenship.[433] However, Emily Reynolds stated that - "The citizenship stunt seemed more akin to a marketing campaign – for Sophia and Saudi Arabia – than it did a genuine statement on humanity, dignity or personhood."[434]

However, in Canada, AI systems are not artificial persons; no province in Canada has recognized AI systems as legal persons, and there is apparently no legislative intention to confer legal personhood on AI systems anytime soon. Thus, from the "ordinary and grammatical meaning" perspective, AI systems do not qualify as inventors under the *Patent Act*.[435]

[431] European Parliament, "European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL)" (February 16, 2017) online: < https://www.europarl.europa.eu/doceo/document/TA-8-2017-0051_EN.html>
[432] Open Letter to the European Commission Artificial Intelligence and Robotics, online: < https://www.politico.eu/wp-content/uploads/2018/04/RoboticsOpenLetter.pdf>
[433]Emily Reynolds, "The agony of Sophia, the world's first robot citizen condemned to a lifeless career in marketing" (June 1, 2018) < https://www.wired.co.uk/article/sophia-robot-citizen-womens-rights-detriot-become-human-hanson-robotics>
[434] Ibid
[435] See section 3.3. of this chapter on further details on personhood.

4.1.2. Conception: The Hallmark of Inventorship

Conception is often considered the "touchstone of inventorship"[436] and "definitive of the act of invention."[437] In the landmark case of *Apotex Inc. v. Wellcome Foundation Ltd*,[438] the appellants, generic drug manufacturers, challenged the validity of Glaxo/Wellcome's patent because the disclosure was misleading. According to them, the patent application ought to have referenced the scientists in the National Institutes of Health (NIH) as "co-inventors." In resolving the appeal, the Supreme Court of Canada defined "inventorship" as follows:

> Inventorship is not defined in the Act, and it must therefore be inferred from various sections. From the definition of "invention" in s. 2, for example, we infer that **the inventor is the person or persons who conceived of** the "new and useful" art, process, machine, manufacture or composition of matter, or any "new and useful" improvement thereto. The ultimate question must therefore be: who is responsible for the inventive concept?
>
> Section 34(1) [now ss. 27(3)] requires that at least at the time the patent application is filed, the specification "correctly and fully describe the invention…to enable any person skilled in the art or science to which it appertains…to … use it". It is therefore not enough to have a good idea … the ingenious idea must be **"reduced…to a definite and practical shape"**.[439]

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[436] *See, e.g., Grantley Pat. Holdings, Ltd. v. Clear Channel Commc'ns, Inc.*, 540 F. Supp. 2d 724, 733 (E.D. Tex. 2008); *Gerrard Wire Tying Machines Co. of Canada v. Cary Manufacturing Co.,* 1926 CanLII 284 (CA EXC), [1926] Ex. C.R. 170,

[437] *Gunter v. Stream*, 573 F.2d 77 (C.C.P.A. 1978).

[438] 2002 SCC 77 153

[439] Paras. 96-97 (S.C.C.) *Emphasis mine.*

The *Apotex's* case highlighted two steps required to establish inventorship in Canada: (1) conception of the invention and (2) its reduction to a practical shape. What amounts to conception has been the subject of debates, and it may sometimes be challenging to distinguish the inventive concept from other essential but non-inventive contributions.[440]

In Canada, it is widely accepted that the doctrine of "conception" involves some level of mental activity.[441] In *Aram Systems Ltd. v. NovAtel Inc,*[442] the Court of Queen's Bench of Alberta defined "conception" as the "Formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice."[443] The Court further stated, "Conception is complete when the idea is so clearly defined in the inventor's mind that only ordinary skill would be necessary to reduce the invention to practice, without extensive research or experimentation."[444] This decision highlights two principles, the "conception" happens in the mind, and it must involve the complete and operative inventive idea.

4.1.2.1. Can Machines Think?

The term "conception" has not been precisely interpreted and applied in the context of AI-generated inventions.[445] It is unclear how electronic systems like AI would satisfy this mental activity. Does it require an AI to mimic human thought or brain system? Or is it

[440] See Stephen J. Perry & T. Andrew Currier, Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 89
[441] See Gregory Hagen, "AI and Patents and Trade Secrets," *supra* note 33 at 57
[442] 2008 ABQB 441 (CanLII).
[443] Ibid at para. 65.
[444].Ibid; See *Townsend v. Smith*, 36 F.2d 292, 295 (C.C.P.A. 1929); Hybritech, Inc. v. Monoclonal Antibodies, Inc., 802 F.2d 1367, 1376 (Fed. Cir. 1986).
[445] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 84, 85.

sufficient that the AI system engaged in a process that resulted in a creative output? "Mental activity" ordinarily suggests some thinking or brain processes in developing and practically applying the inventive idea.[446] However, some commentators have argued that this approach is an anthropomorphic model of conceptualization of invention in contrast to the functionalist model.[447] The functionalist approach focuses on the output of the inventive process, not how the process was undertaken.[448]

In theory, to attain the anthropomorphic approach, the computer scientist may need to design a digitized version of the human brain to meet this standard. The artificial neural network (ANN) systems used by Stephen Thaler to develop the Creativity Machine are the closest to it.[449] As explained in Chapter Two, the ANN imitates the functioning of the human brain[450] "by applying a series of mathematical transformations and processes" to evaluate data.[451]

The critical enquiry in the anthropomorphic approach vis-à-vis AI-generated inventions is whether machines can think? Although the practical possibility of "thinking machines" is a relatively new concept, the challenge of associating thought with computers was since identified by Alan Turing in his famous 1950 paper titled "Computing Machinery and Intelligence."[452] He considered the question, "Can machines think?" He found the question

[446] See Stuart Russel & Peter Norvig, *supra* note 82 at 1021
[447] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 78
[448] Ibid
[449] See chapter 2 for further information.
[450] John D. Kelleher, *Deep Learning* (Cambridge, MA: M.I.T. Press, 2019) 5
[451] See Robin C. Feldman, 'Artificial Intelligence' (2018) 21 Green Bag 2d 201, 202–203; Madeleine de Cock Buning, "Autonomous Intelligent Systems as Creative Agents under the EU Framework for Intellectual Property" (2016) 7 European Journal of Risk Regulation 310, 312.
[452] See Alan M. Turing, "Computing Machinery and Intelligence" (1950) *Mind* 433 – 460

to be ambiguous and unscientific. Instead, he suggested that the better question is whether an individual can distinguish between responses from a computer and an individual? In other words, can machines act like thinking entities (i.e., people)?

Turing called this test the "Imitation Game," which is now commonly referred to as the *Turing test*. According to Turing, the intelligence of AI systems should be determined by a behavioural test.[453] Thus, if a machine acts as intelligently as a human being, it is as intelligent as a human being.[454] The substance of the *Turing test* is that an interrogator should have a conversation (via online, typed messages) with a computer program for five minutes. Thereafter, the interrogator should guess if the conversation is with a program or a person; if it fooled the interrogator 30% of the time, the program passed the *Turing test.* Many people have been fooled when they did not know they might be chatting with a computer.[455]

Some commentators have argued that AI systems passed the *Turing test* when the US Patents and Trademarks Office (USPTO) granted patents for AI-generated inventions on several occasions without knowing that machines developed them.[456] The Patent examiners had no idea that the inventive outputs they were considering were that of computers.[457]

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[453] Turing, *supra* note 453 at 433 – 460; Stuart Russel & Peter Norvig, *supra* note 82 at 1033. Russell & Norvig both argues that "creating programs that behave intelligently…" suffices to answer the question, "Can Machines Think?"
[454] See Turing, *supra* note 453 at 433 – 460
[455] Mark Humphrys, "How my program passed the Turing test." In Epstein, R., Roberts, G., and Beber, G. (Eds.), *Parsing the Turing Test*. (Springer, 2008), online: <https://computing.dcu.ie/~humphrys/Turing.Test/08.chapter.letter.ps>(The ELIZA program and Internet chatbots such as MGONZ and NATACHATA have fooled their correspondents repeatedly, and the chatbot CYBERLOVER has attracted the attention of law enforcement because of its penchant for tricking fellow chatters into divulging enough personal information that their identity can be stolen); see Stuart Russel & Peter Norvig, *supra* note 82 at 1021 (Turing Test-like contests such as the Loebner Prize competition, held annually since 1991, have led to better models of human typing errors).
[456] See Chapter 2 of this thesis – Can AI systems generate inventions?
[457] See Jonathon Keats, "John Koza Has Built an Invention Machine," (April 16, 2006), online: POPULAR SCI. <https://popsci.com/scitech/article/2006-04/john-koza-has-built-invention-machine/>.

Accordingly, Ryan Abbott argues that AI "functionally automates conception"[458] and that an AI system should simply be required to pass the *Turing Test*, not some mental activity.[459] He advocates for "legal neutrality" where "the law does not discriminate between people and AI when they perform the same activities…."[460]

Other commentators have taken the argument to a whole new level. They argue that humans' and machines' "thought processes" are the same because human thought processes and creative abilities are similar to sophisticated algorithms.[461] They further say that "the mind is a computer program that can be executed on any hardware that can run the program, including the brain."[462] However, skeptics have criticized the comparison because human behaviour is far too complex to be captured by any simple set of rules.[463] They argue that computers cannot generate behaviour as intelligent as humans by merely following instructions.[464] According to Computer Scientist Peter Kassan, "the way people [...] reason can't be reduced to an algorithmic procedure like arithmetic or formal logic'.[465]

There is also a philosophical dimension to the arguments. Some philosophers have argued that a computer that "passes the *Turing test* would still not be actually thinking."[466] It would

[458] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 78
[459] See Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" *supra* note 1 at 1083 – 1091.
[460] See Ryan Abbott, "The Artificial Inventor Project" (December 2019), online: *WIPO Magazine* https;//www.wipo.int/wipo_magazine/en/2019/06/article_0002.html.
[461] See Roger Schank & Christopher Owens, "The Mechanics of Creativity" in Raymond Kurzweil (ed), *The Age of Intelligent Machines* (MIT Press 1990) 394; Annemarie Bridy, "Coding Creativity: Copyright and the Artificially Intelligent Author" (2012) Stanford Technology Law Review 58
[462] John R. Searle, *The Rediscovery of the Mind* (Cambridge, Mass.: M.I.T. Press, 1992) at 44.
[463] See Hubert L. Dreyfus, *What Computers Can't Do: A Critique of Artificial Reason* (Cambridge, Massachusetts: The MIT Press, 1972); Stuart Russel & Peter Norvig, *supra* note 82 at 1024
[464] Ibid.
[465] See Peter Kassan, 'AI Gone Awry: The Futile Quest for Artificial Intelligence' (2006) 12 Skeptic 30, 34
[466] See Stuart Russel & Peter Norvig, *supra* note 82 at 1026; Jefferson, G., "The mind of mechanical man: The Lister Oration delivered at the Royal College of Surgeons in England" (1949) 1:25 British Medical Journal at 1105–1121

only be a "simulation of mental states and processes."[467] The designers and engineers would have already comprehended the tasks; the AI systems are merely used to implement them in the form of automation.[468] These philosophers and opponents of the *Turing test* seem to distinguish between "real" and "artificial" thinking. They advocate that human thought processes are very sophisticated to be reproduced by mere simulation. For a computer to think, it must be conscious of its mental state and action or have some form of will, emotion, or intention.[469]

In response to the philosophers, Turing argues that such requirements place a high standard on machines compared to humans because we do not have any direct evidence of the internal mental state of humans.[470] He says, "Instead of arguing continually over this point [of the internal mental state of humans], it is usual to have the polite convention that everyone thinks."[471] On the contrary, Dan Burk, Professor of Law at the University of California, Irvine, argues that AI systems are not intelligent in any robust sense of the word; they cannot have general cognitive abilities of the sort that humans routinely display.[472] Marion Fourcade and Kieran Healy, Professors of Sociology, observed that computer science has given up on making machines that can think in favour of creating machines that can learn.[473]

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[467] Ibid
[468] See Daria Kim et al., *supra* note 128 at 319, 320.
[469] John R. Searle, The Rediscovery of the Mind (Cambridge, Mass.: M.I.T. Press, 1992) at 45. See also John Searle, "Minds, Brains, and Programs" (1980) 3:3 Behav. Brain Sci. 417 [https://doi.org/10.1017/S0140525X00005756]; David Cole, "The Chinese Room Argument" in Edward N. Zalta, ed., The Stanford Encyclopedia of Philosophy, Spring 2019 ed. (Stanford: The Metaphysics Research Lab), online: The Stanford Encyclopedia of Philosophy https://plato.stanford.edu/archives/spr2020/entries/chinese-room/.
[470] See Stuart Russel & Peter Norvig, *supra* note 82 at 1026
[471] Ibid
[472] See Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 307.
[473] Ibid at 303; Adrian MacKenzie, "The Production of Prediction: What Does Machine Learning Want?," (2015) 18 Euro. J. Cult. Stud. 429, 435

Establishing what normatively amounts to "mental conception" and whether an artificial agent can actually perform such mental activity (intentionally, functionally, or behaviorally) may require more scientific and philosophical deliberations. This does not, however, change the position of the law in Canada.

Under the Canadian patent system, mental conception is usually associated with human mental activities.[474] Specifically, conception requires "formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention, as it is hereafter to be applied in practice."[475] Thus, the inventive concept must originate from the inventor's mind to satisfy the inventorship requirements. The key phrase is "formation in the mind." However, machines do not have minds from which such an idea can be formed or originate.[476] There is no indication that the law contemplates a "artificial simulation of the mind." As noted earlier, it is on this basis that corporations cannot be inventors in Canada.[477] Therefore, the scheme of the *Patent Act* does not support AI systems as inventors.[478]

4.1.3. Expectations of the Patent Act

[474] *Apotex Inc. v. Wellcome Foundation Ltd (supra)*
[475] *Aram Systems Ltd. v. NovAtel Inc* 2008 ABQB 441 (CanLII).
[476] See Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 307
[477] *Sarnoff Corp v Canada (Attorney General) (FC*) [2009] 2 FCR 3, 2008 FC 712, [2009] 2 RCF 3, [2008] FCJ No 895, [2008] ACF no 895 at para. 9
[478] See Aviv Gaon & Ian Stedman, Aviv Gaon & Ian Stedman, *supra* note 34 at 1137 - 1165

Although the Act did not explicitly define who or what qualifies as an "inventor," it stipulated certain "factors" or "expectations" of an inventor that provides further insights into the meaning of the term. These factors include (a) owning patents and refusal to apply for patents; (b) assignment of interests, transfer of titles, and infringement liabilities; and (c) moral rights under the *Paris Convention*. If an AI system cannot satisfy these factors, it is only reasonable to conclude that the scheme of the Act does not support AI systems as inventors.

4.1.3.1. Owning Patents and Refusal to Apply for Patents

The language of the *Patent Act* suggests that an inventor should be capable of applying for and holding patents. Section 2 of the Act describes an inventor as a patent applicant, while s 27(1) of the Act defines an inventor as capable of receiving patents. The implication of these statutory provisions is that an inventor should be capable of becoming a "patentee." Although the Act did not explicitly define an inventor, it describes a "patentee" as the "**person** for the time being entitled to the benefit of a patent."[479] The definition of a patentee as a person, therefore, supports the conclusion that the scheme of the Act expects an inventor to be a person. In other words, since a patentee must be a person, only persons can apply for and be granted patents. In a recent case, the UK Court of Appeal described the rights to apply for and be granted patents as "rights" that only a person can exercise.[480] Having established that AI systems are not recognized as persons under Canada's laws, it

[479] See Section 2 of the *Patent Act* (emphasis mine)
[480] *Thaler v. Comptroller General of Patents Trade Marks And Designs* [2020] EWHC 2412 (Pat).

is reasonable to conclude that the context of the Act does not support AI entities as inventors.

The *Patent Act* also contemplates that an inventor should be capable of refusing to apply for patents. Section 31(1) of the *Patent Act* provides as follows:

> Where an invention is made by two or more inventors and one of them **refuses** to make an application for a patent or his whereabouts cannot be ascertained after diligent inquiry, the other inventors or their legal representatives may make the application, and a patent may be granted in the name of the inventors who make the application, on satisfying the Commissioner that the joint inventor has **refused to** make the application or that **his** whereabouts cannot be ascertained after diligent inquiry.[481]

The above provision contemplates a situation where an inventor may refuse to cooperate with other joint inventors in filing or prosecuting a patent application.[482] It recognizes the liberty of an inventor to decline or refuse to make an application for a patent. The net implication of s 31(1) of the *Patent Act* is that an inventor should be a person. For an entity to be able to refuse to cooperate or decline to apply for a patent, it must have some level of consciousness or personhood, not an automated machine.

[481] Emphasis mine.
[482] Stephen J. Perry & T. Andrew Currier, Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 92

4.1.3.2. Assignment of Interests, Transfer of Title, and Infringement liabilities

An inventor under the *Patent Act* has the right to apply for and be granted patents.[483] These rights are proprietary interests that can be owned and assigned, or transferred.[484] In *Yeda Research and Development Company Ltd v. Rhone-Poulenc Rorer International Holdings*,[485] a UK court held that "inchoate ownership" includes "the right to apply for and be granted a patent for the invention."[486] This means the right to apply for a patent is an "inchoate" title that can be transferred to a third party.

Relatedly, s 49(1) of the *Patent Act* states, "A patent, **an application for a patent**, and **the right or interest in an invention** are transferable, in whole or in part."[487] This statutory provision recognizes that "an application for a patent" and any "right or interest in an (unpatented) invention" are proprietary rights that can be transferred in whole or in part. Essentially, an inventor can transfer their right to apply for a patent (or any other interest) in an invention to a third party. The Act further provides that the transfer may be through employment, inheritance, assignment, or other legal mechanisms.[488]

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[483] According to Section 2 of the *Patent Act,* Legal representatives include "heirs, executors, administrators of the estate, liquidators of the succession, guardians, curators, tutors, transferees and all other persons claiming through applicants for patents and patentees of inventions or through holders of certificates of supplementary protection."

[484] The CIPO's notice on March 26, 2019, captures these rights: ("Most applicants choose a patent agent to prosecute their patent application on their behalf. The Office recommends that all persons considering submitting a patent application consult a registered patent agent for advice. While individual inventors or joint inventors who **have not assigned their rights** may prosecute and represent themselves before the Patent Office, all applicants are required by the Patent Rules to appoint a patent agent to represent them.") online: <https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr04583.html.>

[485] 2007] UKHL 43 at 53;

[486] Ibid; *Cadbury Schweppes Inc v FBI Foods Ltd* [2000] FSR 691 at 39. It is important to note that the "transfer" under consideration is not the transfer of the patent but the equitable "right to apply for the patent.

[487] Emphasis

[488] ***Legal representatives*** includes heirs, executors, administrators of the estate, liquidators of the succession, guardians, curators, tutors, transferees and all other persons claiming through applicants for patents and patentees of inventions or through holders of certificates of supplementary protection. See section 2 of the *Patent Act.*

The *Patent Act* also acknowledges that an invention's "chain of title" must begin with the inventor.[489] This means only an inventor (or their representative) can be given a patent.[490] In other words, anyone who applies for a patent must either be the inventor or derive their legitimacy or entitlement from the inventor.[491] This can be seen from section s 27 of the *Patent Act,* which provides that "The Commissioner shall grant a patent for an invention to the inventor or the inventor's legal representative." Accordingly, a patent applicant must file a "statement of entitlement" verifying that they are either the inventor or entitled to apply for the patent. In essence, if an applicant confirms that they are the inventor, that is sufficient to establish that they are eligible to apply for the patents, but if they not, they must show how they derived the title to apply. Specifically, Rule 54 of the *Patent Rules* provides as follows:

> **54 (1)** The application must indicate the name and postal address of each inventor of the subject-matter of the invention for which an exclusive privilege or property is claimed.
>
> **(2)** The application must contain a statement to the effect that either
>
> > **(a)** the applicant is or, if there are joint applicants, the applicants are entitled to apply for a patent, or
> >
> > **(b)** the applicant is the sole inventor of the subject-matter of the invention for which an exclusive privilege or property is claimed or, if there are joint applicants, the applicants are all inventors and the sole inventors of that subject-matter.

Section 27(1) of the Act and "statement of entitlement" implies that the inventor has an equitable title in the invention once the invention is created, which can be transferred to a

[489] *Patent Act*, 1985, s. 27; and Rule 54 of the *Patent Rules*
[490] See Gregory Hagen, "AI and Patents and Trade Secrets," *supra* note 33 at 64.
[491] SOR/2019-251, s. 54(1)(2).

legal representative either expressly or impliedly. As Stephen Perry and Andrew Currier stated, "From the moment that an invention crystallizes in the mind of an inventor, an inchoate ownership right is created of which the inventor is the first owner. Anyone wishing to acquire that right must claim title through the inventor."[492]

Accordingly, the inventor is the "gateway" to patent ownership in Canada because there is no other way a third party can establish title to apply for patents outside the inventor. It is the inventor that has the initial rights to the invention and the rights can be transferred to a third party. Therefore, conferring on the inventor the right to possess and transfer the proprietary interests in an invention means Parliament intended that the inventor must be a person. Although the concept of "the author being the first owner" is more prominent in the copyright regime,[493] the principle is also implicitly operational in patent law, at least from the combined readings of ss. 2, 27(1) of the *Patent Act* and Rules 54 of the *Patent Rules.*

Commenting on similar provisions under the *European Patent Convention,* Nari Lee stated that "…whilst the initial right to receive a patent belongs to an inventor, the inventor may transfer such right, and those who succeed the right including legal persons may file for a patent and may receive the patent."[494] Thus, the first right to a patent application belongs to an inventor, but it can be transferred by an agreement or any other legal mechanism to a third party.

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[492] Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 85.
[493] See section 13(1) of the *Copyright Act* (R.S.C., 1985, c. C-42)
[494] See Nari Lee, "Inventor's Moral Right and the Morality of Patents" (October 21, 2020). Research Handbook on Intellectual Property and Moral Rights, Ysolde Gendreau (ed) Edward Elgar (Forthcoming), Available at *SSRN*: <https://ssrn.com/abstract=3716247> 8

Having established that AI systems are not legal persons in Canada and do not have the legal capacities to transfer proprietary titles or interests, it is unreasonable to imagine that the Parliament intended for AI systems to be inventors. In essence, since the AI machine cannot possess and transfer the equitable title in an invention, it cannot be an inventor.

The inventorship requirements should also be considered and determined having regard to the larger context of rights and liabilities allocated to patentees and inventors. For instance, recognizing AI technology as inventors may imply exposing them to infringement liabilities. However, s 55(1) of the *Patent Act* provides that only a person can be held liable for patent infringement. Thus, what happens if an AI system infringes a third party's patent in course of generating an invention? It appears inconsistent with the Act for AI systems to be recognized as inventors but cannot be held liable for violations because they are not "persons." The inability of AI systems to be held liable for infringements supports the view that they cannot be inventors under the Act.

4.1.3.3. The Paris Convention

International norms and treaties are relevant in determining the scheme of a statute.[495] Several judicial decisions have shown that international treaties are fundamental to the

[495] See *Monsanto Canada Inc. v. Schmeiser,* 2004 SCC 34 (CanLII), [2004] 1 SCR 902; *Baker v. Canada (Minister of Citizenship and Immigration* [1999] 2 S.C.R. 817 at 861 ("the legislature is presumed to respect the values and principles enshrined in international law, both customary and conventional. *These constitute a part of the legal context in which legislation is enacted and read.* In so far as possible, therefore, interpretations that reflect these values and principles are preferred.").

contextual analysis of domestic provisions intended to implement the treaties.[496] As Peter Maxwell pointed out, "every statute is to be so interpreted and applied, as far as its language admits, as not to be inconsistent with the comity of nations, or with the established rules of international law."[497]

The relevant international convention, in this case, is the *Paris Convention.* Article 4ter of the Convention provides that "The inventor shall have the right to be mentioned as such in the patent." This article was inserted only at the Revision Conference of London in 1934.[498] Before the insertion, in the 1920s and early 1930s, there was a "legitimate concern after World War I about the harm of passing off one's invention as that of another" from scientists and a call for it to be "regulated in a harmonized manner."[499] Specifically, there were calls to "secure the interest of scientific labour" as well as protect "both the moral and material interests of scientists."[500]

Consequently, in 1929, the International Labour Office's (ILO) Consultative Commission of Intellectual Workers proposed to the revision conference of the Paris Convention a project for adopting a new Article 4ter requiring that all patents name the "author or authors" where these can be established.[501] The International Bureau, which serves as the

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[496] *Suresh v. Canada (Minister of Citizenship and Immigration)* [2002] 1 S.C.R. 3; *R v. Sharpe* [2001] 1 S.C.R. 45; 114957 *Canada Lte'e (Spraytech) v. Hudson (Town)* [2001] 2 S.C.R. 241; and *Schreiber v. Canada (Attorney General)* [2002] 3 R.C.S. 269, pp. 293-294.
[496] *Schreiber v. Canada (Attorney General*) [2002] 3 R.C.S. 269, PP. 293-294.
[497] Peter B Maxwell, *On the Interpretation of Statutes* (London: Sweet & Maxwell, 1896)122.
[498] *London Act for the Paris Convention for the Protection of Industrial Property, as revised as London Act*, 1938.
[499] See Nari Lee, "Inventor's Moral Right and the Morality of Patents" *supra* note 495 at 8
[500] See Graham Dutfield, "The Curious Persistence of Inventor's Moral Right." In Arapostathis & Dutfield, Eds, *Knowledge Management and Intellectual Property: Concepts, Actors and Practice*s, 2013, Available at SSRN: https://ssrn.com/abstract=3030636
[501] International Union for the Protection of Industrial Property, 1934: 91 cited in Graham Dutfield, *supra* note 501 at 117

Paris Union's secretariat, was receptive to ILO's proposal of the inventor's moral right of attribution.[502] At the 1934 Revision Conference, the sub-committee discussed Article 4ter extensively as a proposed moral right equivalent to attribution in copyright law.[503]

The *Paris Convention* was revised to insert Article 4ter in "response to scientists' demands" for "a moral right of attribution."[504] In a publication celebrating the centennial of the *Paris Convention*, the then WIPO director Árpád Bogsch explained the justification of Article *4ter.* He stated that the provision was meant to protect the "natural pride" of an inventors in their intellectual creation and for the world to "know that the creation is his (their) brainchild."[505] Commenting on the *Paris Convention* and Article 81 of the *European Patent Convention,*[506] Nari Lee argues that "the inventor's attribution right or paternity right indeed exists in patent statutes. As the origin of such right is the Paris Convention, which provides in Article 4ter a right to be named as such in the patent, a similar right should exist in patent statutes of the signatory states to the Paris Convention."[507]

The UK Court of Appeal recently confirmed that Article 4ter is a specie of moral right.[508] In *Stephen Thaler v Comptroller General of Patents Trade Marks and Designs,*[509] the UK Court refused to grant inventorship status to DABUS, partly because of the underlying moral right of Article 4ter. The court held as follows:

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[502] International Union for the Protection of Industrial Property, 1934: 160–1
[503] See Graham Dutfield, *supra* note 501 at 117.
[504] Ibid
[505] See Arpad Bogsch, "The First Hundred Years of the Paris Convention for the Protection of Industrial Property" in WIPO (1983) The Paris Convention for the Protection of Industrial Property from 1883 to 1983, International Bureau of IP, 15-117 at 32.
[506] Article 81 provides that the name of the inventor must be designated in the patent application.
[507] See Nari Lee, "Inventor's Moral Right and the Morality of Patents" *supra* note 495 at 8
[508] *Stephen Thaler v Comptroller General of Patents Trademarks and Designs* [2021] EWCA Civ 1374
[509] Ibid

> Subsection (1), which gives effect to **Article 4ter of the Paris Convention** for the Protection of Intellectual Property 1883 (Stockholm Act 1967), confers a "right" upon "the inventor or joint inventors." **The right is a species of moral right (more specifically, it is, in the jargon of moral rights, a "paternity" right, that is to say, a right to be identified as the creator of something).** Only persons can have rights, and in particular moral rights, and it follows that inventors must be persons. Subsection (2)(a) requires the applicant to identify "the person or persons whom he believes to be the inventor or inventors". It is implicit in this that only persons can be inventors. I therefore conclude that the hearing officer and the judge were correct to hold that DABUS does not qualify as an "inventor" within the meaning of the 1977 Act because it is not a person.[510]

There is no comparable judicial pronouncement in Canada. Although the Canadian *Patent Act* is silent on the inventor's right to attribution, section 54 of the *Patent Rules* provides that an inventor must be named in a patent application.[511] The Rules were issued in 2019 by the Governor-General in Council, on the recommendation of the Minister of Industry, pursuant to sections 12 and 20(18) of the *Patent Act.*[512] It is unclear why s. 54 was inserted into the Rules. The "Regulatory Impact Analysis Statement" that accompanied the draft patent rules was silent on the rationale for the provision.[513] So, it is doubtful if the essence of section 54 of the *Patent Rules* intends to confer moral rights on inventors.

However, considering the UK's decision and the fact that Canada is a party to the *Paris Convention*, it is reasonable to assume that s. 54 of the *Patent Rules* incorporated Article

[510] Ibid, at 121 to 123. (Emphasis mine)
[511] Section 54 of the *Patent Rules*
[512] See Canada Gazette, Part II, Vol. 153 and No. 14.
[513] Department of Industry, "Regulatory Impact Analysis Statement," (December 1, 2018), online: < https://gazette.gc.ca/rp-pr/p1/2018/2018-12-01/html/reg2-eng.html >

4ter of the *Paris Convention.* In many cases, Canadian courts have consistently held that "legislation is presumed to operate in conformity with Canada's international obligations."[514] The presumption can be refuted only where the statute "clearly" compels a different result.[515] In support of this line of argument, Graham Dutfield stated as follows:

> As an international principle of law, the inventor's moral right of attribution came into being in 1934 by virtue of the insertion into the Paris Convention of Article 4ter, which succinctly states that 'The inventor shall have the right to be mentioned as such in the patent.' It follows that any law or patent office practice in any contracting party state that denies such a right would violate this provision.[516]

Although moral rights are more prominent under the Copyright regime,[517] the *Paris Convention* suggests an element of moral right exist in patent law. Most patents are applied for and are owned by corporations. Still, there is the requirement that the inventor is acknowledged in the patent application, perhaps, to protect the "natural pride" of the human creators even when businesses own the intellectual property rights.[518]

Curiously, the scholarship on the role of moral rights under patent law is scanty. Perhaps, because the primary justification for the patent system is more grounded in economic theories and public interest, not the individualistic values of the personality theory. As noted in Chapter One, this thesis is not concerned about the personality rights of inventors.

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[514] *Canada (Minister of Citizenship and Immigration) v. Vavilov*, 2019 SCC 65, para. 114. Also see *Zingre v. The Queen*, [1981] 2 S.C.R. 392, at 409-10; *National Corn Growers Assn. v. Canada*, [1990] 2 S.C.R. 1324, at 1371-72; *R. v. Hape*, 2007 SCC 26,
Para. 53-54; *Németh v. Canada,* 2010 SCC 56, para. 34; *R. v. Appulonappa*, 2015 SCC 59, para. 40; *Quebec (Attorney General) v. 9147-0732 Québec inc*., 2020 SCC 32 [Quebec], para. 25, 31-39).
[515] *R. v. Hape,* 2007 SCC 26, para. 53.
[516] See Graham Dutfield, *supra* note 501 at 115
[517] Margaret Wilkinson & Natasha Gerolami, "The Information Context of Moral Rights under the Copyright Regime" (2004). *Law Publications.* 78, online: retrieved from <https://ir.lib.uwo.ca/lawpub/78>
[518] See Ryan Abbott, *The Reasonable Robot, supra* note 31 at 10.

Still, it is worth mentioning in this section that Article 4ter of the *Paris Convention* reinforces the conclusion that only a natural person can be an inventor.

4.1.4. International Scope: Inventorship in Comparable Jurisdictions

International conventions like the *Paris Convention* signal the desire of states to have parallel intellectual property frameworks. In the *Harvard College* case, Binnie J noted that: "Legislation varies of course, from state to state, but broadly speaking, Canada has sought to harmonize its concepts of intellectual property with other like-minded jurisdictions."[519] This essentially means the IP activities in comparable jurisdictions on AI systems are relevant to the Canadian patent system. Thus, this part examines how other countries have responded to the issue of AI inventorship.

The question of whether an AI system can be an inventor has been decided in some foreign jurisdictions, including the European Union (EU),[520] United Kingdom (UK),[521] the US,[522] New Zealand,[523] and Australia.[524] They all resolved that only a natural person can be an inventor. Although the decisions of foreign courts and tribunals are not binding on the Canadian courts, in the absence of direct case law in Canada, such foreign decisions in

[519] *Harvard v. Commissioner of Patents,* [2002] 4 R.C.S.at p. 51.
[520] European Patent Office, 18275163.6 (Jan. 27, 2020), GRUR-RS 2020, 653; European Patent Office, 18275174.3 (Jan. 27, 2020), GRUR-RS 2020, 647.
[521] *Stephen Thaler v. Comptroller General of Patents Trademarks and Designs* [2021] EWCA Civ 1374
[522] *Thaler v. Hirshfeld* [2021] Case 1:20-cv-903 [LMB/TCB]
[523] Stephen L. Thaler [2022] NZIPOPAT 2
[524] *Commissioner of Patents v Thaler* [2022] FCAFC 62

comparable jurisdictions can be persuasive.[525] Therefore, it is relevant and important to consider some foreign decisions vis-à-vis the Canadian patent system.

While all the foreign decisions are important, this section focuses on three jurisdictions: the UK, the US, and Australia. The reason for this selection is because they are the only countries within the common law heritage that have handed down judicial decisions on AI inventorship. In addition, they share similar patent objectives with Canada and are all parties to the *Paris Convention,* the *TRIPS Agreement*, and the *Patent Cooperation Treaty* (PCT). However, the analysis in this section is not meant to be a comprehensive comparative study but a brief review of the court decisions to determine their similarities to the Canadian patent jurisprudence. In essence, the several legal principles embedded in the decisions will not be evaluated deeply because of the limited scope of this thesis research question.

4.1.4.1. The United Kingdom

As noted in chapter two, Stephen Thaler, the developer of an AI system called DABUS, sought to patent inventions generated by DABUS in several jurisdictions, including the UK, US, and Australia. On December 4, 2019, the United Kingdom Intellectual Property Office (UKIPO) decided, contrary to the wishes of Thaler, that the DABUS applications were deemed to be withdrawn.[526] The UKIPO held that the "Statement of Inventorship

[525] *Vincor International IBC Inc. v. Oenoforos AB* 2011 CarswellNat 2656, 2011 CarswellNat 3907, 2011 TMOB 93, 2011 COMC 93, 94 C.P.R. (4th) 296; *Dayco (Can.) Ltd. v. C.A.W.* 1993 CarswellOnt 883, 1993 CarswellOnt 978, [1993] 2 S.C.R. 230, [1993] S.C.J. No. 53.
[526] The decision was handed down by Mr Huw Jones, Deputy Director acting for the Comptroller (BL O/741/19).

Form" did not satisfy s.13(2) of the UK *Patents Act 1977* because the named inventor was not a person and consequently could not be an inventor. Also, the UKIPO found that Thaler was not entitled to apply for the grant of patents made by an AI system. Accordingly, the applications were deemed to have failed.[527]

Aggrieved with the decision of the UKIPO, Thaler appealed to England and Wales High Court.[528] However, the appeal was dismissed by Marcus Smith J for three reasons. First, DABUS was not a person as required by s. 7(2)(a) of the *Patent Act* and could not be an inventor. Second, Thaler had not proved a right to be granted the patent because DABUS could not hold and transfer property (i.e., the right to apply for a patent).[529] Third that the patent examiner had been correct to find that the patent applications were deemed withdrawn under s13 of the *Patent Act*. The judge also held that the idea of an "inventive step" being something not obvious to a skilled person in the art implies that inventors must be natural persons and that the "inventive concept" suggests a matter arising from the mind of a natural person.[530]

Thaler was again not satisfied with the decision of the High Court. Consequently, he further appealed to the UK Court of Appeal.[531] On September 21, 2021, the Court of Appeal rejected Thaler's appeal. The appellate court upheld the decisions of the UKIPO and the High Court that the DABUS applications were deemed withdrawn because no human

[527] In response to the box requiring the name of the inventor, Dr. Thaler wrote "DABUS" and in response to how he derived the right to apply, he wrote, "by ownership of the creativity machine 'DABUS'".
[528] See *Thaler v. Comptroller General of Patents Trade Marks And Designs* [2020] EWHC 2412 (Pat))
[529] Ibid
[530] Ibid at para. [45(3)(c)]).
[531] *Stephen Thaler v. Comptroller General of Patents Trademarks and Designs* [2021] EWCA Civ 1374

inventor was named. A majority 2-to-1 decision rejected the appeal. Lord Justices Arnold and Laing gave the leading judgment, while Lord Justice Birss dissented. However, the three Lord Justices of the Court of Appeal agreed that the language of the UK Patents Act 1977 could not be interpreted to permit an AI system to be considered an inventor. The Lord Justices disagreed on whether Thaler complied with Section 13(2) of the *UK Patents Act,* which requires an applicant to file a statement identifying whom he believes to be an inventor and how the applicant derived the right to be granted the patent.

Three issues were raised at the Court of Appeal. First, can DABUS qualify as an "inventor" within the meaning of the *Patents Act 1977*? Second, is Dr. Thaler eligible to apply for patents concerning the inventions generated by DABUS? Third, was the hearing officer correct to hold that the applications are deemed to have been withdrawn by section 13(2) of the 1977 Act? In addressing these issues, three assumptions were made. First, DABUS created the inventions even though DABUS was not a natural or legal person, second, the inventions were potentially patentable, and third, Thaler was the owner and creator of DABUS.

Concerning the first issue - whether DABUS could be considered an inventor? The three Lord Justices agreed that DABUS could not be an inventor under the UK Laws. Lord Justice Birss specifically held as follows:

> First, it is no accident that s7(1) provides expressly that "any person" may make an application for a patent without qualification…The rest of the 1977 Act is drafted on the footing that the inventor is a person. For example s7(2)(c) of the 1977

> Act refers to "person or persons mentioned in paragraph (a) or (b)" and s13 of the Act require an applicant to identify the "person or persons whom he believes to be the inventor or inventors"….Within the meaning of the 1977 Act the "inventor" is the person who actually devised the invention.[532]

However, the Court took the view that the argument around "inventive concept" being something not obvious to a "person skilled in the art" does not provide independent support for construing the meaning of the term "inventor."[533] On the second issue, whether Thaler is qualified to apply for patent protection of DABUS inventions, the Lord Justices disagreed in their resolution of this issue. But the majority decision affirmed that Thaler is not qualified to apply for patent protection of DABUS inventions. In the decision, Lord Justice Arnold held as follows:[534]

> In my judgment, there is no rule of law that a new intangible produced by existing tangible property is the property of the owner of the tangible property, as Dr Thaler contends, and certainly no rule that the property contemplated by section 7(2)(b) in an invention created by a machine is owned by the owner of the machine. Accordingly, the hearing officer and the judge were correct to hold that Dr Thaler is not entitled to apply for patents in respect of the inventions given the premise that DABUS made the inventions.[535]

On the third issue - whether the hearing officer could deem the applications withdrawn because Thaler did not identify an inventor and establish how he derived the right? The Lord Justices also disagreed. The majority judgment delivered by Arnold LJ concludes that the hearing officer could deem the applications withdrawn for failure to comply with the

[532] Ibid, paras. 51 & 54.
[533] Ibid
[534] The position of Arnold LJ was adopted by Laing LJ.
[535] *Stephen Thaler v. Comptroller General of Patents Trademarks and Designs* [2021] EWCA Civ 1374 at para. 137.

patent laws.[536] However, Birss LJ disagreed. According to him, since the statement filed by Thaler honestly reflect his belief, it is not within the Comptroller's function to deem the applications as withdrawn simply because the statement did not identify the inventor.[537] Birss LJ also believes that there exists a rule of law that gives an "owner and operator of a machine… the right to apply for and be granted a patent for an invention created by that machine."[538] Consequently, the fact that the creator of an invention is a machine does not impede patents from being granted to the applicant.[539]

The above UK Court of Appeal decision is very comprehensive (when compared to the US and Australia decisions). The court decided several issues that may be persuasive to Canadian patent regime. First, the Court of Appeal determined that the requirement of naming an inventor in a patent application is a moral right. Specifically, the court described the right as "a "paternity" right, that is to say, a right to be identified as the creator of something."[540] The Court further held that "only persons can have rights, and in particular moral rights, and it follows that inventors must be persons."[541]

Canada has a similar legislative provision in its *Patent Rules* (as discussed in section 3.2.5.3 of this chapter), but the courts have not interpreted it to mean "moral right." The UK decision may provide a solid basis for Canadian courts to incorporate or affirm the existence of moral rights in the Canadian patent system, considering that both countries are

[536]Ibid, paras. 138, 139, 143, 144 & 149. The position of Arnold was adopted by Laing LJ.
[537] Ibid, para. 91.
[538] Ibid, para. 82 & 83.
[539] Ibid, para. 97.
[540] Ibid, para. 121
[541] Ibid

parties to the *Paris Convention,* where the moral right principle or argument emanated. Also, the UK decision may be persuasive considering that the Canadian *Patent Act* finds its origins in the UK patent statutes and that Canadian common law also originates from the UK system.

Second, the UK Court of Appeal resolved whether the owner of an AI system can claim ownership of an AI-generated invention. Thaler contended, he was entitled to apply for the patents as the owner of DABUS, relying on a principle of law that "the owner of a thing, such as a tree, is the owner of the fruits of that thing." In the majority decision, the court rejected Thaler's position and decided that no such rule of law exists regarding machine inventions. The Court specifically held that "there is no rule of law that a new intangible produced by existing tangible property is the property of the owner of the tangible property..."[542]

Thaler's contention is shared by some proponents of AI inventorship like Francesco Banterle and Ryan Abbott that the AI developers should automatically own AI-generated inventions in line with the traditional property rules.[543] The significance of the UK's decision is the affirmation that no such principle exists in the common law, which means ownership of an AI system does not automatically confer one with the right to the AI-generated invention. It may be argued that the UK Court made a "distinction without a difference," if the owner of land has a right under common law to the fruits produced by

[542] Ibid, para. 137

[543] See Francesco Banterle, "Ownership of Inventions Created by Artificial Intelligence," AIDA, University of Milan, (2018) at 26 (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=3276702). 133; and Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law" (2016) 57:4 B.C.L. Rev. 1079 at 1083 – 1091.

his property, why should not the owner of an AI system have rights to the fruits of the AI system.

The UK majority decision may be relevant to the Canadian patent regime, where applicants are required to file a "statement of entitlement" showing they are entitled to apply and be granted patents. The entitlement can be established by either verifying that they are the inventors, or they derived their title from the inventors.[544] By the UK's judgement, it can be argued that an applicant does not derive title from the AI system (for the purposes of patenting an AI-generated invention) simply because they developed or owned the AI system.

Third, the UK Court of Appeal's decision also highlighted the relationship between the right to apply for patents and inventorship.[545] The Court held that the right of an inventor to apply for patents is a relevant factor in determining the meaning of "inventorship." Since only persons can apply for patents, AI systems cannot be inventors. In Canada, the *Patent Act* also grants an inventor the right to apply for patents.[546] As the UK Court pointed out, this could be interpreted to exclude non-persons like AI systems from the inventorship landscape.

Another instructive aspect of the UK Court of Appeal judgement is how the Court addressed the relationship between "inventive concept" and inventorship. The High Court

[544] *Patent Act*, 1985, s. 27; and Rule 54 of the *Patent Rules*
[545] See the definition of Patentee under section 2 of the Canadian *Patent Act*
[546] See the definition of Patentee under section 2 of the Canadian *Patent Act*

judge held that the standard of "inventive concept" being something not obvious to a skilled person in the art implies that inventors must be natural persons.[547] On the contrary, the Court of Appeal held that the patentability criteria of non-obviousness do not provide independent support for construing the meaning of the term "inventor."[548]

The Court of Appeal's position aligns with my earlier arguments (in section 3.1.2.1 of this chapter) concerning recognizing the distinctions amongst the several patent concepts. An invention can be obvious and unpatentable even if there is an inventor and an acceptable statutory subject matter, *vice versa.* The non-obviousness assessment is distinct and separate from the statutory subject matter as well as inventorship. Conflating these concepts makes the preliminary stages of the patent examination process redundant, which is contrary to the intention of Parliament.

Overall, the UK decision on the moral rights, ownership of AI-generated inventions, inventor's right to apply for patents, and the distinction between inventorship and non-obviousness can be adopted in Canada. This is because there are legislative provisions in Canada that can be interpreted to support these principles.

4.1.4.2. United States

On April 22, 2020, like the UK position, the United States Patents and Trademarks Office (USPTO) rejected the DABUS patent applications because they did not disclose a natural

[547] Paragraph [45(3)(c)]).
[548] Ibid

person as the inventor of the claimed inventions. [549] Dissatisfied with the decision of the USPTO, Thaler filed a complaint under the Administrative Procedure Act ("APA") to the US District Court in Virginia. The sole issue before the Court was "can an artificial intelligence machine be an inventor under the Patent Act?" Thaler sought several court orders, including "[a] declaration that a patent application for an AI-generated invention should not be rejected on the basis that no natural person is identified as an inventor."

The Court delivered its judgment on September 2, 2021. It held that the "USPTO's interpretation of the *Patent Act* was carefully considered and was consistent with the *Patent Act's* language and the case law."[550] The court held as follows:

> As the statutory language highlights above, both of the definitions provided by Congress for the terms "inventor" and "joint inventor" within the Patent Act reference an "individual" or "individuals" 35 U.S.C. §§ 100(f)-(g). Congress used the same term – "individual" – in other significant provisions of the Patent Act which reference an "inventor," including requiring that "each individual who is the inventor or a joint inventor" execute an oath or declaration and permitting a substitute statement in lieu of the oath or declaration "with respect to any individual who" meets the requirements. § 115(a)(1). Similarly, the oath or declaration must contain a statement that "such individual believes himself or herself to be the original inventor or joint inventor of [the] claimed invention" § 115(b)(2).
>
> Accordingly, the issue of whether an artificial intelligence machine can be an "inventor" turns on the plain meaning of the statutory term "individual"… "Because the [Patent Act]

[549] Dr Stephen Thaler filed the applications at the USPTO on July 29, 2019 and assigned US Application Serial Nos. 16/524,350 and 16/524, 532.
[550] See page 9 of the Judgment

> does not define the term 'individual," we look first to the word's ordinary meaning." When used "[a]s a noun, 'individual' ordinarily means '[a] human being, a person" (quoting 7 Oxford English Dictionary 880 (2d ed. 1989)… Congress's use of the term "individual" in the Patent Act strengthens the conclusions that an "inventor" must be a natural person…."[551]

Thaler also made several policy arguments before the Court that the Congress' intent was "to create a system that would encourage innovation, as well as to promote disclosure of information and commercialization of new technologies," therefore, DABUS should be recognized as an inventor in order to advance the Congress' intention. However, the Court relied on several Supreme Court and Federal Circuit decisions to hold that "policy considerations cannot overcome a statute's plain language, and that "[m]atters of policy are for Congress, not the courts to decide."[552] It is important to note that Thaler has appealed against the decision and the matter is pending before the Court of Appeal.[553]

The US District Court's decision came as no surprise to the patent law community. While there is no express definition of the term "inventor" in Canada, the U.S. Congress promulgated the *Leahy-Smith America Invent Act* in 2011,[554] which formally amended the U.S. *Patent Act* to provide an explicit statutory definition for the term "inventor." The term was defined as "the individual, or, if a joint invention, the individuals collectively who invented or discovered the subject matter of the invention."[555] The Act also defines a "joint inventor" as "any one of the individuals who invented or discovered the subject matter of

[551] See pages 11, 12 7 13 of the Judgment
[552] See pages 15 & 16 of the Judgment
[553] Thaler v. Vidal, U.S. Court of Appeals for the Federal Circuit, No. 21-2347
[554] Sept. 16, 2011. [H.R. 1249]
[555] 35 U.S.C. § 100(f) (Definitions).

a joint invention,"[556] and requires that "[a]n application for patent shall be made, or authorized to be made by the inventor…in writing to the Director."[557] Furthermore, the Act requires an inventor or joint inventor to "execute an oath or declaration" that "such individual believes himself or herself to be the original inventor or joint inventor of [the] claimed invention"[558] or file a substitute statement identifying the individual inventor.[559]

Although the promulgation of the Act was not motivated by AI technology (it appears that the specific intention of Congress was to eliminate corporations from claiming inventorship), the statute's narrow definition of an inventor to mean "individuals" is relevant in determining AI inventorship in the U.S. Meanwhile, the law represents the most substantial reform to the U.S. patent system since the 1952 *Patent Act.*[560] It switched the U.S. patent system from a "first to invent" to a "first-inventor-to-file" system, expanded the definition of *prior art* to include foreign offers for sale and public uses, eliminated interference proceedings, and created two new administrative procedures to resolve the validity of a patent grant: a post-grant review, which allows a party to file a petition seeking the review of a patent within nine months of its grant, and inter-partes review, which permits a party to challenge the validity of a patent after the nine month window on the grounds of *prior art* patents or printed publication.[561]

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[556] Ibid, § 100(g)
[557] Ibid, § 111(a)(1)
[558] Ibid, § 115(b)a
[559] Ibid, § 115(d)(2)
[560] 35 U.S. Code
[561] Steven M. Auvil, "5 things med tech companies need to know about the Leahy-Smith America Invents Act" (November 15, 2011), online: *MedCity News* < https://medcitynews.com/2011/11/5-things-med-tech-companies-need-to-know-about-the-leahy-smith-america-invents-act/>

Accordingly, the relevance of the U.S. decision to the Canadian patent regime on AI-generated inventions is limited. While the statutory language of the US patent law is unambiguous that an inventor must be a natural person,[562] it is not that explicit in Canada. In fact, to make it abundantly clear that an inventor must be an individual, the US law requires an inventor to execute an oath verifying that they are the inventor; in the alternative, the applicant should file a statement identifying the individual inventor. These legislative provisions show that US framework on inventorship is more robust than the Canadian framework.

The two jurisdictions are, however, similar on the issue of conception. Under US law, conception means 'the complete performance of the mental part of the inventive act'[563] or "formation in the mind of the inventor."[564] Expectedly, the USPTO lawyers argued before the District Court that an AI system could not satisfy the threshold of mental conception. [565] The District Court regrettably did not specifically address this argument because of the clear and express provisions of the *American Invents Act.* If it had, that aspect of the decision would have been very relevant and persuasive to the Canadian patent regime.

[562] Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 1 at 114. (The US Patent law does not contemplate the possibility of a nonhuman inventor); Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980) ("the Court held that the subject matter of patents covers whatever is "a product of human ingenuity" and "include anything under the sun made by man."); and New Idea Farm Equip. Corp. v. Sperry Corp., 916 F.2d 1561, 1566 (Fed. Cir. 1990) (concerning whether corporations can be inventors, the Federal Circuit has stated most succinctly that "people conceive, not companies").
[563] Article 211 of the Manual of Patent Examining Procedure ("MPEP")
[564] Beech Aircraft, 990 F.2d at 1248; Max-Planck, 734 F.3d at 1323.
[565] See page 6 of the Judgment

4.1.4.3. Australia

The DABUS applications before the Australian Patent Office were filed under the *Patent Cooperation Treaty* (PCT). The application entered the national phase of processing on September 9, 2020. During the formalities review of the applications, the Deputy Commissioner of the Australian patent office determined that the applications did not comply with reg 3.2C(2)(aa) of the *Patents Regulations*, *1991* because they failed to identify a natural person as the inventor. The consequence was that the application lapsed.[566]

Aggrieved with the decision of the Deputy Commissioner, Thaler filed a judicial review at the Federal High Court of Australia under the *Administrative Decisions (Judicial Review) Act 1977* (Cth) and the *Judiciary Act 1903* (Cth).[567] He contended that the Act and the Regulations did not preclude an AI system from being treated as an inventor. Thus, the question for determination before the court was whether an "inventor" could be an AI system for the purposes of the Act and the Regulations?

In a groundbreaking decision, the Federal High Court per Justice Beach held that the PCT, the *Patent Act* and the *Regulations* did not preclude a non-human such as an AI machine from being named an inventor. The Court considered "inventor" as an "agent noun" that applies to any entity that invents regardless of whether the entity is a natural person.[568] Furthermore, the Court relied on the object clause of the *Patent Act* to hold that term

[566] Regulation 3.2C(4)(5) of the Patent Regulations
[567] *Thaler v Commissioner of Patents,* [2021] FCA 879
[568] Paragraph 120 of the Judgment

"inventor" can be construed to include AI machines.[569] Consequently, it set aside the determinations of the Deputy Commissioner.

Dissatisfied with the decision, the Commissioner of Patents appealed to the Full Court of the Federal Court of Australia, which delivered its judgment on April 13, 2022.[570] The central question in the appeal was whether a device characterized as an AI machine could be an "inventor" within the meaning ascribed to that term in the *Patents Act* 1990 (Cth) and the *Patents Regulations* 1991 (Cth). The Court answered the question in the negative. It overturned Justice Beach decision and found that an AI machine is not capable of being recognized as an "inventor" on a patent application.

There are certain aspects of the Full Court's decision that are instructive to Canada. First, the court held that the term "patentee" is synonymous with "inventor" because it is the inventor's invention that warrants the grant of the patent, and a "patentee" means the person for the time being entered in the Register as the proprietor of a patent.[571] Therefore, if a patentee is a person, then the inventor must be a person.

In Canada, the *Patent Act* similarly provides that patents can only be granted to inventors or their legal representatives and defined the term "patentee" as the person entitled to the benefits of a patent.[572] Therefore, the association between an inventor and a patentee also

[569] The object clause is provided in section 2A of the Patent Act: "The object of this Act is to provide a patent system in Australia that promotes economic wellbeing through technological innovation and the transfer and dissemination of technology. In doing so, the patent system balances over time the interests of producers, owners and users of technology and the public."
[570] *Commissioner of Patents v Thaler* [2022] FCAFC 62
[571] Ibid at para. 91.
[572] S. 2 of the Patent Act

applies in Canada, But it is doubtful if Canadian courts will adopt the term "synonymous" to describe the relationship between the meaning of an "inventor" and a "patentee" because the two terms are distinct.

Second, the Court held that the obligation of an inventor to "make truthful and honest representations" as to the nature of the invention in the "specification" suggest that an inventor must be a natural person. While this interpretation appears convincing, it is doubtful if Canadian courts would adopt this interpretation because s 27(3) of the *Patent Act* did not expressly use the phrase "truthful and honest." There is no indication in the Act that it must be the inventor that describes the claimed invention or any requirement for the inventor to take an oath. The description could also be made by the Applicant, who may be different from the inventor.

Third, the Australian Court resolved the connection between mental conception and AI inventorship. The Court held that an AI system could not be an inventor because the grant of a patent is premised upon an invention arising from the mind of a natural person or persons. This decision is instructive as it categorically determined that an AI system does not have a mind to conceive an invention and may be the first judicial decision on this point, making it a good source of authority for Canada. The Australian and Canadian patent systems have a similar understanding of the meaning and purpose of "conception." Thus, the Canadian courts are likely to rely on this decision to conclude that AI systems do not have the required "mindset" to conceive of an invention for the purposes of inventorship.

Meanwhile, for proponents of AI inventorship, this aspect of the decision is a fundamental drawback to their arguments that machines can think in a functional or behavioural sense.

Lastly, the Australian Court held that a patent can only be granted to the inventor or somebody claiming through the inventor, and one of the ways of transferring interest is "assignment." Since only legal entities can undertake such assignments, an AI system cannot be an inventor. In comparison, the Canadian *Patent Act* has similar provisions that an inventor should be able to transfer expressly or impliedly the proprietary interests in the invention to a third party.[573] Therefore, an inventor like AI systems that cannot transfer their interest contractually or otherwise to third parties is inconsistent with the Act.

4.1.5. The Object of the Act and AI Inventorship

The Canadian *Patent Act* aims to incentivize the production of innovations and ensure public access to inventive knowledge by granting inventors or their representatives the right to exclude others for a temporary period.[574] The essence of the patent system is to encourage firms and inventors to generate more inventions for the public benefit.[575] This purpose, as further explained in chapter four, is only relevant to entities that can be incentivized by commercial gains. In the case of AI systems, they cannot be incented because they simply rely on algorithms, large data sets, machine learning models, and performance functions to create.[576] Thus, granting inventorship status to AI systems does

[573] Section 27(1) of the Act.
[574]See *Teva Canada Ltd v. Pfizer Canada Inc,* 2002 SCC 60 at para. 32; Donald S. Chisum et al., *Understanding Intellectual Property Law*, 2d ed (LexisNexis, 2011). 1C
[575] For further details see chapter 4.
[576] See Gregory Hagen, "AI and Patents and Trade Secrets," *supra* note 33 at 59

not advance the goal of the patent system. In other words, the Parliament could not have intended that AI systems be "inventors" under the *Patent Act.* This conclusion aligns with the textual and contextual meaning of an inventor as discussed in (section 3.2.1 and 3.2.2 of this chapter).

4.2. Ownership and Exercise of Patent Rights

Assuming AI-generated inventions are patentable, this section discusses whether AI systems can own and exercise patent rights under the *Patent Act.* Unlike the case of an inventor, the *Patent Act* is clear about who can own and exercise patent rights. Section 42 of the *Patent Act* grants to the "patentee and the patentee's legal representatives" for the patent term "the exclusive right, privilege and liberty of making, constructing and using the invention and selling it to others to be used." Therefore, in determining whether AI systems can own and exercise patent rights, the focal point is "who" or "what" is a patentee. If an AI system can qualify as a patentee, it means the system has the right to enjoy that bundle of rights that comes with patents.

The interpretative section of the *Patent Act* expressly defines a patentee as "the person for the time being entitled to the benefit of a patent."[577] This definition is straightforward and unambiguous: it denotes that a patentee must be a person. "Persons" in law is used to identify people and entities that are accorded "juridical existence."[578] Only two kinds of

[577] S. 2 of the Patent Act. Similarly, s 79(1) of the *Patent Act* dealing with inventions pertaining to medicines, provides that the "patentee" means the person for the time being entitled to the benefit of the patent for that invention and includes, where any other person is entitled to exercise any rights in relation to that patent other than under a licence continued by subsection 11(1) of the Patent Act Amendment Act, 1992, that other person in respect of those rights."
[578] See Kathleen A. Lahey, "Legal "Persons" and the Charter of Rights: Gender, Race, Sexuality in Canada" (1998) 77 The Canadian Bar Review 402 at 407.

persons are recognized under Canadian law: natural and legal.[579] Natural persons refer to human beings,[580] while legal persons refer to entities created by the operation of law and conferred with rights.[581] Legal persons include "business corporation, the society, the municipality, ecclesiastical corporations, non-profits, associations, co-operatives, and the crown."[582] Accordingly, a patentee can either be a natural person or a legal person.

While what it takes to have legal personhood is a strongly contested issue, it is not debatable that in Canada AI system are not legal persons.[583] In *Thomas Kennedy (Applicant) v Canada Customs and Revenue Agency and Canada Ottawa-Carleton District School Board (Respondents*),[584] the tribunal was invited to determine the meaning of the term "person" under the Canadian "Income Tax Act." The Tribunal held as follows:

> [A] "person' in its ordinary meaning includes a human being or a natural person as well as an artificial person such as a corporation. The primary sense of the word is a natural person; the secondary sense, an artificial person such as a corporation."[585]

[579] Michael Welters, "Towards a Singular Concept of Legal Personality" (2013) 92 Can Bar Rev 417 at 418, 455
[580] Merriam-Webster Dictionary, "natural person," (29 May 2022), online: <https://www.merriam-webster.com/legal/natural%20person#:~:text=Legal%20Definition%20of%20natural%20person,compare%20juridical%20person%2C%20legal%20person>
[581] See *Thomas Kennedy (Applicant) v Canada Customs and Revenue Agency, and Canada Ottawa-Carleton District School Board (Respondents),* 2000 DTC 6524
[582] Michael Welters, "Towards a Singular Concept of Legal Personality" (2013) 92 Can Bar Rev 417 at 418, 455; Notably, in 2021, the Innu Council of Ekuanitshit and a local body, the Minganie Regional County Municipality granted "the Magpie river legal personhood rights." The river is located in the Cote Nord region of the Canadian province of Quebec. However, it is unclear what would happen if the designation is tested in a Canadian court. See Jillian Kestler-D'Amours, "This River in Canada is now a 'legal person' (3 April 2021), online: *Al Jazeera* <https://www.aljazeera.com/news/2021/4/3/this-river-in-canada-now-legal-person>
[583] See Pressley Nietering, *supra* note 22 at 17.
[584] 2000 DTC 6524
[585] Ibid at 17

The tribunal held that artificial persons "are created and devised by human laws for the purposes of society and government, which are called corporations or bodies of politic."[586] This decision highlights the principle of law that legal personhood is a legal fiction. In other words, an artificial entity can only be considered a person where there is an express legislative intent to confer personhood on it. AI systems have not been granted personhood under Canadian law; therefore, they cannot own and exercise patent rights in Canada based on the ordinary meaning of a patentee.

In further determination of who qualifies as a "patentee," it is important to highlight that a patent is a form of personal property with exclusive rights and privileges.[587] Specifically, a patent is a chose in action,[588] which may be sold, transferred, conveyed, or otherwise dealt with like any other property.[589] For instance, it could be licensed or used to negotiate funding, venture capital or other forms of financing.[590] Also, a patent right is divisible regarding the content, time and territory and may be transferred, either in whole or part.[591] The key point here is that a patent is a form of property.

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[586] Ibid at 15.
[587] S. 42 of the Patent Act
[588] A "chose in action" under Common Law refers to a "Personal rights of property which can only be claimed or enforced by action and not by taking physical possession (as distinct from choses in possession, things capable of physical possession). Divided into legal and equitable choses in action, depending on whether they can be recovered or enforced by action at law (such as debts, insurance, claims of shares in a corporation) or, formerly, only by a suit in equity (such as an interest under a trust). See Thomson Reuters, "Chose in action" online: *<https://ca.practicallaw.thomsonreuters.com/Document/I03414efe280f11e698dc8b09b4f043e0/View/FullText.html?navigationPath=Search%2Fv1%2Fresults%2Fnavigation%2Fi0ad7140b0000018267ae81afcb9d96b5%3Fppcid%3D0cb06479a4164f5f81316ceb1926923a%26Nav%3DKNOWHOW_PLC_CA%26fragmentIdentifier%3DI03414efe280f11e698dc8b09b4f043e0%26parentRank%3D0%26startIndex%3D1%26contextData%3D%2528sc.Search%2529%26transitionType%3DSearchItem&listSource=Search&listPageSource=72959449e4122f9555d9227db491b9aa&list=KNOWHOW_PLC_CA&rank=3&sessionScopeId=0f0c84d22f8d08a41b56da4e18923b9924225473 83f4e622152e802c0319e03b&ppcid=0cb06479a4164f5f81316ceb1926923a&originationContext=Search%20Result&transitionType=SearchItem&contextData=%28sc.Search%29>*
[589] *Forget v. Specialty Tools of Canada Inc.,* [1995] B.C.J. No. 1653 at para. 16, 62 C.P.R. (3d) 537 (B.C.C.A.).
[590] 6.01.02 of the MOPOP
[591] R.S.C. 1985, c. P-4, s 49(1) of the *Patent Act*

Ownership of tangible properties in Canada is regulated by provincial laws.[592] The provincial laws only recognize "persons" as capable of owning and disposing of real and personal properties.[593] This means the provisions of the *Patent Act* that a "patentee" must be a person is consistent with the broader Canadian legal framework concerning owning properties.

Furthermore, ownership of a patent may be obtained by "legal representation."[594] The *Patent Act* described "legal representatives" as "heirs, executors, administrators of the estate, liquidators of the succession, guardians, curators, tutors, transferees **and all other persons** claiming through applicants for patents and patentees of inventions or through holders of certificates of supplementary protection."[595] The phrase "and all other persons" clearly indicates that the preceding class of entities are "persons."

Also, the ordinary meanings of the mentioned forms of legal representatives show that they are persons. For example, "heir" refers to someone who inherits real or personal property by will or intestate succession.[596] An "executor" is "a person named by a testator to carry out the provisions in the testator's will."[597] An "administrator of an estate" is a "person to whom the grant of letters of administration has been made."[598] A "guardian" refers to a "person who has the legal right and duty to take care of another person or that person's

[592] See *Constitution Act,* 1867; and Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 86
[593] *Property Law Act* [RSBC 1996] Chapter 377; *Protection of Property Act* [1989] R.S., c. 363; and *Property Rights and Responsibilities Act*, 2009.
[594] *Patent Act*, R.S.C. 1985, C. P-4, S. 49(1); and Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 86.
[595] S. 2 of the *Patent Act*
[596] See Bryan A. Garner (ed), *Black's Law Dictionary* (11th ed) (US: Thomson Reuters, 2019) at 869; Bryan A. Garner, *Garner's Dictionary of Legal Usage* (3rd ed) (Oxford: Oxford University Press, 1995) at 405
[597] Ibid at 716; Ibid at 340
[598] Datinder S. Sodhi, *The Canadian Law Dictionary* (Ontario, Canada: Law and Business Publications Inc., 1980) at 27.

property because that other person (for example, a child) cannot legally take care of himself or herself."[599] Correspondingly, a "curator" is someone who manages the affairs of another, typically a minor who has passed the age of puberty.[600] A "tutor" is a guardian of a minor - a person appointed to take care of a minor's estate. A "liquidator" refers to "a person appointed to wind up a company's business."[601]

The common denominator of these definitions is that they are persons, thereby excluding AI systems. Although the meaning of the term "legal representative" is non-exhaustive under the Act, the *ejusdem generis* canon of interpretation is applicable. Any additional example can only include items of the same kind or class as those listed.

In Canada, computers like AI systems lack the legal capacity to own, assign, or receive proprietary interests, including patents, to or from a third party. They also lack the capacity to enter contractual arrangements for the purpose of acquiring ownership of a patent. Interestingly, a lead proponent of AI inventorship, Ryan Abbott, admitted that "AI systems lack both legal and moral rights and thus the ability to own property."[602]

As would become clearer in chapter five, the above understanding aligns with the theoretical objective of the Canadian patent system, which seeks to incentivize the creation and development of inventions by granting patentees exclusive and limited-term commercial rights. Patentees are given these rights to encourage them to risk their capital

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[599] Ibid at 167
[600] See Bryan A. Garner (ed), Black's Law Dictionary (11th ed) (US: Thomson Reuters, 2019) at 480
[601] Ibid at 230.
[602] See Ryan Abbott, "The Artificial Inventor Project" (December 2019), online: *WIPO Magazine* <https;//www.wipo.int/wipo_magazine/en/2019/06/article_0002.html.>

in the generation of further inventions. The patent system presumes that these limited monopoly rights will enable the patentees to recoup their R&D costs and stimulate further innovations.

Since AI systems are artificial entities that lack consciousness and awareness and the need to recoup costs and make investments, they do not need the incentives that patent law supplies to generate new inventions, whether in the form of rights or anything else. As Ralph D. Clifford pointed out, “until computers are endowed with a consciousness that makes evaluation of "personhood" for computers mandatory,” granting them patent rights will be inappropriate.[603] Accordingly, granting ownership of patents to AI systems does not support the objectives of the *Patent Act* because they cannot be incentivized.

Compared to corporations, AI is a computer or information system, not an association of people like corporations.[604] A corporation is not only a legal person but is a legal fiction that holds a group of natural persons together to account for their group actions.[605] This means corporations can be incentivized to generate novel inventions and commercially exploit the patents; on the other hand, AI systems cannot.

4.3. Summary

Whether an AI system can qualify as an inventor depends on the mental conception requirement of inventorship and the expectations of the *Patent Act*. This chapter’s analysis

[603] Ralph D. Clifford, *supra* note 31 at 1696 – 1702, 1703.
[604] See Tom Allen & Robin Widdison, “Can Computers Make Contracts?” (1996) 9:1 Harv. J. L. Tech. 25 at 39.
[605] Ibid, at 38 -39.

establishes that AI systems cannot satisfy these standards. Accordingly, AI-generated inventions are not patentable because of failure inventorship: they are arguably "inventorless inventions" since they do not possess legally known inventors.[606] The net implication of an "inventorless invention" is that an applicant (the AI owner or otherwise) can't derive rights or the title to apply for and be granted patents for the AI-generated inventions.

Finally, this chapter's examination reveals that to own and exercise patent rights, one must be a legally recognizable person with the capacity to own properties. Therefore, since AI systems are not legal persons and do not possess the legal ability to hold properties, they cannot be patent owners under the Canadian patent regime.

[606] See David L Schwartz & Max Rogers, *supra* note 20 at 564

Chapter Five: Theoretical Underpinnings of Granting Patents to AI-generated inventions

The previous two chapters discuss the concepts of statutory subject matter, inventorship, and ownership of patent rights vis-à-vis AI-generated inventions within the context of the Canadian patent framework. The discourse revealed that AI-generated inventions could qualify as statutory subject matter based on the meaning of an invention under the *Patent Act*, but AI systems cannot be inventors because they do not have the "mind" to undertake the required mental conception as well as meet the various expectations of the Act. Finally, AI systems cannot own or exercise patent rights as they are not natural or legal persons. While those chapters focus on the doctrinal aspects of the central research question - whether AI-generated inventions "can" be patentable in Canada, this chapter approaches the question from a theoretical perspective – whether AI-generated inventions "should" be patentable - by examining the four major arguments for patent protection – Lockean labour theory, Hegelian personality theory, utilitarianism, and law and economics.

However, the focus of this chapter is the utilitarian (and its complementary law and economics arguments) because they form the bases of the Canadian patent system. Specifically, this chapter seeks to answer three questions: (a) are AI-generated inventions subject to the public goods problem? (b) is it efficient (i.e., the allocation of resources that yield the greatest net benefit) to extend patent protection to AI-generated innovations? And (c) how should the ownership rights of AI-generated inventions be allocated? The utilitarian, the law and economics, and empirical research methodology (as explained in

sections 1.4.2.1 and 1.4.2.2. of this thesis) has been employed to examine these research questions.

The analysis in this chapter is divided into three main parts. The first section examines the main arguments for the justification of the global patent system to determine the objectives of the Canadian patent system. The second part analyzes the economic structure of patent protection by discussing the "public goods problem," social costs, and social utility to provide analytical tools to analyze the theoretical bases of the Canadian patent system. The third and final part discusses the efficiency of granting patents to AI-generated inventions, including an analysis of incentives to innovate, trade secret protection for AI-generated inventions, the cost of producing AI-generated inventions, transaction costs, and allocation of ownership rights.

5.1. Structure of the Canadian Patent System

5.1.1. Objectives of the Patent System

A lot has been written about the objectives of the patent system.[607] Considering the breadth of this thesis research question, I will limit myself in the following sections to a brief synopsis of the major arguments put forward to justify the creation of the patent system. Each argument constitutes an important framework for determining where the balance should rest between the interests of the rights holders and society, the subject matter that could be granted patent protection, and the scope of rights conferred on rightsholders.

[607] See Edward C. Hettinger, "Justifying Intellectual Property," (1989) 18 PHIL. & PUB. AFF. 31, 44; and Justin Hughes, *supra* note 42 at 287, 288–89

Although there are several objectives of the patent system, which could be subdivided into several components,[608] this thesis focuses on four main theories: Lockean labour theory, Hegelian Personality theory, utilitarianism, and law and economics.[609]

5.1.1.1. Lockean Labour Theory

This philosophical conception is based on John Locke's 1690 *Second Treatise of Civil Government: "*every man has a 'property' in his own person."[610] He argued that while the world's natural resources initially belong to no one (i.e., commonly held by all humanity), once a person exerts her labour on such resource, the value added by that labour forms the basis of private property rights.[611] In other words, by "mixing" one's labour with land or other tangible property, a person acquires a "natural right" to the property.[612] Accordingly, proponents of the Lockean labour theory justification for intellectual property (IP) protection argue that an inventor should be granted IP rights because of their inherent right to the fruits of their intellectual labour.[613]

However, three conditions associated with the labour theory make the Canadian patent system incompatible with the labour theory. First, it is essentially an individualistic approach to intellectual property protection; it seeks to reward the inventor for their labour.

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[608] M Du Bois, "Justificatory Theories for Intellectual Property Viewed through the Constitutional Prism" (2018) PER / PELJ 2018(21).
[609] In subsequent parts of this chapter, this author expounded more on the economic model of patent protection.
[610] John Locke, *supra* note 43; Robert P Merges, *supra* note 42 at 32–33.
[611] Ibid, John Locke at para. 25, 26.
[612] M Du Bois, "Justificatory Theories for Intellectual Property Viewed through the Constitutional Prism" (2018) PER / PELJ 2018(21) at 8.
[613] John Locke, *supra* note 43 at 20; and Robert P Merges, *supra* note 42 at 32–33

In comparison, the Canadian patent regime aims to promote social welfare and public interests.

Second, the labour theory requires that "one acquire property rights to satisfy one's needs and no more."[614] The idea behind this condition is to prevent waste, but in practice, the motive for acquiring patents is irrelevant. For instance, some companies obtain patents not to satisfy their "needs" but for strategic (as with patent suppression and defensive patenting) and offensive reasons (as with so-called patent trolls).[615]

Lastly, the inventor's labour does not play any role in the Canadian patent registration system. For instance, an inventor who first files a patent application receives protection regardless of the labour of another who simultaneously or even earlier develops the same invention. Likewise, previous inventors on whose shoulders the new inventor stands are not regarded as co-inventors or joint inventors by virtue of their labour.[616] In view of the above, the labour theory (and rightly so) is not the justification for patent protection in Canada.[617]

Labour theory cannot also be used to support the patentability of AI-generated inventions because it appears unreasonable to argue that AI systems have natural rights to their

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[614] John Locke, *supra* note 43 at 20-21.
[615] Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2241; Emir Aly Crowne, "The Utilitarian Fruits Approach to Justifying Patentable Subject Matter," (2011) 10 J. Marshall Rev. Intell. Prop. L. 753, 759; at 2241
[616] See also, William W. Fisher, *Theories of Intellectual Property, in New Essays in the Legal and Political Theory of Property* 185-86 (Stephen R. Munzer ed., 2001) (citing additional problems with a purely Lockean approach to intellectual property--e.g. "what counts as 'intellectual labor?"' and "what exactly is the 'commons' in intellectual property?").
[617] *Apotex v. Wellcome Foundation*, 2002 SCC 77 [The Supreme Court stressed that "[a] patent is not intended as an accolade or civic award for ingenuity…].

output.[618] Indeed, AI systems are not persons, so they cannot be said to have inherent rights to the fruits of their intellectual labour or have a property in their "person." Equally, the AI developers or programmers cannot rely on the labour theory to justify their ownership of the AI-generated invention because the production of the inventions was independent of their direct efforts. The human initiators may have mixed their labour with other tangible properties to produce the AI system, but that is separate from the production of the AI-generated inventions.[619]

5.1.1.2. Hegelian Personality Theory

Personality theory is often credited to the works of Georg Wilhelm Friedrich Hegel, who posited that property rights are mediums by which people develop and realize their personalities.[620] Hegel argues that the core of a person's existence is her internal will which constantly seeks to find expression in the external world through her personality.[621] Therefore, private property rights enable an entity to become a person and express its actual will. According to the personality theory, "an idea belongs to its creator because the idea is a manifestation of the creator's personality."[622] An author's "personality, spirit and will" cannot be free unless they own their work.[623]

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[618] See Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 299.
[619] The aim of this thesis is not to discuss the intersection of AI-generated inventions and Labour theory. This is just a brief analysis of the author's preliminary thoughts.
[620] G.W.F. Hegel, *Philosophy of Right* translated by Thomas Malcolm Knox (Oxford: The Clarendon Press, 1957). Beyond Hegel, many other scholars have advocated similar personality-based justifications of property rights such as Wilhelm von Humboldt and Immanuel Kant. See Tom G. Palmer, "Are Patents and Copyright Morally Justified? The Philosophy of Property Rights and Ideal Objects" (1990) 13 Harv. J.L. & Pub. Pol'y 817 at 821827 at 835843; and Margaret Radin, "Property and Personhood" (1982) 34 Stan. L. Rev. 957.
[621] Justin Hughes, *supra* note 42 at 331 ("[f]or Hegel, the individual's will is the core of the individual's existence, constantly seeking actuality and effectiveness in the world" and personality is "the will's struggle to actualize itself")
[622] Ibid at 330 (discussing the different justifications for intellectual property law).
[623] Tony Ciro, "The Scarcity of Intellectual Property" (2005)) The Journal of Information, Law and Technology 2.

Hegel's rationale suggests that property and ownership are essential to forming self-identity and achieving self-actualization.[624] In other words, inventors fuse their inventions with their personality or will, making the invention personal or individualistic.[625] Unlike the labour-based justification, the Hegelian theory seeks to protect the bond between a creator and her creations. Thus, it is usually used to justify moral rights in copyright law.[626] The Hegelian theory also differs from the utilitarian analysis, which is based on incentives and seeks to promote society's goals of wealth maximization.[627]

The Hegelian concepts of "self-actualization" and "self-identity" are not apparent in the production processes of an invention. This is because inventions are not usually manifestations of the inventor's personality but functional solutions to specific needs.[628] For example, in developing an invention, inventors search for materials that will add value to the workings of their inventions, not materials that would express their personality.[629] Also, in practice, the individualistic values of the personality theory appear largely inappropriate for the Canadian "first-to-file" method of determining priority for patent eligibility. It is the first inventor that gets to the patent office that is considered the proper person to reap the benefits of patent protection not the inventor that best express their personality in an invention.

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[624] Kanu Priya, "Intellectual Property and Hegelian Justification" (2008) NUJS L Rev. at 362
[625] Ibid
[626] Natalie C. Suhl, "Moral Rights Protection in the United States under the Berne Convention: A Fictional Work," (2001) 12 Fordham Intell. Prop. Media & Ent. L.J. 1203.
[627] See Justin Hughes, *supra* note 42 at 330.
[628] Ibid at 351
[629] See Lionel Bently & and Brad Sherman, *Intellectual Property Law*, 5th ed. (Oxford University Press, 2018) at 397; Justin Hughes, *supra* note 42 at 341 ("In inventing the light bulb, Edison searched for the filament material that would burn the longest, not a filament that would reflect his personality.")

Not surprisingly, proponents of patents for AI-generated innovations do not rely on personality theory to justify their arguments. This is because AI systems do not have personalities or spirits seeking self-actualization or freedom, and there is no bond between AI systems and their inventions or between the human initiators and the AI-generated inventions that need to be protected. In fact, AI systems are unconscious and unaware of what they created to justify reliance on personality theory.

5.1.1.3. Utilitarian Theory

The most common theoretical justification for patent law is utilitarianism.[630] According to this theory, laws should be enacted in such a way as to promote social welfare, maximizing the greatest happiness for the greatest number of people.[631] The right action (i.e., good law) is the action that produces the "most good." The first methodical account of utilitarianism was developed by Jeremy Bentham, who was notably interested in social reform and promulgated the principle of utility to detect what was morally problematic about governments, laws, and individuals.[632] He saw utility as actions that produce 'the greatest amount of good for the greatest number."[633] He also famously argued that humans are governed by two sovereign masters: "pleasure" and "pain." The utility of any action

[630] Peter S. Menell*, Intellectual Property: General Theories, in* Encyclopedia of Law & Economics 129, 129 (Boudewijn Bouckaert & Gerrit de Geest eds., 2000) ("Utilitarian theorists generally endorsed the creation of intellectual property rights as an appropriate means to foster innovation, subject to the caveat that such rights are limited in duration so as to balance the social welfare loss of monopoly exploitation.").
[631] John Stuart Mill, *Utilitarianism,* 7th Ed. (London, UK: Longmans, Green & Co, 1879) at 8; and Jeremy Bentham, *An Introduction to the Principles of Morals and Legislation* (Oxford, UK: Clarendon Press, 1823) at 1 -5.
[632] See Jeremy Bentham, *An Introduction to the Principles of Morals and Legislation.* (Oxford: Clarendon Press, 1907). Although Bentham is the focus here, there are other early utilitarian thinkers like John Stuart Mill and Henry Sidgwick
[633] Ibid

depends on the minimization of 'pain' and maximization of 'happiness or pleasure' for the largest number of people possible.[634]

The Canadian patent system pursues a utilitarian objective by seeking "to stimulate the creation and development of new technologies" for the benefit of society.[635] The origin of patent protection in Canada can be traced to the monopolies generously granted under the prerogative power of the English Crown in medieval times as a means to introduce new technologies and a source of revenue.[636] The practice was criticized for its doubtful legality and constraint of free trade.[637] However, in *Darcy v. Allen*,[638] the Court of the Queen's Bench ruled that such state-granted monopolies were prohibited except in circumstances that would benefit the commonwealth. This utilitarian objective of the patent system was subsequently codified in the *Statute of Monopolies of 1623*, which made it clear that patents were granted by virtue of privilege (and not natural right) and permitted only for new manufactures that contributed to the public good.[639]

The Legislature of Lower Canada enacted the first patent statute of Canada in 1823, which transformed the prerogative power of the Crown into a statutory right.[640] Several centuries

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[634] Ibid
[635] David Vaver, *supra* note 276 at 271; and Norman Siebrasse, "The Structure of the Law of Patentable Subject Matter" (2011) 23 I.P.J. 169 ("[i]t is well accepted that the purpose of the patent system is to spur innovation for the social good" at 178).
[636] Douglass North & Robert Paul Thomas, *The Rise of the Western World: A New Economic History* (Cambridge, U.K.: Cambridge University Press, 1973) at 146 - 148
[637] Daniel Whalen, "On Social Welfare and the Incentive to Share: Towards a Unified Understanding of Intellectual Property Law in Canada" (2012) 25 I.P.J. 29 at 1
[638] (1602), 11 Co. Rep. 84b, 77 Eng. Rep. 1260, 74 E.R. 1131 (Q.B.D.) (the court accepted the defendant's argument that, where useful trades and inventions had been brought into the commonwealth by a person, "the King may grant to him a monopoly patent for some reasonable time, until the subjects may learn the same, in consideration of the good that he doth bring by his invention to the commonwealth: otherwise not" at 1139)
[639] *English Statute of Monopolies* of 1623, 21 Jac. 1, c. 3, s. 1.
[640] *Lower Canada Patent Act* of 1823 (U.K.), 21 Jac. I, c. 3 (1623); H.G. Fox, *The Canadian Law and Practice Relating to Letters Patent for Inventions,* vol. 1 (Toronto: Carswell, 1947) at 26.

later, Canadian courts have explicitly upheld the *English Statute of Monopolies'* focus on social welfare as the fundamental justification for patent monopolies in Canada. In *Free World Trust v. Électro Santé*,[641] Binnie J. stated for the majority that: "The patent system is designed to advance research and development and to encourage broader economic activity."[642] This is achieved by granting inventors (or their legal representatives) monopoly rights to profit from their inventions as well as propel economic activities from enterprises possessing intangible assets.[643]

The focus of the Canadian patent system is social welfare, not the individual entitlements associated with labour and personality theories. The system seeks to incentivize the development of further innovations by granting temporary monopolies to inventors, allowing them to recoup their research and development (R&D) costs.[644]

The framework of the utilitarian regime is based on four broad theories.[645] The first is the *invention-inducement theory* that seeks to incentivize the creation of new innovations. This theory posits that the ex ante promise of exclusive rights and the anticipation to receive patents provides motivation to create to new and useful inventions.[646] The second is the *disclosure theory* that seeks to ensure public access to technological knowledge.[647] This is

[641] 2000 SCC 66, 9 C.P.R. (4th) 168 [Free World Trust].
[642] Ibid, at para. 42.
[643] See *Harvard College v. Canada (Commissioner of Patents),* 2002 SCC 76 at para. 185, 21 C.P.R. (4th) 417 [Harvard College]. See also Teresa Cheung & Ruth M. Corbin, "Is There a Method to the Madness? The Persisting Controversy of Patenting Business Methods" (2005) 19 I.P.J. 29 at 73; Clarisa Long, "Patent Signals" (2002) 69 U. Chicago L. Rev. 625; Bronwyn H. Hall, "Business and Financial Method Patents, Innovation, and Policy" (2009) 56 Scot. J. Polit. Econ. 443 at 459 [Hall].
[644] However, patents are allowed for a lot more profiting that simply recouping R&D costs.
[645] Examining the broad details of the various theories is beyond the scope of this research work.
[646] Mark A. Lemley, *"Ex Ante* Versus *Ex Post* Justifications for Intellectual Property" (2004) 71 U. Chicago L. Rev. 129 at 130
[647] *AstraZeneca Canada Inc. v. Apotex In*., [2017] S.C.J. No. 36, 2017 SCC 36 at para. 39 (S.C.C.)

an ex post requirement for inventors to disclose the making and use of their inventions to the public to prevent secrecy and incentivize follow-on development of the inventions.[648] The third is that *development and commercialization theory* that considers patenting as a means by which smaller firms attract large companies or venture capitalists to invest in the development of an invention or "handing off the task [developing and commercializing an invention] to an organization better situated for development and commercialization."[649] According to this theory, the societal benefits of patents is derived from enabling universities and smaller firms enter the capital markets for financing or sell their exclusive licenses to large firms that can develop and commercialize them.[650] The fourth and last is the *Prospect Development Theory* that seeks to prevent duplicative and wasteful inventive resources by granting broad proprietary interests of in very early stages of technical development to patent holders to enable them to coordinate the orderly exploration and development of the patented technology from various dimensions.[651]

Although the "prospect" theory can serve socially useful functions, the traditional rationale of the Canadian patent system is arguably based on *invention-inducement theory, disclosure,* and *development and commercialization* theories.[652] Therefore, the later arguments in this chapter focus on these theories (that is, the incentive to invest in

[648] Roger T Hughes & John H. Woodley, *Hughes and Woodley on Patents,* looseleaf (Toronto: Betterworths, 1984) at 1.
[649] Richard D. Nelson & Roberto Mazzoleni, "Economic Theories About the Costs and Benefits of Patents" *Intellectual Property Rights and the Dissemination of Research Tools in Molecular Biology: Summary of a Workshop Held at the National Academy of Sciences*, February 15–16, 1996, online: < https://www.ncbi.nlm.nih.gov/books/NBK233535/#:~:text=Another%20interpretation%20of%20the%20development,can%20develop%20and%20commercialize%20them>; Bronwyn H. Hall & Rosemarie Ham Ziedonis, "The patent paradox revisited: an empirical study of patenting in the US semiconductor industry, 1979-1995" (2001) rand Journal of Economics 101-128.
[650] Ibid
[651] Edmund Kitch, "The nature and function of the patent system" (1977) 20 J Law Econ 265–290.
[652] *Free World Trust v. Électro Santé* 2000 SCC 66, 9 C.P.R. (4th) 168 [Free World Trust]; and Jeremy De Beer, "Evidence-Based Intellectual Property Policymaking: An Integrated Review of Methods and Conclusions" (2016) 19:5-6 The Journal of World Intellectual Property at p. 150-177.

innovation, publicly disclose valuable innovations, and commercialize new products and processes) to analyze patenting AI-generated inventions while recognizing that in certain circumstances like university patenting, the incentive theory is arguably not that strong, or are at least complicated by other incentives like obtaining government grants, academic promotion, and the pressure to publish – "publish or peril."[653]

5.1.1.4. Law and Economics Theory

The law and economics approach to patent protection is a derivative of the utilitarian theory. This theory applies the tools of the microeconomic system to analyze legal rules and institutions. The approach aims to maximize the total social welfare from an economic perspective.[654] This theory answers a critical methodological question: what is social welfare? It defines social welfare as wealth and utility.[655] Wealth is "the sum of all goods and services in the society weighted by their value,"[656] while utility means "happiness - 'the surplus of pleasure over pain'- aggregated across all of the inhabitants ... of 'society."[657] Wealth is objective and measurable, while happiness is subjective and

[653] See E. Richard Gold, "Should universities get out of the patent business?" (April 3, 2019) *Centre for International Governance Innovation*, online: <https://www.cigionline.org/articles/should-universities-get-out-patent-business/>; Viktoriya Galushko & Ken Sagynbekov. "Commercialization of University Research in Canada: What Can We Do Better?" (2014) 5:5 International journal of business administration 1.

[654] Shlomit Yanisky-Ravid, "The Hidden Though Flourishing Justification of Intellectual Property Laws: Distributive Justice, National Versus International Approaches," (2017) 21 LEWIS & CLARK L. REV. 1; Amy Kapczynski, "The Cost of Price: Why and How to Get Beyond Intellectual Property Internalism," (2012) 59 UCLA L. REV. 970, 970, 977–79.

[655] William M. Landes & Richard A. Posner, *The Economic Structure of Intellectual Property Law* (Cambridge, MA: Harvard University Press, 2003) at 269

[656] Richard A Posner, *The Economics of Justice* (Cambridge, MA: Harvard University Press, 1981) at 60; see also Francesco Parisi & Jonathon Klick, "Functional Law and Economics: The Search for Value-Neutral Principles of Lawmaking" (2004) 79 Chicago-Kent L. Rev. 431 ("[u]nder wealth maximization principles, a transaction is desirable if it increases the sum of wealth for the relevant parties (where wealth is meant to include all tangible and intangible goods and services)" at 443).

[657] Richard A. Posner, *The Economics of Justice* (Cambridge, MA: Harvard University Press, 1981) at 49; Francesco Parisi & Jonathon Klick, "Functional Law and Economics: The Search for Value-Neutral Principles of Lawmaking" (2004) 79 Chicago-Kent L. Rev. 43 (defines utility as "human happiness and well-being" at 269).

abstract. But the concepts are interrelated because wealth often increases happiness.[658] According to the law and economics approach, the law's central goal is maximizing social wealth and utility. However, the Richard Posner and Chicago School of Economists later popularized the concept of "efficiency" as a maxim in the law and economics analysis.[659] Posner defined "efficiency as "exploiting economic resources in such a way that value - human satisfaction as measured by aggregate willingness to pay for goods and services - is maximized."[660]

Several schools of thought have put forward divergent views concerning the economic foundations of patent law. This thesis relies on the perspectives of the Chicago School of Economics and its related schools of thought, most notably neo-classical economics, because they represent the most traditional framework for the subject of this thesis' analysis. The theory developed by the Chicago School of Economics postulates that patent law seeks to maximize efficiency by solving the "free-rider" or "public goods" problem associated with intellectual property assets.[661]

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[658] Ibid, Richard A. Posner, *The Economics of Justice* (Cambridge, MA: Harvard University Press, 1981) at 66 ("[w]ealth is positively correlated, although imperfectly so, with utility").
[659] See Francesco Parisi & Jonathon Klick, "Functional Law and Economics: The Search for Value-Neutral Principles of Lawmaking" (2004) 79 Chicago-Kent L. Rev. 431 at 264 ("[t]he primary hypothesis advanced by positive economic analysis of law [advanced by Posner and the Chicago school of economics] is thus the notion that efficiency is the predominant factor shaping the rules, procedures, and institutions of the common law"). See also Isaac Ehrlich & Richard A. Posner, "An Economic Analysis of Legal Rulemaking" (1974) 3 J. Legal Stud. 257; William M. Landes & Richard A. Posner, "An Economic Analysis of Copyright" (1989) 18 J. Legal Stud. 325 at 325; William M. Landes & Richard A. Posner, "Trademark Law: An Economic Perspective" (1987), 30 J.L. & Econ. 265 at 269.
[660] Richard A. Posner, *Economic Analysis of Law* (2d ed. 1977) 10.
[661] William M. Landes & Richard A. Posner, *The Economic Structure of Intellectual Property Law* (Cambridge, MA: Harvard University Press, 2003) 39-40; Richard A. Posner, *Economic Analysis of Law* 6th ed. (Wolters Kluwer Law & Business, 2014)

Intellectual property assets are often very costly to create, but the cost of copying and making them available to the public is very low, at least relative to the investment costs.[662] If imitators are allowed to copy the new inventions and enter the market, the price of the goods would be sold at a marginal cost, creating a situation where the inventor will not be able to recoup their investment costs (i.e. fixed costs). Imitators can afford to sell at a marginal cost because they did not incur any R&D costs. From an *ex post* perspective, this is an optimal outcome as the price of goods would be marginal, but from an *ex ante* perspective, inventors will not be motivated to incur the necessary R&D costs to invent.

According to the law and economics model, a patent serves as a device by which the inventor places a legal fence around intangible assets to control entry and unlicensed usage.[663] The exclusive rights granted to inventors will enable them to prevent others from "free-riding" their inventions.[664] The opportunity to earn supranormal profits and recoup their R&D costs is expected to incentivize investments in producing goods that would otherwise be underproduced.

This section briefly examined four main arguments that justify patent protection: labour, personality, utilitarianism, and economics. The labour and personality theories are based on individualistic natural rights, while the utilitarian and economics approaches are based on public interests and social welfare. The Canadian patent system aligns with the latter by seeking to incentivize inventions for the benefit of society. The next section deploys the

[662] Richard A. Posner, "Intellectual Property: The Law and Economics Approach" (2005) 19:2 Journal of Economic Perspectives 58.
[663] Peter S Menell & Suzanne Scotchmer, *supra* note 13 at 1475
[664] Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2239

utilitarian normative values and the "efficiency" concept under the law and economics approach to determine if Parliament should extend patent protection to AI-generated inventions.[665]

5.2. The Economic Model of Patent Protection

Having established that the Canadian patent framework aligns with the economic incentive arguments for patent protection, it is only reasonable that the theoretical justifiability of AI-generated inventions is rooted in economic theory. Therefore, this section seeks to provide a deeper analysis of the economic basis for granting patents to inventions by discussing three key concepts: "the public Goods" problem, social costs, and social utility, which would provide a prequel for subsequent arguments in this chapter on the economic efficiency of granting patent protections to AI-generated inventions.

5.2.1. "The Public Goods" Problem

In economics, a public good is a product that is both non-excludable and nondepletable (or non-rivalrous).[666] A good is non-excludable if one cannot exclude others from enjoying the benefits of the goods once provided, while non-rivalrous connotes that the enjoyment by one person does not diminish the amount available to others.[667] Therefore, a public good refers to a good that more than one person can consume at a time, and there is no way of excluding consumers from utilizing it in the absence of IP rights. Examples of public good

[665] It is important to note that it is not possible within the scope of this research work to fully detail the vast body of literature on the utilitarian and economic structure of the patent system However, the thesis highlights the main themes arising from the subject that are relevant to AI-generated inventions.
[666] Sean Ingham, "Public Goods" (October 3, 2018), online: Encyclopedia Britannica < https://www.britannica.com/topic/public-good-economics>
[667] Ibid

include clean air and national defence. Once a unit of any of these items comes into existence, the benefit of the good can be simultaneously enjoyed by multiple individuals; the use by one individual does not deplete the amount left for others, and there is no way of excluding someone from enjoying the benefit of such a unit.

Unlike private tangible goods, intellectual property assets are typically described as public goods because, in many situations, they cannot be physically sequestered from consumption and can be consumed by more than one person simultaneously.[668] Since there is no obvious way of excluding people from consuming public goods, extracting payment for them may be challenging if a consumer chooses not to pay. There is instead, the likelihood that rational consumers and rivals may free-ride on such goods, taking the benefits without rewarding the inventors for their creativity. Consequently, "there is little incentive to create public goods in the first place, as a rational producer will know that payment for a public good, once it comes into existence, is unlikely."[669]

Another challenge with intellectual property assets as public goods is that inventors may not be able to recoup their research and development (R&D) costs as imitators can easily copy the goods and sell them at a marginal cost. This has the potential to create sub-optimal levels of innovation. For instance, inventors expend time and resources to generate inventions, hoping to get returns from the investments through selling and licensing the

[668] Richard A. Posner, "Intellectual Property: The Law and Economics Approach" (2005) 19:2 Journal of Economic Perspectives at 58; Samuelson P., "The pure theory of public expenditures" (1954) Rev. Econ. Stat. 36:387—89, Page 5

[669] Dan L Burk, "Law and Economics of Intellectual Property: In Search of First Principles" (July 20, 2012). UC Irvine School of Law Research Paper, 2012-60, Available at SSRN: https://ssrn.com/abstract=2113975 or http://dx.doi.org/10.2139/ssrn.2113975 at 6.

inventions. The degree of time and effort exerted depends on the potential returns: the higher the returns, the more willing potential inventors would be to provide the necessary resources. If inventors are unable to restrict rivals from entering the market and copying the inventions, there is little incentive to devote the required time and resources to generate inventions. In other words, most rational firms would not expend resources to develop new technologies in a competitive market where competitors could enter the market and dissipate the profits without incurring high fixed costs.[670]

Economists describe this situation as a "public goods problem."[671] If the market is allowed to run its natural course, the private sector will not produce intellectual assets or will do so at a sub-optimal level. As Karl Heinrich Rau, a German political economist, stated, though "some important inventions are made by accident," however, many require great effort, and one "would not make such sacrifices if he could not hope for a period of protection from encroachment by competitors in the use of his invention."[672] As would become clearer in later parts of this work, in practice, this theoretical problem is not equally visible and applicable in every industry.[673]

The patent law solves this market failure by granting temporary monopoly rights to inventors over their inventions' production, use, and sale – usually twenty years from the

[670] Ibid
[671] William M Landes & Richard A Posner *The Economic Structure of Intellectual Property Law* (London: Harvard University Press, 2003) at 294.
[672] Karl Heinrich Rau, *Grundsätze der Volkswirthschaftspolitik, Lehrbuch der polltischen Oekonomic* (Heidelberg: 3d edition, 1844) , vol. II, p. 362.
[673] Jeremy De Beer, "Evidence-Based Intellectual Property Policymaking: An Integrated Review of Methods and Conclusions" (2016) 19:5-6 The Journal of World Intellectual Property at p. 150-177.

filing date.[674] These monopoly rights provide an efficient method for firms to internalize the benefits of their R&D, thus promoting technological progress and innovation. Armed with patents, inventors can restrict others from making, selling, or using their inventions and, more particularly, control the pricing of the inventions.[675]

5.2.2. Social Costs

The pricing power of patent holders and the potential to make supra-competitive profits can serve as incentives to invent. But it also entails social costs such as "deadweight loss" – pricing certain consumers out of the market.[676] The rights owner can artificially raise the price of the protected item beyond the marginal cost, exclude competitors, or require them to pay high royalties for the license to use or produce the invention.[677] These monopolistic activities can exclude certain consumers from the market who value the goods above the competitive price but less than the monopoly price. Consumers who might have enjoyed the product for free or at a meagre marginal cost may be unwilling or unable to pay the high price.[678] Economists described this situation of dissipation of consumer surplus "as the dead weight loss of gains that go unrealized either to the producer or the consumer."[679]

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[674] Ibid
[675] David S Olson, *supra* note 19 at 199
[676] Dan L Burk, "Law and Economics of Intellectual Property: In Search of First Principles" (July 20, 2012). UC Irvine School of Law Research Paper, 2012-60, Available at SSRN: https://ssrn.com/abstract=2113975 or http://dx.doi.org/10.2139/ssrn.2113975 at 8.
[677] Christine Greenhalgh & Mark Rogers, *Innovation, Intellectual Property and Economic Growth* (Princeton: Princeton University Press, 2010) at 33 – 34.
[678] Dan L Burk, "Law and Economics of Intellectual Property: In Search of First Principles" (July 20, 2012). UC Irvine School of Law Research Paper, 2012-60, Available at SSRN: https://ssrn.com/abstract=2113975 or http://dx.doi.org/10.2139/ssrn.2113975 at 8
[679] Ibid

Patents could also lead to artificial scarcity of the patented technologies in situations where a few firms manage the production of the patented technology in order to maximize the monopoly rights.[680] For instance, the intellectual property rights (including patent restrictions, trade secrecy, and limited access to manufacturing know-how) over the Covid-19 vaccines caused that after 18 months of the vaccines being available, only about 16% of the population in low-income countries had received at least one dose.[681]

Patent monopoly also has the potential to impede cumulative innovation or further research as it could raise the costs of generating new works and rightsholders have the right to prevent others from using their patented technology to create secondary inventions.[682] According to Eli Salzberger "most new inventions are based on older ones and thus full propertization of every idea and expression would slow down scientific and cultural progress."[683] This means innovation is generally incremental: many small steps are required to produce a new invention, and many pathways to innovation intersect and interconnect.[684] Therefore, where each path is patented, the pace of innovation could be

[680] Alexandra George & Toby Walsh, "Artificial intelligence is breaking patent law" (24 May 2022), online: *nature* < https://www.nature.com/articles/d41586-022-01391-x#ref-CR2>

[681] Ibid; and Gregg Gonsalves & Gavin Yamey. "The covid-19 vaccine patent waiver: a crucial step towards a "people's vaccine" (2021) BMJ 373; Matthew Herder, E. Richard Gold, and Srinivas Murthy "University Technology Transfer Has Failed to Improve Access to Global Health Products during the COVID-19 Pandemic" (2022) 17:4 Healthcare Policy 15; and Marianne Meijer, Marieke Verschuuren, & Ella Weggen, "COVID-19 vaccines a global public good? Moving past the rhetoric and making work of sharing intellectual property rights, know-how and technology," (2021) 31:5 European Journal of Public Health, at pages 925–926.

[682] See Heller MA & Eisenberg RS., "Can patents deter innovation? The anticommons in biomedical research" (1998) 280 Science 698–701

[683] Eli Salzberger, "Economic Analysis of the Public Domain," in The Future of The Public Domain 27-59 (2006), http://papers.ssrn.com/sol3/papers.cfm?abstractid=934127.

[684] Alberto Galasso & Mark Schankerman, "Patents and Cumulative Innovation: Causal Evidence from the Courts" (March 26, 2013), online(pdf) at 1: *UTexas*<https://law.utexas.edu/wpcontent/uploads/sites/25/CAFC_Complete_26March13.pdf>

slowed because a patent holder can prevent others from using, making, or selling their claimed inventions.[685]

There are several cases where firms acquire or develop new technology, patent it, and then decide not to make it, use it, or license it just to prevent competitors from creating better technology.[686] For instance, some authors have argued that instead of promoting innovation, software patents have "been used for years now in the software industry as a blunt weapon to suppress innovation, kill competition, and generate undeserved royalties."[687] Similarly, a study by the Organisation for Economic Co-operation and Development (OECD) shows that increased patenting of software-related inventions may "inhibit follow-on innovation or the assembly of complex programmes" because of transaction costs.[688]

The social costs of impeding technological progress can be high because secondary inventions could be as socially beneficial as the initial discovery.[689] As some commentators pointed out, an invention's most essential social benefit may be derived from its follow-on

[685] See Ruth Eisenberg, "Bargaining over the transfer of proprietary research tools: Is this market failing or emerging?" RC Dreyfuss, DL Zimmerman, & H First, ed., *In Expanding the Boundaries of Intellectual Property: Innovation Policy for the Knowledge Society*, ed. (Oxford, UK: Oxford Univ. Press, 2001) pp. 223–50.
[686] See William M. Landes & Richard A. Posner, *The Economic Structure of Intellectual Property Law* (Cambridge, MA: Havard Unviersity, 2003) at 321.
[687] See Monica Goyal, "Software Patents: Current Challenges and Future Solutions" (2011) 1:3 *Technology Innovation Management Review*, at 18; James Bessen, "A Generation of Software Patents" (2012) 18 B.U. J. Sci. & Tech. L. 241, 248 (arguing that patenting low-cost inventions in the software industry has created social costs in the nature of patent thickets. He described a patent thicket as the circumstance where firms acquire a large number of patents and subsequently create a barrier of entry to the market).
[688] See OECD, "Patents and Innovation: Trends and Policy Challenges" (Paris: OECD publications, 2004) 24.
[689] See Richard R. Nelson & Sidney G. Winter, *An Evolutionary Theory of Economic Change* (Cambridge, MA: Harvard University Press, 1982); and C. T. Taylor & Z. A. Silberston, *The Economic Impact of the Patent System: A Study of the British Experience* (Cambridge: Cambridge University Press, 1973).

innovators.[690] For instance, automobiles, computers, electric light systems, and biotechnology inventions have relied on incremental innovation.[691]

The patent system employs several policies to minimize the social costs associated with patents, such as the requirement of public disclosure, time-limitation, and the patentability criteria: novelty, useful, and non-obviousness. This patentability criteria help to prevent useless ideas, basic research discoveries, and inventions that are already known or trivial from being patented. Granting time limited-monopoly rights for these kinds of inventions does not serve any social valuable function. Thus, the patentability criteria assist to block them out.

Concerning the public disclosure, the patent law requires the inventor to disclose the processes of the invention in sufficient detail to enable an ordinary person skilled in the technology to use or reproduce the invention.[692] Although this information is publicly available, competitors cannot, on that basis, reproduce the invention without the patentee's permission while the patent is pending. The advantage of the public disclosure is that it adds to the storehouse of technical knowledge even before the patent is granted.[693] Also, competing firms can use the information to invent around the invention and determine the

[690] Suzanne Scotchmer, "Standing on the shoulders of Giants: Cumulative Research and the Patent Law" (1991) 5:1 Journal of Economic Perspectives at 29-41, and Peter S Menell & Suzanne Scotchmer, *supra* note 13 at 1495
[691] Ibid
[692] *Patent Act*, R.S.C., 1985, c. P-4, s. 27(3)
[693] See *Kewanee Oil Co. v. Bicron Corp.,* (1974) 416 U.S. 470, 481 (the court explained that when the information disclosed in a patent goes public it adds to the "general store of knowledge" and, assumedly, "will stimulate ideas and the eventual development of further significant advances in the art")

feasibility of improvement without the need to conduct the preliminary experiments, thus lowering the cost of production.[694]

However, it is debatable to what extent the public disclosure requirements promote further innovations or social good. Some scholars have argued that patents "seldom teach enough so that someone can actually go out and actually do the invention without some additional work."[695] The reason, perhaps, is because there is no requirement for claimed inventions to be actually reduced to practice at the time of patent applications. As Sean B. Seymore explains: "a disclosure regime which does not require actual experimentation all too often produces patent documents which have little if any, technical value."[696] In other words, since there is no obligation for the inventor to provide working examples to the patent office, "the inventor is in some sense speculating or guessing about the features of an invention not yet built."[697] In addition to impracticability, there are also cases of unreadable and indecipherable patent descriptions that inhibit the ability of the public to benefit from the patent disclosure.[698]

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[694] William M Landes & Richard A Posner *The Economic Structure of Intellectual Property Law* (London: Harvard University Press, 2003) at 298 - 99

[695] See Benjamin N. Roin, "The disclosure function of the patent system (or lack thereof)" (2005) Harv. L Rev. at 2025; See, e.g., Alan Devlin, "The Misunderstood Function of Disclosure in Patent Law" (2010) 23 Harv. J.L. & Tech. 401at 403 ("[T]he extent to which patent documents successfully teach the inner workings of cutting-edge technologies is quite limited."); Jeanne C. Fromer, "Patent Disclosure," (2009) 94 IOWA L. Rev. 539, 542 at 560 ("[A] good deal of evidence suggests that technologists do not find that [the patent document] contains pertinent information for their research."); Mark A. Lemley, "The Myth of the Sole Inventor," (2012) 110 Mich. L. Rev. 709, at 745 ("[I]nventors don't learn their science from patents."). On the contrary, see Robert P. Merges, "Commercial Success and Patent Standards: Economic Perspectives on Innovation," (1988) 76 CALIF. L. Rev. 803, 808–09 at 808 ("There is a significant amount of evidence showing that inventors in many fields rely on published patents for technical information.") and Lisa Larrimore Ouellette, "Do Patents Disclose Useful Information?" (2012) 25:2 Harv. J Law & Tech 533 ("…many researchers do use patents as a source of technical information.")

[696] Sean B. Seymore, "The Teaching Function of Patents," (2005) 85 Notre Dame Law Rev. 621 at 632.

[697] Dan L. Burk & Mark A. Lemley, "Is Patent Law Technology-Specific," (2002) 17 Berkeley Tech. L.J. 1155, 1174

[698] See, e.g., Daniel C. Munson, "The Patent-Trade Secret Decision: An Industrial Perspective," (1996) 78 J. Pat. & Trademark OvF. Soc'v 689, 713-14 (observing that chemical patents tend to be "shrouded in chemical nomenclature," which makes them hard to comprehend)

Finally, in a further bid to reduce the social costs, patent law also excludes abstract ideas, and mere scientific and technological principles from patent monopoly to prevent enormous transaction costs from being imposed on users.[699] These ideas and principles are not only basic research tools for technological progress but can also be general and ambiguous, covering a broad range of issues. Therefore, it can be challenging to determine their exact scope. The implication of patenting such broad scope of inventions is that it could create uncertainties in the market and compel newcomers to get licenses, in situations where they may not be needed, potentially increasing production and transaction costs and stifling technological advancements.

5.2.3. The Social Utility Balance

The intersection between social benefits and social costs accounts for the most critical question of patent law: whether, on balance, a particular invention increases or reduces social welfare. While patents have strong economic benefits, there are also accompanying considerable social costs. Therefore, an efficient patent system reflects a situation where the social costs of promoting new inventions are lower than societal gains. For instance, if the scope of patent law extends too far, the social utility is decreased as the harm from the monopoly will exceed the gains. On the other hand, if the scope is too narrow, it would create a sub-optimal level of innovation, also decreasing social utility.

[699] William M Landes & Richard A Posner *The Economic Structure of Intellectual Property Law* (London: Harvard University Press, 2003) at 305.

The social utility goal is to provide an efficient quantity of patent protection to foster inventive activity. This involves a complex balancing between the social costs of a limited monopoly and the benefits of the increased invention.[700] For instance, the economic rationale for excluding abstract theorem and scientific principles from the statutory subject matter is because the deadweight loss is always more than the increased invention. The lack of patent protection for abstract ideas and scientific principles may create a sub-optimal production of such ideas. However, granting a patent to abstract ideas may vest monopoly power over all products and processes that rely on the idea, leading to a high deadweight loss.

Social utility is also achieved by providing incentives only for works that would otherwise be underproduced, not merely rewarding inventors for their creative capacities (or refusing to protect works just to increase access to innovations).[701] Many inventions can be and are being developed without the incentive of patent exclusivity - some innovators create to enhance their reputation, seek promotions, fun or incidentally to other activities.[702] In those circumstances, the cost of exclusion leaves the society worse off because the inventors would have developed the goods without exclusive rights.[703] As some researchers at Max Planck Institute for Innovation and Competition pointed out, "Given that patents impose welfare costs, they can only be justified by benefits that, in the absence of patent protection,

[700] See, e.g., Peter S. Menell & Suzanne Scotchmer, Intellectual Property Law, in 2 Handbook of Law and Economics, 1473, 1476-78 (A. Mitchell Polinsky & Steven Shavell eds., 2007).
[701] David S Olson, *supra* note 19 at 195.
[702] Silbey J. "Harvesting intellectual property: inspired beginnings and "work-makes-work," two stages in the creative processes of artists and innovators. (2011) 86 Notre Dame Law Rev. 2091–132
[703] Dan L. Burk "Law and Economics of Intellectual Property: In Search of First Principles" (2012) 8:1 *Annual review of law and social science* 397–414 at 403.

would not occur."[704] In essence, patents are cost justified from a social standpoint if the monopoly rights are granted in necessary circumstances.[705]

A growing body of empirical evidence shows that the costs of innovation in different technologies vary significantly and that the industrial sectors that rely on these technologies experience the patent system differently.[706] Not surprisingly, these industries show marked differences in how they procure, license, enforce, and use patents.[707] For instance, innovation in pharmaceuticals or semiconductors, where development costs are astronomical, and the risks of lost investment are high, requires a greater reward to prompt investment compared to innovation in the software industry, where the investment that is needed to produce a competitive product is far lower.

The empirical evidence shows that the cost and benefit analysis of the welfare patent system is fact-driven.[708] Thus, market presumptions of the necessary pecuniary incentives ought to be supported by empirical findings for each sector and marketplace to determine if a patent is needed. On the contrary, patent regimes often rely on a general estimation,

[704] See Daria Kim, Josef Drexl, Reto M. Hilty & Peter R. Slowinski, "Artificial Intelligence Systems as Inventors?" 9 (Max Planck Inst. for Innovation and Competition Rsch. Paper Series, No. 21-20, 2021) at 10.
[705] See William M Landes & Richard A. Posner, *supra* note 16 at 21.
[706] See Domique Foray, "A primer on patent and innovation" (2010) 14:3 Management international / Gestiòn Internacional / International Management at 19–28. https://doi.org/10.7202/044290ar ("...the relationship between patents and innovation is guaranteed to be a complex one, and one that may vary over time and across industries."); Organisation for Economic Co-operation and Development (OEC), "Patents and Innovation: Trends and Policy Challenges" (2004) online: < https://www.oecd.org/science/inno/24508541.pdf>
[707] See William M Landes & Richard A. Posner, *supra* note 16 at 411.
[708] Some commentators believe that "utilitarian approach is not universally applicable to all types of goods (and especially to certain types of health goods)" see Fritz Machlup, An Economic Review Of The Patent System (Study of the Subcommittee on Patents, Trademarks, and Copyrights of the Committee on the Judiciary, United States Senate, 85th Congress, Second Session. Study No. 15)

more like speculation, that the social cost of the patent monopoly is less than the social benefits.[709]

The general estimation explains why, upon any new invention's emergence, there are calls for it to be patented, without regard for the nature of the subject matter and the marketplace. This approach is inconsistent with the utilitarian theory. Before any new subject matter is considered for patents, there ought to be some empirical evidence to justify or at least some theoretical market analyses to determine the correlation between patent protection and investments. The grant of patent protection should not be a matter of course. Monopoly brings social harms such as deadweight losses - high prices, scarcity, and stifling competitors.[710] Thus, any new technology field should pass the efficiency test before being admitted into the patent framework.

5.3. The Efficiency of Patentability of AI-generated inventions

This section seeks to determine how society could maximize the value of AI-generated inventions within the context of patent law by making three major arguments. First, excluding a certain class of subject matter from patent protection is economically justifiable to lessen the patent office's burden of examining unwarranted patent applications. Second, the Canadian patent system has historically excluded undeserving inventions from the patent system. Third, there is a strong economic case to exclude AI-generated inventions from the Canadian patent regime because there exist incentives to

[709] Julie E. Cohen, "Copyright and the perfect curve" (2000) 53 Vanderbilt Law Rev. 1799–819
[710] See William M. Landes & Richard A. Posner, *The Economic Structure of Intellectual Property Law* (Cambridge, MA: Havard Unviersity, 2003), pp. 13 – 14.

produce the inventions, they can be protected under trade secret, and the protection may create unnecessary transaction costs. I discuss these arguments in detail in the next sub-sections.

5.3.1. Economic Justification of Subject Matter Discriminations

In a perfect world, without transaction costs, information asymmetries, and limited time, it would *arguably* be the responsibility of the patent office to determine if patent protection is necessary for a particular invention.[711] This involves examining the surrounding circumstances of a subject matter to determine whether patents would incentivize the development of the invention and that the deadweight loss from the monopoly is less than the increased invention. But in reality, undertaking this analysis would be impossible due to time, resources, and information constraints.

Patent offices, for instance, do not have the staff capacity and unlimited time to scrutinize each patent application at such a deep level. Moreover, information asymmetries could make it impossible for the patent office to access all the relevant information to decide if a particular claimed invention should be granted a patent monopoly.[712]

Consequently, the most efficient manner of determining the social value of patent applications is to first decide on a class-by-class basis whether specific categories of inventions should be patentable. This includes determining whether the subject matter suffers from the public goods problem or if there are other factors outside patent law that

[711]David S Olson, *supra* note 19 at 204.
[712] Ibid

adequately incentivize the production of the invention.[713] After this subject matter scrutiny is successfully concluded, the invention could be subjected to the test of novelty, non-obviousness, utility, and enablement disclosure requirements.

The subject matter eligibility should be the first step in the patent examination process to avoid wasting time and resources on other tests. If the public goods problem does not exist in a class of subject matter, either because of the nature of the invention or other incentives exist outside patent law, the invention should be taken as a non-statutory subject matter, and the patentability enquiry should end.[714] It is more efficient to begin the patentability process by determining on a class-by-class basis instead of an invention-by-invention basis. Once an invention falls within an unpatentable class, it should be considered a non-statutory subject matter.

Suppose a class of subject matter is excluded from patent protection. In that case, it also has the potential to lessen the burden of the patent office and allow patent examiners to focus on more deserving patent applications. If every invention (including the unjustified innovations) is permitted into the substantive patent system, it may create an inefficient patent examination process. Specifically, the patent office may be overburdened with unnecessary patent applications, and the likelihood of "bad patents" being issued in such circumstances is higher.[715] Thus, it is economically justifiable for Parliament or courts to

[713] Ibid at 206.
[714] David S Olson, *supra* note 19 at 206.
[715] Jay P Kesan & Andres A. Gallo, "Why 'Bad' Patents Survive in the Market and How Should We Change? —The Private and Social Costs of Patents," (2006) 55 EMORY L.J. 61.

exclude certain subject matter classes from patent law because it advances the efficiency of the patent office. Specifically, the courts have traditionally been known globally for excluding certain kinds of invention from patent protection, such as laws of nature, abstract ideas, and natural phenomena.[716] The next section examines the role of the Canadian courts with respect to these kinds of exclusions.

5.3.2. The Courts' Historical Role in Excluding Inefficient Subject Matter

Canadian courts have historically served as gatekeepers, although informally or implicitly, of whether a particular class of subject matter advances the utilitarian objective. In this regard, the courts have ruled certain subject matters as inappropriate for patenting, including methods of medical treatment,[717] professional skills, such as the method of sub-dividing land and oratory skills of a barrister,[718] higher life forms,[719] arts or processes lacking in commercial value,[720] and mathematical formula.[721] To further expound on the "gatekeeping" role of the courts, this part examines two judicial decisions: *Harvard*

[716] Ian McMillan, "Unilateral Acquisition and the Requirements of Freedom: A Kantian Account of the Judicial Exceptions to Patent Protection" (2022) 35:2 Canadian J of L & Jurisprudence, at 459-486. ("Courts have long held that some kinds of inventions meeting the statutory requirements of being new, unobvious, and useful are nonetheless excluded from patent protection. These excluded inventions are categorized as natural phenomena, abstract ideas, and laws of nature ('the judicial exceptions')." See, e.g., *Diamond v. Diehr*, 450 U.S. 175, 185 (1981), in which the US Court held that it "has undoubtedly recognized limits to § 101 and every discovery is not embraced within the statutory terms. Excluded from such patent protection are laws of nature, natural phenomena, and abstract ideas;" *Association for Molecular Pathology v. Myriad Genetics, Inc.,* [2013] 133 S. Ct. 2107 (the US Supreme Court held that "a naturally occurring DNA segment is a product of nature and not patent-eligible"); and *D'Arcy v. Myriad Genetics, Inc.,* [2015] 258 CLR 334 (the Australian Court held that a naturally occurring DNA is not patenable). See also Kathleen Marsman & Graeme Boocock, "Judicial Exclusions To Patent Eligibility in the US – The Beginning of the End" (July 18, 2019), *Mondaq* < https://www.mondaq.com/canada/patent/827236/judicial-exclusions-to-patent-eligibility-in-the-us-the-beginning-of-the-end>

[717] *Tennessee Eastman Co. v. Canada (Commissioner of Patents),* [1974] S.C.R. 111, 33 D.L.R. (3d) 459 [Tennessee Eastman cited to SCR].

[718] *Lawson v Canada (Commissioner of Patents)* (1970), 62 C.P.R. 101 (Can. Ex. Ct.)

[719] *Harvard College v. Canada (Commissioner of Patents),* 2002 SCC 76, [2002] 4 S.C.R. 45 at para. 158, [2002] S.C.J. No. 77

[720] *Progressive Games Inc. v. Canada (Commissioner of Patents)* (1999), 3 C.P.R. (4th) 517, (sub nom. *Progressive Games Inc. v. Commissioner of Patents*) 177 F.T.R. 241 (Fed. T.D.) [*Progressive Games* cited to C.P.R], affirmed 9 C.P.R. (4th) 479, 265 N.R. 392 (Fed. C.A.).

[721] *Shell Oil Co. v. Canada (Patent Commissioner*), [1982] 2 S.C.R. 536, 142 D.L.R. (3d) 117 [Shell Oil cited to SCR];

College v. Canada (Commissioner of Patents)[722] and *Tennessee Eastman Co. v Commissioner of Patents,*[723] where the court identified two classes of subject matter as outside the scope of patent statutes based on social welfare considerations.

First, in *Harvard College v. Canada (Commissioner of Patents),*[724] the President and Fellows of Harvard College sought to patent a mouse that had been genetically altered to increase its susceptibility to cancer, which makes it useful for cancer research. The main issue before the Supreme Court was whether the definition of invention in s. 2 of the *Patent Act* encompasses higher life forms. In resolving the issue, the court refused to recognize the genetically altered mouse as a patentable subject matter because, in part, patenting higher life forms raises "unique concerns which do not arise with respect to other non-living inventions, and which are not addressed by the scheme of the Act."[725]

The concerns noted in the *Harvard College* decision include that: (a) biologically based inventions are living and self-replicating, and the grant of a patent covers not only the plant, seed or animal sold but also all its progeny containing the patented invention; (b) it raises environmental and animal welfare concerns; (c) it may deter further innovation in the biomedical field; and (d) it increases the potential for objectification and commodification of human life. More particularly, the court held that "should this Court determine that higher life forms are within the scope of s. 2, this must necessarily include human beings.

[722] 2002 SCC 76, [2002] 4 SCR 45
[723] (1970), 62 C.P.R. 117 (Ex. Ct.); aff'd [1974] S.C.R. 111
[724] 2002 SCC 76, [2002] 4 SCR 45 [Harvard College]
[725] Ibid at 48

There is no defensible basis within the definition of "invention" itself to conclude that a chimpanzee is a "composition of matter" while a human being is not."[726]

The concerns noted in *Harvard College* are social welfare issues. In essence, the appellant could not persuade the court to accept higher life forms as statutory subject matter partly because their potential social harms far outweighed the social benefits. The court held that "the manner in which Canada has administered its patent regime reveals that the promotion of ingenuity has at times been balanced against other considerations."[727] This means the mere fact that an invention would promote innovation is not sufficient to grant patent protection. The protection should be balanced with other welfare factors.

The *Harvard College* decision confirms that social considerations are critical factors in construing the meaning of a statutory subject matter and that courts are permitted to exclude subject matters that do not advance the utilitarian objective of the patent system. As Stephen Perry and Andrew Currier pointed out, the Supreme Court undertook some degree of policymaking in *Harvard College;* the "likely concern in that decision was that patenting mice was morally offensive, presumably because society does not want to encourage those kinds of (creepy) commercial activities."[728]

[726] Ibid at 50
[727] Ibid at page 49.
[728] See Stephen J. Perry & T. Andrew Currier, *supra* note 223 at 166

Second, in *Tennessee Eastman Co. v Commissioner of Patents,*[729] the appellant sought to patent a surgical method for joining or bonding the surfaces of incisions or wounds in living animal tissue by applying certain adhesive compounds. The compounds were old and well known, but the discovery of the bonding properties of the compound was new, useful, and non-obvious. The issue before the Exchequer Court was whether the new method for surgical purposes was a statutory subject matter. The Commissioner of Patents had refused the patent application partly because "such medical or surgical processes are not involved in commerce, trade and industry and are therefore outside the scope of a process which falls under Section 2(*d*) of the Patent Act." The Commissioner further ruled that "even if the arguments presented by the applicant are accepted as proof of novelty, utility and nonobviousness, the claims must fail for lack of subject matter."[730]

On appeal to the Exchequer Court, the Commissioner's decision was affirmed. The court held that the claimed invention involves professional skill and, as such, does not advance the economic incentives of the *Patent Act* because it does not produce a result concerning trade, commerce or industry. Kerr J. of the Exchequer Court of Canada held as follows:[731]

> In my view, the method here does not lay in the field of manual or productive arts nor, when applied to the human body, does it produce a result in relation to trade, commerce or industry or a result that is essentially economic. The adhesive itself may enter into commerce, and the patent for the process, if granted, may also be sold and its use licensed for financial considerations, but it does not follow that the method and its result are related to commerce or are essentially economic in the sense that those expressions have been used in patent case judgments. The method lies essentially in

[729] (1970), 62 C.P.R. 117 (Ex. Ct.); aff'd [1974] S.C.R. 111 [Tennessee Eastman]
[730] Ibid
[731] (1970), 62 C.P.R. 117.

> the professional field of surgery and medical treatment of the human body, even although it may be applied at times by persons not in that field. Consequently, it is my conclusion that in the present state of the patent law of Canada and the scope of subject matter for patent, as indicated by authoritative judgments that I have cited, the method is not an art or process or an improvement of an art or process within the meaning of subsection (*d*) of section 2 of the *Patent Act.*[732]

The Exchequer Court decision in *Tennessee Eastman* has been cited and approved by the Supreme Court of Canada as the authority for the proposition that medical methods are non-patentable because they are *non-economic and unrelated to trade, industry or commerce* professional arts.[733] *Tennessee Eastman* confirms the importance of social welfare factors when construing the meaning of a statutory subject matter. The claimed medical treatment method was rejected, in part, because the invention did not support the "economic incentives" purpose of the Act. In other words, the technique is not likely to be directed to economic matters involving trade, commerce, or industry; therefore, the invention was excluded from patent protection. If protected, the *Tennessee Eastman* invention had the potential not only to be kept private but may also restrict the dissemination of new medical treatments and increase medical care costs, thereby creating an enormous deadweight loss that outweighs the social benefits.

The Supreme Court of Canada in *Harvard College* highlighted another social welfare concern in *Tennessee Eastman.* The Court held that the medical or surgical methods of treatment were disallowed in that case "presumably so as not to impede physicians in the

[732] Ibid at 115.
[733] *Shell Oil Co. v. Canada (Patent Commissioner),* [1982] 2 S.C.R. 536, 142 D.L.R. (3d) 117 [Shell Oil cited to SCR] at 41; and *Apotex Inc v. Wellcome Foundation Ltd.,* 2002 SCC 77, [2002] 4 S.C.R. 153 at para. 49, 21 C.P.R. (4th) 499.

practice of their profession."[734] Similarly, relying on *Tennessee Eastman,* the Federal Court held that "for ethical and public health reasons, physicians should not be prevented or restricted from applying their best skill and judgment for fear of infringing a patent covering a pure form of medical treatment (as distinct from a vendible medical or pharmaceutical product)."[735] These commentaries suggest that the court in *Tennessee Eastman* sought to strike a balance between private monopoly and public interests. As Mike Wilke pointed out, "Considering that the overarching policy rationale for granting patents at all is to encourage innovation, it would appear that refusing medical method patents (in *Tennessee Eastman*) is intended to strike a balance between encouraging inventive solutions to practical problems on the one hand and promoting public health (and perhaps not offending the public sense of morality) on the other."[736]

The *Harvard College and Tennessee Eastman* cases confirm the importance of economic and social welfare considerations in determining a statutory subject matter and the role of the courts as gatekeepers. This "gatekeeping task" should not be abdicated by the courts, a concern that David Olson highlighted with respect to the U.S. patent system.[737] While Parliament is generally considered the appropriate body to undertake public policy issues, it is *arguably* not the rightest body for determining whether an invention constitutes an efficient subject matter. This is because Parliament is susceptible to lobbying and industry capture and may not have the necessary time, practical insights, or the ability to develop

[734] *Harvard College, supra* at para. 145.
[735] *Janssen Inc. v. Mylan Pharmaceuticals ULC*, 2010 FC 1123 at 53.
[736] Mark S. Wilke, "Prohibiting Medical Method Patents: A Criticism of the Status Quo" (2011) 9:1 CJLT at 231.
[737] See David S Olson, *supra* note 19 at 207 ("…courts historically have served as gatekeepers making rough determinations, albeit in an informal, implicit, or intuitive manner, of whether invention in particular subject matter classes needed incentivization via patent grants…." However, the courts have "now completely surrendered the gatekeeper role with regard to patentable subject matter.")

the best assessments for the various classes of potentially patentable subject matters.[738] On the other hand, the court is probably better suited because of its independence, experience, practical facts, accessibility, and evidence-based evaluations.

5.3.3. The Case for Excluding AI-Generated Inventions

Society must strike a balance between the competing interests of patent protection in order to spur innovation and costs to society from the deadweight loss of patent monopoly rights. Thus, the goal of the utilitarian patent system is to provide enough protection to maximize incentives to engage in innovative works while also putting in place rules that minimize the effect on the commercial marketplace and society.[739] For instance, the system should not support granting protections to every kind of potentially patentable subject matter without asking whether there is a market failure present to warrant legal encouragement. If there is, the subject matter should be protectable. If not, no patent should exist for that class of innovation.[740] Specifically, two factors are key when assessing the need for patents: (a) would exclusive rights be necessary to incentivize the production of this type of invention? And (b) would granting patent rights to this type of invention cause more deadweight loss than the increased invention.

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[738] Vincent R. Johnson, "Regulating Lobbyists: Law, Ethics, and Public Policy," (2006) 16 Cornell J.L. & Pub. Pol'y 1, 12 ("Although modern practices are more subtle, lobbying continues to pose threats to the proper operation of government. This is particularly true in cases where lobbyists distort relevant facts, produce decisions based on favoritism rather than the merits, or give some segments of the community a real or perceived unfair advantage in securing access to members of government.")

[739] Andrew Beckerman-Rodau, "The Problem with Intellectual Property Rights: Subject Matter Expansion," (2010) 13 Yale J. L. & Techn. 36, 36.

[740] In *Roberts v. Sears, Roebuck & Co.,* 723 F.2d 1324 (7th Cir. 1983), Judge Posner posited that patent monopoly should be granted only for inventions that would not otherwise be developed.

Accordingly, this part examines whether AI-generated inventions are more likely to fit within the category for which patent protection is unnecessary because of the nature of the invention or the deadweight to society exceeds increased invention. As would become more apparent below, there are strong reasons to suggest that recognizing AI-generated innovation corresponds to the two factors; thus, it should be excluded from the patent framework because: (a) there already exist incentives to innovate; (b) it can be protected under trade secrets; (c) the cost of production is low; (d) it creates transaction costs; and (d) grants undeserved benefits.

5.3.3.1. Incentives to Innovate

The current landscape of patenting AI technologies seems to support AI innovation and development, including AI-generated inventions. Empirical evidence suggests that there has been a "surge of patenting activity claiming AI techniques and applications" even without specific amendments to the patent laws to accommodate AI-generated inventions.[741] A 2019 study by the World Intellectual Property Organization (WIPO) established that "since artificial intelligence emerged in the 1950s, innovators and researchers have filed applications for nearly 340,000 AI-related inventions and published over 1.6 million scientific publications."[742] Specifically, filings for machine learning (ML) related patents had increased annually by an average of 28 percent,[743] while AI functional

[741] See World Intellectual Property Organization (WIPO), "WIPO Technology Trends 2019: Artificial Intelligence" (accessed on July 19, 2022), online(pdf) at 4: < https://www.wipo.int/publications/en/details.jsp?id=4386>; and Richard Seeley, Global Spending on AI Systems to Hit $98 Billion by 2023--IDC, ADTmag (Sept. 9, 2019), https://adtmag.com/articles/2019/09/04/ai-spending.aspx.
[742] Ibid at 4
[743] World Intellectual Property Organization (WIPO), "WIPO Technology Trends 2019: Artificial Intelligence" (accessed on July 19, 2022), online(pdf) at 4: < https://www.wipo.int/publications/en/details.jsp?id=4386>

applications, such as computer vision, had grown annually by an average of 24 percent.[744] Also, there was a 262% growth in AI patent filings between 2013 and 2016.[745]

Similarly, a 2020 empirical study by the European Patent Office (EPO) showed that patent filings in the "core technologies underlying artificial intelligence (such as neural networks, deep learning and rule-based systems) show a spectacular increase, with an average annual growth rate of 54.6% since 2010."[746] In 2018, corporations in the US invested over $37.5 billion in AI software and hardware, and the figure is expected to grow to $97.9 billion by 2023.[747] According to a study by IPlytics, the U.S. had about 279, 145 patent applications in the field of AI as of March 2019.[748] Finally, a recent report by the CIPO revealed that approximately 85,000 AI systems were patented between 1998 and 2017 globally.[749] The report attributed more than 1,500 to Canadian institutions and researchers.[750] These positive figures suggest that innovation in the AI industry appears to be booming globally.

It is doubtful if additional compensation in the form of inventorship or monopoly rights for AI-generated inventions would make any practical difference in the AI industry based on two reasons. First, it is widely accepted that AI systems lack consciousness and self-

[744] Ibid at 5 (21,011 patent applications filed in 2016)
[745] World Intellectual Property Organization (WIPO), "Patents families" <https://www.wipo.int/export/sites/www/tech_trends/en/artificial_intelligence/docs/wtt_ai_findings.pdf>
[746] European Patent Office, "Patents and the Fourth Industrial Revolution" (December 2020), online(pdf) at 29: < https://www.epo.org/service-support/publications.html?pubid=222#tab3>
[747] Richard Seeley, "Global Spending on AI Systems to Hit $98 Billion by 2023--IDC," ADTmag (Sept. 9, 2019), https://adtmag.com/ articles/2019/09/04/ai-spending.aspx.
[748] IPlytics, "Who is patenting AI technology?" (March 29, 2019), online: < https://www.iplytics.com/report/who-patenting-ai-technology/>
[749] See Canadian Intellectual Property Office (CIPO), "Processing Artificial Intelligence: Highlighting the Canadian Patent Landscape" (2019), online (pdf) at 8 <Canada.ca/intellectualproperty>
[750] Ibid

awareness to be financially motivated because their functioning is controlled by "dead" algorithms, large data sets, artificial neural networks (ANN), software programs, and other machine learning models. Although they may operate autonomously, AI systems are not self-aware of their environment and cannot respond to pecuniary gains.[751] To argue that such systems require incentives to invent or act is unreasonable.[752] In essence, machines have no intention to create works and "no heart (and obviously no soul)" or consciousness to be motivated by incentives through patent rights.[753] Given these characteristics, it is evident that AI systems do not need incentives to produce inventions. Thus, there is no utilitarian basis for recognizing AI-generated inventions as statutory subject matter.[754]

As Pamela Samuelson argued, "it simply does not make any sense to allocate intellectual property rights to machines" because machines have no use for patents to generate output.[755] This means granting patent rights to AI systems or patent protection to AI-generated inventions depletes the public domain "with no payoff to the creator (i.e., the AI technology) who does not need incentives to function and/or create new content."[756]

[751] See Daria Kim, Josef Drexl, Reto M. Hilty & Peter R. Slowinski, "Artificial Intelligence Systems as Inventors?" 9 (Max Planck Inst. for Innovation and Competition Rsch. Paper Series, No. 21-20, 2021) at 10.
[752] See Gregory Hagen, "AI and Patents and Trade Secrets," *supra* note 33 at 59
[753] For more on the question of whether AI systems can be alive, see Laura McQuillan, "A Google engineer says AI has become sentient. What does that actually mean? (June 24, 2022), online: *CBC News* <https://www.cbc.ca/news/science/ai-consciousness-how-to-recognize-1.6498068>; Phil McNally & Sohail Inayatullah, "The Rights of Robots: Technology, Culture and Law in the 21st Century," (1998) 20 FUTUREs 119.
[754] See Gregory Hagen, "AI and Patents and Trade Secrets," *supra* note 33 at 59; See also Noam Shemtov, "A Study On Inventorship In Inventions Involving AI Activity" 35 (2019) at 24. Pamela Samuelson, "Allocating Ownership Rights in Computer-Generated Works," 47 U. Pitt. L. Rev. 1185, 1207 (1986); Robert Yu, "The Machine Author: What Level of Copyright Protection Is Appropriate for Fully Independent Computer-Generated Works?" (2017) 165 U. PA. L. Rev. 1245, 1261; Victor M. Palace, "What if Artificial Intelligence Wrote This? Artificial Intelligence and Copyright Law," (2019) 71 FLA. L. Rev. 217, 236.
[755] See Pamela Samuelson, "Allocating Ownership Rights in Computer Generated Works," (1989) 47 U. T. L. Rev. at 1119; Ralph D. Clifford, *supra* note 31 at 1696 – 1702, 1703
[756] Amir H Khoury, *supra* note 5 at 656.

Consequently, AI-generated inventions and AI-inventors should be excluded from the patent framework.

Second, since AI systems are responsible for making AI-generated inventions, it is logical to presume that the only way to have more AI-generated innovations is to have more AI systems. Thus, the target of the utilitarian theory should be incentivizing the development of AI systems. The current state of the law supports the development of AI systems. Depending on the nature of the invention, AI developers or programmers can either protect their new and sophisticated AI systems under patent or copyright law, which should constitute sufficient legal incentives to produce such systems. In other words, the extant Canadian patent or copyright law provides adequate incentives to AI programmers and developers to develop the material framework of the AI systems. For instance, AI programmers can copyright the source code, algorithms, and relevant computational models and commercially exploit them. Likewise, the AI developer can patent the AI techniques and ML applications in the AI systems that manifest discernable effects. Indeed, several empirical reports have established that there has been a surge in patenting AI systems.[757] Specifically, the study by WIPO revealed that filings for AI-related patents had grown annually by an average of 28 percent.[758]

[757] European Patent Office, "Patents and the Fourth Industrial Revolution" (December 2020), online(pdf) at 29: < https://www.epo.org/service-support/publications.html?pubid=222#tab3>; and Canadian Intellectual Property Office (CIPO), "Processing Artificial Intelligence: Highlighting the Canadian Patent Landscape" (2019), online (pdf) at 8 <Canada.ca/intellectualproperty>

[758] World Intellectual Property Organization (WIPO), "WIPO Technology Trends 2019: Artificial Intelligence" (accessed on July 19, 2022), online(pdf) at 4: < https://www.wipo.int/publications/en/details.jsp?id=4386>

Notably, as seen in chapter two, AI developers or owners are open to patenting inventive AI systems. For instance, the "Creativity Machine" that allegedly developed an invention called "Neural Network-Based Prototyping System and Method (NNBPSM)" was patented under the title: "Device for the Autonomous Generation of Useful Information" at the USPTO.[759] In this case, the incentives derived from patenting the "Creativity Machine" appears sufficient to spur the creation of the NNBPSM. It is not clear how patenting NNBPSM may aid the development of further AI-generated inventions as NNBPSM was automatically created, presumably, because of the existence of the "Creativity Machine." In other words, the availability of patent protection for the "Creativity Machine" can be directly linked to the development of the NNBPSM.

Likewise, the DABUS AI system is itself an invention that could be protected under the patent regime. The accessibility of patents for DABUS should be adequate incentive to spur the development of AI-generated inventions, such as "Neural Flame" and "Fractal Container."[760]

Meanwhile, commentators that are advocating for the recognition of AI-generated inventions under the patent system have not provided any evidence to prove their hypothesis that such acceptance would boost AI development and production.[761] On the contrary, some empirical evidence exist to show that there has been a steady rise in patenting AI techniques and applications despite the non-recognition of AI-generated

[759] See U.S. Patent No. 5,659,666 (filed Oct. 13, 1994).
[760] See 2.3.5 in chapter two of this thesis.
[761] See Ryan Abbott, *The Reasonable Robot: Artificial Intelligence and the Law* (Cambridge, UK: Cambridge University Press, 2020) at 11; and David L. Schwartz and Max Rogers, *supra* note 20 at 564.

inventions as statutory subject matter or AI systems as inventors or owners of patent rights.[762]

In addition to the patent or copyright protection for AI systems, other incentives such as scientific curiosity, the boost of reputation, collaboration with peers, and first-mover advantage will continue to drive development in the AI industry. In one of his recent works, Ryan Abbott stated: "Today, there are strong incentives to develop inventive machines. Inventions by these machines have value independent of intellectual property protection, but they should also be eligible for patent protection."[763] This argument is debatable. If AI-generated inventions have value independent of patent protection, adding to the fact that AI systems cannot be incentivized, and IP rights already exist for developing AI systems. In that case, it can be argued that there is no basis for extending patent protection to such an area of innovation. In other words, it would be inefficient to confer monopoly rights in an area where none is needed. Before patent law is expanded to new subject matters or fields of technology, there should be evidence that the new class of invention suffers from a lack of incentives to innovate. This is because patents are not meant to reward inventors for new inventions but to spur innovations that would otherwise be underproduced. Where there exist sufficient incentives to innovate, or the factual inventor cannot be incentivized, granting patents in such circumstances may impede the social welfare objective of the *Patent Act*.[764]

[762] See generally World Intellectual Property Organization, Technology Trends 2019. Artificial Intelligence (WIPO 2019).
[763] See Ryan Abbott, "Everything is Obvious" (2018) 66:1 UCLA Law Review at 48.
[764] Ibid

In conclusion, there exist incentives for AI developers, programmers, and other human players to develop AI systems needed for AI-generated invention. More particularly, empirical evidence suggests that the AI industry is not suffering from a lack of incentives to innovate. As noted earlier, there has been a surge in patenting AI applications, techniques, and other material parts of AI systems, suggesting sufficient incentives exist for AI-generated inventions. Thus, it would be inconsistent with the utilitarian approach to grant rights for AI outputs or recognize AI-generated inventions as patentable subject matter that AI systems would have produced without legal encouragement.

5.3.3.2. Trade Secret Protection

Machine learning processes are usually characterized as "black box" because they can operate without disclosing their underlying principles.[765] This is especially true for machine learning algorithms that are based on neural networks.[766] The systems may sometimes iteratively re-program themselves, altering their makeup and characteristics, to achieve a particular result without requiring explicit coded instructions from a human programmer.[767] Some commentators have stated that given the "very opaque and black box" nature of advanced AI, the technology can be a "chunk of math" that functions "without providing their creators (or anyone else) any significant insight as to" the system's

[765] See Yavar Bathaee, "*The Artificial Intelligence Black Box and the Failure of Intent and Causation*," (2018) 31 Harv. J.L. & Tech. 889, 901.
[766] Gopinath Rebala, Ajay Ravi and Sanjay Churiwala, "An Introduction to Machine Learning" (Springer 2019) at 2
[767] See Josef Drexl et al., "Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective," (October 2019), online(pdf) at 4 *SSRN* <https://ssrn.com/abstract=3465577>. 12; Ryan Abbott, *The Reasonable Robot, supra* note 31 at 32, 33; Luciana Parisi, "Critical Computation: Digital Automata and General Artificial Thinking," (2019) 36 Theory, Culture & Soc'y 89, 109–10.

underlying logic.[768] This concern was also noted by WIPO when it requested comments on the intersection of AI and IP policy.[769]

The "black box" problem of AI systems refers to the *computational complexity or non-linearity* of machine learning model,[770] the convolution of their *data representation* within a neural network,[771] the problem of *data retrieval* from a neural network to support retrospective explanation,[772] and a limited understanding of the *causality* of the "learned" statistical correlations.[773] One of the world's leading innovators, particularly in the area of AI inventions, IBM, in response to a request for comments by the USPTO on the intersection of AI and patent policy, stated as follows:

> AI inventions can be difficult to fully disclose because even though the input and output may be known by the inventor, the logic in between is in some respects unknown. In fact, we can feed the same machine the same dataset, and yet, it may not always yield the same solution. This is due in part to the inherent randomness in AI algorithms. So, if inventions are made and operated in such a black box, it may be difficult for the inventor to

[768] See Stacy Rush, "The Challenges of Patenting Artificial Intelligence" (November 27, 2017), online: *Canadian Lawyer Magazine,* https://www.canadianlawyermag.com/news/opinion/the-challenges-of-patenting-artificial-intelligence/274698: "Artificial Intelligence's 'black box' decision-making presents challenges for AI and machine learning innovators who want to file for patents"; Daria Kim, "AI-Generated Inventions: Time to Get the Record Straight," *supra* note 31 at at 443– 456; Andreas Holzinger et al, "Causability and Explainability of Artificial Intelligence in Medicine" (2019) 9 WIREs Data Mining Knowl Discov 10.

[769] See World Intellectual Property Organization Secretariat, *WIPO Conversation on Intellectual Property (IP) and Artificial Intelligence (AI): Draft Issues Paper on Intellectual Property Policy and Artificial Intelligence* (December 13, 2019), online: *World Intellectual Property Organization* https://www.wipo.int.edocs/mdocs/mdocs/en/wipo_ip_ai_2_ge_20/wipo_ip_ai_2_ge_20_1.pdf.

[770] Rainer Mühlhoff, "Human-Aided Artificial Intelligence: Or, How to Run Large Computations in Human Brains? Toward a Media Sociology of Machine Learning," (Nov. 2019) New Media & Soc'y, at 2, 3.

[771] Andreas Holzinger and others, "Causability and Explainability of Artificial Intelligence in Medicine" (2019) 9 WIREs Data Mining Knowl Discov 10.

[772] Pat Langley, "Planning Systems and Human Problem Solving" (2018) 7 Advances in Cognitive Systems 13, 19.

[773] Wojciech Samek & KlausRobert Mu¨ ller, 'Towards Explainable Artificial Intelligence' in Wojciech Samek and others (eds), Explainable AI: Interpreting, Explaining and Visualizing Deep Learning. Lecture Notes in Computer Science, vol 11700 (Springer 2019) at 16

> understand exactly how the AI accomplishes the end-result, and in turn, provide a sufficient disclosure to secure patent protection.[774]

If IBM's statement to USPTO is true, it appears that the current position is that the ML process leading to AI-generated inventions cannot be sufficiently detailed in a manner that would enable the POSITA to reproduce the invention. This opaque nature of AI systems raises two utilitarian issues. First, if AI-generated inventions are not capable of sufficient description to enable an ordinary person skilled in the art to reproduce or practice the invention, in that case, from a social welfare perspective, the *quid pro quo* is disproportionately skewed in favour of the private owners.[775] The patent owners reap the benefits of the monopoly without disclosing to the public how the invention works so that at the expiration of the patent term, anyone can use the information to reproduce similar works. This means patenting AI-generated inventions have the potential of giving their owners a perpetual monopoly to the detriment of society. Obviously, it is inefficient for the boundaries of patentable subject matter to be extended this far.[776]

Some commentators have argued that a system like the deposit of microorganisms should be created for AI-generated inventions.[777] In essence, inventors should only be required to

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[774] See Manny W Schecter & Jennifer M. Anda, *supra* note 31 at 6

[775] See *Amazon.com, Inc. v. Canada (Attorney General) [2011]* F.C.J. No. 1621 at para. 27 ("It is fundamental that "patent protection rests on the concept of a bargain between the inventor and the public" (per Justice Binnie at paragraph 13 of Free World Trust). The inventor is granted, for a limited time, the exclusive right to exploit his or her invention. In return, the inventor must disclose the invention to the public so that when the term of the patent expires, the invention may be exploited by anyone. The object of the Commissioner's examination of a patent application, understood in its broadest possible sense, is to determine whether the terms of the bargain are met.")

[776] Emir Aly Crowne, "The Utilitarian Fruits Approach to Justifying Patentable Subject Matter" (2011) 10 J. Marshall Rev. Intell. Prop. L. 753

[777] Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 301; Josef Drexl et al., "Technical Aspects of Artificial Intelligence: An Understanding from an Intellectual Property Law Perspective," (October 2019), online(pdf) at 4 *SSRN* <https://ssrn.com/abstract=3465577>; and *Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure* (as amended on September 26, 1980).

deposit the AI-generated inventions at the patent office in a manner that is accessible to the public. In this regard, Dan Burk argues that "if this [deposit system] satisfies enablement for biotechnology, it would surely do so for machine learning."[778] While the deposit system may have worked fine for microorganisms, it is not clear if the deposit system would be suitable for AI applications. First, AI-generated (as seen in the DABUS application) may be method or process patents, which cannot be physically sequestered and deposited. Second, AI-generated inventions are distinct from microorganisms in their make-up, it is debatable if the deposit system would solve the ML's "randomness problem" or provide the public with any insights into AI inventions. Additionally, it may even be challenging to ascertain the scope of the AI system that should be deposited since not every part of it might be necessary for the workings of the AI-generated invention.

The second implication of the "black box" problem is that AI-generated inventions are inherently protected, which might provide sufficient incentives for their human initiators (if any motivation is needed). This means the human initiators can recoup their investment costs (if any) before competitors are able to duplicate them, and studies have shown that the opaqueness of AI-based tools will likely become more acute as machine learning models become more complex.[779] William Landes and Richard Posner have highlighted the role of trade secrecy in providing "incentives to innovate."[780] If an inventor feels

[778] See Dan L Burk, "AI Patents and the Self-Assembling Machine" *supra* note 31 at 307.
[779] Michèle Finck, "Automated Decision-Making and Administrative Law," (2020) In Max Planck Institute For Innovation And Competition Research Paper Series 14 (Max Planck Inst. for Innovation & Competition Research, Research Paper No. 19-10 at 15
[780] See William M Landes & Richard A. Posner, *supra* note 16 at 360 and 361 ("…rational inventors choose trade secret protection when they think that patent protection is too costly in relation to the value of their invention or will yield them a profit substantially less than that value…it would be a mistake to place too much weight on the effect of trade secret law in sometimes giving an inventor a longer period of legal protection than he would have had he gone the patent route. A more important consideration is that the patent route, because of its cost and required disclosures, often just is not

confident that their invention is opaque and can be kept secret for more than twenty years, they will undoubtedly elect trade secrecy over patenting.[781]

Compared to patents, trade secrets are cheaper and quicker to obtain and offer a higher level and longer-term protection.[782] On the other hand, patents are limited in scope and duration, require recurring legal and other fees to maintain, and permit competitors to use the information disclosed by the patent to invent around the technology.[783] As David Olson stated, "When trade secret protection is available to inventors, no patent is needed."[784] Accordingly, if AI-generated inventions are inherently protected, and their operations cannot be sufficiently disclosed, the proper or convenient IP regime to seek protection is trade secrets, which also provides incentives to innovate.[785]

Meanwhile, the DABUs patent claims (as described in chapters two and three of this thesis) arguably suggest that in certain circumstances the workings of AI-generated inventions may be capable of description. Indeed, some commentators stated: "it is generally possible to enable the skilled person to reproduce the results of an AI algorithm by, e.g. disclosing the underlying algorithm and/or the training steps involved (e.g. in the training of the

attractive to an inventor of a patentable invention, so that to abolish or curtail trade secrecy would undermine incentives to innovate").

[781] Dan L Burk, "Legal Constraint of Genetic Use Restriction Technologies," (2004) 6 Minn.J. L. Sci. & Tech. 335, 348.

[782] Mark A Lemley, "*The Surprising Virtues of Treating Trade Secrets As IP Rights*," (2008) 61 Stan. L. Rev. 311, 313.

[783] Richard A Posner, "Intellectual Property: The Law and Economics Approach" (2005) 19:2 J of Economic Perspectives at 66

[784] David S Olson, *supra* note 19 at 206.

[785] However, this form of trade secret protection is unique because nobody knows the recipe of the invention, including the owners or developers of the AI systems. Therefore, it is not clear how much value the owner of the invention may derive from it. It may even be argued that it is not within the realm of trade secret protection since the owner of the invention does not have superior knowledge. The validity or otherwise of this argument is beyond the scope of this research.

classifier)."[786] This contention is, however, debatable as the description contained in the DABUS patent claims have not been tested before any patent office or a court of competent jurisdiction.

5.3.3.3. Low Cost of Production

The free-rider challenge associated with intellectual property assets is unlikely to lead to underproduction of the invention (i.e., the "public goods problem") in situations where the production cost is low.[787] The nature of AI-generated inventions indicates that a low cost of production is likely because they are automatically and "unpredictably" generated. While developing AI systems may be expensive and time-consuming, creating the need for patent protection,[788] the same cannot be said of AI-generated inventions – where the invention happens in a flash. Although how an invention is created does not usually matter to patent examiners or policymakers, in the context of AI-generated inventions, how the invention is made is critical because the patents would not spur further "flashes of genius." In other words, patent protection for AI-generated inventions will not impact AI systems' creative abilities and motivations.

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[786] European Patent Office (EPO), "Request from the United States Patent and Trademark Office for Comments on Patenting Artificial Intelligence Inventions," online: <https://www.uspto.gov/sites/default/files/documents/European-Patent-Office_RFC-84-FR-44889.pdf>

[787] Richard A Posner, "Why There are Too Many Patents In America*," supra* note 21 ("In an industry in which teams of engineers are employed on a salaried basis to conduct research on and development of product improvements, the cost of a specific improvement may be small, and when that is true it is difficult to make a case for granting a patent. The improvement will be made anyway, without patent protection, as part of the normal competitive process in markets where patents are unimportant.").

[788] Gary Marcus, *DeepMind's Losses and the Future of Artificial Intelligence*, Wired (Aug. 14, 2019), https://www.wired.com/story/deepminds-losses-future-artificial-intelligence/.

Another implication of a relatively low-cost production is that there may be no or little R&D costs to recoup, creating the potential for excessive rent-seeking. In the pharmaceutical industry, to develop a new drug, the firm hires researchers, builds and maintains the overhead for research laboratories, undertakes several stages of experiments, and completes Health Canada trials. AI systems do not need such large labour expenditures to create. In fact, scholars like Francesco Banterle and Tim Dornis, advocating that AI-generated inventions should be patented, acknowledge their low cost of production but suggest that the patent duration be reduced appreciably.[789] But their argument is inconsistent with the TRIPs Agreement, which provides a minimum of twenty years for patent protection.[790]

Meanwhile, copying inventions is not inherently bad if it will not lead to the "public goods problem" (i.e., forces of competition creating sub-optimal investments in producing the inventions).[791] In fact, it is a welcome development for rivals to move into the market for low-cost goods to drive economic profits down so that the producer and consumer surplus is maximized in the aggregate. In the case of low-cost inventions like AI-generated inventions, it is unlikely that copying such inventions would cause the "public goods problem." Therefore, society suffers greater harm patenting such low-cost inventions as the inventions would have been produced despite the free-riding.

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[789] See Francesco Banterle, "Ownership of Inventions Created by Artificial Intelligence," (2018) AIDA, University of Milan at 26 (http://papers.ssrn.com/sol3/papers.cfm?abstract_id=3276702). 133; Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 4 at 150.

[790] Agreement on Trade-Related Aspects of Intellectual Property Rights, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197 (1994)

[791] David S Olson, *supra* note 19 at 241.

5.3.3.4. The Transaction Costs and Coase Theorem

Determining the owner of AI-generated inventions can be a complex issue because of the several parties involved in the development process. At least nine entities are partially, indirectly, significantly, or temporarily engaged in the invention process of an AI-generated invention: software programmer, data supplier, trainer, owner, operator, user, public and investor.[792] All of them may have legitimate claims to the invention.[793] The first stakeholder is the software programmer who developed the program and algorithms of the AI system.[794] The second stakeholder is the data supplier who supplied the AI system with relevant data needed for its innovative enterprise.[795] In this regard, the process may require some skill to select and label the appropriate data. The third stakeholder is the trainer, who "checks the AI system's results and corrects them when necessary, playing an important role in establishing the system's capacity."[796] The fourth stakeholder is the owner of the AI system, who may have initiated the idea of developing the system or simply bought it. They may be "the first or successive owners, firms, or individuals."[797] The fifth stakeholder is the operator or user of the AI system, who is most likely the first to recognize the AI's output and determine its social utility.[798] This may be a licensee or the owner's service provider. The sixth stakeholder is the employer of the stakeholders who may have entered into an agreement with them or are entitled to the AI-generated invention as a matter of

[792] See Shlomit Yanisky-Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2232
[793] Ibid at 2237
[794] See Pamela Samuelson, "Benson Revisited: The Case Against Patent Protection for Algorithms and Other Computer ProgramRelated Inventions," (1990) 39 Emory L.J. 1025, 1148 (arguing that the role of the software programmer is crucial).
[795] See Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2215 – 2263 at 2232
[796] Yaniv Taigman et al., DeepFace: Closing the Gap to Human-Level Performance in Face Verification 1-8 (June 24, 2014) (unpublished paper), <https://research.fb.com/wp-content/uploads/2016/11/deepface-closing-the-gap-to-human-levelperformance-in-face-verification.pdf?>
[797] See Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2232
[798] Ibid

law.[799] The seventh stakeholder is the public, who owns the AI-generated invention by default if none of the other stakeholders are entitled to the patent rights.[800] Also, we have the investor who "sponsored the development of the AI system or any other player" and expects returns on their investments.[801] Finally, there is the AI system, particularly where it is shown to be autonomous.[802]

Who among these stakeholders is the owner of the AI-generated invention or should be entitled to the patent benefits or rights where the AI system independently generates an invention? According to Shlomit Yanisky-Ravid and Xiaoqiong (Jackie) Liu, the several stakeholders involved in AI-generated invention make "identifying a single owner of an AI-generated invention under traditional law no longer practicable."[803] Not surprisingly, AI inventorship and ownership proponents are strongly divided on who should be entitled to the patent benefits.[804] Meanwhile, it is likely that the issue may get more complicated as AI systems' computing power increases and more players get involved in the development process.

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[799] Ibid

[800] Ibid citing Managing Government Property Assets: International Experiences (Olga Kagnova & James McKeller eds., 2006).

[801] See Ryan Abbott, "I Think, Therefore I Invent: Creative Computers and the Future of Patent Law," *supra* note 1 at 1080-81 (discussing AI systems as inventors and owners); Gabriel Hallevy, "The Criminal Liability of Artificial Intelligence Entities—from Science Fiction to Legal Social Control," (2010) 4 Akron Intell. Prop. J. 171, 172–85.

[802] See Ryan Abbott, "I Think, Therefore I Invent," *supra* note 1 at 1080-81 (discussing AI systems as inventors and owners).

[803] Shlomit Yanisky Ravid & Xiaoqiong (Jackie) Liu, *supra* note 1 at 2215 – 2263, 2231 – 2233. These include software programmers, data and feedback suppliers, trainers, system owners and operators, employers, the public, investors, the government, and possibly the AI system itself.

[804] See Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 4 at 97 (arguing that the rights should be allocated to AI users because they are the first to recognize the social value of the AI-generated invention); Ryan Abbott, *The Reasonable Robot, supra* note 31 at 11 (arguing for AI owner because they it is consistent with traditional property allocation); and Jan Phillip Rektorschek & Tobias Baus, "Protectability and Enforceability of AI Generated Inventions" in Kai Jacob, Dierk Schindler & Roger Strathausen (eds), *Liquid Legal. Towards a Common Legal Platform* (Springer 2020) 459, 475 (arguing for employers because it is more practicable)

While contracts may resolve the ownership crisis, the transaction costs resulting from the negotiations, licensing, and likely litigations make it a source of inefficiency. According to the Coase theorem, which provides a model for allocation of initial rights to properties, "when transaction costs are zero, the efficient use of resources results from private bargaining, regardless of the legal assignment of property rights."[805] However, the existence of transaction costs makes things complex and complicated.[806] These include the costs of discovering the party to transact and the market prices, costs of negotiating a contract and undertaking inspection where needed, costs of drawing up the contract including the payment of legal and other fees, and the cost of ultimately enforcing the contract.[807] The transaction costs have the potential to block or limit the "property rights" from reaching the actor with the highest utility.[808]

Accordingly, to avoid or minimize these transaction costs and advance efficiency, the party with the greatest utility from the ownership should be awarded the initial property rights, thereby reducing the potential number of parties involved in the transfer as costs increase per-party basis.[809] As Robert Merges pointed out, "Coase admonishes us to pay attention to transaction costs in allocating property rights and setting rules for their exchange."[810]

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[805] Ronald Coase, *supra* note 54 at 1

[806] Ibid at 8. See also Robert P. Merges, "Of Property Rules, Coase, and Intellectual Proeperty" (1994) 94 Colum. L. Rev. 2655 at 2664, and Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 4 at 156

[807] Ronald Coase, *supra* note 54 at 8; and R.S. Khemani & D.M. Shapiro, "Glossary of Industrial Organisation Economics and Competition Law" (March 14, 2003), online(pdf): *Directorate for Financial, Fiscal and Enterprise Affairs, OECD* < http://www.oecd.org/dataoecd/8/61/2376087.pdf>

[808] Ibid

[809] See See Gareth Porter, "Pollution Standards and Trade: The "Environmental Assimilative Capacity Argument," (1998) 4 Geo. Pub. Pol'y Rev. 49 at 63; and W Michael Schuster, *supra* note 31 at 1945 at 1978-81.

[810] Robert P. Merges, "Of Property Rules, Coase, and Intellectual Proeperty" (1994) 94 Colum. L. Rev. 2655 at 2657; see also Thræainn Eggertsson, *Economic Behavior and Institutions* (Cambridge University Press, Cambridge, 1990) at 105 ("Coase's main contribution ... was to arouse our awareness of the implications of positive transaction costs.")

Therefore, the initial property rights should be awarded to the party that would value the property the most.

In the context of patents, the party who will most value the property rights or idea is the party in the marketplace commercially exploiting the invention.[811] The party that is able to use or adopt the invention for its business. But it is uncertain who among the several stakeholders in the AI inventive process may be in the market. Some authors have suggested that the end user is most likely the party who will utilize the property rights.[812] However, there is the possibility that it could also be the owner, developer, trainer, or programmer, and there could be multiple users simultaneously.

The potentially high transaction costs that may arise in trying to get the inventive idea or proprietary interest to the party with the greatest utility is a source of inefficiency. While this "transaction costs" challenge may not be peculiar to AI-generated inventions, it is an avoidable, unwarranted, and unnecessary social cost in the context of AI-generated inventions because the stakeholders involved could be (or presumably, have been already) compensated for their socially beneficial R&D efforts in generating the inventive AI system.

Therefore, the proper party to own the inventive idea should be the public. This allows whomever most values the intellectual asset to enjoy or commercialize the inventive idea

[811] See W Michael Schuster, *supra* note 31 at 1985 ("…patents are most valuable to market participants")
[812] Ibid; and Tim W. Dornis, "Artificial Creativity: Emergent Works and the Void in Current Copyright Doctrine," (2020) 22 Yale J. Law & Tech. at 51

without the need to engage in trades and expenditures to get the property, thereby minimizing transaction costs and achieving efficiency.[813] In other words, passing the AI-generated invention into the public domain will likely avoid transaction costs because all the relevant stakeholders are equally entitled to exploit the invention in the marketplace. This argument may only apply to AI-generated inventions that are accessible to the public or can be reverse engineered. The "public domain" conclusion is consistent with the theoretical underpinnings of the Coase theorem of property allocation, which seeks to avoid transaction costs.

As Kristofer Erickson stated, expanding the public domain has the potential to reduce transaction costs because innovators would have free access to the invention.[814] Similarly, Jessica Litman noted that the public domain preserves "raw material of authorship to the commons, thus leaving that raw material available for other authors to use."[815]

Having the inventive idea of AI-generated invention as part of the collective wealth of the public domain is also as essential to social welfare and scientific progress like IP rights.[816] According to Mathew Herder the public domain "is just as, if not more important to innovation than propriety knowledge, such as patented inventions."[817] Thus, there is a need for a normative shift in how the public domain is perceived. As Kristofer Erickson noted,

[813] "Property" is used in a general sense to encompass unpatented inventive ideas.
[814] Kristofer Erickson, "Defining the public domain in economic terms: Approaches and consequences for policy" (2016) 10:1 Etikk i praksis - Nordic Journal of Applied Ethics at 61-74.
[815] Jessica D. Litman, The Public Domain, (1990) 39 EMORY L.J. 965, 1024.
[816] Eli Salzberger, "Economic Analysis of the Public Domain," in The Future of The Public Domain 27-59 (2006), http://papers.ssrn.com/sol3/papers.cfm?abstractid=934127.
[817] Mathew Matthew "Demythologizing PHOSITA - Applying the Non-Obviousness Requirement under Canadian Patent Law to Keep Knowledge in the Public Domain and Foster Innovation" Osgoode Hall Law Journal 47.4 (2009) : 695-750 at 701.

instead of describing the public domain as an "information commons," we need to establish its role as an "instrumentalized engine of economic growth" that needs to be protected.[818] This means allocating the ideas of AI-generated inventions to the public makes economic sense because “ideas and expressions in the public domain have value” as they can be utilized by a broad range of innovators to generate new knowledge and ideas.[819]

Related to the issue of ownership rights is the challenge of determining the inventive contribution of each AI system where multiple AI systems are involved in producing an AI-generated invention.[820] The problem becomes even more complex when different companies own the AI systems.[821] In such a situation, who should be considered the inventor? In the context of joint human inventorship, the courts usually apply the doctrine of mental conception to determine the actual inventor. Such mental doctrine cannot apply in the context of machines, making it difficult, if not impossible, to identify the true inventor where multiple systems are involved.

The scarce time and resources that the AI owners would expend to determine each computer system's inventive contribution can be a source of inefficiency. For instance, the parties may need to conduct negotiations, undertake empirical reviews, and draw up contracts, leading to high transaction costs. To avoid these transaction costs, the inventive idea should fall into the public domain. In other words, allocating the intellectual property asset to the public would allow any human initiators or stakeholders to exploit the

[818] Kristofer Erickson, “Defining the public domain in economic terms: Approaches and consequences for policy” (2016) 10:1 Etikk i praksis - Nordic Journal of Applied Ethics at 61-74.
[819] Amir H Khoury, *supra* note 5 at 659
[820] See Martin Stierle, *supra* note 393 at 128.
[821] Ibid

invention, eliminating the need to determine the inventor and possible contractual crisis and potential lawsuits.

5.3.3.5 Undeserved Benefits

As part of exploring the social welfare implications of AI-generated inventions, it is important to highlight that the class of AI systems that this thesis is concerned about are those that operate independently to generate inventions (as outlined in chapter two). Thus, their human developers or initiators are substantially divorced from the outcomes of those computer processes to deserve patent incentives.[822] This means granting patent protections for AI-generated inventions would amount to conferring undeserved monopoly benefits on the programmer, owner, trainer, or data supplier as the inventive processes of AI-generated inventions can be dissociated from their human initiators.

AI systems are not often programmed to invent; they generate inventions "unpredictably" and to the surprise of their programmers.[823] This unpredictability has been credited to the randomness of AI algorithms. As IBM stated, "we can feed the same machine the same dataset, and yet, it may not always yield the same solution."[824] Therefore, there is a large leap from setting up the AI model and selecting the training data to the AI's performance of the "inventive step."[825] As Ralph Clifford stated, "no one derives rules for the computer to control its creativity; rather, using its learning algorithm and based on the training

[822] See chapter 4 for further details on this argument.
[823] See Jason Tanz, Soon We Won't Program Computers. We'll Train Them Like Dogs, WIRED (May 17, 2016), https://www.wired.com/2016/05/the-end-of-code/.
[824] See Manny W Schecter & Jennifer M. Anda, *supra* note 31 at 6
[825] See Tim W. Dornis, "Artificial Intelligence and Innovation: The End of Patent Law As We Know It," *supra* note 4 at 154.

examples it is given, it develops rules on its own."[826] If an AI system can and does independently and unpredictably generate an invention, there is no sufficient connection to warrant giving the patent benefits to a third party.

Equally, the AI's owner has little role in the AI's invention process besides purchasing the system. As Amir Khoury pointed out, owners of AI systems cannot claim ownership of AI-generated inventions because they "made no value-added contribution to the creation of the IP."[827] The owner may even have acquired the system for a different purpose or may not be aware of the creative potential of the AI system like the other stakeholders. Therefore, granting patents to the owner or the other human initiators may be inequitable.

The economic implication of such inequity is that it may disincentivize other legitimate inventors and create unwarranted monopolies. Enjoying the benefits of an AI's work would not matter to a machine, but it may diminish the efforts of people who have legitimately created patentable works, decrease competition, stifle technological progress, and overburden the patent office. It may also discourage the end users in the marketplace from using sophisticated AI systems, knowing that they would not be entitled to inventions that the AI generates.[828]

In conclusion, AI-generated inventions as a class should be excluded from patent protection, just like scientific principles and abstract ideas, because they do not advance

[826] Ralph D. Clifford, *supra* note 31 at 1675, 1676-77
[827] Amir H Khoury, *supra* note 5 at 650.
[828] Ibid

the utilitarian goal of the Canadian patent system and would waste the Patent Office's valuable time and resources. Although the courts can broadly interpret the textual meaning of an *invention* to encompass a wide variety of subject matter, so long as it meets the requirements of novelty, non-obviousness, and utility, such an approach is not in line with the social welfare philosophy of the patent system. Patent protection should only be granted where there is a *public good problem,* and the increased invention exceeds the deadweight loss. In such cases, the social costs are justified, and the public can temporarily pay for the benefits of innovation. However, empirical evidence suggests that additional incentives are not needed in the AI industry to spur the development of AI-generated inventions, and AI systems do not need patent incentives to innovate. Thus, society would be worse off if exclusive rights were granted to inventions that would still be optimally produced without such exclusive rights.

5.4. Summary

This chapter's analysis establishes that the Canadian patent system pursues the maximization of social welfare, which contrasts with the labour and personality theories that focus on individualistic entitlements. This philosophical framework implies that the social costs associated with the limited patent monopoly must be lower than the social benefits. Against this backdrop, subjects like abstract ideas and scientific principles have been expressly excluded from the Canadian patent system.

Consequently, this chapter examined whether extending patent protection to AI-generated inventions would maximize social welfare. In the analysis, the author discussed whether

AI-generated innovations suffer from the public goods problem and if AI systems need the incentives that patent law provides. The research suggests that AI-generated inventions as a class do not suffer from the public goods problem because there exist enough incentives to create AI systems needed to develop AI-generated inventions; AI systems can be protected under trade secrets, and the cost of producing AI systems is relatively low and would not be significantly affected by the free-rider problem, and granting patent protection may create unnecessary transaction costs, and the protection may amount to awarding undeserving benefits to some parties.

Chapter Six: Conclusion

This thesis studies the intersection of AI-generated inventions and the Canadian patent regime. The research was motivated by DABUS patent applications filed in several countries, including Canada, where an AI machine was listed as the inventor.[829] The international trend has been to refuse the applications, but only because the application did not name a natural person as the inventor.[830] Other critical issues arising from the applications were not addressed, such as whether AI-generated inventions are eligible as statutory subject matter as well as can AI systems exercise patent ownership rights. More importantly, the courts and patent offices did not interrogate the theoretical basis of the patent system vis-à-vis AI-generated inventions.

This thesis examines the above issues raised by the DABUS patent applications more deeply. It began by discussing AI's meaning, functions, and subfields such as machine learning and evolutionary algorithms, and whether AI could generate inventions autonomously. The research identified and studied some AI-generated innovations like the food container, neural flame, internet search devices, the cross-bristle design of the Oral-B CrossAction toothbrush, antennas, and microelectronic devices.

The thesis then analyzes if AI-generated inventions can qualify as a statutory subject matter under the Canadian patent framework. The research discusses the textual meaning of art, process, and machine, as well as the statutory exclusions of "mere scientific principles and

[829] See section 2.2. of chapter two.
[830] Ibid

abstract theorem" under the *Patent Act.* The insight from the study is that AI-generated invention can satisfy the broad textual meaning of a statutory subject matter.

The thesis also analyzes the characteristics of an inventor under the Canadian patent system to determine whether AI systems can meet them. The research reveals that although there is no express definition of an inventor in the Canadian *Patent Act,* certain provisions in the statute suggest that an inventor must be a person. More particularly, the jurisprudence shows that an inventor must be able to satisfy the "mental conception" test, which involves the "formation in the mind of the inventor of a definite and permanent idea of the complete and operative invention." The critical insight from the analysis is that AI systems do not have the needed "mind" to fulfill the conception test and, therefore, cannot be an inventor.

The thesis also examines some foreign jurisdictions where the courts have had the opportunity to determine if an AI system can qualify as an inventor. For instance, the UK Court of Appeal's decision that confirms the existence of moral rights in the patent system is particularly instructive, as well as the Australian Court's decision on the need for mental conception to establish inventorship.

The research also examines whether AI systems can own and exercise patent rights. The key issue was the meaning of a "patentee" under the *Patent Act.* The insight from the analysis is that AI systems do not have the legal capacity to own and exercise patent rights because they have not been recognized as artificial persons under Canadian laws.

Finally, the thesis examines four theories of patent protection: labour, personality, utilitarianism, and law and economics, and establishes that the Canadian patent system pursues the utilitarian objective that seeks to maximize social welfare by bringing more inventions to the public. Using the analytical tools of law and economics, which complements the social welfare approach, the thesis discusses the concepts of "public good problem" and "social utility." In this regard, the thesis highlights that if an invention does not suffer from the public good problem, it should be excluded from patent protection because the purpose of the patent system is to provide incentives to produce inventions that would otherwise be underproduced.

Against this backdrop, the thesis analyzes whether AI-generated invention suffers from the public goods problem considering the nature of the invention. Relying on some empirical evidence, this thesis contends that AI-generated inventions do not need the incentives of patents to spur production because there are sufficient incentives to produce inventive AI systems. Also, granting such protection may create unnecessary transaction costs and give some parties undeserved patent benefits. Finally, the low cost of producing AI-generated inventions is not likely to lead to the “public goods problem” despite any free-riding.

Consequently, this thesis suggests that AI-generated inventions should be expressly excluded from the Canadian patent system, like natural phenomena and abstract principles, with respect to the statutory subject matter, inventorship, or ownership of rights. In other words, society would be better off having AI-generated inventions in the public domain as there is no market failure arising from the lack of protection for such a class of inventions.

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