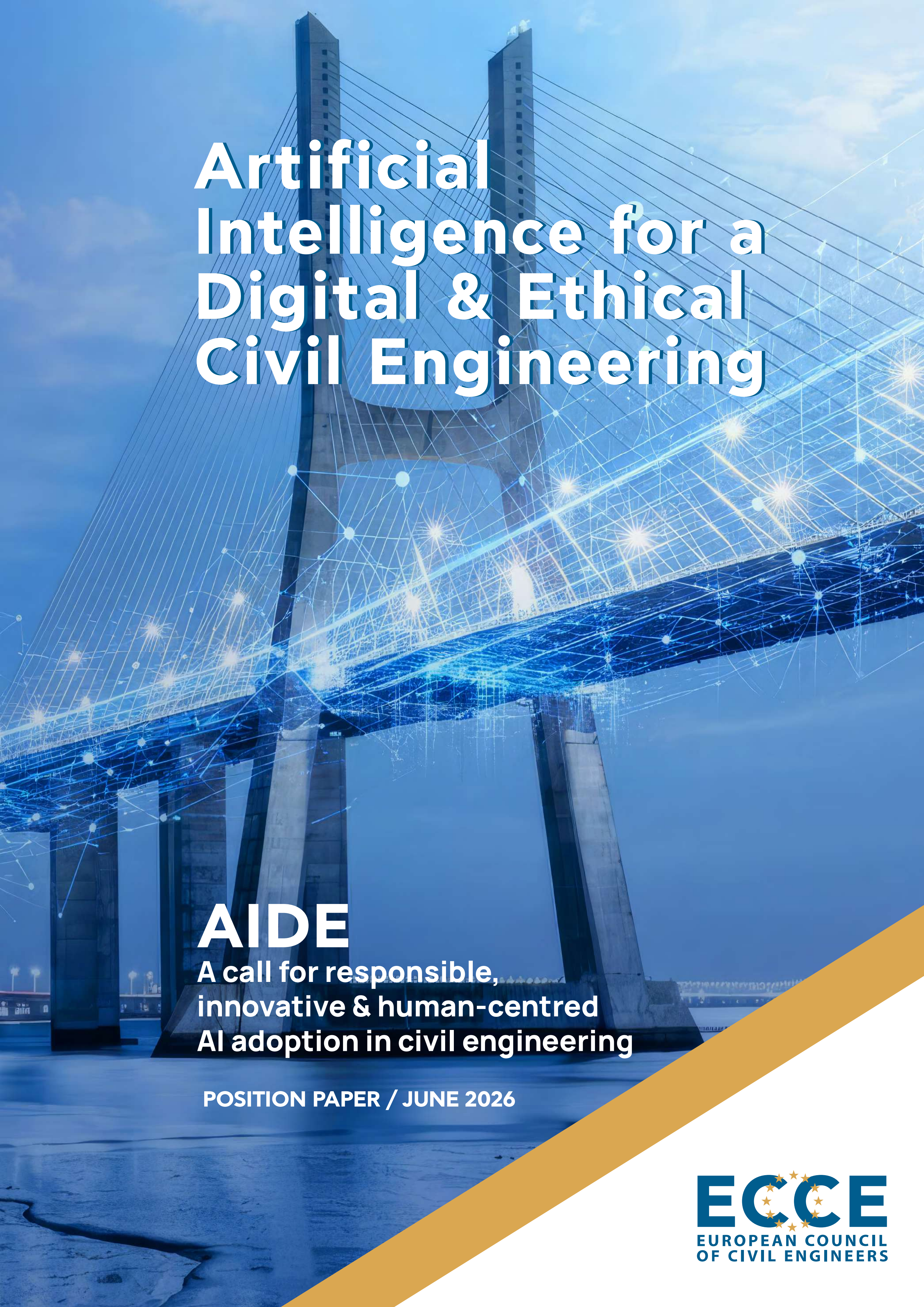

# Artificial Intelligence for a Digital & Ethical Civil Engineering

## AIDE

### A call for responsible, innovative & human-centred AI adoption in civil engineering

POSITION PAPER / JUNE 2026

ECCE
EUROPEAN COUNCIL OF CIVIL ENGINEERS

“*AI is already embedded within civil engineering practice.*

*The defining challenge is ensuring its integration remains aligned with professional responsibility.*”

# The Current State:
# AI as an Emerging Condition in Civil Engineering

The integration of artificial intelligence within the European construction industry is characterised by growing momentum, yet uneven implementation. While the potential of AI is widely recognised, its adoption remains fragmented across countries, organisations, and project scales. The current state is best understood not as a mature transformation, but as an emerging shift shaped by clear drivers, selective applications, and persistent structural barriers.

## Drivers of AI Adoption

The growing focus on artificial intelligence in civil engineering is driven by structural challenges rather than technological curiosity. Key pressures include labour shortages, increasing project complexity, and persistently low productivity. AI offers opportunities to augment capacity, optimise workflows, and improve coordination through data-driven decision-making.

Sustainability requirements further reinforce this need, with European policies demanding improved energy performance, resource efficiency, and carbon reduction—areas where AI can support modelling and lifecycle optimisation. As illustrated in Figure 1, these combined drivers position AI not as an optional enhancement, but as a structural response to systemic pressures, making structured and responsible integration essential for safe and reliable outcomes.

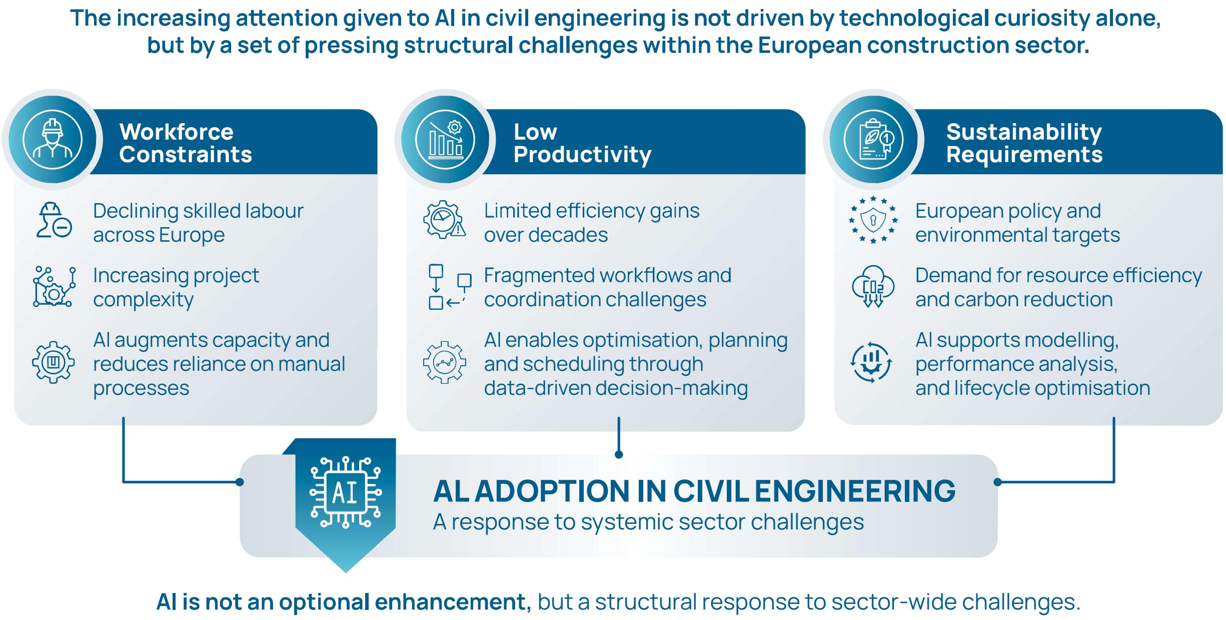


Figure 1: Systemic Drivers Positioning AI as a Necessity in Civil Engineering

## The Hierarchy of AI Adoption Barriers

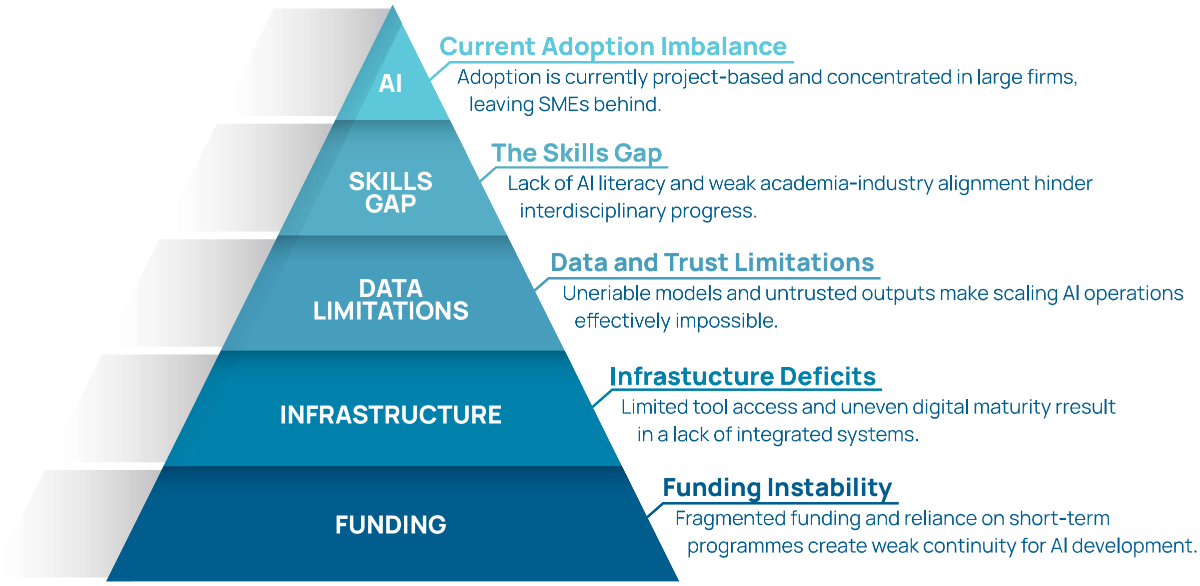


Figure 3: AI Adoption as a Function of Structural Preconditions

The adoption of artificial intelligence is contingent upon a hierarchy of structural preconditions, from infrastructure and data to skills and funding is shown in Figure 3. The absence of any of these layers disrupts coherence, leading to uneven adoption patterns that challenge the consistency expected of engineering practice.

Taken together, these conditions reveal a critical shift: the challenge facing the sector is no longer whether artificial intelligence can be adopted, but whether its adoption can be made coordinated. In the absence of such coherence, the increasing presence of AI within engineering workflows introduces variability that cannot be reconciled with the profession's obligation to ensure safety, reliability, and consistency.

# The Need for Responsible AI Implementation

The integration of artificial intelligence in civil engineering signals a shift not only in tools and processes, but in professional responsibility. As AI increasingly informs design, risk, and operational decisions, the focus is no longer on whether it is used, but on how it is governed to uphold the profession's core values.

## A Shift in Responsibility

AI systems increasingly shape the inputs informing engineering decisions, from design optimisation to predictive analysis. However, responsibility remains with the engineer. Civil engineering is grounded in accountability, requiring decisions to meet regulatory and societal expectations. AI may support decision-making but does not replace professional judgement. Responsibility cannot be delegated to non-accountable systems; therefore, AI outputs require verification, validation, and oversight. Rather than shifting responsibility, AI intensifies the need for demonstrable and

This results in a fragmented landscape where frameworks lack translation into day-to-day decisions. As illustrated in Figure 4, this gap risks creating a false sense of assurance, where compliance exists in principle, but safe and consistent practice is not guaranteed.

This fragmentation does not arise from a lack of frameworks, but from their limited capacity to inform engineering action. The issue is therefore not the existence of principles, but their translation. It is at this point—between intention and execution—that coherence is either established or lost.

## From Principles to Practice

The central challenge is therefore not the absence of principles, but the absence of their translation into engineering practice. Civil engineers are not operating in a regulatory vacuum. Ethical guidelines, professional codes, and emerging AI frameworks already exist. However, these are often too abstract to inform specific engineering decisions, such as how to validate AI-generated design outputs, how to assign liability, or how to integrate AI into site operations.

What is required is a structured approach that bridges this gap, translating high-level principles into actionable guidance that can be applied within design processes, construction activities, and asset management.

It is within this context that the AIDE position paper is valuable: not as an additional layer of principles, but as a means of operationalising them within the realities of civil engineering practice. Translation is not a supporting function; it is the missing infrastructure of AI governance. Figure 5 presents this translation as a structured system, linking principles, practices, adaptation, and professional capability. It is within this system that coherence is established, ensuring that artificial intelligence can be integrated in a manner consistent with engineering responsibility.

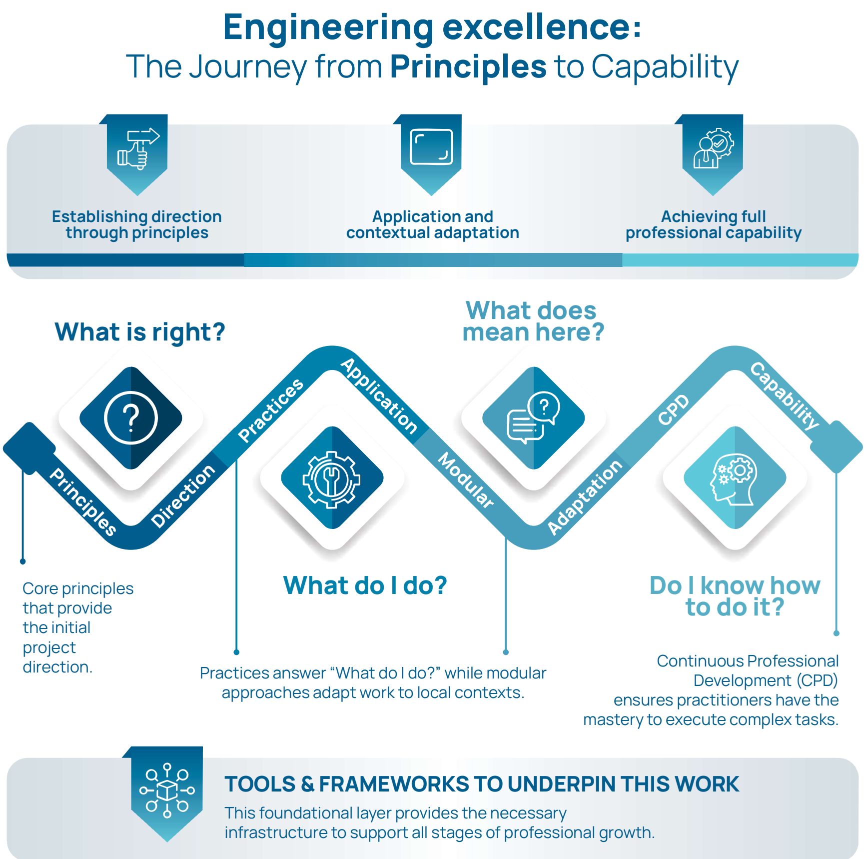


Figure 5: A System of Ethical AI Guidance: From Principles to Practice, Adaptation, and Capability

deliberate integration, there is a growing risk of producing engineers who apply AI tools without fully understanding their implications.

### Insights on AI in Education, Research and Knowledge Transfer

The findings suggest that the challenge is not the absence of AI within education and research, but its fragmented and peripheral integration. Without a more coordinated approach, there is a risk of developing uneven competencies across Europe, leading to inconsistencies in how future engineers understand and apply artificial intelligence in practice

## Societal Factors and Impact

The responses relating to societal factors reveal a clear awareness that the integration of artificial intelligence in civil engineering extends beyond technical considerations. AI is recognised as having direct implications for public safety, trust, equity, and the overall quality of the built environment.

A central theme is the question of public trust. While AI offers opportunities to enhance safety, efficiency, and sustainability, its use introduces concerns regarding transparency and accountability. The "black box" nature of many AI systems challenges the ability of engineers, regulators, and the public to fully understand how decisions are made. This lack of explainability can undermine confidence, particularly in a sector where safety and reliability are paramount.

Workforce transformation is another key consideration. AI is expected to reshape professional roles, automating certain tasks while augmenting others. Across responses, there is a consistent emphasis on the need for reskilling and upskilling, ensuring that engineers are equipped to work alongside AI systems rather than being displaced by them. The future is not framed as a replacement of human expertise, but as a reconfiguration of it. As illustrated in Figure 6, the evolution of professional roles reflects a transition from traditional practice to AI-integrated workflows. Ensuring coherence across this transition is essential to maintain continuity in responsibility, competence, and trust within the profession.

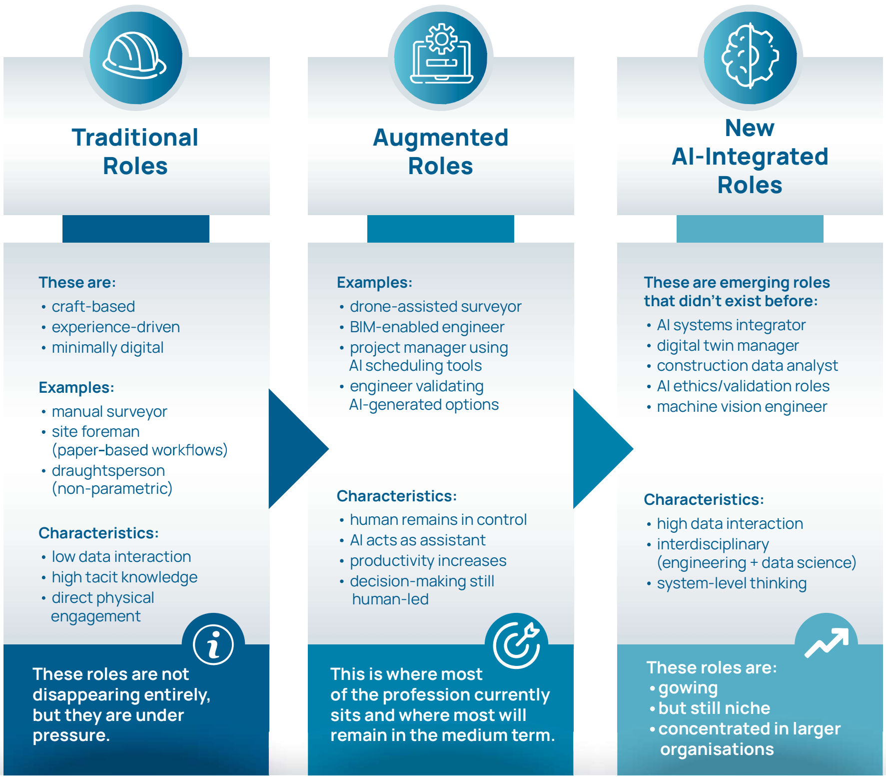


Figure 6: The Workforce Transition Spectrum: Evolving Roles in AI-Enabled Civil Engineering

# Demand to Framework:
# What Engineers Are Asking For

Taken together, the findings across all three pillars point to a consistent and underlying message. Engineers are not asking for more abstract principles; they are asking for the translation of those principles into real practice. This demand can be understood as a structured system composed of four interrelated components:

- **Principles**— ethical direction
- **Industry-specific practices** — application in engineering decisions
- **Modular guidance** — adaptable frameworks
- **Professional development** — building capability

In practical terms, this requires clarity on how AI informs design validation, responsibility, and integration into workflows. The gap is not conceptual but operational—less about more guidance, and more about usable guidance. As shown in Figure 7, weak links across education, industry, policy, and society hinder coherence, requiring stronger alignment for effective AI integration.

The articulation of this need marks a transition from observation to responsibility. If the challenge is one of coherence, then the question is no longer what is required, but who is positioned to enable it.

# Implications for ECCE:
# Enabling Coherent Integration Across the Profession

These concerns define a clear role for ECCE within the evolving AI landscape. The task is not to establish principles in isolation, but to operationalise them within civil engineering practice. This requires translating existing frameworks into actionable guidance, supporting capacity building, and promoting consistent adoption across Europe.

By bridging the gap between principle and practice, ECCE can lead and provide the structure needed for responsible and effective integration. The findings therefore move beyond describing the current state, outlining the conditions for future development and positioning ECCE not only as a contributor, but as a structuring agent within the profession.

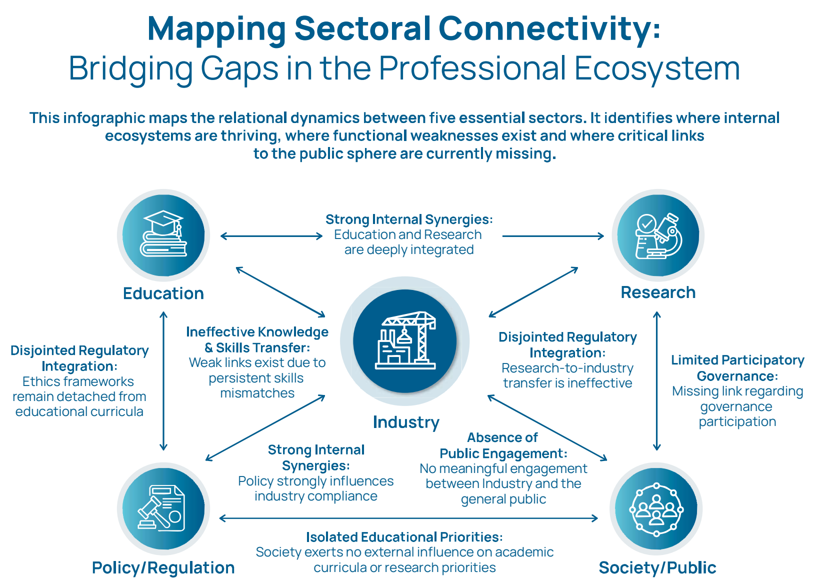


Figure 7: A system transition: Uneven linkages in the adoption of AI in civil engineering

Read the
Position Paper
Executive Summary

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