ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

PRACTICE ADVISORY

USE OF ARTIFICIAL INTELLIGENCE (AI) IN PROFESSIONAL PRACTICE

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This practice advisory has been issued for professional registrants of Engineers and Geoscientists BC (engineering/geoscience professionals) to provide guidance on using Artificial Intelligence (AI) appropriately in their professional activities or work. It discusses the fact that engineering/geoscience professionals remain professionally responsible for their work even when it is generated by or includes AI output. It also discusses items to consider when using AI or when incorporating it into engineering and geoscience activities or work, including how to remain in compliance with quality management requirements while using AI.

This practice advisory is aimed towards engineering/geoscience professionals who use or interact with third-party AI-based systems and tools; it does not address the development or design of AI-based systems and tools by engineering/geoscience professionals. The guidance given in this practice advisory is broadly applicable to any system that uses AI in some capacity, including historical, conventional, and novel AI methods and systems.

Additionally, this practice advisory does not discuss the appropriateness of the use of AI-based systems and tools in engineering/geoscience work, but instead discusses the responsibility of the professional to consider the risks and legal implications associated with such use. It is paramount that, when using AI, engineering/geoscience professionals consider their ability to meet the documented checking, direct supervision, document retention, and independent review quality management requirements, as outlined in the Engineers and Geoscientists BC Bylaws and discussed below. Engineering/geoscience professionals must also practice only in those areas where their training and ability make them professionally competent, as per Principle 2 of the Engineers and Geoscientists BC's Code of Ethics (Engineers and Geoscientists BC 2021). This ethical duty applies not only to the use of AI, but also the ability to recognize and mitigate risks associated with its use.

The following are examples of how an engineering/geoscience professional might use or incorporate AI into their professional work:

- **Text and Image Generation/Recognition** – AI can both produce and recognize text and images based on inputted data.
- **Design and Modelling** – AI can optimize design and modelling by using generative algorithms and simulations that are based on specified constraints and objectives. This can enhance the entire design process, from ideation to implementation.

- **Predictive Maintenance** – AI can anticipate and therefore prevent failures in facilities and equipment, which results in optimized operation, reduced downtime, and improved performance.
- **Quality Control and Inspection** – AI can identify and classify defects, anomalies, or deviations from desired specifications using visual automation.
- **Process Optimization** – AI can analyze data and identify patterns to improve efficiency and reduce waste in several applications, such as supply chain management and energy consumption.
- **Summarization** – AI can summarize large volumes of text or information from one or more sources. For example, AI could summarize text from several sources on the Internet.

AI's rapid advancement and expanding use has resulted in increased questions about how an engineering/geoscience professional can use AI-based systems and tools responsibly within their practice. This includes how to meet the regulatory requirements set out by the *Professional Governance Act, Engineering and Geoscientists Regulation,* and Engineers and Geoscientists BC Bylaws.

BACKGROUND

WHAT IS ARTIFICIAL INTELLIGENCE (AI)?

AI is a term that is used to broadly describe the ability of computers or machines to simulate or mimic characteristics of human intelligence to perform tasks that include a combination of perceiving, reasoning, learning, problem solving, and decision-making (European Union 2024) (Stuart Russel 2010) (Government of Canada 2023).

Within the scope of AI, a wide range of methods and types exist. Historically, "expert systems" consisting of complex and well-defined rule sets were considered AI. Presently, AI often involves aspects of machine learning (ML), where the AI learns or identifies patterns from large training data sets that are specific to the problem domain. A common use of the ML method is classifying inputs into categories. For example, the AI elements of the perception systems in semi-autonomous/ autonomous vehicles are trained to classify surrounding objects based on data sets consisting of images and videos of pedestrians, vehicles, cyclists, and similar objects.

As of writing, generative AI (GAI) is a novel type of AI that has received recent significant public recognition. GAI processes data from human users and can generate new textual, visual, or audio content based on a prompt from a human. Large Language Models (LLMs) allow a GAI system to predict the next word in a sequence, when given the words that have come before. It is important to note that, like the generation of AI and ML models that came before, LLMs are statistical in nature and can only predict the most likely output based on the data they were trained from. OpenAI's ChatGPT and Microsoft's Copilot products are two examples of GAI-based systems that are both widely available and have received significant attention from the broader public.

OVERVIEW OF TYPES OF AI

Many different categorizations and levels of autonomy are available for AI-based systems and tools. As these categorizations can become quite complex, for the purpose of this practice advisory, the following two types are discussed: Static AI and Dynamic AI. The key difference between Static and Dynamic AI is whether the AI's behaviour changes or evolves over time, in response to the inputs it receives from its environment. Since the behaviour of Dynamic AI can change over time, it can pose unique challenges in terms of risk management.

- **Static AI** does not change over time. Static AI systems are trained and tested in a controlled environment, and then locked against modifications before being deployed. Once the model is trained, repeatedly providing identical inputs will result in the model producing identical outputs. However, the model may be sensitive to minor changes in inputs that could cause unexpectedly large changes in outputs.
- **Dynamic AI** can adapt, learn, and evolve over time. Therefore, the output may change based on new learnings, and thus the results may vary from use-to-use and over time.

PROFESSIONAL PRACTICE

RISK, RISK ASSESSMENT, AND RISK MANAGEMENT

Engineering/geoscience professionals are required to hold paramount the safety, health, and welfare of the public, including the protection of the environment and the promotion of health and safety within the workplace, as per Principle 1 of the Code of Ethics (Engineers and Geoscientists BC 2021). When using AI-based systems as a tool, engineering/geoscience professionals must assess, understand, and manage or mitigate the harm that AI-based systems and tools can potentially cause, either directly or indirectly.

There is currently much uncertainty surrounding the potential risks of using AI-based systems and tools in professional work including the protection of private information, the intellectual property of an AI output, civil liability, and the risk factors mentioned below. It is critical that engineering/geoscience professionals understand these risks — including any unintended consequences (see the section below on Risk Considerations) — so that those risks can be managed or mitigated. The risks associated with AI-based systems and tools differ and are unique from traditional software risks, as outlined in Appendix B of the Artificial Intelligence Risk Management Framework (National Institute of Standards and Technology, 2023). Therefore, if an engineering/geoscience professional intends to use an AI-based system or tool, they should understand and remain familiar with how it is intended to function, exercise their professional and ethical judgment on a continuing basis as per the Code of Ethics (Engineers and Geoscientists BC 2021), and understand that they remain professionally responsible their work even when it is generated by or includes AI output.

If an engineering/geoscience professional is not competent by training or experience to identify the risks associated with the use of AI-based systems and tools in their professional practice (see Principle 2 of the Code of Ethics [Engineers and Geoscientists BC 2021]), then those systems and tools should not be used. If an engineering/geoscience professional determines they can appropriately identify the risks and moves forward with use of the AI-based system or tool, they

should remain open to managing and mitigating those risks collaboratively with appropriately qualified experts (for example, by seeking legal advice on whether the AI-based system's license agreement is compatible with any confidentiality or non-disclosure provisions governing the professional work).

Per Engineers and Geoscientists BC Bylaws, a documented risk assessment must be completed for all professional activities or work. As part of the risk assessment, an engineering/geoscience professional is expected to identify hazards, consequences, severity of the consequences, likelihood of the consequences, and level of risk. For hazards that have been identified, the engineering/geoscience professional is expected to mitigate those risks, where applicable, in their professional activities. A multidisciplinary approach to risk management may be appropriate, as risks can arise outside of the scope of engineering or geoscience. A resource for completing a risk assessment can be found in Appendix B of the *Guide to The Standard for Documented Independent Review of High-Risk Professional Activities or Work* (Engineers and Geoscientists BC 2023a).

RISK FACTORS

Engineering/geoscience professionals must understand the inherent risks when using AI in their professional practice. These include the following:

- **Biases** – Biases can occur and be amplified in AI-based systems and tools, which can result in inaccurate decisions or results. Biases can include computation and statistical biases, and human-cognitive biases.
    - Computational and statistical bias can occur in datasets and algorithm processes. This type of bias stems from systematic errors, which are caused by non-representative samples being used for the AI training process. Alternately, the systematic errors may be due to a misunderstanding of the underlying processes and mechanisms that may result in AI being trained with survivorship bias, which is a logical error that occurs when the AI concentrates on entities that pass a selection process, while overlooking those that do not.
    - Human-cognitive bias can occur when humans use and trust the information given by AI-based systems and tools to make decisions or fill in missing information. For example, some users might trust the output of an AI-based system or tool more than their own knowledge or judgement, even if there is no basis for that trust in the AI-based system or tool in question.
- **Trustworthiness** – Trustworthy AI-based systems and tools are those that have had their risks managed or mitigated to a level considered acceptable by interested parties. The Artificial Intelligence Risk Management Framework (National Institute of Standards and Technology, 2023) defines trustworthy AI-based systems and tools as those without harmful bias and that have characteristics that are valid, reliable, safe, secure, resilient, accountable, transparent, explainable, interpretable, privacy-enhanced, and fair. It should be noted that trustworthiness is specific to the context of its use (i.e., an AI-based system or tool may be considered trustworthy in one application, but not in another).
- **Transparency, explainability, and interpretability** – For many AI-based systems and tools, it can be hard for humans to understand the process that the system or tool took to produce an output, or the output cannot be interpreted in the context of its designed functional purposes.

Transparency, explainability, and interpretability are distinct characteristics that support each other and can help humans understand the process of an AI based system or tool.

Trustworthy AI: Managing the Risks of Artificial Intelligence (National Institute of Standards and Technology, 2024) defines these terms as follows. Transparency reflects the extent to which information about an AI system and its outputs is available to individuals interacting with such a system. Explainability refers to a representation of the mechanisms underlying an AI systems' operation. Interpretability refers to the meaning of AI systems' output in the context of their designed functional purposes (National Institute of Standards and Technology 2024).

Engineering/geoscience professionals remain responsible for their work that incorporates or is based on AI output. Where the work engages the safety, health and welfare of the public, including the protection of the environment and the promotion of health and safety in the workplace, transparency, explainability and interpretability are of great importance. Engineering and geoscience professionals should not use or rely on AI outputs for projects involving safety or environmental risks unless they understand the underlying processes and reasoning behind the AI system's output.

- **Lack of repeatability** – This refers to the inability to replicate or reproduce results from AI-based systems. Some AI systems may produce differences in outputs even when identical or very similar inputs are used, which can lead to an inability to replicate or reproduce results from AI-based systems and tools. Changes in versions of the AI-based system or tool can also lead to differing results.
- **Confidentiality and privacy** – AI-based systems and tools may be controlled by third parties. By using AI-based software, confidential information may become owned or accessible to a third-party. In addition, the data that is uploaded to an AI-based systems or tool may be used to further train the AI model, leading to other AI users having access to the original user's confidential information.
- **AI hallucinations** – AI hallucinations occur when an output of a generative AI model appears to be plausible but turns out to be factually incorrect, inaccurate to the inputs, or otherwise nonsensical (Ji et al. 2023). Engineering/geoscience professionals remain responsible for their work product and can face professional consequences for work product containing AI hallucinations.
- **Human dependence on AI** – Overreliance on AI can risk diminishing creativity, critical thinking, and human intuition. This emphasizes the importance of maintaining a balance between AI assistance and human cognitive capabilities.
- **Privacy & Intellectual Property** - AI-based systems and tools can be trained using a wide variety of data, which may include private information, copyrighted or trademarked material, intellectual property, or other information that is owned by another entity. Therefore, work product generated by AI may inappropriately use or reproduce content without appropriate permissions or rights to do so. Advice on these potential risks is beyond what Engineers and Geoscientists BC can provide, and Engineering/geoscience professionals using AI should seek their own legal advice where appropriate.

RISK CONSIDERATIONS

When assessing the level of risk involved with the use of AI-based systems or tools in professional activities or work, an engineering/geoscience professional should consider the following questions:

- How is the output of the AI being used?

    - Is the output being used as a support tool or aid that can be further verified or checked? Or is it being used as a decision-making tool or leading to decision-making functions where full verification of the output of the AI prior to making a decision is not possible (e.g., assigning an assessment score for a large data set)?
    - What is the risk to the public, property, economic interests, public welfare, or the environment, should the output of the AI data be incorrect or otherwise flawed? (Engineers Canada 2016)
    - What is the risk to the safety, health, and welfare of the public, including the protection of the environment and the promotion of health and safety in the workplace?
    - Am I comfortable taking full professional responsibility for all of my work that incorporates or is based on AI output?
- Does the AI exhibit dynamic characteristics that impact the repeatability of the results it produces?
- What is the data the AI was trained on and how could this influence the output? Are there errors or biases in the trained data that could affect the results?
- Who retains ownership of the output data, considering that input data may belong to the owner of the AI, while ownership rights for trained data may be shared or subject to confidentiality agreements?
- Are the engineering/geoscience professionals using the AI competent in the area the AI is operating and could they have produced the same result using conventional/traditional methods?
- Has the AI been validated by the organization providing the AI service and are the results available to be reviewed prior to being relied upon for engineering or geoscience decisions?
- Can the results of the AI be validated for the specific application and use of AI? Consider the following questions:
    - What does validation look like for the specific application?
    - How often is validation needed?
    - Who is qualified to undertake the validation?

In general, the use of an AI-based system or tool during professional activities and work should be approached with caution and different considerations should be taken into account when the work is generated directly by an engineering/geoscience professional. As such, additional mitigation or management strategies will likely be required (e.g., additional checking, independent review, audits, and continuous monitoring and evaluation to ensure performance).

QUALITY MANAGEMENT

When using an AI-based system or tool in their work, engineering/geoscience professionals are responsible for meeting the intent of Engineers and Geoscientists BC's quality management requirements during all phases of the work, per Engineers and Geoscientists BC Bylaw 7.3. To do this, engineering/geoscience professionals and firms must establish, maintain, and follow documented quality management processes.

When using AI-based systems or tools in professional activities and work, both engineering/geoscience professionals and firms have considerations that should be taken into account in relation to quality management.

DIRECT SUPERVISION

To comply with the requirement for direct supervision when delegating professional activities, engineering/geoscience professionals must be aware of and be actively involved in the work of subordinates before they take professional responsibility for the work. If the use of AI-based systems or tools is within the delegated work, the engineering/geoscience professional taking professional responsibility for the work must apply the same standard of care as if they were using the AI-based system or tool themselves. Engineering/geoscience professionals must be aware that they are ultimately responsible for all of their work.

DOCUMENTED CHECKS

For documented checks, a process like the one laid out in Section 3.3.3 of the *Guide to the Standard for Documented Checks of Engineering and Geoscience Work* (Engineers and Geoscientists BC 2023b) can be used. This process is for documented checks for design software:

> "Calculations performed using design software or spreadsheets can only be as accurate as the software, spreadsheet, or Input Data used. Ideally, the software should be validated periodically by using it to perform a known design calculation, such as one included in a textbook exercise or confirmed in past work. Alternatively, the software can be validated against a hand calculation. It is imperative to keep a record or log of when the validation was last conducted, by whom, and what, if any, corrective action was needed."

For the use of AI-based systems and tools, the following documented checks may also be required:

- Noting the make and version of the AI-based system or tool used.
- Developing a range of test cases and running the data through the AI-based system or tool, noting the outputs and the results generated.
- Recording the input data and outputs for the validation and verification process.
- For dynamic AI, considering that outputs may need to be validated with each use.

This list is not exhaustive. Depending on the outcome of the risk assessment, additional documented checks may also be required.

RETENTION OF PROJECT DOCUMENTATION

When an AI-based system or tool is used, appropriate project documentation must be maintained and retained. The level of project documentation will depend on the extent to which the AI-based system or tool has been used in a project. For example, if AI is used to assist with written content for a report (e.g., grammar or paragraph structure) and this content is then reviewed by an engineering/geoscience professional, this may not need documentation. However, if AI is used to generate results for a report or to make design decisions, then its use must be documented to the same extent as if an engineering/geoscience professional had researched the sources or completed the calculations themselves, as the responsibility for the work product rests entirely with the engineering/geoscience professional regardless of whether AI-based systems or tools are used. Records must be retained and preserved for a minimum of 10 years after the end of a project or 10 years after a document used in continuing work is no longer in use.

HIGH-RISK PROFESSIONAL ACTIVITIES AND WORK

Bylaw 7.3.6 outlines the requirement for independent reviews of high-risk professional activities or work. The risk factors and considerations outlined above should factor into risk assessments when AI is utilized for engineering/geoscience activities or work. If the result of the risk assessment is that the work is deemed high-risk, then an independent review is required and must be undertaken by a separate engineering/geoscience professional. Further information on this requirement can be found in the *Guide to The Standard for Documented Independent Review of High-Risk Professional Activities or Work* (Engineers and Geoscientists BC 2023a).

FIRM CONSIDERATIONS

Firms should consider implementing a robust set of internal policies and procedures in order to enhance their organization's AI governance, with special consideration given to the quality management requirements outlined above.

As AI technology and the legislative framework surrounding it are both evolving rapidly, any engineering/geoscience firm using AI-based systems or tools should be familiar with the technology and how it is intended to function, and maintain their familiarity with these systems and tools. Firms also need to be familiar with the contract or end-user license agreement governing their use of an AI product. Firms should also consider providing proficiency training for their employees for any AI-based systems or tools that they deploy.

In 2023, ISO/IEC published *ISO/IEC 42001:2023 Information technology – Artificial intelligence – Management system* (ISO/IEC 2023), which specifies the requirements and provides guidance for establishing, implementing, maintaining, and continually improving an AI management system within the context of an organization. This standard may be of use for firms navigating the use of AI within their organization.

OTHER CONSIDERATIONS

DISCLOSURE ON THE USE OF AI

At this point in time, Engineers and Geoscientists BC does not have explicit requirements on the disclosure of the use of AI-based systems and tools. There are, however, requirements around documented risk assessments (see Section 7 of Engineers and Geoscientists BC Bylaws). Where there are risks associated with the use of AI-based systems and tools in professional work, those risks must be assessed and documented, and consideration should be given to sharing those risks with the client.

Engineering/geoscience professionals must also be aware of other disclosure requirements, such as those identified in a contract and by legislation, and adhere to Principle 13 of the Code of Ethics (Engineers and Geoscientists BC 2021) by conducting themselves with fairness, courtesy, and good faith towards clients, colleagues, and others.

ENVIRONMENTAL AND EQUITY IMPACTS

AI-based systems and tools may have an environmental impact due to the energy consumption required for their operation. Depending on how they are developed and trained, they may also have

environmental, equity, fairness, and inclusivity biases. Engineering/geoscience professionals are encouraged to consider this when selecting and using an AI-based system or tool.

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VERSION HISTORY

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