ASCE

AI Roadmap for Application in Civil Engineering (AI RACE)

2026

AI RACE Advisory Committee

asce.org/initiatives/ai-race

Executive Summary

Overview and Strategic Vision: The American Society of Civil Engineers (ASCE) has developed a comprehensive, thematic roadmap to guide the integration of Artificial Intelligence (AI) across the entire infrastructure lifecycle. The organizing vision is that **civil engineers will harness AI as a powerful, verifiable tool to deliver safer, more resilient, sustainable, inclusive, and accessible infrastructure more efficiently**. A foundational principle throughout the roadmap is that the licensed professional must always retain "responsible charge" over engineering decisions, and that where licensure does not apply a named, competent person remains accountable, ensuring public health, safety, and welfare are never compromised by autonomous systems. The roadmap focuses on AI in the practice of civil engineering.

The Core Imperative: Responsible Adoption with Accountability. The core question of this roadmap is how civil engineers incorporate AI into their practice responsibly while maintaining accountability. Society is already demanding AI for countless applications; the profession's task is to harness it deliberately, so that every use of AI in civil engineering strengthens rather than dilutes the engineer's responsible charge. The roadmap therefore applies a single lens to every application: the boundary between what AI may do and what must remain human, including interpretation of code compliance, selection of governing assumptions, loads, and failure modes, acceptance and transfer of risk, and the resolution of conflicting data. Defining this boundary in practical depth is one of the open questions the roadmap must resolve as it matures; a starter Human-AI Boundary Matrix is now proposed (Appendix A), and five human red lines state plainly what AI must not do (Section 2). The roadmap also keeps the boundary itself under review as evidence about AI performance accumulates, while accountability to the public always rests with identifiable people and institutions (Section 1).

Human red lines. Five rules apply at every capability level under current practice (Section 2): accountability is never delegated, and AI does not hold responsible charge or seal work; no AI output is relied on without verification by a competent person, in proportion to the consequence of error; engineering judgment on code intent, governing assumptions, and risk stays human; ethical, legal, and community-facing judgments stay human; and people set the limits of any agentic or autonomous function and keep the override. Where licensure applies, the licensed engineer holds responsible charge; where it does not, a named, competent person and the organization deploying the AI remain accountable.

AI requires massive, integrated physical infrastructure (data centers, edge computing, and the energy, water, and communications systems) that civil engineers will plan and build whether or not the profession adopts AI in its own practice. This includes the telecommunications and cloud-to-edge backbone (fiber networks, edge compute nodes, and power systems within public rights-of-way, surface transportation, and utility corridors); terrestrial and non-terrestrial integration across the subsurface-to-space data continuum and the ground-air systems interface supporting drones, advanced air mobility, and satellite technologies; and management of AI's immense energy and water demands against the interdependent systems it operates. This enabling infrastructure is a parallel area of work, not a prerequisite for adoption: firms and agencies can use AI in appropriately scoped applications today without waiting for new cloud-to-edge infrastructure (Section 3). ASCE Policy Statement 573 addresses how civil engineers use AI; a companion policy statement on the sustainable design, construction, and operation of AI infrastructure, with communities involved throughout, is proposed (Section 3).

Four Domains, Eleven Pillars. The roadmap is structured around eleven pillars, which readers can enter through four domains, beginning with people: People, Ethics & Public Trust (Pillars 8–10); Engineering Practice & Delivery (Pillars 1–3); Infrastructure Systems & Resilience (Pillars 4–6); and Data & Knowledge Foundations (Pillars 7 and 11). Section 4 presents the pillars in two groups. How AI can be used in civil

engineering (Pillars 1–6): AI-augmented planning, design, and automated checking against codes, standards, and specifications (1); intelligent construction delivery, off-site fabrication, and robotics (2); AI-driven predictive maintenance of public assets (3); smart, real-time operations of infrastructure systems and communities (4); resilience, hazard mitigation, climate adaptation, and disaster risk management (5); and sustainable materials, carbon, and environment (6). What is needed to enable AI in civil engineering (Pillars 7–11): interoperable data, sensing, and digital foundations (7); workforce upskilling and human-AI teaming (8); ethics, governance, licensure, data sovereignty, and independent evaluation of AI tools (9); equity, accessibility, and community-centered outcomes (10); and the research, standards, and knowledge ecosystem (11).

Implementation Timeline and Maturity Arc. The roadmap sequences its actions across three overlapping time horizons, each labeled by the year work is initiated rather than a fixed end date; advancement beyond the short term is gated by readiness milestones, because AI capability and industry practice may move faster than any fixed schedule; for the same reason, guidance, training, and verification and validation (V&V) documentation are pulled forward, and the roadmap is refreshed annually and whenever a trigger event occurs. Adoption is also moving at two speeds: in 2025 surveys, only 27 percent of architecture, engineering, and construction professionals reported using AI (Bluebeam, as reported by ASCE) and about 45 percent of construction professionals reported no AI implementation in their organizations (RICS), while early adopters already run multi-step agentic workflows under engineer supervision. Organizations will therefore move through the horizons at different speeds:

1. **Short term (initiate 2027), Adopt & Build Foundations:** Focuses on foundational AI literacy, policies and governance (including IP ownership and accountability for AI-assisted work), data readiness and data trust (provenance, stewardship, and sharing incentives), assistive and early agentic AI tools, pilot programs, publishing practical guidance, and beginning the joint sector planning for cloud-to-edge enablement.
2. **Medium term (initiate about 2029, readiness-gated), Integrate & Augment:** Focuses on embedding validated AI, including supervised agentic workflows, into standard workflows, publishing machine-readable codes and standards, independent evaluation of AI tools, managing digital twins, and developing siting standards for roadside compute and edge data centers.
3. **Long term (capability-triggered, about 2032 and beyond), Transform:** Envisions a shift to AI-native practice, where autonomous infrastructure systems and autonomous preliminary designs operate continuously under human responsible charge, and cloud-to-edge infrastructure becomes a permanent civil asset class.

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1. Purpose and Significance

This document is the comprehensive skeleton of a unified ASCE roadmap for AI application in civil engineering. It is intentionally thematic rather than prescriptive: it names the territories the profession must cover, sequences them across three overlapping time horizons, and describes the role ASCE can play in each. Its purpose is to give ASCE staff and volunteer leaders a common frame for sharing initiatives, spotting gaps and overlaps, and negotiating ownership, not to fix conclusions in advance. It is written to be absorbed into ASCE's existing programs rather than to run alongside them.

Scope. This roadmap addresses AI in the practice of civil engineering: how engineers plan, design, build, operate, and maintain infrastructure with AI, and what the profession needs to do so responsibly. It starts with education, because foundational AI literacy, including ethics, governance, and roles and responsibilities, comes first. It also covers credentialing and research, standards, and publications as they bear on practice. It is not a complete plan for AI in ASCE's activities, such as student competitions, conferences, and ASCE's internal operations.

The roadmap spans the full project lifecycle (planning, design, construction, operations, maintenance, renewal, and end of life) and all major civil engineering disciplines. It deliberately pairs the "hard" engineering applications of AI with the human-centric dimensions (workforce, ethics, equity, privacy, worker dignity, community voice, and public trust) because the profession's obligation to public health, safety, and welfare makes these inseparable.

Who the roadmap serves. The roadmap is written for civil engineers, but AI-enabled infrastructure increasingly involves other engineering disciplines, data scientists, and the software and platform providers whose systems shape how infrastructure performs. Its principles of responsible use apply to the engineering work itself, whoever performs it, and it calls on civil engineers to work across those boundaries rather than within a single discipline (Pillars 8 and 9).

The roadmap also carries a set of cross-cutting threads that no single pillar owns: the infrastructure systems and project delivery data and digital environments; AI model grounding, evaluation, and development decisions; a lifecycle digital thread from planning and design through delivery, operations, and maintenance; technical, practice, and business process integration and transformation, in design, operations, and asset management as well as construction; digital and intellectual property; corporate and jurisdictional data sovereignty; organizational capacity and workforce development; resilience; cybersecurity and AI system assurance; digital twins as a shared capability; multidisciplinary collaboration; value and business models; and the development and integration of infrastructure systems, including relevant standards needed, to enable AI itself, from cloud to edge, in the public right-of-way, energy, telecommunications, surface infrastructure, and ground-air systems interface.

A premise held open. The roadmap rests on today's premise, consistent with ASCE Policy Statement 573, that AI augments rather than replaces professional judgment. It does not assume that premise is permanent. For specific, well-bounded tasks, evidence may eventually show AI performing more reliably than human judgment, which would bring the current form of human-in-the-loop oversight under legitimate scrutiny. The roadmap leaves that question open for the long term. Any change to where people sit in the decision loop should follow validated evidence, transparent public deliberation, and updated professional and legal frameworks, never commercial pressure alone, and accountability to the public must always rest with identifiable people and institutions.

Alternative futures. Two further contingencies are held in view alongside the base case that AI is additive to current practice. Civil infrastructure may be absorbed into a broader digital ecosystem steered by AI and software platforms outside engineering practice, as when navigation platforms rather than agency signal systems route urban traffic; the profession's role would then shift toward specifying, auditing, and advocating for the public interest in how software steers physical systems. Market forces, from consolidation among large firms to rapid entry by start-ups, may also destabilize practice, creating opportunity alongside the risk that AI is treated as the engineer or deployed mainly to transfer value rather than to improve safety and the human experience of infrastructure. Each update of the roadmap will test these contingencies against observed trends.

2. Vision and Organizing Framework

Working vision: Civil engineers harness AI as a powerful, verifiable tool to deliver safer, more resilient, more sustainable, and more inclusive and accessible infrastructure efficiently, with the licensed professional retaining responsible charge, consistent with ASCE Policy Statement 573.

Four domains: the entry point to the pillars. The eleven pillars are grouped for readers into four domains, beginning with people. Section 4 presents the pillars in two groups; the domains are a way into the roadmap, not another layer of governance. The Section 3 foundation layer, the infrastructure AI itself runs on, sits alongside all four.

Domain	The question it answers	Pillars
People, Ethics & Public Trust	Who directs AI, who is accountable for its use, and who is served by the infrastructure it shapes?	8, 9, 10
Engineering Practice & Delivery	How is infrastructure planned, designed, built, and maintained with AI?	1, 2, 3
Infrastructure Systems & Resilience	How do infrastructure systems operate, withstand hazards, and protect the environment with AI?	4, 5, 6
Data & Knowledge Foundations	What data, research, standards, and knowledge does all of this rest on?	7, 11

AI boundaries, the lens applied throughout: what must remain human. Consistent with ASCE Policy Statement 573, the civil engineer must maintain responsibility for engineering decisions, and AI is not a replacement for professional judgment. Every pillar of this roadmap is to be read through this boundary between engineer and machine, and the boundary applies to the engineering work itself, whoever performs it. Functions that sit clearly on the human side today include interpretation of code intent and compliance; selection of governing assumptions, loads, and failure modes; acceptance and transfer of risk; the decision to override or accept conflicting data and model results; and ethical judgments affecting public health, safety, and welfare. The boundary works at two levels: Policy Statement 573 remains the governing principle, and a practice-specific Human-AI Boundary Matrix (Appendix A), to be completed for each area of practice, makes it operational.

Human red lines. The boundary is stated most plainly in five rules that apply at every capability level under current practice. They are the roadmap's no-go expectations for AI, and every pillar, product, and partnership is held to them:

- **Accountability is never delegated.** AI does not hold responsible charge or seal, sign, or certify engineering work. Where licensure applies, the licensed engineer in responsible charge answers for the

work; where it does not, a named person with demonstrated competence, and the organization that deploys the AI, remain accountable (named accountable competence).

- **No reliance without verification.** No AI output is relied on until a competent person has verified it, with depth proportional to the consequence of error, and its use is recorded (Appendix B).
- **Engineering judgment stays human.** Interpretation of code intent; selection of governing assumptions, loads, and failure modes; and acceptance or transfer of risk are decided by people (Appendix A).
- **Ethics and the public stay human.** Ethical judgments, legal responsibility, and engagement with affected communities, including consent, cultural sensitivity, and care for the people infrastructure serves, are not delegated to AI.
- **People set the limits and keep the override.** Agentic and autonomous functions operate only within limits set by accountable engineers, with human override and a safe fallback when the AI fails.

AI capability levels and human-AI interaction. Responsible charge is exercised differently as AI takes on more of the work. The roadmap uses three capability levels, each with a practical interaction model:

- **Assistive:** AI drafts, retrieves, and recommends; the engineer makes each decision.
- **Agentic:** AI plans and carries out multi-step tasks within predefined limits under engineer supervision; the engineer approves results at defined checkpoints.
- **Autonomous:** AI performs bounded routine functions continuously; the engineer sets the limits, monitors performance, and retains approval and override authority.

Short-term actions mostly concern assistive and early agentic use; medium-term actions bring supervised agentic workflows into standard practice; long-term actions concern autonomous functions under responsible charge. Appendix A applies the three levels to the human core functions listed above.

Using, adapting, and developing AI. Using an AI copilot, integrating or adapting AI within an organization's own tools and data, and developing new AI models are different undertakings, with very different demands for expertise, data, governance, and validation, and the roadmap distinguishes them throughout. For ASCE itself, the default posture is to govern, evaluate, and supply authoritative content. ASCE sets professional requirements and validation criteria; maintains the standards, benchmark datasets, and evaluation suites against which AI tools are tested; and makes its knowledge available to AI through a model-agnostic computable knowledge layer. It works through partners where they offer a better way to deliver applications, keeps independent evaluation separate from any content licensing or development role, and would consider developing or operating a model only where defined evidence shows that grounding existing models in authoritative sources is insufficient (Pillars 1, 9, and 11).

Time horizons, start years, and readiness gates: Each theme progresses through a common maturity arc across three overlapping horizons:

- **Short term** (initiate 2027; roughly 2027–2029), Adopt & Build Foundations: foundational AI literacy, assistive and early agentic AI, data readiness and data trust, pilots, practical guidance, and inventories of what already exists.
- **Medium term** (initiate about 2029, or when short-term readiness gates are met), Integrate & Augment: validated AI, including supervised agentic workflows, embedded in standard workflows, updated standards and curricula, independent evaluation and V&V regimes.
- **Long term** (capability-triggered; about 2032 and beyond), Transform: AI-native practice, autonomous systems under human responsible charge, self-adaptive infrastructure.

Readiness gates and pace. Horizons name when work begins, not when it ends; most actions, once initiated, continue across later horizons, and calendar years are planning estimates. Advancement beyond

the short term is gated by readiness rather than by the calendar: medium- and long-term actions proceed when their prerequisites are demonstrably in place, for example validated benchmark suites, adopted documentation norms, model rules in force, and evidence from pilots. Actions marked “Immediate” respond to decisions engineers face now and can begin in late 2026 or 2027. Two tracks run at different speeds: practice guidance, manuals of practice, training, and V&V documentation, which need no consensus process, move on cycles of months, while consensus standards follow their required process, informed by what the faster products teach. The long-term direction is held steady but refreshed annually and whenever a trigger event occurs, and each action advances only through evidence gates. Because adoption is moving at two speeds and organizations will advance at different rates, an organizational AI readiness self-assessment covering data readiness, workforce capability, governance, validation, and deployment capability is proposed as an early product (Pillar 8).

Structure: Section 3 details AI infrastructure systems integration and enablement as a foundation layer that runs parallel to, rather than ahead of, the pillars. Eleven thematic pillars follow in Section 4, each presented as a table with five readings: the pillar itself; the illustrative critical issues for civil engineering; ASCE’s prospective role; ASCE action needs and concepts, each developed across the three time horizons; and the envisioned pillar outcome, internal and external to ASCE. The pillars are organized in two groups, how AI can be used in civil engineering (Pillars 1–6) and what is needed to enable AI in civil engineering (Pillars 7–11), and grouped for readers into the four domains above. Human-centered concerns (trust, privacy, justice, worker dignity, community voice) are woven through every pillar. Appendices A and B provide a starter Human-AI Boundary Matrix and a draft AI-Use Record template.

3. Foundation Layer: AI Infrastructure Systems Integration and Enablement

Every inference at a roadside traffic-control or telecommunications cabinet, every digital twin refreshed from field sensors, and every autonomous system operating under responsible charge depends on fiber, power, compute, cooling, spectrum, and physical siting rights. That AI infrastructure has to be planned, permitted, designed, built, powered, cooled, secured, and maintained. Siting an edge data center, allocating a jurisdiction's water to cooling, or granting long-term compute rights in a public right-of-way are public health, safety, and welfare decisions. They are being made now, mostly without civil engineering standards to govern them and often without civil engineers at the table, so that siting can be driven by political and commercial considerations rather than sound engineering principles. Buildout is also often neither transparent nor consistent, raising community concern about environmental and local impacts and putting the social license for this infrastructure at risk. The AI infrastructure systems comprise six interdependent elements.

Relationship to the pillars. This foundation layer is a related, parallel area of work, not a prerequisite for adopting AI in practice. Firms and agencies can adopt AI now in appropriately scoped applications that run on existing computing and communications; nothing in the pillars waits on new cloud-to-edge infrastructure. The layer matters for a different reason: data centers, edge computing, and their energy and water demands are being sited and approved today, and the standards they need are required whether AI adoption in engineering practice proceeds quickly or slowly. Civil engineers are both users of AI and enablers who build the infrastructure it runs on; ASCE’s positions must hold both roles in balance, with the public interest first.

Telecommunications and cloud-to-edge backbone. Fiber trunk and distribution networks, conduit and duct bank systems, edge compute nodes, roadside cabinets, small cell and antenna siting, and the civil, structural, geotechnical, electrical, and mechanical engineering work supporting all of it. Includes trenchless installation, joint-trench coordination, and utility conflict management in congested corridors.
Energy supply and grid interface. Generation adequacy, transmission and substation capacity, interconnection queues, on-site and behind-the-meter generation (including gas turbines and small modular or micro-reactors where grid capacity is insufficient), backup and islanding capability, and the load growth that large compute facilities impose on regional systems. Includes the reliability consequences for the communities sharing that grid.
Water, thermal, and emissions management. Cooling water sourcing, consumption and reuse, discharge quality and temperature, and the interaction between data center demand and municipal or agricultural allocation, particularly in water-stressed and island jurisdictions. Includes air emissions and other waste streams from on-site power generation.
Public right-of-way and land use. Siting authority, permitting pathways, franchise and access agreements, co-location on existing assets, zoning and setback treatment for edge facilities, restoration standards after installation, and equitable distribution of both the benefits and the burdens across communities.
Ground-air systems interface and the subsurface-to-space continuum. Physical and data integration across buried utilities, surface infrastructure, structures, low-altitude airspace supporting drones and advanced air mobility, and satellite communications and observation. Includes vertiport and landing infrastructure, airspace-to-ground data handoff, and the surveying and geospatial reference frames that tie the continuum together.
Physical security and resilience of AI infrastructure. Hardening of compute, power, and communications assets against natural hazards (including space weather that can degrade satellite positioning and timing) and deliberate physical and cyber attack; redundancy and graceful degradation when the layer fails; and the cascading consequences for the infrastructure systems that have come to depend on it.

ASCE is positioned to act as convener across sectors that do not routinely plan together, as the developer of siting and design standards that do not yet exist, as an advocate for the public interest, and for civil engineering participation, in siting and resource allocation decisions, and as the technical adviser public owners currently lack when negotiating agreements that will bind their jurisdictions for decades. ASCE holds the recognized standards of practice for siting, designing, powering, cooling, and securing AI-enabling infrastructure, and provides public owners with the technical basis for decisions they currently make without engineering standards or an independent technical adviser. The physical foundation of AI is planned as deliberately as any other public infrastructure, with energy and water demands reconciled against the communities and systems that share them, siting burdens distributed fairly and with consent, and resilience commensurate with the dependence that infrastructure systems have come to place on it.
How AI is built, not only how it is used. ASCE Policy Statement 573 addresses how civil engineers use AI. A companion policy statement on the sustainable design, construction, and operation of AI infrastructure is proposed, together with an environmental management framework (Pillar 6) and a Manual of Practice (Pillar 11). Practical products would follow: a Data Center Toolkit for public owners and communities (checklists, questions to ask, and a report card for evaluating proposals), community planning toolkits, guidance for communities and technology companies, and working groups and industry partnerships. ASCE should have a seat at the table where AI infrastructure is planned, and should help ensure that others,

especially affected communities, have one too, including through clear public communication, in the mass media and elsewhere, about what this infrastructure requires and how its impacts are managed.

4. Thematic Pillars

Each pillar is presented as a table. Reading across: the illustrative critical issues the profession faces, ASCE's prospective role, and ASCE's action needs and concepts, each developed over the three time horizons (labeled by initiation year and readiness gate; see Section 2), followed by the envisioned pillar outcome internal and external to ASCE. Issues, roles, and actions are illustrative starting points for discussion and refinement, not exhaustive lists. Actions marked "Immediate" can begin in late 2026 or 2027. Section 2 also groups the pillars into four domains for readers.

Group A. How AI Can Be Used in Civil Engineering (Pillars 1–6)

Pillar 1. AI-Augmented Planning, Design & Engineering Analysis

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 1. AI-Augmented Planning, Design & Engineering Analysis *Generative and AI-assisted design, simulation and surrogate modeling, automated checking against codes, standards, and specifications, technical process transformation, and the human judgment that must direct it all.*	**Short term (initiate 2027)**			**Internal:** ASCE codes and standards are computable, AI-consumable, and the benchmark against which design AI is independently evaluated. **External:** Safer, better-optimized, lower-carbon designs delivered faster, with engineers demonstrably in charge and public confidence in AI-assisted engineering intact.
	– Unverified AI outputs are already entering sealed work; liability and standard of care are unclear. – General-purpose frontier models are not grounded in civil engineering physics, codes, or data. – Engineers lack trust, training, and evaluation criteria for AI design tools; small firms risk being left behind. – Decisions on which AI tools to adopt are often made by IT, procurement, or vendors rather than by the engineers accountable for the work. – Firms are deciding now whether and how to deploy enterprise copilots, open-weight models, and agentic tools, with little independent guidance. – Many public agencies and laboratories may use only approved AI tools inside security-restricted environments, so guidance must work within operational and organizational constraints.	– Publisher of practice guidance and V&V protocols for AI-assisted design. – Convener of independent tool evaluations accessible to firms of every size. – Assessor of build-versus-connect options: when grounding existing models in authoritative ASCE sources suffices, and what evidence would justify more.	– **Immediate:** Publish practical adoption guidance for AI copilots and agentic workflows in calculations, drawings, specifications, and reports: deployment patterns, tool evaluation, data handling, and the verification obligations of the engineer of record, published as part of a practitioner playbook. – Initiate pilots of generative design and optioneering on real projects; advance physics-informed ML and surrogate models (FEA, CFD, hydrology, seismic). – Prototype automated checking against codes and standards, beginning with selected ASCE 7 provisions; define the requirements any AI model or tool must meet to be used with ASCE content. – Build human-AI trust deliberately: explainability expectations, engineer-in-the-loop checkpoints, and training that keeps judgment sharp.	
	Medium term (initiate about 2029; readiness-gated)			

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	– Technical processes need end-to-end re-engineering; codes are not machine-readable. – Uncertainty quantification and explainability are immature, yet reviewers and the public need both. – Domain-adapted models raise unresolved questions of training data rights, validation, control, ownership, hosting, upkeep, liability for outputs, and funding. – Design tools, model updates, and AI supply chains can be compromised, silently corrupting engineering outputs.	– Standards modernizer: machine-readable ASCE 7 and companion standards. – Independent evaluator of design AI against a public benchmark library, rather than certifier of commercial products. – Owner of a model-agnostic computable knowledge layer: curated, versioned ASCE content, with attribution and IP safeguards, that any qualified AI tool can draw on.	– Publish machine-readable versions of key ASCE standards enabling automated checking. – Redesign technical processes around human-AI teaming; embed AI in performance-based and multi-hazard design with uncertainty quantification as standard output. – Extend verification practice to supervised agentic workflows: defined checkpoints, approval gates, and audit trails for multi-step AI agents. – Ground AI design tools in authoritative ASCE content through the computable knowledge layer; consider dedicated model development, with partners, only where evidence shows grounding is insufficient. – Optimize designs jointly for cost, carbon, constructability, and lifecycle performance.	
	Long term (capability-triggered; about 2032+)			
	– AI-native design challenges how human judgment, creativity, and responsible charge are exercised and demonstrated. – Codes and review processes built for human-paced design cycles cannot govern continuous machine-paced design. – Engineering algorithms and AI tools are increasingly written by people outside the engineering profession, beyond the reach of professional accountability.	– Keeper of the standard of care for AI-native practice. – Guarantor that the licensed engineer remains in responsible charge of autonomous design.	– Deploy AI-native design environments exploring the full design space, with the licensed engineer directing intent and holding responsible charge. – Evolve computable codes and standards that update continuously from observed infrastructure performance. – Qualify autonomous preliminary design for standard facility types, sealed and verified by professional engineers.	

Pillar 2. Intelligent Construction & Project Delivery

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	Short term (initiate 2027)			**Internal:**

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 2. Intelligent Construction & Project Delivery *AI on the jobsite and in the project office: safety, quality and consistency, progress, cost, schedule, contracts, robotics, off-site fabrication and modular construction, and the project delivery and business administration data and digital environment that underpins them.*	– Project delivery and business administration data (contracts, costs, schedules, submittals) is fragmented across incompatible systems. – Thin margins limit AI investment, especially for small and mid-size contractors. – Field workers, especially in unskilled and semi-skilled roles, fear displacement; safety incidents persist; procurement rules lag the technology.	– Convener of owners, contractors, and designers on AI adoption. – Publisher of adoption playbooks scaled to small contractors and public owners. – Advocate for field workers: augmentation and upskilling, not displacement.	– Deploy computer vision for site safety, PPE compliance, quality and consistency checks, and progress tracking against 4D models. – Adopt AI-assisted estimating, bid analysis, and schedule risk forecasting; apply document intelligence to contracts, submittals, RFIs, and change orders. – Standardize the project delivery and business administration data environment: common data environments, digital contracting, structured cost and schedule data. – Pilot construction robotics and automated machine guidance with worker input on deployment.	ASCE practice standards make ASCE the home for AI-enabled project delivery knowledge. **External:** Projects delivered faster, safer, and on budget; construction careers upgraded rather than eliminated, with the most dangerous work done by machines.
	Medium term (initiate about 2029; readiness-gated)			
	– Business administration processes (finance, procurement, HR, risk) and technical workflows must transform together or AI gains stall. – Robotics at scale, and the AI embedded in robots, raise safety assurance, liability, supervision, and workforce transition questions. – Owners lack contract language and evaluation criteria for AI-enabled delivery.	– Author of model contract language and business process transformation guidance. – Standard-setter for AI-assisted project controls and claims analytics.	– Scale semi-autonomous equipment and robotic crews for repetitive and hazardous tasks, paired with field workforce transition and upskilling programs. – Run AI-driven integrated 4D/5D project controls with predictive claims and dispute-risk analytics. – Transform business administration processes alongside technical ones: AI-enabled finance, procurement, risk, and compliance. – Optimize off-site, modular, and additive construction; apply AI to materials logistics and embodied-carbon-aware procurement.	
	Long term (capability-triggered; about 2032+)			
	– Highly automated sites redefine the human role in construction. – Accountability for robotic work and AI-managed programs is unsettled.	– Standard-setter for automated construction QA, assurance of AI embedded in robots, and human oversight of robotic fleets.	– Operate highly automated sites where humans supervise robotic fleets, supported by a skilled workforce of robotics technicians, programmers, and maintainers, and jobsite fatalities approach zero. – Institutionalize continuous, self-verifying as-built capture eliminating the design-versus-built gap. – Deliver megaprograms with AI-managed portfolio controls.	

Pillar 3. Asset Management, Inspection & Predictive Maintenance

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 3. Asset Management, Inspection & Predictive Maintenance *Condition assessment, structural health monitoring, deterioration modeling, and maintenance optimization for all physical infrastructure, including bridges, buildings, tunnels, utilities, pipelines, pavements, rail, dams, levees, and ports.*	**Short term (initiate 2027)**			**Internal:** The Infrastructure Report Card runs on continuous, AI-informed condition data rather than periodic estimates. **External:** Longer-lived, safer assets; the public sees current, honest infrastructure condition and the case for investment.
	– Inspection backlogs grow while the inspector workforce ages; condition ratings remain subjective. – Decades of inspection records are trapped in unstructured reports and PDFs. – Owners hesitate to trust AI-derived condition data for funding decisions.	– Publisher of AI-assisted inspection guidance aligned with NBI and agency standards. – Augmenter of the inspector workforce: AI as a force multiplier for scarce experts. – User of AI-informed data in the Infrastructure Report Card.	– Standardize drone- and vehicle-based inspection with AI defect detection (cracks, spalls, corrosion, scour, leaks). – Use connected-vehicle telematics and other crowdsourced data as condition sources (for example, pavement roughness), validated against conventional measurement. – Deploy ML deterioration and remaining-service-life models on inventory data; digitize legacy inspection records. – Use AI for risk-based inspection and maintenance prioritization under constrained budgets, with treatment selection and budget decisions requiring human sign-off. – Publish SHM data interpretation and anomaly detection guidance.	
	Medium term (initiate about 2029; readiness-gated)			
	– Fusing inspection, sensor, and operational data into one asset picture is technically and institutionally hard. – Predictive maintenance requires funding models built for reaction, not anticipation. – Automated ratings must earn regulatory and public acceptance. – AI inspection systems, sensors, and condition data can be manipulated to hide or fabricate defects; data integrity needs assurance.	– Independent evaluator of automated condition-rating tools against public benchmarks. – Convener of owners (DOTs, utilities, districts) on twin-based asset management. – Advocate for transparent public reporting of asset condition.	– Operate digital-twin-based asset management fusing inspection, sensor, and operational data for major networks. – Shift from scheduled to predictive maintenance at network scale; align automated condition ratings with national standards. – Qualify embedded and self-sensing materials in design standards. – Publish transparent public dashboards so communities can see the condition of infrastructure they depend on.	
	Long term (capability-triggered; about 2032+)			

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	– Autonomous inspection at national scale raises airspace, liability, and data governance questions. – Closing the loop from observed performance back into design codes has no institutional home.	– Steward of the national performance feedback loop from assets to codes.	– Field self-diagnosing, self-reporting infrastructure and autonomous inspection fleets covering the national inventory continuously. – Mainstream self-healing material systems. – Institutionalize AI stewardship of whole-life portfolios, feeding observed performance back into design codes (Pillar 1).	

Pillar 4. Smart Operations of Infrastructure Systems & Communities

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 4. Smart Operations of Infrastructure Systems & Communities *Real-time AI operation of transportation, water, utilities, ports, buildings, and urban and rural communities, plus the infrastructure systems development and integration (cloud-to-edge) needed to enable it.*	**Short term (initiate 2027)**			**Internal:** A standing community of practice for infrastructure operations, spanning disciplines, with shared standards for AI-run systems. **External:** Infrastructure that serves more people better with less energy, with privacy, accessibility, and equity engineered in rather than bolted on.
	– Operations are siloed by sector; legacy SCADA and control systems resist integration. – Pervasive sensing raises privacy concerns communities have not consented to. – Public rights-of-way, energy, and telecom networks lack the edge computing and power capacity AI operations require.	– Convener across transportation, water, energy, and telecommunications operators. – Publisher of privacy-protective sensing guidance that keeps community trust. – Planner's voice for AI-enabling infrastructure in the public right-of-way.	– Pilot AI traffic signal optimization, incident detection, and demand prediction; deploy AI for water loss, demand forecasting, and treatment optimization. – Apply AI to building energy, indoor environment quality, and grid-interactive operation; predict utility outages. – Begin joint sector planning for cloud-to-edge enablement: edge nodes, fiber, and power integrated with surface transportation and utility corridors. – Set privacy and community-consent norms for operational sensing.	
	Medium term (initiate about 2029; readiness-gated)			
	– Interdependencies (energy-water-transport-telecom) mean local optimization can cause system failure. – Connected and automated vehicles and the ground-air systems interface (drones, advanced air mobility) demand new physical and digital integration. – Cybersecurity of AI-operated critical infrastructure becomes a life-safety issue.	– Standards developer for AI-operated critical infrastructure, including fail-safes and cybersecurity. – Standards developer for hosting cloud-to-edge assets in streets, structures, and utility corridors, and for the ground-air interface.	– Manage integrated corridors including CAVs; coordinate multimodal and freight operations; integrate the ground-air systems interface. – Operate community- and city-scale digital twins linking transportation, water, energy, and buildings. – Optimize port, inland waterway, and coastal navigation logistics with AI. – Adopt cybersecurity and fail-safe requirements for AI-operated critical infrastructure.	

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	Long term (capability-triggered; about 2032+)			
	– Algorithms increasingly decide who gets service, when, and at what price. – AI's own energy and water demands compete with the systems it operates. – Infrastructure is increasingly steered by software platforms outside engineering practice (for example, traffic routed by navigation apps), shifting operators toward safeguarding the public interest. – Adversaries may use AI to attack the AI that operates infrastructure, creating asymmetric cyber-physical threats.	– Guardian of public-interest objectives (safety, equity, accessibility) inside autonomous operations. – Advocate for the public interest in how software platforms steer infrastructure systems.	– Run self-optimizing, interdependent networks balancing service, cost, energy, emissions, and equity in real time. – Integrate autonomous mobility fully into roadway, transit, and land-use systems. – Operate adaptive urban systems that reconfigure for events, disruptions, and demographic change. – Prepare for AI-enabled cyber-physical attack through adversarial testing, manual fallback, and degraded-mode operation of AI-operated systems.	

Pillar 5. Resilience, Climate Adaptation & Disaster Risk Management

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 5. Resilience, Climate Adaptation & Disaster Risk Management *AI for hazard prediction, risk quantification, mitigation and adaptation planning, emergency response, and recovery across seismic, wind, flood, coastal, geotechnical, fire, and winter storm hazards.*	**Short term (initiate 2027)**			**Internal:** ASCE becomes the coordination point where hazard communities share AI methods instead of reinventing them. **External:** Fewer lives and livelihoods lost; communities, especially the most vulnerable, are measurably safer and recover faster.
	– Hazard data gaps and forecast skill limit warning time; damage assessment after events is slow. – Vulnerable populations are hit first and recover last, and current models rarely see them. – Climate projections arrive in forms engineers cannot directly design against.	– Convener of hazard communities across disciplines. – Standards developer for AI-based rapid damage assessment. – Translator of climate science into engineering design inputs.	– Improve AI hazard forecasting: flood and storm surge, hurricane wind fields, wildfire spread, landslide susceptibility, seismic ground motion, ice storms, and heavy snowfall. – Standardize AI rapid damage assessment from satellite, aerial, and street-level imagery. – Downscale climate projections with ML for design inputs; compile fragility datasets suitable for machine learning. – Map social vulnerability into risk models so protection reaches those who need it most.	
	Medium term (initiate about 2029; readiness-gated)			

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	– Codes assume stationary climate; loads are no longer stationary. – False-alarm fatigue erodes trust in warnings; risk communication is an afterthought. – Adaptation investment lacks defensible prioritization. – Aging infrastructure faces loads it was not designed for, leaving systems underdesigned and stressed at the same time.	– Embedder of AI-derived, nonstationary climate loads into ASCE 7, ASCE 24, and MOP series. – Champion of human-centered risk communication and warning design.	– Deploy community-scale multi-hazard early warning with AI-driven evacuation modeling and human-centered, multilingual risk communication. – Run probabilistic regional risk digital twins to prioritize mitigation, adaptation, and hardening, weighted for equity as well as economics. – Embed nonstationary climate loads into standards; design nature-based and hybrid coastal defenses with AI.	
	Long term (capability-triggered; about 2032+)			
	– Anticipatory infrastructure requires standards that do not yet exist. – Managed retreat poses ethical and governance questions no algorithm should answer alone.	– Trusted arbiter of adaptation standards, including equitable frameworks for managed retreat.	– Field anticipatory infrastructure that senses precursors and reconfigures before hazard events. – Coordinate regional emergency response and recovery logistics with AI under human incident command. – Re-plan dynamic adaptation pathways, including managed retreat, continuously as climate signals evolve.	

Pillar 6. Sustainability, Environment & Advanced Materials

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 6. Sustainability, Environment & Advanced Materials *Decarbonization, lifecycle assessment, circular economy, environmental protection and restoration, stewardship of natural resources for future generations, and AI-accelerated materials innovation directed at verified performance and sustainability needs rather*	**Short term (initiate 2027)**			**Internal:** Sustainability metrics are embedded in every ASCE standard and design tool. **External:** Decarbonized, regenerative infrastructure protecting the health of current and future generations.
	– Carbon accounting is immature and inconsistent; greenwashing risk is real. – Environmental review and permitting delays stall good projects. – Material innovation outpaces qualification and codes.	– Publisher of carbon estimation guidance and benchmarks. – Convener with the materials industry and environmental agencies.	– Provide AI tools for embodied and operational carbon estimation at design time. – Optimize low-carbon concrete and alternative mixes with ML; apply AI to environmental monitoring, water quality, and contaminated site characterization. – Use document AI to accelerate environmental review and permitting while protecting review integrity and community voice. – Develop, with the Section 3 foundation layer, an environmental management framework for AI infrastructure that accounts for energy, water,	

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
than innovation for its own sake.			land, and emissions and reduces AI's environmental footprint.	
	Medium term (initiate about 2029; readiness-gated)			
	– Novel AI-discovered materials lack qualification pathways. – Circular-economy logistics (deconstruction, reuse) have no data infrastructure. – AI's own energy, water, land, and air-emissions footprint must be counted honestly.	– Standards developer for AI-discovered materials qualification. – Integrator of automated LCA into codes and design practice. – Honest broker on AI's own environmental footprint in infrastructure.	– Accelerate discovery and qualification of sustainable materials (binders, geopolymers, bio-based) via AI. – Automate lifecycle assessment inside design tools; make carbon a first-class constraint alongside safety and cost. – Plan deconstruction, material reuse, and circular-economy logistics with AI; model watersheds, ecosystems, and water-energy-food interactions.	
	Long term (capability-triggered; about 2032+)			
	– Net-zero must become the default, not the premium option. – Landscape-scale restoration exceeds human planning capacity without AI.	– Global voice for sustainable, resilient, regenerative, AI-enabled infrastructure.	– Make net-zero and regenerative infrastructure the default design outcome. – Run AI-managed environmental restoration (wetlands, rivers, coastal ecosystems) at landscape scale. – Integrate civil infrastructure into planetary-scale monitoring and carbon accounting.	

Group B. What Is Needed to Enable AI in Civil Engineering (Pillars 7–11)

Pillar 7. Data, Sensing & Digital Foundations

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	Short term (initiate 2027)			

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 7. Data, Sensing & Digital Foundations *The infrastructure systems data and digital environment every other pillar depends on: standards, sensing, interoperability, a common geospatial reference, reference datasets, digital twins, and the cloud-to-edge physical infrastructure that enables AI.*	– Infrastructure systems data is fragmented, siloed, and inconsistently structured across owners, agencies, and firms; much of the record is not yet digital. – No common schemas or quality benchmarks; data gaps, quality, and availability vary widely; data ownership and rights are unclear. – Project data are often not tied to a common geodetic reference, so they cannot flow into digital twins, operations, or wider spatial analysis and become disposable after the project. – Infrastructure owners rarely monitor performance or collect data in AI-ready form. – Many relevant standards and schemas already exist across the surveying, geospatial, and digital twin communities; duplication is a real risk. – Data provenance is rarely recorded: users cannot tell where data came from, how it was processed, or whether it is fit for use, and synthetic or AI-generated data can enter records unlabeled. – Public and federal data sources the profession depends on are being reduced or discontinued, with no party responsible for their continuity or funding. – Firms and agencies have little incentive to share data, and contributors receive little credit when they do. – Public rights-of-way, energy, and telecommunications systems were not planned to host the cloud-to-edge computing that AI operations will require. – Legacy infrastructure was neither designed nor retrofitted for autonomous operation.	– Convener of owners, agencies, and industry on data standards. – Curator of a limited set of reference datasets for evaluation, hosted with partners, and author of data-quality guidance; a convener rather than a data holder. – Advocate for the continuity of public datasets and for their sustainable stewardship by partners. – Early voice on planning public infrastructure for AI enablement.	– Convene targeted federal-society-sector task forces, modeled on the NOAA-ASCE partnership (for example with NIST, DOT, or DOE), to identify and produce the specific AI-ready datasets and tools the profession needs; establish governance and sharing frameworks, with ASCE as convener rather than data holder. – **Immediate:** Form an ASCE data advisory board, supported by a technical committee, to chart a roadmap for open civil engineering data models and benchmark datasets (structure, hosting, and governance), working with nonprofit open-source foundations, so that anyone who wants to create, access, or steward a dataset knows where to start. – Encourage and guide infrastructure owners to monitor performance and collect AI-ready data as part of routine asset management. – Adopt common metadata and interoperability standards (BIM, GIS, digital as-builts, ASCE 38/75), recognizing that AI is changing conventional metadata practice; promote the modernized National Spatial Reference System (NSRS) as the common geodetic reference for project data. – Before developing new ASCE products, review existing standards and best practices across the surveying, geospatial, and digital twin communities (for example TRB, OGC, ISO, NSPS, buildingSMART International, RICS, the Digital Twin Consortium, and federal NSDI working groups) and fill only the gaps. – Curate a limited set of reference datasets for evaluation (inspection imagery, load histories, hydrologic records, soil borings, connected-vehicle telematics), hosted with partners rather than by ASCE. – Publish data provenance expectations for AI-ready infrastructure data (source, collection method, processing history, quality, rights, and fitness for use, carried with the data), including engineering review of data used to train or ground models, and controls for synthetic and AI-generated data: labeling, validation against	**Internal:** ASCE standards and reference datasets become the reference data layer for the profession, available through ASCE services and through the third-party tools engineers already use, and every civil engineering discipline builds on one shared digital foundation. **External:** An interoperable, trusted national infrastructure data and digital environment, physically enabled from cloud to edge, that powers every other pillar.

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
			measured data, and limits on use in design and evaluation. – Identify the public datasets civil engineering depends on, assess their continuity risk, and publish a stewardship position naming candidate custodians and sustainable funding routes. – Design incentives for data and knowledge sharing: credit and recognition for contributors, tiered access, and protection for proprietary and sensitive data (with Pillar 11). – Launch planning guidance for AI-enabling infrastructure: edge compute, fiber, and power in public rights-of-way, surface transportation, and the ground-air interface.	
	Medium term (initiate about 2029; readiness-gated)			
	– Digital twins and similar smart infrastructure systems lack standard schemas and lifecycle handover rules; real-time sensor integration is ad hoc. – Data rights and sovereignty questions multiply as data crosses corporate and jurisdictional boundaries. – Training data, sensor feeds, and model updates are attack surfaces: poisoned or spoofed data can silently corrupt AI outputs. – Edge computing, fiber, and power demands begin competing for space and capacity in streets, structures, and utility corridors.	– Standards developer for digital twin kind of system schemas, data handover, and autonomous data capture. – Broker, not operator, of a shared infrastructure data commons hosted by partners. – Standards developer for accommodating cloud-to-edge assets in the public right-of-way.	– Broker a tiered-access infrastructure data commons hosted by partners, run as public digital infrastructure: open where possible, held in trust, governed in the public interest, and complementing rather than competing with existing providers. – Standardize digital twin schemas and lifecycle data handover from design through operations, with common expectations across all pillars for interoperability, synchronization, validation, uncertainty, and lifecycle management. – Define criteria for AI-ready data pipelines; extend surveying and geomatics standards for autonomous capture (UAS, LiDAR, satellite, subsurface imaging). – Advocate for policy that treats digital and geospatial data, and the frameworks that support them, as critical infrastructure alongside physical infrastructure, including dedicated funding for the National Spatial Data Infrastructure. – Develop siting, structural, and utility standards for edge data centers and roadside compute.	
	Long term (capability-triggered; about 2032+)			

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	– National-scale federated digital infrastructure systems require sustained governance, funding, and trust; the National Spatial Data Infrastructure called for by the Geospatial Data Act of 2018 still lacks dedicated funding. – Continuous data streams from smart assets outpace validation and archiving practice. – Cloud-to-edge infrastructure (including the ground-air systems interface for drones and advanced air mobility) becomes a permanent new civil asset class.	– Trusted national and international convener and standards body for the infrastructure data environment. – Keeper of the framework federating regional digital systems into a national picture.	– Federate continuously updated digital twin models of regional and national infrastructure systems. – Standardize self-describing smart assets streaming condition and usage data from commissioning to decommissioning. – Integrate the subsurface-to-space data continuum underpinning autonomous engineering workflows.	

Pillar 8. Workforce, Education & Professional Practice

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 8. Workforce, Education & Professional Practice *Preparing people and organizations to use AI well: foundational AI education for every civil engineer and student; development of judgment at every career stage; curricula, credentials, and career paths; human-AI teaming; and the capacity of firms and public agencies to adopt AI responsibly.*	**Short term (initiate 2027)**			**Internal:** ASCE becomes the profession's home for AI upskilling; membership grows because members are visibly supported through change. **External:** A larger, more diverse profession confidently directing AI, with organizational capacity reaching small firms and public agencies, and no member left behind.
	– AI literacy gaps exist at every career stage; hype and fear both distort decisions. – Small firms and public agencies lack organizational capacity to adopt AI responsibly. – Faculty and curricula lag practice; students graduate unprepared for AI-augmented work. – Reliance on AI differs by career stage: early-career engineers risk leaning on AI before they develop their own judgment, mid-career engineers gain workflow support and error flags, and those in responsible charge gain faster testing and review of designs; at every stage, AI can shortcut the routine work through which judgment is learned. – Much real adoption is driven by individual engineers and students building their own tools (automation scripts, document-processing pipelines, retrieval systems) outside formal programs.	– Educator: foundational AI literacy common to all civil engineers first, then CEUs, certificates, and webinars tailored to each practice area. – Trainer of trainers: preparing faculty, supervisors, and mentors to teach AI use. – Honest communicator on workforce impacts, resisting both hype and fear. – Capacity-builder for small firms and public agencies, keeping AI learning and tools affordable.	– **Immediate:** Launch a foundational AI literacy program common to all civil engineers and students (how AI works, its strengths and failure modes, verification, ethics, governance, and roles and responsibilities), with practice-area modules built on that common base; integrate AI and data science into curricula and the CE Body of Knowledge. – **Immediate:** Develop a profession-wide AI competency framework: what civil engineers need to lead, use, and develop AI at each career stage, from specifying requirements and prompting to verification, together with human-centered skills such as communication, creativity, and teamwork, feeding the CE Body of Knowledge, continuing education, credentials, and job preparation standards. – **Immediate:** Train the trainers: prepare faculty, supervisors, and mentors to teach AI use, through AI content in ASCE's ExCEEd teaching workshops for faculty, a focus group on AI teaching practices	

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	– Hour-based fees penalize productivity: if AI compresses design hours, firms earn less, so they rationally hesitate to adopt. – Faculty, supervisors, and mentors are expected to teach AI use they were never taught, while many members are trained first by vendors with a commercial interest. – AI tools that feel free today may become expensive after the current introductory period, and access to tools and training is uneven across firm sizes, public agencies, regions, and schools. – Adoption stalls when leaders are less comfortable with AI than their staff; change leadership matters as much as tools. – Demand for infrastructure work is outpacing the supply of engineers, so AI is needed to extend the profession's capacity, not only its efficiency.		and training needs, premade course modules in a shared repository, and an AI Education Summit. – Reach practitioners quickly through early adopters in practice and academia: case-based webinars, short courses, and a virtual training series, with AI sessions at the ASCE 2027 conference recorded and shared. – Publish organizational capacity and adoption playbooks for firms and agencies of every size: tool selection, low-cost options, pilots, upskilling, change management. – Publish an organizational AI readiness self-assessment covering data readiness, workforce capability, governance, validation, and deployment capability. – Assess workforce impacts honestly (which tasks change, which roles emerge) and communicate them plainly to members. – Support early-career engineers whose traditional learning tasks are being automated with mentorship and development models that build judgment, including the habit of challenging AI outputs rather than simply operating tools. – Safeguard skills: identify the core skills engineers must retain without AI, design assignments and training so that AI does not shortcut learning, and build verification reflexes. – Develop change leadership for executives, principals, department heads, and senior faculty: leading people through adoption, managing change, and communicating with staff and clients. – Recognize practitioner-builders and student-builders through an annual Member and Student AI Showcase that feeds independent evaluations (Pillar 11); set clear AI-use expectations for ASCE student competitions.	
	Medium term (initiate about 2029; readiness-gated)			

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
	– Accreditation and licensure evolve slower than the technology. – New roles (infrastructure data scientist, digital twin engineer, robotics technician) have no defined pathways; the profession competes with tech for talent, yet has not made the case that AI moves civil engineering work away from monotony and toward judgment. – Mid-career reskilling at scale has no delivery model.	– Credentialing body for AI competencies; partner to ABET and NCEES. – Architect of human-AI teaming role definitions and career ladders.	– Embed the AI competency framework in ABET accreditation and the next CE BOK edition; establish micro-credentials and specialty certifications. – Redesign roles and career ladders around human-AI teaming; create pathways for infrastructure data scientists and digital twin engineers. – Define an AI-use career lifecycle: what engineers should be able to do without AI, with AI, and in directing AI at each career stage, and how judgment is developed and assessed along the way. – Lead a collective effort with owners and industry partners (for example ACEC) on compensation models that reward quality and outcomes rather than hours as AI raises productivity. – Prepare civil engineers to work in multidisciplinary teams with other engineering disciplines, data scientists, and software and platform providers. – Use AI itself to widen and diversify the talent pipeline: personalized learning, multilingual training, outreach to underrepresented groups. – Build organizational transformation support on the readiness self-assessment: peer exchanges, advancement plans, and shared staff development resources.	
	Long term (capability-triggered; about 2032+)			
	– As AI absorbs routine analysis, the profession must redefine the engineer's distinct, enduring value. – Human skills (judgment, ethics, empathy, leadership) risk atrophy if education does not deliberately cultivate them.	– Definer and defender of the engineer's enduring professional value.	– Transform education from tool instruction to directing, verifying, and taking responsibility for intelligent systems. – Center curricula on judgment, ethics, systems thinking, communication, and public leadership. – Make continuous, AI-supported lifelong learning the professional norm.	

Pillar 9. Ethics, Governance, Licensure & Public Trust

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 9. Ethics, Governance, Licensure & Public Trust *Responsible AI use, professional responsibility and liability, digital and intellectual property, corporate and jurisdictional data sovereignty, verification and validation, independent evaluation of AI tools, security across the AI lifecycle, the definition of quality for AI-assisted work, and licensure, including accountability where licensure does not apply.*	**Short term (initiate 2027)**			**Internal:** ASCE governance products are adopted by licensing boards, agencies, and courts as the reference standard of care. **External:** Public trust preserved; engineers' intellectual property, client confidentiality, and jurisdictional data sovereignty protected as AI becomes ubiquitous.
	– Liability for AI-assisted errors is unsettled; the standard of care is shifting under practitioners' feet. – Digital and intellectual property is contested: who owns AI outputs, and whose work trained the models? – Client and public data entered into third-party models crosses corporate and jurisdictional boundaries without clear sovereignty rules. – Engineers and students build their own AI tools, with unclear ownership when built outside employment and unclear conditions for relying on self-built code in sealed work. – Market pressure from consolidating large firms and fast-moving start-ups risks treating AI as the engineer, and deploying it to transfer value rather than to improve safety and the human experience. – Not all jurisdictions, sectors, or delivery models require a licensed engineer, leaving accountability for AI-assisted work undefined where no license applies. – There is no shared definition of quality for AI-assisted work, so the standard of care is being set by default rather than by the profession. – Unvalidated AI applications for civil engineering are proliferating, and engineers cannot easily tell which have been checked by qualified peers. – Using a third party's AI tool does not transfer accountability: organizations remain responsible for the outcomes of the AI they deploy, including bias in tools used for hiring and workforce decisions.	– Ethics standard-setter, operationalizing Policy Statement 573. – Convener with insurers, licensing boards, attorneys, owners, public agencies, software providers, and other professions. – Guidance author on IP, data rights, and data sovereignty in engineering practice. – National convener and advocate for public health, safety, and welfare in AI and infrastructure policy.	– Operationalize PS 573 and the human red lines (Section 2): the licensed engineer retains responsible charge where licensure applies, a named, competent person remains accountable where it does not, and AI does not seal work. – **Immediate:** Publish V&V protocols that scale the depth of verification to the consequence of error, and a one-page AI-Use Record for sealed deliverables and other work affecting public safety, documenting sources and versions, assumptions, calculations, checks performed, limitations, and decisions made, retained with the project record so that responsible charge, or named accountable competence, is demonstrable (draft template in Appendix B). – **Immediate:** Define quality for AI-era engineering work: what an acceptable AI-assisted deliverable must show (traceable sources and versions, verification proportional to consequence, documented limitations and uncertainty, and evidence of the engineer's own judgment), as the basis for the standard of care and the no-go expectations in the human red lines. – **Immediate:** Issue digital and intellectual property guidance: training data rights, output ownership, model licensing, attribution, and self-built tools, including employer ownership claims and the conditions under which a licensee may rely on custom code in sealed work. – Publish corporate and jurisdictional data sovereignty guidance: data residency, export controls, confidentiality, and procurement clauses for AI services. – Publish practical human-AI interaction models and a Human-AI Boundary Matrix (Appendix A), with practice-specific versions for each area of practice that map where AI enters each phase of the project lifecycle and who is accountable at each point. – Initiate, with NCEES and state boards, a review of how licensure should adapt to AI and the	

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
			drafting of model rules for AI in sealed work, together with agency procurement guidance for AI services. – **Immediate:** Review the ASCE Code of Ethics for AI-era obligations, including the duty to act when AI produces wrong or harmful results and accountability where licensure does not apply. – Review contract language for AI use with partners such as EJCDC: disclosure of AI use, allocation of responsibility among owner, designer, contractor, and software provider, and data rights. – Assess, through concept visioning and a market assessment, an ASCE workflow verification program in which AI applications are submitted with the civil engineering workflow they support, reviewed by ASCE subject-matter experts against public benchmarks, and listed with the scope, version, and date of review; the assessment should settle liability, re-review at each release, and independence from revenue.	
	Medium term (initiate about 2029; readiness-gated)			
	– No accepted regime exists to evaluate engineering AI tools independently; certifying fast-changing commercial products would require standing test capacity, re-testing at every release, and liability for the result. – State, national, and international rules are diverging; firms face compliance chaos. – Autonomous decisions need audit trails that current practice does not produce.	– Independent evaluator of engineering AI tools against public benchmarks, kept separate from any role ASCE has in content licensing or tool development. – Model-rule author with NCEES for AI in sealed work. – Advisor to public agencies on procurement and governance of AI services.	– Adopt model rules for AI use in sealed work with NCEES and state boards; integrate AI into PE examination and CPD. – Create an independent evaluation scheme for engineering AI tools, scoped by task, model, and software version, with defined triggers for re-evaluation, performance benchmarks, and failure reporting, and governed separately from ASCE's content licensing, drawing on the short-term workflow verification assessment. – Publish security guidance across the AI lifecycle: design tools, inspection systems, digital twins, training data, sensors, and model updates. – Publish procurement and contracting guidance for public agencies; establish incident-reporting and lessons-learned mechanisms for AI-related failures and near-misses. – Launch a voluntary commitment program for responsible AI use, modeled on the SE 2050	

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
			commitment program, in which firms and agencies commit to the human red lines, AI-Use Records, and training, and report progress.	
	Long term (capability-triggered; about 2032+)			
	– Accountability chains for autonomous engineering systems remain undefined. – Public trust, once lost to a high-profile AI failure, would challenge the profession to re-establish it, as it has after past failures.	– Global reference point for infrastructure AI governance.	– Harmonize international standards for AI in infrastructure. – Define demonstrable accountability chains for autonomous engineering systems. – Evolve licensure to certify competence in directing and verifying intelligent systems. – Revisit, on validated evidence, where human oversight adds safety for well-bounded tasks, keeping accountability with identifiable people and institutions (Section 1).	

Pillar 10. Communities, Equity & Human-Centered Outcomes

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 10. Communities, Equity & Human-Centered Outcomes *AI in service of the people infrastructure serves: public engagement, environmental justice, accessibility, land development, and equitable distribution of benefits and risks.*	**Short term (initiate 2027)**			**Internal:** Equity and human-centered metrics are embedded in ASCE tools, standards, and the Report Card. **External:** Infrastructure benefits are shared fairly; communities see themselves as co-authors of their infrastructure futures
	– Optimization trained on historic data encodes historic underinvestment and biases; data are often sparse in underserved communities and rural regions. – Engagement processes exclude non-English speakers and communities across the digital divide. – Prioritization algorithms are opaque to the people they affect.	– Conscience of the profession: guidance on equitable AI in infrastructure decisions. – Promoter of accessible, multilingual, AI-enabled public engagement.	– Use AI for public engagement: visualization of alternatives, multilingual outreach, synthesis of community input at scale. – Add equity screening to AI-driven project prioritization; set guardrails against algorithmic bias in siting, routing, and resource allocation. – Improve accessibility analysis (ADA, universal design) with AI in buildings and public rights-of-way.	

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
			– Help engineers communicate deliberately with communities about AI-informed decisions and AI infrastructure: plain-language explanation of technical analysis, engagement that begins early, and respect for local knowledge and culture.	rather than subjects of algorithms.
	Medium term (initiate about 2029; readiness-gated)			
	– Distributional impacts of investment are rarely measured, so inequity is invisible in the data. – Communities have not consented to the sensing that smart systems require. – Participatory tools can become participation theater without real power-sharing.	– Standards developer for equity metrics and distributional impact reporting. – Convener of communities, agencies, and engineers around participatory tools.	– Offer participatory digital twins letting communities explore and co-design infrastructure futures. – Report distributional impacts of infrastructure investment as standard project metrics. – Target service gaps in water, broadband, transit, and safe housing using AI; establish community consent norms for sensing.	
	Long term (capability-triggered; about 2032+)			
	– Wellbeing and equity must become optimization objectives, not constraints to satisfy minimally. – Communities need genuine standing in the governance of autonomous infrastructure.	– Advocate for community standing within autonomous systems governance.	– Make community wellbeing, health, and equity routine optimization objectives alongside cost and performance. – Institutionalize inclusive governance in which affected communities meaningfully shape AI-informed infrastructure choices.	

Pillar 11. Research, Standards & Knowledge Ecosystem

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
Pillar 11. Research, Standards & Knowledge Ecosystem *Research agendas, benchmarks and evaluation*	**Short term (initiate 2027)**			**Internal:** The ASCE corpus becomes the trusted training and reference substrate for engineering AI, governed by the profession
	– Research is fragmented and results are not comparable across groups.	– Agenda-setter for civil engineering AI research grand challenges.	– Publish an AI research agenda spanning the civil engineering disciplines, including AI reliability, bias, explainability, cybersecurity, and performance in safety-critical infrastructure;	

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
suites, publications, machine-readable standards, a model-agnostic computable knowledge layer, authorized access to ASCE knowledge through third-party tools, and the pipeline from discovery to practice.	– General frontier models are not designed for civil engineering data, physics, or safety requirements. – The gap between published research and adopted practice remains years wide. – ASCE remains the source of trusted knowledge, but other organizations increasingly determine how that knowledge is discovered, interpreted, and presented to engineers. – Members need practice guidance faster than consensus standards can deliver it, and AI-related resources across ASCE have not yet been inventoried against the gaps.	– Host of a public engineering AI benchmark library, evaluation suites, competitions, and open datasets. – Assessor of build-versus-connect options, with defined evidence for when, if ever, ASCE should develop or operate a model. – Coordinator of a unified ASCE approach to AI standards and manuals of practice.	establish a public benchmark library and evaluation suites, competitions, and open datasets. – Set journal and conference policies for AI-assisted authorship, reproducibility, and data availability. – Advocate for aligned federal research funding (NSF, DOT, EPA, NOAA, NIST, DOE), and convene federal-society-sector task forces to develop specific tools and products the profession needs, without ASCE becoming the data holder. – Define the evidence that would justify ASCE developing or operating a model, compared with grounding existing models in authoritative sources and validated engineering tools, covering safety, validation, ownership, hosting, upkeep, liability, and funding. – **Immediate:** Run a bounded knowledge-access pilot: a defined set of content ASCE is authorized to share, including knowledge contributed by members, accessed through more than one independent application, testing retrieval accuracy, attribution, version control, engineering review, and correction handling, with a prototype trusted, ASCE-branded knowledge repository demonstrated at the ASCE 2027 conference. – Establish a participation and sustainability model for knowledge contributors: recognition and contributor credentials, access benefits, funding or compensation where appropriate, permissions and attribution preserved through downstream use, and funding for expert review, updates, and corrections. – **Immediate:** Inventory existing ASCE standards and technical resources relevant to AI, conduct a gap analysis, choose the right product for each gap (standard, manual of practice, guideline, or practice advisory), and coordinate a unified approach across ASCE. – **Immediate:** Develop a Manual of Practice for AI use in civil engineering, with subdiscipline chapters and cross-discipline content, as a faster	itself, with ASCE's authority visible and verifiable wherever its knowledge is used. **External:** A faster, validated science-to-practice pipeline; the profession shapes the behavior of the AI it relies on through the standards, benchmarks, and evaluation suites every model is held to, rather than by owning models.

Thematic Pillar	Illustrative Critical Issues for Civil Engineering	ASCE's Prospective Role	ASCE Action Needs & Concepts	Envisioned Pillar Outcome (Internal & External to ASCE)
			route to practice guidance while consensus standards follow.	
	Medium term (initiate about 2029; readiness-gated)			
	– Researchers lack testbeds on real infrastructure; validation science for engineering AI is immature. – Multi-year standards cycles cannot govern fast-moving methods. – Any AI built on the ASCE corpus needs governance: whose data, whose validation, whose control, and how are contributors recognized and sustained?	– Operator of academia-industry-agency testbeds. – Modernizer of the standards portfolio to machine-readable form. – Owner and steward of the computable knowledge layer and the public benchmark library that models are trained against and evaluated on.	– Stand up joint testbeds for AI methods on real infrastructure. – Convert the ASCE standards portfolio to machine-readable form; pilot AI-assisted standards development. – Build the model-agnostic computable knowledge layer: curated, versioned ASCE content in open, interoperable (openBIM-compatible) schemas, exposed through secure retrieval and API access, with source attribution, edition, applicability conditions, and corrections traveling with every answer, and with official standards, commentary, research, and AI-generated interpretations kept distinguishable. – Enable authorized access to ASCE knowledge through the third-party software and AI applications engineers already use, alongside ASCE-hosted services. – Synthesize post-implementation evidence on what works, feeding guidance and standards.	
	Long term (capability-triggered; about 2032+)			
	– AI-accelerated discovery can outpace the profession's ability to validate and absorb it. – Knowledge integrity (provenance, reproducibility, attribution) is at risk in AI-mediated literature.	– Steward of the profession's living knowledge base.	– Maintain a continuously updated, AI-accessible knowledge base of civil engineering practice built on ASCE's corpus. – Accelerate scientific discovery in mechanics, materials, hydrology, and geotechnics with AI. – Evolve standards continuously from observed performance rather than multi-year revision cycles.	

Appendix A. Human-AI Boundary Matrix (Provisional Template)

This matrix makes the "what must remain human" lens practical. Rows are the five human core functions named in Section 2; columns are the three AI capability levels. Each cell states what AI may do and what remains with the engineer. Engineers in each area of practice are invited to develop a practice-specific version.

Human core function	Assistive: AI recommends; the engineer decides	Agentic: AI executes within limits; the engineer supervises and approves	Autonomous: AI runs bounded functions; the engineer sets limits and can override
Interpretation of code intent and compliance	AI retrieves provisions, flags potential noncompliance, and cites sources and editions; the engineer interprets and decides.	AI runs compliance checks across a model or drawing set and reports findings with citations; the engineer reviews every flagged item and resolves questions of intent.	Not delegated. Automated checks may run continuously as screening only; interpretation of intent stays with the engineer.
Selection of governing assumptions, loads, and failure modes	AI proposes candidates and sensitivity results; the engineer selects and documents the rationale.	AI explores alternatives within engineer-set bounds; the engineer approves the governing set before it is used.	Not delegated for design. In operations, AI may adjust within pre-approved envelopes, with alerts outside them.
Acceptance and transfer of risk	AI quantifies risk and presents trade-offs; the engineer and owner accept or transfer risk.	AI assembles risk registers and mitigation options; the engineer approves.	Not delegated. Acceptance of risk remains with accountable people and institutions.
Overriding or accepting conflicting data and model results	AI surfaces conflicts and their provenance; the engineer resolves them.	AI applies engineer-defined resolution rules and logs every resolution for review.	AI may apply pre-approved rules in real time with fail-safe defaults; the engineer reviews the logs and retains override.
Ethical judgments affecting public health, safety, and welfare	Not delegated. AI may inform; the engineer decides.	Not delegated. AI may inform; the engineer decides.	Not delegated. AI may inform; accountable people decide.

"Not delegated" marks functions that remain human at every capability level under current practice; the human red lines in Section 2 state these limits in plain terms. Section 1 explains why the roadmap keeps that premise open to evidence over the long term.

Appendix B. AI-Use Record for Engineering Deliverables (Provisional Template)

Purpose: To make the exercise of responsible charge demonstrable when AI contributes to a sealed deliverable, and to make named accountable competence demonstrable for other work affecting public safety where no seal applies. The depth of verification recorded should be proportional to the consequence of error. The record is retained with the project file and does not replace the seal. This draft is for refinement under Pillar 9.

Field	What to record
Project and deliverable	Project name and number; deliverable, sheet, or calculation reference.
Accountable professional	Name; license number and jurisdiction where licensure applies; otherwise, basis of competence and the accountable organization.
AI tools used	Product, model, and version; deployment (enterprise, open-weight, vendor-hosted, or self-built); dates used.
Capability level	Assistive, agentic, or autonomous (Section 2).
Scope of AI use	Tasks performed with AI, and tasks deliberately performed without it.
Authoritative sources	Codes and standards relied on, with editions; data sources and versions.
Assumptions	Key assumptions the AI proposed, and which the engineer accepted, modified, or rejected.
Consequence and verification depth	Consequence of an error in this deliverable (for example low, moderate, or high) and the depth of verification applied in proportion to it.
Independent checks	Hand checks, alternative software, comparison with benchmark problems, and peer review performed.
Conflicts and resolutions	Conflicting data or model results identified, and how each was resolved.
Limitations	Known limitations and conditions of applicability.
Data handling	Client or confidential data exposed to AI services; data residency and permissions.
Engineer's decisions	Decisions made by the engineer and the basis for them.
Attestation	Signature and date of the accountable professional (the engineer in responsible charge where licensure applies).