Why and How?—A Primer on AI Integration for Engineering Firms from the ACEC Technology Committee

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From professional conferences to happy hours, Artificial Intelligence (AI) is dominating conversation among members of the architecture, engineering, and construction (AEC) industry. The American Council of Engineering Companies (ACEC)—the business voice of the nation's engineering industry—recently released a comprehensive whitepaper on the unique challenges and opportunities the expanding AI landscape presents for its member firms. This paper was commissioned by ACEC's Technology Committee as a service to the Council's member firms. It serves as a roadmap for the effective and responsible adoption of AI, with an eye toward enhancing productivity, innovation, and sustainability in engineering.

A word at the outset: there is a wealth of invaluable information within the pages of the full Report, and we wholeheartedly recommend that firms use the Report as a starting point for their AI journeys. That said, we also felt it would be useful to create a truncated version of the Report—a "Cliff's Notes" of sorts that would serve as a quick reference on specific topics surrounding AI. To that end, the content within these pages represents an abbreviated summary of the information within the full Report. We have divided the information into three discrete categories: The Case for Adopting AI; The Challenges of Adopting AI; and The Path for Adopting AI. This is not a full accounting of the larger Report, nor is it intended to be. Rather, this summary outlines the reasons why firms should adopt AI—and how they can overcome obstacles to that adoption.

What Are the Different AI Technologies? What Can They Do?

AI is not a "thing," but rather a diverse set of capabilities, all with the potential to streamline, support, and strengthen the work of engineers. Key AI concepts include:

- **Machine Learning (ML)**: This is a subset of AI where algorithms learn patterns and make predictions from data without being explicitly programmed for each task. In AEC, ML powers applications like cost estimation models trained on historical project data, predictive scheduling tools that identify potential delays by analyzing past performance and current progress, and risk identification systems that flag projects with characteristics similar to those that previously encountered issues.

- **Natural Language Processing (NLP)**: NLP enables computers to understand, interpret, and generate human language. AEC applications include analyzing complex legal contracts or lengthy technical reports to extract key clauses or information, processing Requests for Information (RFIs) to identify trends or route them appropriately, analyzing client communications for sentiment or requirements, and powering internal chatbots that provide access to company knowledge bases or standards.

- **Computer Vision (CV)**: CV techniques train computers to "see" and interpret visual information from images or videos. In AEC, this translates to powerful tools for site safety monitoring (e.g., detecting if workers are wearing appropriate Personal Protective Equipment (PPE) or identifying potential hazards like open edges), tracking construction progress by analyzing drone imagery against BIM models, performing automated quality control checks

(e.g., identifying cracks in concrete or misaligned components), and processing reality capture data (like point clouds) for as-built verification.

The application of these AI technologies is already delivering tangible benefits and transforming established workflows. Moving beyond general potential, specific examples illustrate AI's current impact:

- **Generative Design**: Tools such as Autodesk Forma (formerly Spacemaker) or TestFit employ AI algorithms (often ML-based) to rapidly generate and evaluate potentially thousands of design options for site layouts, building massing, or floor plans. These tools consider user-defined constraints like site boundaries, zoning regulations, target unit mix, cost parameters, and energy performance goals, allowing design teams to explore a wider solution space in the early project phases.

- **Predictive Analytics for Scheduling and Risk**: Platforms like Alice Technologies or Buildots utilize AI (ML and simulation) to analyze complex project schedules, simulate different construction sequences, identify potential bottlenecks or conflicts, and predict completion dates with greater accuracy. They often integrate real-time site data (e.g., from CV analysis) to compare planned versus actual progress, enabling proactive risk mitigation.

- **Site Safety Monitoring**: Systems developed by companies like Indus.ai (now part of Procore) or Scaled Robotics leverage CV to analyze video feeds or site imagery captured by cameras or drones. They can automatically detect safety violations (e.g., personnel not wearing hard hats in designated zones), identify unsafe conditions (e.g., proximity of workers to heavy equipment), and provide alerts to site managers, enhancing preventative safety measures.

- **Automated Document Review and Analysis**: AI tools are emerging that use NLP to scan and extract critical information from large volumes of documents, such as construction contracts, technical specifications, or submittal packages. This can significantly reduce the manual effort required for due diligence, compliance checking, or information retrieval.

- **Predictive Maintenance**: For infrastructure assets or critical building systems, ML models can analyze data from sensors (e.g., vibration, temperature, strain) to predict potential equipment failures or structural degradation before they occur. This allows for proactive maintenance scheduling, reducing downtime and preventing costly emergency repairs.

How Can Integrating AI Benefit Firms?

These applications directly contribute to the significant benefits firms seek: **Increased Operational Efficiency** through automation of repetitive tasks and workflow optimization; **Improved Design Quality** by leveraging data analytics for enhanced insights and performance predictions; **Enhanced Project Management** via better scheduling, resource allocation, and proactive risk assessment; **Greater Client Satisfaction** resulting from more efficient project delivery and higher quality outcomes; **Improved Talent Attraction & Retention**; and ultimately, a stronger **Competitive Advantage** in a market increasingly driven by technological capability.

These benefits are achievable, particularly when pursued through a responsible lens. Indeed, responsible practices are key to *sustainably* realizing these benefits; unchecked AI use leading to errors, ethical breaches, security incidents, or loss of trust can quickly negate any perceived gains.

More and more engineering firms are recognizing the potential—and the necessity—of integrating AI into their operations. The ACEC Research Institute Engineering Business Sentiment Survey from the first quarter of 2025 reveals a significant shift: 63% of member firms report having an AI strategy in place or being actively engaged in developing one. This represents a notable 11-point increase from the previous year, indicating that AI is moving from the periphery to the core of strategic planning for a majority of firms.

The will is there. It's the "way" that presents obstacles, but understanding these barriers and potential mitigation strategies is crucial for developing a realistic adoption plan.

The Challenges of AI Adoption—and How to Mitigate Them

- **Lack of Technology Leadership**: Many firms struggle without a clear champion to drive AI initiatives. Senior leadership may be hesitant to invest in technologies perceived as complex or unproven, lacking a designated individual or group to research potential applications, advocate for investment, build consensus, and guide pilot projects.
  - *Mitigation (Small Firms)*: Identify a tech-savvy individual within the firm, even if not in senior management, who shows enthusiasm and aptitude. Empower this 'internal champion' with dedicated time and a modest budget for exploration and learning. Leverage external resources like ACEC guidance, vendor consultations, or specialized consultants for initial direction. Focus communication on how specific AI tools can address existing business pain points, using clear language and avoiding jargon.
  - *Mitigation (Large Firms)*: Establish a formal structure, such as an AI steering committee composed of representatives from various departments (IT, operations, design, legal). Consider appointing a Chief Technology Officer (CTO) or Chief Innovation Officer (CIO) with a clear mandate for exploring and integrating emerging technologies like AI. Develop and communicate a clear AI vision that aligns with the overall business strategy.
- **Uncertainty About Return on Investment (ROI)**: Quantifying the financial benefits of AI adoption can be difficult, making it challenging to justify the necessary investments in software, training, and process changes. For instance, justifying a significant expenditure on predictive scheduling software requires demonstrating how it will tangibly reduce project delays or contingency costs.
  - *Mitigation*: Begin with tightly scoped pilot projects focused on use cases with easily measurable outcomes. Examples include tracking the reduction in hours spent on a specific automatable task (like quantity takeoffs) or measuring the decrease in RFIs related to design clashes detected by an AI tool. Utilize industry benchmarks and case studies (see Section 6) to build the business case. Develop simple ROI calculators tailored to specific applications, considering not only direct cost savings but also factors

like risk reduction, quality improvement, and speed to market. Focus on tracking leading indicators (e.g., faster generation of design options) alongside lagging indicators (e.g., final project profitability).

- **Resource Constraints (Budget, Time, Personnel)**: Firms, particularly SMEs, often operate with tight budgets and limited personnel time. Allocating billable hours for staff to research, evaluate, test, and learn new AI tools can seem prohibitive.
  - *Mitigation*: Prioritize exploring low-cost or free trial versions of AI features often embedded within existing software subscriptions (e.g., CAD or PM platforms). Focus initial efforts on AI tools designed to address immediate time-consuming bottlenecks, thereby freeing up personnel time that can be reinvested in further exploration. Consider phased implementation strategies, starting small and scaling gradually. Investigate potential ACEC group purchasing programs or industry partnerships that might offer cost advantages.
- **Personnel & Skills Gap**: Effective AI implementation requires personnel with new skills. Engineers proficient in traditional design or project management software may lack the data analysis skills needed to interpret ML model outputs, manage large datasets, or customize AI tools.
  - *Mitigation*: Invest strategically in targeted training programs – online courses (e.g., Coursera, edX, LinkedIn Learning), workshops, or vendor-specific training. Consider hiring personnel with data science or analytics backgrounds or establishing partnerships with universities or specialized consulting firms. Initially, focus on adopting more user-friendly AI tools that require less specialized expertise ("low-code/no-code" platforms). Crucially, foster an organizational culture that values and supports continuous learning and adaptation (see Section 4.1).
- **Time to Evaluate**: The sheer pace of AI development and the proliferation of tools can be overwhelming. Project managers and discipline leaders, already burdened with project deadlines, may struggle to find the necessary time to research, compare, and select appropriate AI solutions.
  - *Mitigation*: Delegate the initial research and evaluation tasks to the dedicated cross-functional team or internal champion (see Section 7). Leverage curated resources, such as ACEC recommendations, industry technology reports, and reputable review sites. Schedule specific, protected time blocks for evaluation activities. Utilize vendor demonstrations effectively by providing them with specific pain points or use cases to address.
- **Cost**: The initial investment required for AI software licenses, potential hardware upgrades (e.g., for processing large datasets or running complex models), and comprehensive training can be a significant barrier, especially when ROI is uncertain.
  - *Mitigation*: As mentioned, explore AI capabilities within existing software investments first. Seek out modular AI solutions that allow firms to pay only for the specific capabilities they need, rather than large, monolithic platforms. Carefully evaluate open-source AI tools, weighing the cost savings against potential challenges related to support, security, and usability. Frame the discussion around long-term value and ROI rather than solely

focusing on the upfront cost.

- **Integration & Compatibility**: New AI tools must function effectively within the firm's existing technology ecosystem and workflows. Poor integration can create data silos, require cumbersome manual data transfer, and ultimately negate efficiency gains. Compatibility issues can also arise if AI tools cannot produce deliverables in formats required by clients or partners.
  - *Mitigation*: Prioritize AI solutions that offer robust Application Programming Interfaces (APIs) and have documented success integrating with the firm's core software platforms (e.g., BIM, ERP, project management systems). Conduct thorough integration testing during the pilot project phase. Involve the IT department early in the evaluation process to assess technical feasibility and requirements. Proactively discuss technology use and deliverable formats with clients and project partners.

It is important to recognize that these barriers are often interconnected. A lack of leadership can directly impede the allocation of resources needed to evaluate tools or train staff. Uncertainty about ROI reinforces reluctance to commit budget. Integration problems can quickly erode any potential cost savings, validating initial cost concerns. Therefore, addressing AI adoption requires a holistic approach. Tackling leadership commitment and building a clear business case (even for a small pilot) can often unlock the resources needed to overcome other obstacles. Pilot projects are particularly valuable because they allow firms to test not only the AI tool itself but also its integration and impact on workflows in a controlled environment, thereby mitigating multiple risks simultaneously.

Furthermore, the impact of these barriers can differ based on firm size. While smaller firms may face more acute resource constraints, they can often be more agile in decision-making and implementation once a path is chosen. This agility might lead to a faster realization of benefits across the organization, potentially explaining why smaller firms sometimes report higher ROI on foundational technology investments. Larger firms, conversely, may have more resources but can face greater challenges related to integrating new tools across diverse teams, managing internal resistance to change, and navigating more complex organizational structures. Guidance and strategies should therefore be adaptable, offering low-cost entry points and clear ROI justifications for smaller firms, while providing frameworks for managing scale, integration, and cultural shifts for larger organizations.

The Human Side of AI Integration: Cultural Adaptation and Change Management

Successfully integrating AI into an AEC firm involves far more than selecting and deploying software; it requires a deliberate focus on the human element of change. AI adoption is fundamentally a change management initiative that impacts people, processes, and the underlying organizational culture. Neglecting this aspect is a common reason why technology implementations fail to deliver their expected value.

Fostering Buy-in: Gaining support from employees at all levels is critical. This starts with clear communication from leadership about the *reasons* for adopting AI – connecting it to strategic goals, competitive pressures, and tangible benefits for the firm *and* its employees. It is essential to proactively address common fears, particularly regarding job displacement. Frame AI primarily as a tool for *augmentation* – automating tedious, low-value tasks to free up engineers, designers, and project managers for more complex problem-solving, creativity, and client interaction – rather than replacement. Involving staff in the evaluation, selection, and piloting of AI tools can significantly increase acceptance and ownership. Highlighting "what's in it for them," such as reduced administrative burden or access to more powerful analytical tools, can also foster enthusiasm.

Managing the Transition: Integrating AI tools often requires modifying established workflows and processes. This necessitates careful planning:

- **Process Mapping**: Clearly document existing workflows and identify precisely where and how the AI tool will be integrated.
- **Impact Assessment**: Analyze how the change will affect different roles, responsibilities, and required skills.
- **New Standard Operating Procedures (SOPs)**: Develop clear, documented SOPs for using the AI tool, including guidelines for data input, interpreting outputs, required human oversight, and quality control steps.
- **Training and Support**: Provide comprehensive training that goes beyond basic functionality to cover responsible use (see Section 5) and troubleshooting. Offer ongoing support mechanisms (e.g., internal experts, vendor support contacts) as users adapt.

Developing an AI-Ready Culture: Beyond specific implementations, successful long-term AI adoption requires cultivating an organizational culture that embraces innovation and continuous learning. This involves:

- **Encouraging Experimentation**: Create a safe environment where employees feel empowered to experiment with new tools and approaches, understanding that not every pilot will be successful but that learning from failures is valuable.
- **Promoting Data Literacy**: Foster a baseline understanding of data concepts across the organization, enabling staff to better understand how AI tools work and critically evaluate their outputs.
- **Valuing Continuous Learning**: Support ongoing professional development related to AI and data skills.
- **Leadership Modeling**: Senior leaders must visibly champion AI initiatives and demonstrate curiosity and openness to new ways of working.
- **Recognition and Rewards**: Acknowledge and reward teams and individuals who effectively leverage AI tools to improve processes or project outcomes.

The Path to AI Integration: A Checklist

1.   Educate & Build Awareness

- Share foundational AI resources and host internal workshops.
- Focus on practical business applications, not technical details.

2. Form a Cross-Functional Team

- Assemble a small group from IT, operations, finance, and leadership.
- Set clear roles and objectives to guide AI exploration.

3. Identify High-Impact, Low-Risk Use Cases

- Target repetitive tasks and workflow bottlenecks.
- Prioritize based on impact, ease of implementation, cost, and risk.

4. Launch Pilot Projects

- Choose 1–2 use cases with SMART goals.
- Keep scope limited and document results thoroughly.

5. Draft an Initial AI Use Policy

- Create basic guidelines for tool usage, data privacy, and oversight.
- Use the Responsible AI framework (as detailed in Full Report) and update as needed.

6. Evaluate Existing Tools

- Audit current software for built-in AI features.
- Engage vendors to activate and understand these capabilities.

7. Invest in Training

- Train staff on tool usage, limitations, and responsible AI principles.
- Use vendor resources and online platforms.

8. Prioritize Data Governance

- Improve data quality, organization, and accessibility.
- Establish strong governance protocols to support AI success.

AI Governance for Engineering Firms

That last point about good governance is perhaps the most important stop on your firm's AI journey. It's not a way station—it's the destination and getting it right is a critical component of being a responsible corporate citizen in this digital age. Indeed, using AI can bring tremendous risks or tremendous advantages and good governance is a determining factor of which side one lands.

A note at the outset: every firm must determine its own discrete policies and guardrails around the use of AI. The legal landscape specifically governing AI is still evolving, making it imperative for firms to rely on existing legal principles while actively monitoring developments and seeking expert counsel. ACEC's Risk Management Committee has developed a set of guidelines for the use of AI by design professional firms, with the caveat that these are merely guidelines. That said, this

document can serve to provide direction for firms to develop their own policies surrounding the use of AI.

And creating those policies rises to the level of a must-do. Missteps in contractual language, IP management, data handling, or liability allocation could expose AEC firms to severe financial penalties, legal disputes, and reputational harm. Therefore, engaging legal counsel with demonstrated expertise in technology law, intellectual property, data privacy, and the specific nuances of the AEC industry is not just recommended, it is a non-negotiable aspect of responsible AI adoption and proactive risk management. This legal review should encompass internal policies, client and partner agreements, and AI tool procurement contracts.

Closing Argument

Artificial Intelligence is no longer on the horizon; it is actively reshaping the Architecture, Engineering, and Construction industry, presenting both unprecedented opportunities and significant challenges. For ACEC member firms, the question is not if AI will impact their business, but how they will strategically and responsibly integrate it to enhance operations, deliver superior value to clients, and maintain a competitive edge.

That's the impetus behind ACEC's AI whitepaper and behind this abbreviated version of the same. Integrating AI can boost productivity by automating the routine tasks that can detract from more technical ones. Giving over to AI what AI can do leaves more time and space for what must be left to human ingenuity and innovation. But integration must be thoughtful: training people, creating and iterating rules, and guarding against bias and misuse so its benefits reach everyone. With careful planning, AI can be a tool that raises standards instead of widening gaps.