Artificial Intelligence in Design & Construction

ACEC BIT Webinar / Sept. 2023

Leo E. Argiris, PE

GREYLING.COM

The New York Times

Meet quietly where it's loud
hp

HOW WORK IS CHANGING

How A.I. Is Helping Architects Change Workplace Design

With more hybrid workers and new office needs, firms like Zaha Hadid Architects are turning to artificial intelligence for solutions

At the headquarters of Zaha Hadid Architects in London, Uli Blum, left, and a colleague analyze a visualization of employees' locations and interactions in their office — part of ZHAI, the firm's unit devoted to using A.I. to rethink work spaces. Jeremie Souteyrat for The New York Times

By Farah Nayeri
Reporting from London

June 15, 2023

Harnessing AI To Revolutionize Construction Scheduling

The construction industry has used manual scheduling techniques for decades, but artificial intelligence (AI) is now revolutionizing construction s[...] drastically red[...] the efficiency a[...]

Technology First Read

ChatGPT and Other Conversational AIs Can Help Construction

Conversational artificial intelligence has the potential to be a huge time saver in construction

By Mehdi Nourbakhsh

Conversational AIs, such as ChatGPT, in construction could be a gamechanger for harried project managers and superintendents inundated with requests and questions.

March 9, 2023

AI Takes on the Built World

The AEC industry has a unique set of challenges, and AI is helping to solve them.

WRITTEN BY
Jessica Zimmer

PUBLISHED
Feb 23, 2023

READING TIME
~5 mins

LISTEN TO STORY

AI is rebuilding the field of Architecture, Engineering, and Construction (AEC). The combination of AI algorithms with sensors and cameras changes the roles of engineers by making it easier to understand project limitations and find solutions to problems in real time.

The global construction market is projected to reach nearly $22.9 trillion by 2026, according to a July 2022 report by Research and Markets. Yet the construction industry has been frustrated by new concerns, including COVID-19-related supply chain disruptions and labor shortages. AI may be critical to increase the speed to execute capital projects and ensure work and structures are sustainable. AI can also help AEC companies overcome other challenges, like rising materials costs related to geopolitical conflicts.

https://www.engineering.com/story/ai-takes-on-the-built-world

3D Printing: A Game Changer for Construction
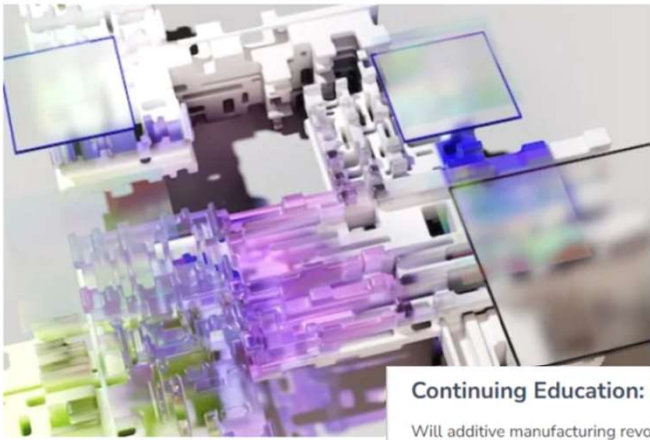
In recent years, 3D printing has revolutioniz[...] construction sector is no exception. 3D prin[...] the construction industry, allowing for the p[...] imaginable and for the creation ...

Continuing Education: 3D-Printed Houses

Will additive manufacturing revolutionize residential design and construction?

By Sarah Amelar

In Ravenna, Italy, Mario Cucinella Architects has built a twin-domed prototypical house of earth reinforced with corn husks. *Photo © Iago Corazzo*

May 1, 2022

BLOG > 7 AEC TECHNOLOGY TRENDS THAT INDUSTRY LEADERS CAN'T IGNORE

7 AEC Technology Trends That Industry Leaders Can't Ignore

by Brendon Cussio

Tech drives strategy in the AEC industry by offering competitive advantages to early adopters. Learn about 7 aec technology innovations every firm should consider.

PUBLISHED: 10/06/2022   SHARE: f 𝕏 in

As with other AEC industry trends, rapid technological changes offer both threats and opportunities. While implementing new technology can be difficult, trailblazing firms that leverage innovative AEC technology can gain competitive advantages. Pioneering AE firms that invested in Building Information Modeling (BIM) technology a decade ago, for example, are today's industry leaders. Those who didn't were left in the dust.

Top 7 AEC Technologies to Watch

How is technology changing the AEC industry? These seven AEC technologies will play substantial roles in shaping the future of the industry:

- Virtual Reality
- Artificial Intelligence/Machine Learning
- Blockchain
- Digital Twin
- Cybersecurity
- 3D Printing
- Data Products

Let's take a closer look at how these technologies are shaping the AEC industry landscape.

Outline

Introduction; Are we in new territory?

Buzz Words

The Legal Landscape

How does AI change the picture?

Risks & Opportunities Faced by Design Firms

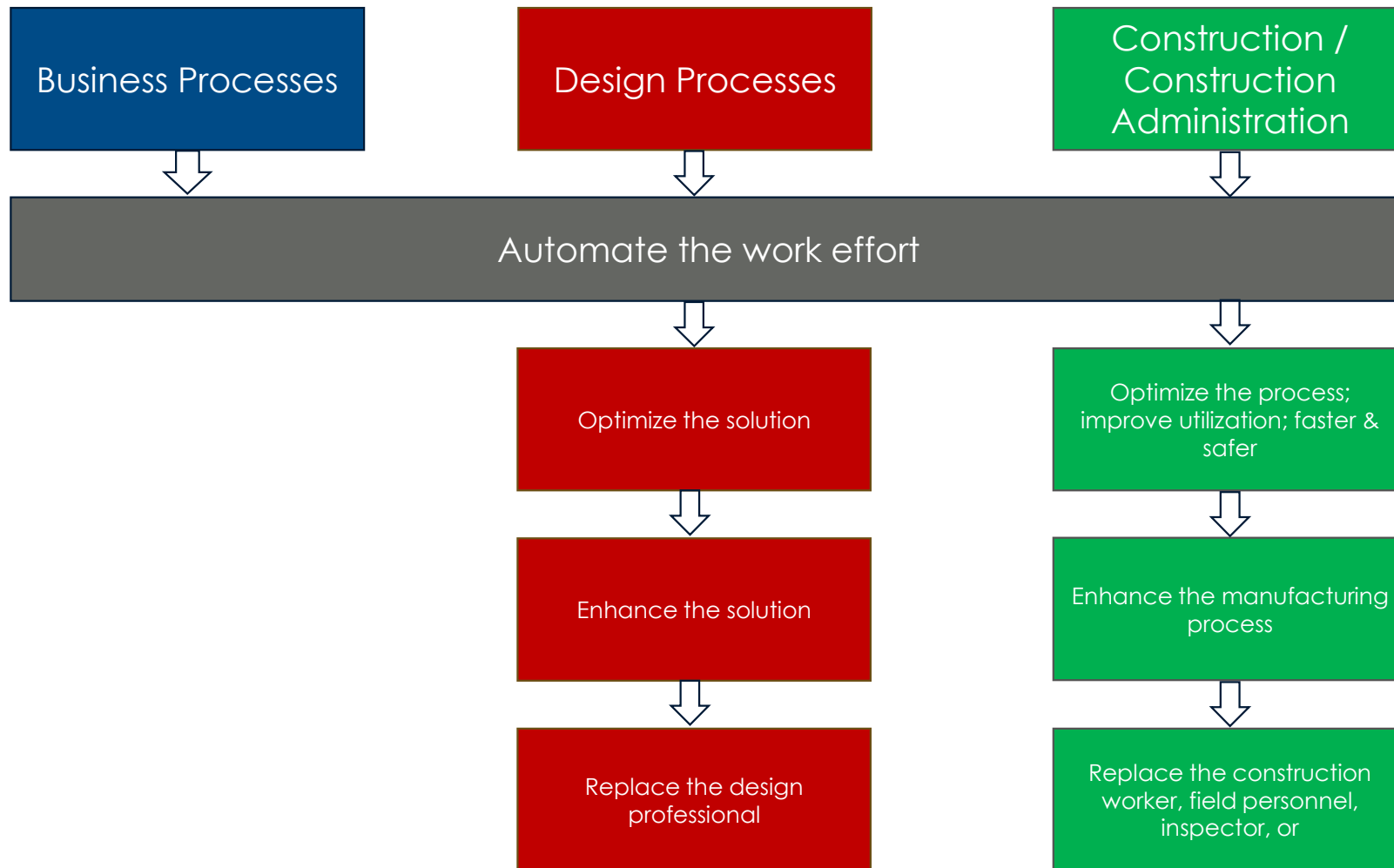**What Can Designers do to Manage Their Risk?**

Discussion

Introduction
Are we in new territory?

The Industry has been going Digital for some time

Business Processes	Design Processes	Construction / Construction Administration

Automate the work effort

	Optimize the solution	Optimize the process; improve utilization; faster & safer
	Enhance the solution	Enhance the manufacturing process
	Replace the design professional	Replace the construction worker, field personnel, inspector, or

Engineers began the automation journey in the 1960's with the advent of structural analysis software.

The optimization kick was in full swing in the 1980's.

Engineers began making design decisions using computer programs in the 1980's.

3 Distinct Offerings by Design Professionals; Distinct Terms & Conditions; Distinct Risk profiles

Professional Services w or w/o Technology Based Services	Technology Based Services	Technology Products / Software

The Construction Industry has been using computing technology to improve delivery for many years.

5D BIM modeling
(3 dimensions + cost + time)

3D printing

Drones & Robots to facilitate access

3D imaging, Linar Scanning, Image processing

The Industry is full of buzz words and tools

Optimization

Chat GPT

Digital Twins

Machine Learning

Technology Products

Building Information Modeling (BIM)

Augmented Reality

Artificial Intelligence

Technology Products

Digital Transformation

Generative AI

Data Science

Generative Design

Automation

Graphic Information Systems (GIS)

Parametric Design

Virtual Reality

3D Printing

Acceptable Use Policy (AUP)

The Legal Landscape

The Practice of Engineering

Rules and Regulations of the State of Georgia

Department 180 STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS AND LAND SURVEYORS

Current through Rules and Regulations filed through February 8, 2023

https://rules.sos.ga.gov/gac/180-6

Rule 180-6-.03. Rules of Practice.

(1)   The engineer or land surveyor shall perform services only in areas of his/her competence. The engineer or land surveyor shall undertake to perform engineering or land surveying assignments only when qualified by education or experience in the specific technical field of professional engineering or land surveying involved.

(2)   The engineer or land surveyor may accept an assignment requiring education or experience outside of his/her own field of competence, but only to the extent that his/her services are restricted to those phases of the project in which he/she is qualified. All other phases of such project shall be performed by qualified associates, consultants or employees who shall sign, seal, and be responsible for such other phases or technical segments of the project.

(3)   The professional engineer who develops the design criteria and engineering concept for a project, provides analysis, and is responsible for the preparation of the construction documents shall be responsible for the design of the project within his/her contractual area of engineering services and shall be known as the engineer of record.

(4)   In the event that a professional engineer who is not the engineer of record is used for specific portions of the work, that individual shall be a registered engineer in the State of Georgia and shall seal, sign, and date his/her own reports, calculations, and drawings. He/she shall coordinate his/her work with the engineer of record and shall be responsible to the engineer of record for that specific portion of the project design. He/she shall be known as the specialty engineer.

(5)   The engineer or land surveyor shall not affix his/her signature and/or seal to any engineering or land surveying plan, document, or plat unless such plan, document, or plat is prepared by the registrant or an individual in the employ of the registrant. All plans, documents, and plats prepared by non-registrants must be prepared under the direct supervisory control of the registrant on a daily basis.

(6)   "Direct supervisory control" shall require the registrant to have daily interaction with and provide guidance and direction to any non-registrant employee or non-registrant contract employee in the preparation of engineering or land surveying plans, documents or plats, in each phase of the preparation of the calculations, drawings, specifications, reports, surveys and all other documents completed by the non-registrant. Direct supervisory control may be typically established at a location (address) where both the registrant and the non-registrant employee (whether full time or part time or contract) are employed and there is a direct connection between the registrant and the non-registrant employee. If the registrant and the non-registrant employee are not located at the same location, then the registrant shall be able to demonstrate how direct supervisory control is maintained over the non-registrant and how the registrant and the employee maintain a direct connection for the direct supervisory control of the engineering or surveying work as indicated above, upon an inquiry from the Board. Satisfactory proof of direct supervisory control from the registrant over the non-registrant employee includes, but is not limited to, written guidance or directions to the non-registrant employee; written records of ongoing communication during the project; and work product mark-ups by the registrant to the non-registrant. The Board shall determine if such direct supervisory control is being provided by the registrant is acceptable to the Board.

Who is at fault when an AI system fails to perform?

The inevitability of AI disputes

Who is at fault when an AI system fails to perform?

As there are many parties involved in an AI system (data provider, designer, manufacturer, programmer, developer, user and AI system itself), liability is difficult to establish when something goes wrong and there are many factors to be taken into consideration, such as:

Nature or cause of damage	If so, who is liable?
Was damage caused when in use and were the instructions followed? Was the AI system provided with any general or specific limitations and were they communicated to the purchaser?	User or owner?
Was the damage caused while the AI system was still learning?	Developer or data provider?
Was the AI system provided with open source software?	Programmer?
Can the damage be traced back to the design or production of the AI system, or was there an error in the implementation by its user?	Designer, manufacturer or user?

CMS
law·tax·future

https://cms.law/en/gbr/publication/artificial-intelligence-who-is-liable-when-ai-fails-to-perform

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Legal Advice Varies Widely

Quote from Trent Cotney, Adams & Reese LLP

Who's Liable?

How do you determine liability when the culprit doesn't have an ID, a social security number, or even a pulse? This is one of the prominent questions barring AI from being introduced to the construction industry. Is it the fault of the person who greenlit the use of AI? Or the fault of the developer who created the AI? There are no clear answers for this right now, which means most contractors are going to avoid AI altogether until they can be certain that they'll be safe when something goes awry.

Source: https://www.cotneycl.com/examining-the-legalities-of-construction-ai/

Who has liability?

A. An offshore platform requires inspection to determine whether any of the welds in the supporting structure are showing signs of fatigue and need to be repaired.

B. The owner engages an engineering firm to perform the inspections & perform the evaluation.

C. The engineer deploys drones to perform the inspection by photographing and videoing the welds. The images are uploaded in the cloud and an AI/ML algorithm is deployed to assess the welds and determine which welds require repair.

D. A PE working for the engineering firm, reviews the recommendations from the AI/ML system and issues the recommendations to the owner of the platform.

E. The recommendations of the engineering firm are accepted by the owner who hires a contractor to execute the repairs.

F. One month after the completion of the weld repairs, a weld that was not repaired fails and the platform is out of commission. The cause of failure is identified to be fatigue.

G. Who has liability?

However,

What if a Professional Engineer was not involved in the previous example?

The drones and AI computer systems were owned by a "Tech" Company.

No Professional Engineer validated the repair decisions.

The same contractor performed the repairs.

Who is liable? Is there likely to be any insurance coverage?

Does it make a difference if the Tech Company developed the algorithms used internally?
If the algorithms were purchased?
If the algorithms were open-source coding?

How does AI change the picture?

Tech Companies want to muscle in on the AEC Industry

Software only solutions to design problems.

Challenges to Engineering and Architecture Authority.

"Don't be surprised when technology companies begin purchasing infrastructure design firms. Their interest won't lie in delivering plans or projects, but rather acquiring the talent to assist with advancing their software to automate the design space."
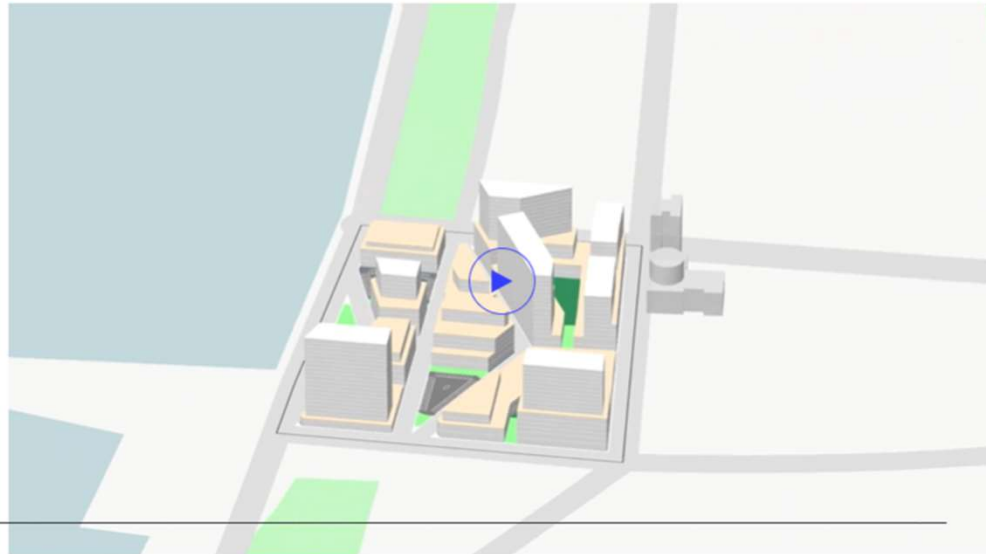
– David Wantman, PE
CEO, WGI

Changes to the Standard of Care

Marketing efforts by design firms are volunteering a higher standard of care.

Clients are listening to the media and expecting a higher standard of care.

"By bringing buildings and assets fully into the digital realm, we can produce a step change in the built and natural environment – net zero buildings, new user experiences, incredible operational insights and reduced costs."

Will Cavendish
Global Digital Services Leader

WHAT'S INCLUDED?

› Mobile application to monitor system alerts and issues on the go

› Access your signal status data any time of the day or night

› Easily share data with the click of a button
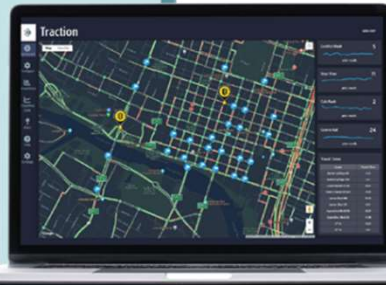
»TractionLive

THE MOST **INNOVATIVE SOFTWARE SOLUTIONS** AVAILABLE

»KITS
Software Solutions.

Compressed Schedules & Lower Design Fees

Firms sign up to overly aggressive schedules.

Reliance on Technology without sufficient professional oversight.

CAPABILITIES

ASTERISK

Want to shave months off conceptual and schematic design? Our structural optioneering app generates structural solutions – in seconds – from a simple building massing model.

https://www.thorntontomasetti.com/capability/asterisk

Overlaps & Gaps in Insurance Coverage

When do professional services morph into selling software products?

How deliberate are design firms into keeping clear separation between professional services and the sale of a product?

How diligent are we in securing coverage for Technology Based Services & Technology Products in PL policies?

Professional Services w or w/o Technology Based Services	Technology Based Services	Technology Products / Software

Standard
of Care ↑

Schedule ↓

Fees ↓

Professional
Oversight ↓

= RISK ↑

Are Tech E&O policies part of the answer?

Tech E&O policies provide coverage for companies selling technology products or offering consulting services related to information technology.

Coverage is intended to cover:

Acts, errors or omissions in the performance of technology services

Defects, Deficiencies or inadequacies in a technology product

Failures in performance of tech products or services in accordance with a contract

Tech E&O policies are not a substitute for a Professional Liability policy. For AEC firms, Tech E&O policies complement a PL policy.

The *Chubb Professional Portfolio Technology Products and Services Liability* Coverage Part is specifically designed for technology companies, including:

- Software developers
- Information technology consultants
- Technology service providers
- Network service providers
- Hardware manufacturers

Professional Insurance for Engineers   A DIVISION OF **EPIC**

Other exposures in an AI world / Is there coverage?

Exposure

I. IP Infringement
   - ❑ Whose IP was used to train the AI system utilized? It will be very rare for firms to own proprietary AI systems.

II. Corporate decision making influenced by AI products.
   - ❑ IP claims
   - ❑ breach of fiduciary duties
   - ❑ Shareholder derivative claims

III. Employment Practices impacted by AI driven decision making
   - ❑ Hiring decisions
   - ❑ Promotion decisions
   - ❑ Performance evaluations
   - ❑ Wrongful termination claims
   - ❑ Discrimination claims
   - ❑ Harassement claims

IV. Media exposures impacted by AI driven marketing & communications
   - ❑ Content creation
   - ❑ Defamation
   - ❑ Invasion of privacy
   - ❑ IP infringement

Insurance Coverage

I. Intellectual Property Insurance
   - ❑ Many PL policies contain exclusions for claims arising from IP infringement

II. D&O Insurance
   - ❑ Consider whether limits are adequate.

III. Employment Practices Liability Insurance (EPLI)
   - ❑ EPLI can help protect businesses from potential algorithmic bias-related lawsuits.

IV. Media Liability Insurance
   - ❑ For businesses that use AI to generate and curate content, coverage can protect again claims of defamation, invasion of privacy and IP infringement

Risks & Opportunities Faced by Engineering Firms

There are real opportunities to solve important problems in the built environment

The Kadence system optimizes traffic signal timing to balance performance benefits for safety and efficiency. The system is not intended to replace the need for sound traffic engineering, but rather to supplement the traffic engineer's toolbox with another tool that can handle fluctuations in demand and short and long-term changes in land use and traffic patterns.

https://www.kimley-horn.com/solutions/smart-cities/kadence/

Featured project

Designing better flood defences with machine learning

Shanghai's population has tripled since 1990, leading to growing city flooding and river pollution, made worse by climate change. Our masterplanning team used remote sensing to scan greater Shanghai, and built a machine learning tool to interpret the images and categorise the entire area into 12 categories of flooding protection need. The project demonstrates how human ingenuity and community priorities can be supercharged by the power of machine learning to achieve previously impossible things.

Find out more about our work →

https://www.arup.com/services/digital/artificial-intelligence-and-machine-learning

Enhanced Safety on the Construction Site

During the construction phase, AI can be used to monitor progress, optimize resource allocation, and improve safety. For example, AI-powered drones can be used for site inspections, reducing the need for human workers to perform dangerous tasks.

ML can be used in visual and audio data emerging from a construction site for recognizing safety threats and carrying safety updates to eradicate elevated hazards. The adoption of ML on construction sites can take the level of safety to new heights.

Source: https://www.esds.co.in/blog/how-ai-with-machine-learning-is-changing-the-future-of-construction/#:~:text=ML%20can%20be%20used%20in,of%20safety%20to%20new%20heights.

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Risks related to the DATA & Computer Models

- Ownership of data & models

  Projects teams are increasing relying on shared computer models and on data sets increasingly hosted on cloud services. Who on the team owns the data and is responsible for its curation and preservation?

- Data Protection

  The project data is accessed by numerous parties. Who is responsible for protecting the data? Who is liable if the data is corrupted?

- Cybersecurity

  When cloud services are attached, who is liable for damages?

- Licensing

  If one party owns the data and/or software, are there clear licensing agreements in place all parties needing to access the data and software?

- Archiving & Retrieval

  Projects have long lives. Claims linger after projects are completed and occupied. Who is archiving the data and recuring future retrieval?

The Professional Engineer is in "direct supervisory control of the AI/ML algorithms"

- This is the requirement in the engineering statutes.

- Is the professional engineer sufficiently knowledgeable of the underlying algorithms?

- Does the professional engineer have sufficient fee to do the job of being "in responsible charge?"

What Can Engineers Do To Manage Their Risks?

1. Do not over promise and establish a heightened standard of care.

There is considerable hype in the media about the transformative power of Artificial Intelligence. Be cautious in making promises to the client on what can be delivered.

Be careful not to promise perfection, reduced errors, faster delivery, etc…. Yes, some such statement may be helpful to win the project; but be cautions on what gets into the proposal and the contract.

Be clear on what is possible to deliver today, what has been properly QA'd and what can be relied upon to deliver today. Be clear on what the tools will cost and who will be paying for the licensing fees.

2. **Be diligent to secure enough fee and time to execute the engineer's statutory responsibilities as the "engineer of record"**

AI / ML tools may be deployed on the project, but a Professional Engineer still needs to take responsibility for the work product.

AI / ML tools may actually create more work than more traditional design methods. Yes, AI can create 1000 options of interior floor plans. Who has the time to go through this number of options, explain them to the client and lead a decision-making effort?

3.   Be clear when services are no longer professional design services

T&C's appropriate for design services may not be appropriate for digital services or for the sale of software.

Use the appropriate contracting methods and the appropriate terms & conditions.

Where digital services are being offered, is there an appropriate "Service Level Agreement" in place? Do you have the resources in place to deliver to the "Service Level Agreement"?

4. AI & ML are multidisciplinary endeavors that require appropriate data. Do you have the right skills and data in place?

Do you have the right staff and/or consultants in place to deliver the service?

Do you have good quality data that is appropriately curated? Without good data most of the AI / ML algorithms deliver poor results.

# 5.	Address the issue of licensing and ownership of data and computer models

Address licensing, ownership, maintenance issues around data and computer models explicitly in your contracts. Do not assume that something will be figured out during the project.

Develop an "Acceptable Use Policy, AUP" for all users of software and technology products.

For a discussion on the benefits and uses of an AUP refer to:

https://www.techtarget.com/whatis/definition/acceptable-use-policy-AUP?Offer=abt_pubpro_AI-Insider

6. Perform due diligence on your vendors & subconsultants

Vendor and Consultant Questionnaires.
Simply ask…"Are you using AI to deliver services to us?" If the answer is yes, include indemnity and insurance requirements.

Intellectual Property Indemnification. Supplier shall indemnify, defend and hold Buyer and Buyer's customers harmless from any and all claims against Buyer and/or Buyer's customers alleging intellectual property infringement of any patent, copyright, trademark, trade secret or other intellectual property rights of any third party arising out of the use, sale, importation, distribution, reproduction or licensing of any product, service, article or apparatus, or any part thereof constituting goods or services furnished under this Order, as well as any device or process necessarily resulting from the use thereof (the "Indemnified IP"), including the use, sale, importation, distribution, reproduction or licensing of such Indemnified IP, in foreseeable combinations with products or services not supplied by Supplier. Buyer shall notify Supplier promptly of any such suit, claim or proceeding and give Supplier authority and information and assistance (at Supplier's expense) for the defense of same, and Supplier shall pay all damages, costs and expenses incurred or awarded therein, including reasonable attorneys' fees. Notwithstanding the foregoing, any settlement of such suit, claim or proceeding shall be subject to Buyer's consent, such consent not to be unreasonably withheld. If use of any Indemnified IP is enjoined, Supplier shall, at Buyer's option and Supplier's expense, either: (a) procure for Buyer the right to continue using such Indemnified IP; (b) replace the same with a non-infringing equivalent; or (c) remove the Indemnified IP and/or halt such use of the Indemnified IP in providing goods and/or services under this Order and refund the purchase price to Buyer, and in all cases, Supplier shall be responsible for all related costs and expenses. Supplier agrees that it shall use commercially reasonable efforts to obtain an intellectual property infringement indemnity from its direct or indirect suppliers providing goods and/or services as part of the deliverables under this Order consistent with the intellectual property infringement indemnity it provides to Buyer in this Order.

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Questions?

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