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THE BRIDGE

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Ctrl+Alt+Educate: Engineering Education & AI

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Burt Dicht

Eta Chapter

"I once heard a commentator refer to this as "techno-stupidity." While the phrase may make us smile, it raises a serious question: as technology advances, will we still know how to do essential things ourselves?"

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THE BRIDGE, May 2025

Message from the Editor-in-Chief

It is both an honor and a privilege to write my first Editor's Message as Editor-in-Chief (EIC) of *THE BRIDGE*. Having served on the editorial board for the past two years, I have witnessed firsthand the commitment to excellence that defines this publication. I extend my sincere thanks to my predecessor, Dr. Jason Hui, Dr. Hulya Kirkici, who served as the acting EIC during the transition, to my colleagues on the editorial board, and the IEEE-HKN staff, whose dedication has made *THE BRIDGE* the outstanding magazine it is today. I am deeply mindful of the trust placed in me and I am committed to maintaining the high standards our members expect.

My own journey with IEEE-HKN began as an IEEE staff member, where I had the opportunity to work closely with the organization. I have always admired the professionalism, spirit of service, and sense of community that IEEE-HKN members bring to everything they do. It is this spirit that I hope to foster and support as we move forward.

For this issue, I also have the unique experience of serving as Guest Editor. One of the editorial board's strengths is its tradition of inviting board members and external contributors to guide themed issues. This approach brings fresh perspectives and ensures that *THE BRIDGE* remains dynamic and relevant. We spend considerable time selecting topics that are timely, thought-provoking, and important to our community.

The theme for this issue—Artificial Intelligence in Engineering Education—was one that I suggested during our discussions. Although I am not an educator by profession, I have been fascinated by how quickly this field is evolving and the profound impact it is having on how we prepare future engineers. Many years ago, when mobile phones began storing contact information, it marked the beginning of technology doing something for us that we once did ourselves. I know I am dating myself, but we all used to remember phone numbers.

I once heard a commentator refer to this as "techno-stupidity." While the phrase may make us smile, it raises a serious question: as technology advances, will we still know how to do essential things ourselves? I often ask people if they can read a map—the answer is usually "no." With the development of autonomous vehicles, will even basic driving skills erode? These kinds of questions sparked my interest in the implications of AI for engineering education.

New tools will always emerge as technology advances, but AI has the potential to be far more disruptive, with both positive and negative effects. Critical thinking skills remain essential for engineering and technology professionals. As AI becomes part of the educational environment, faculty must ensure that it serves as a tool for learning—not a substitute for foundational skills—and must continue to promote the abilities students need for success in the workplace. For students, it is about using these tools to support their education without allowing them to become a crutch. The articles in this issue provide a multi-dimensional look at how engineering education is responding to this new reality.

We open with "Integrating AI into Engineering Education – Preparing Students for the Future," drawn from a lively panel discussion at the IEEE-HKN Pathways to Industry Conference. Dr. Candice Bauer, Assistant Dean for Assessment, Compliance, and Evaluation at the University of Nevada, Reno, moderated a panel of her faculty colleagues who shared real-world experiences embedding AI into their curricula. Their reflections remind us that while AI offers powerful tools, it demands an even greater emphasis on critical thinking, ethical reasoning, and adaptability—skills essential for engineering success.

Our second feature, "Building Responsible AI into Engineering Education" by Dr. Jesse Kirkpatrick and Dr. Missy Cummings from George Mason University, examines why responsible and ethical approaches must be at the core of preparing future engineers. Through examples of curriculum innovation and interdisciplinary collaboration, they show how educators can equip students not only with technical expertise, but also with the ethical frameworks needed to ensure technology serves society in positive and equitable ways.

> "The integration of AI into engineering education is not just about new technology. It is about shaping a generation of engineers who are thoughtful, resilient, and ready to lead in a world where technology and society are more deeply intertwined than ever before."

Our third feature, "Preparing the Future AI Workforce," comes from a team at the University of South Alabama: Dr. Shenghua Zha, Dr. Na Gong, Dr. Silas Leavesley, Dr. Jinhui Wang, and Dr. Hulya Kirkici. Their work explores efforts to introduce AI literacy at the pre-university level, highlighting creative, cross-disciplinary approaches that can bridge the gap between classroom learning and real-world technology. Their program offers a powerful model for nurturing the next generation of engineers, scientists, and innovators.

We also include a guest essay, "AI Will Reinvent Higher Education," by Dr. Stephen J. Andriole from Villanova University. He argues that rapid advances in machine learning and generative technologies are permanently reshaping how faculty teach and how students learn. As he explains, these changes challenge traditional assumptions about education, engagement, and assessment—and raise important questions about the evolving role of faculty and institutions.

As you read these articles, I hope you will find, as I did, that the integration of AI into engineering education is not just about new technology. It is about shaping a generation of engineers who are thoughtful, resilient, and ready to lead in a world where technology and society are more deeply intertwined than ever before.

Thank you for the opportunity to serve as Editor-in-Chief. I look forward to working with the editorial board, our contributors, and, most importantly, our readers, to continue making *THE BRIDGE* a resource that informs, inspires, and connects us all.

AI Panel, from left front - Kelly Keselica, Jamie Gutual, Erin Keith, Gabielle Bachand, from right back, Ryan Schoenfeld, Ann-Marie Vollstedt, Candice Bauer

Integrating AI into Engineering Education – Preparing Students for the Future

Candice Bauer

1. Introduction

On February 19, a panel discussion at the IEEE-HKN Pathways to Industry Conference brought together educators from the University of Nevada, Reno, to explore how artificial intelligence (AI) is reshaping engineering education. Each panelist brought a unique engineering background and varying levels of experience with AI integration—some were just beginning their journey; others were already deeply engaged in curriculum development. This article summarizes their insights on AI's evolving role in the classroom and its broader implications for students, faculty, and early-career engineers. Topics ranged from incorporating AI tools into coursework to career readiness and ethical considerations. Throughout the discussion, panelists emphasized that AI should be viewed as a tool to enhance, not replace, critical thinking and technical skills. This summary is intended as a resource for educators and students seeking to understand and navigate AI's growing impact on engineering education.

2. Panelist Biographies

All panelists are faculty within the College of Engineering at the University of Nevada, Reno.

Candice Bauer (Moderator) – *Assistant Dean for Assessment, Compliance, and Evaluation*. She specializes in assessment strategies, compliance initiatives, and student success frameworks in engineering education. Candice's background is in mechanical engineering, aeronautical engineering, engineering management, and educational leadership.

Ann-Marie Vollstedt – *Teaching Associate Professor.* Ann-Marie's background is in mechanical engineering. She specializes in teaching large multidisciplinary courses in engineering design and statics. She also runs the Engineering Freshmen Intensive Training Program for new students each year. Ann-Marie is involved with research projects in engineering education focused on assessing course changes to increase student learning in engineering, activities that increase engineering identity and self-efficacy, and best practices for online learning.

Kelly Keselica – *Lecturer*. Kelly is a licensed professional engineer and has a B.S. and M.S. degree in civil engineering and an MBA. She is an award-winning lecturer and teaches undergraduate engineering courses such as Mechanics of Solids, Dynamics, Introduction to Engineering Design, and leadership courses.

Gabrielle Bachand – *Lecturer*. Gabrielle's background is chemical engineering and materials science and engineering. Her research and industry work experience focus on the fabrication, testing, and characterization of lithium-ion battery materials. Gabrielle teaches courses focusing on technical communications, engineering societal impacts, and sustainability.

Jamie Gutual – *Lecturer*. Jamie's background is in electrical and biomedical engineering. Her work has explored hands-on learning in K-12 engineering outreach, sensor array modeling, microfluidic device characterization, and electromagnetic field simulation. Jamie also coordinates the Engineering Freshman Intensive Transition (E-FIT) program and teaches courses in engineering communications and circuit design.

Ryan Schoenfeld – *Lecturer*. Ryan's background is in engineering physics, electrical engineering, and computer engineering. Ryan actively uses technology in his classrooms including iPads, MATLAB, Python, and various web-based suites to enhance student learning.

Erin Keith – *Lecturer*. Erin's background is in computer science and engineering. With over five years of industry experience, Erin worked at many levels of the software engineering process, from testing through implementation to deployment. She teaches multiple courses, including introductory courses, C++, and data structures.

3. AI in the Curriculum

Question: What specific skills or tools should students focus on learning to effectively integrate AI into their future careers, and how can they remain adaptable as AI technologies evolve?

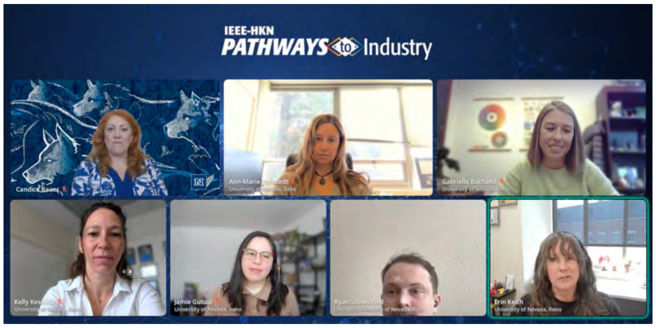
Ann-Marie and Kelly emphasized that the fundamentals of engineering education remain unchanged: students must develop strong problem-solving skills, proficiency in programming, and a solid foundation in engineering principles. However, AI can serve as a tool rather than a crutch, helping students refine their design thinking and analytical abilities. Ann-Marie advocated for having a growth mindset and being adaptable to change and moving with the times. Kelly described how AI is being incorporated into introductory engineering courses, where students use generative AI tools like ChatGPT to create infographics and refine technical communication. She noted that the goal is not to replace foundational learning but to teach students how to critically engage with AI-generated content. She gave an example of students effectively using AI to review their resumes and request modifications to enhance them.

Gabrielle strongly advocated for ensuring that students continue to learn skills without AI, stating, "If you don't bring anything more to the table than what someone could get using an AI tool, then you won't be able to demonstrate value for the workplace." She stressed the risk of students losing critical thinking abilities if they rely too heavily on AI. "There are so many scenarios in which you won't have the time to pause conversations to consult an AI tool—whether you're on a manufacturing floor, in a live presentation, or handling an emergency. You have to be able to think independently."

Jamie reinforced the importance of structuring AI-based assignments to prevent students from simply memorizing outputs. She advocated for designing coursework that requires original analysis and synthesis, ensuring that AI complements rather than replaces cognitive effort. She also noted that AI-driven tools should encourage students to engage in a process of iteration and refinement, rather than simply accepting AI outputs as final answers.

Ryan pointed out that while AI can enhance learning, students must be trained to critically evaluate AI-generated solutions rather than accept them at face value. "You have to ask yourself—does this AI-generated solution actually make sense in a real-world engineering context?" he stated.

As a computer science educator, Erin teaches a data systems course that provides students with a deeper understanding of AI systems "under the hood." She emphasizes that large language models are fundamentally based on linguistics and that numerous AI tools can generate entire programs. Viewing AI as a tool, she draws a parallel to the impact calculators had on math education, noting how automation shifts expectations regarding student skills and mastery. Similar to how calculators shifted the emphasis from manual calculations to higher-order problem-solving, AI is transforming the expectations placed on students in computer science. As a result, students must memorize and build knowledge and hone their evaluation skills earlier in their education. While expertise naturally brings the ability to assess and refine work, AI's rapid integration into programming requires students to develop these critical evaluation skills much sooner. Erin's core advice to students is to view this shift as an opportunity—learning to assess, verify, and improve AI-generated outputs will be essential for success in an evolving technological landscape.



Screenshot of the virtual session during Pathways to Industry Conference

4. AI Skills & Career Readiness

Question: How are educators integrating AI into curricula to equip students with both the technical knowledge and critical thinking skills needed to navigate AI's impact in their fields?

Ann-Marie noted that students must develop strong prompting skills when working with AI tools since the quality of AI-generated output is directly tied to the specificity and clarity of the input. She highlighted that a significant aspect of AI literacy involves generating responses and critically evaluating them. A major focus in her coursework is teaching students how to refine their prompts to receive more accurate and relevant information. Additionally, she stressed the importance of verifying references provided by AI, ensuring that students do not take AI-generated citations at face value. Instead, they must actively cross-check sources, gather additional information beyond what was initially provided, and develop a habit of scrutinizing the credibility and reliability of AI-assisted research.

Kelly shared that she uses AI as a tool to assist in writing letters of recommendation, particularly for scholarships, by integrating details from a student's resume with the specific requirements of the application. AI helps streamline the process by organizing key information and structuring the letter effectively. However, she detailed the importance of thoroughly reviewing and editing the AI-generated content to ensure accuracy, proper tone, and personalization. While AI can polish writing and improve clarity, final revisions are essential to maintain authenticity and avoid errors.

Gabrielle emphasized the need for critical thinking and ensuring students demonstrate sufficient understanding of material. She recommends the incorporation of real-life workplace demonstrations, presentations, verbal discussions, and project-based learning. She integrates hands-on, in-class activities and live interactions with classmates to help students develop practical skills in real time. She also stressed the importance of encouraging students to find joy in learning, as critical thinking and problem-solving make work more engaging, fulfilling, and meaningful in their careers – and, importantly, provide an advantage in being more flexible as changes inevitably affect the discipline over time.

Jamie encouraged students to explore industry applications of AI beyond traditional computer science fields. "Mechanical, electrical, and civil engineers are all using AI in different ways. Understanding how AI fits into your specific discipline will make you more competitive in the job market." Jamie also urged that instructors take responsibility for helping students understand bias and inaccuracies as well as the ability to recognize limitations of generative AI as a whole.

Ryan echoed this by noting that students must develop the ability to assess AI-generated solutions critically. In his electrical engineering courses, students are required to validate AI-produced answers against fundamental engineering principles. "If the AI gives you an answer that contradicts physical laws, then you have to be able to recognize that error," he explained. Ryan expressed hesitation about encouraging AI use in the classroom, drawing a comparison to how students are not allowed to use calculators in early math education to ensure they develop foundational skills first. He strives to maintain this principle in his teaching, though he recognizes that students will inevitably turn to AI tools. For example, one student admitted to using ChatGPT after struggling with a topic, but when Ryan reviewed the AI-generated response with them, they discovered it was incorrect. The concerning part, he noted, was that the student lacked the ability to recognize the mistake, highlighting the need to build strong analytical and verification skills before relying on AI.

Erin discussed how AI is reshaping the software engineering landscape. Erin pointed out the need for guidance when using AI in education. While AI can help supplement learning, such as explaining basic concepts in simple terms, its limitations become more apparent as coursework becomes more specialized, often producing objectively incorrect answers. However, completely avoiding AI in the classroom also does students a disservice. She suggested incorporating AI in structured ways, such as using it for code reviews. For example, a lesson plan could involve having the model generate tests while students evaluate and refine them. By treating AI as a collaborative tool rather than a replacement for critical thinking, she is experimenting with ways to integrate it realistically into coursework.

5. Ethics & Governance in AI

Question: **From the classroom to the boardroom, how can individuals and organizations ensure that AI is developed, used, and governed in a manner that upholds ethical standards and promotes transparency and integrity?**

Ann-Marie stated that ethical engineering must be a foundational principle in AI development and governance. Engineers and organizations must recognize the legal and ethical implications of their work and commit to doing what is right, rather than solely focusing on technological advancement. Continuous professional development and iterative improvement are crucial in ensuring that AI systems remain aligned with ethical standards. Engineers should be proactive in evaluating the broader impact of their work and the consequences of AI applications, ensuring that the outcomes align with societal needs and do not lead to unintended harm.

Kelly illustrated the importance of distinguishing between ethical personal AI use and the potential dangers of AI-driven technologies. She noted that AI can be beneficial in individual learning experiences. She gave the example of using AI to practice conversational skills in a foreign language. However, she raised concerns about AI's role in more controversial applications, such as weapon development, where ethical boundaries become significantly blurred. She emphasized that society must critically examine the ways AI is applied and ensure that its use does not lead to harmful or unintended consequences. Organizations and policymakers must take responsibility for regulating AI applications that could have detrimental effects on individuals and communities.

Gabrielle cautioned against the hasty development of AI models and the opaque nature of their data collection and training methods. She cautioned against the tendency to trust AI-generated outputs as authoritative, like how people unquestioningly accept answers from a calculator. AI systems are trained on human-generated data, which inherently includes biases, yet they often present information with an undeserved level of confidence. Transparency in AI development and disclosure of AI-generated content remain inconsistent, raising critical ethical questions. She posed thought-provoking considerations about AI's role in personal versus professional contexts—society continues to grapple with when it "feels" acceptable to use AI across various use cases. She also noted that much of AI marketing promotes surreptitious use when AI should instead function as an assistive tool. Its use should not be a substitute for human cognition, and society must continue to work to define its boundaries for ethical use.

Jamie made clear that AI tools are not infallible and should not be blindly trusted. She stressed that before individuals and organizations integrate AI assistants into critical decision-making; they must first establish a clear understanding of what ethical AI governance should look like. Many AI models are trained on vast amounts of data without clear verification of source accuracy, making it essential for users to critically assess AI-generated information. Rather than assuming AI-driven tools provide reliable outputs, individuals and businesses must take responsibility for verifying their validity and ensuring that AI applications align with ethical and professional standards.

Ryan expressed concern about the long-term implications of AI, noting that society is still years away from fully understanding its effects. He drew the comparison that, much like the environmental impact of early automobiles, AI's long-term effects—especially its energy consumption—are still largely unknown. Similarly, AI's vast energy consumption and its long-term sustainability must be carefully examined. Organizations and individuals must consider whether the benefits of AI use justify the significant computational power it requires. Thoughtful deliberation on AI's environmental footprint and its broader societal consequences is essential in determining its ethical application.

Gabrielle supported Ryan's concern. She went into detail on the often-overlooked physical costs of AI, highlighting its heavy reliance on energy, fossil fuels, and water. AI exists in an "invisible, intangible place" for many users, but its resource demands pose serious ethical and moral dilemmas. She pointed to the growing debate over data centers consuming water that could otherwise support housing needs, questioning whether society is willing to prioritize AI's resource usage over essential human needs.

Erin reinforced that AI is fundamentally an automation tool, much like the internet and search engines have been. However, as AI automates more complex cognitive processes, it raises profound concerns about its impact on education and society. Education systems must shift from emphasizing memorization to teaching students how to critically engage with AI-generated information. The danger lies in automating critical thinking skills at a time when these skills are already underdeveloped in many learners. The far-reaching consequences extend beyond the classroom; as students become adults, the automation of decision-making can influence how they vote and make other major life choices. It is imperative to consider the broader impact of AI-driven cognitive automation and ensure that it enhances, rather than replaces, human reasoning.

6. AI as a Study Tool

Question: **There are AI tools that are able to convert lectures, presentation slides, and readings into summary notes, flashcards, and other study aids. What are your thoughts on this use?**

The panelists stressed that students must engage in the synthesis process themselves to build true understanding. Ann-Marie likened this to being on a production floor, where engineers must answer questions on the spot, reinforcing the need for real-time problem-solving assessments. Kelly noted that while smaller classes can incorporate oral exams to ensure authentic learning, the broader challenge lies in adapting K-12 education and assessment methods as AI use expands. Jamie emphasized that while AI can be a tool, students still need to develop foundational skills, requiring new assessment strategies to push learning further. Erin drew focus to the need for more in-class engagement, shifting introductory material outside of class while emphasizing hands-on activities and informal assessments to hold students accountable. She warned that AI can become a crutch, especially for getting started, and stressed the importance of fostering a learning mindset where students are comfortable making mistakes and refining their understanding.

7. Emotional Response to AI

Question: **How Do the Panelists Feel About AI—Fear, Concern, or Acceptance?**

The panelists had a range of emotions about AI, from concern to cautious acceptance. Ann-Marie recognized the inevitability of new technology and suggested that instead of fearing it, we should seek to understand its workings and effective applications. Kelly found AI both impressive and unsettling, particularly in how it collects and stores user data, raising concerns about privacy. Gabrielle clarified that her emotions were not fear but a mix of skepticism, anger, curiosity, and engagement, likening AI's ethical dilemmas to those seen with social media and virtual reality—urging critical inquiry rather than blind adoption. Jamie did not fear AI itself but worried that students might misuse it as a shortcut, emphasizing that engineering leaves no room for superficial understanding.

Ryan admitted feeling apprehensive, drawing a parallel to physicist Richard Feynman's concerns about the Manhattan Project, where scientific advancements were made without fully considering their long-term consequences. Erin described her feelings as complex: she's energized by its rapid evolution but also worried about its implications for computer science students, particularly regarding job prospects and a decline in critical thinking. She also warned of the dangers of unregulated AI, third-party influences, and biases reinforcing flawed information, stressing the importance of reflection and responsible use before AI's influence spirals beyond control.

8. Conclusion

Artificial intelligence is undeniably transforming engineering education. The challenge for educators lies in striking a balance: harnessing AI's potential while ensuring students continue to develop core problem-solving and critical thinking skills. As AI continues to evolve, education must adapt accordingly—while maintaining a strong commitment to ethical standards and professional integrity.

You can watch the whole session on the HKN YouTube channel.

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Building Responsible AI into Engineering Education: Curriculum Building, Classroom Strategies, and Sandbox Innovation

Jesse Kirkpatrick and Missy Cummings

1. Introduction

Artificial Intelligence (AI) is reshaping industries, including healthcare, finance, and defense, as well as government processes and regulatory responsibilities. As AI systems become integral to critical societal functions, concerns over reliability, safety, bias, transparency, accountability, and governance highlight the need for Responsible AI (RAI) education.

RAI education equips students and professionals with the technical, ethical, and policy-oriented knowledge necessary to design, develop, and deploy AI systems that are aligned with human values. Engineers must learn not only to build safe and effective AI but also to assess its ethical and societal implications, ensuring that AI technologies benefit society while minimizing harm.

Despite growing recognition of RAI's importance, many engineering and computer science (CS) curricula still lack structured frameworks for embedding ethical and societal considerations into AI coursework. Traditionally, ethics courses have been housed in humanities or social science departments, but the demand for AI ethics in engineering is increasing. Frameworks such as the IEEE Ethically Aligned Design, NIST AI Risk Management Framework, and the EU AI Act underscore the importance of integrating RAI principles into engineering education [1].

Universities are responding by adopting different approaches, each with varying degrees of effectiveness and implementation challenges. Standalone courses in AI ethics and governance offer a focused, in-depth exploration of ethical considerations, but they often struggle to attract technical students who may not initially recognize their relevance. Additionally, embedding ethical content into AI coursework requires faculty with both technical and ethical expertise, which can be difficult to recruit or develop. Interdisciplinary programs that merge engineering with philosophy or public policy provide a well-rounded perspective, but they demand strong institutional support and coordination across departments—presenting logistical hurdles. Some universities have created curriculum sandboxes to allow for experimentation before full-scale adoption, though these too face obstacles such as limited funding and faculty buy-in. Understanding these trade-offs is critical for institutions seeking to successfully integrate Responsible AI (RAI) into their curricula.

This article explores best practices, challenges, and lessons from institutions that have successfully integrated RAI into engineering education, offering practical strategies for scalable and sustainable implementation.

2. The Need for Responsible AI Education

AI is influencing critical decisions across society, but without ethical safeguards, AI failures can have serious consequences. Cases such as Amazon's biased hiring algorithm, the COMPAS risk assessment tool's racial disparities, wrongful arrests due to facial recognition misidentifications, and the recent Cruise autonomous vehicle pedestrian accident illustrate the risks of deploying AI without responsible oversight [2] [3] [4] [5] [6]. These failures highlight the urgency of training engineers to incorporate ethical and societal impact reasoning alongside technical expertise. Without proactive governance and accountability measures, AI systems risk reinforcing discrimination, endangering public safety, and eroding public trust in technology.

Industry and policymakers recognize this need and have introduced key frameworks that emphasize the importance of RAI education. The IEEE 7000 Series provides AI design standards prioritizing ethics, while the NIST's AI Risk Management Framework offers structured evaluation methods [7]. The EU AI Act introduces a regulatory framework mandating transparency and accountability for high-risk AI and ABET accreditation updates now require programs to incorporate ethical AI considerations [8]. As these regulations and standards evolve, engineering curricula must align with them to ensure that graduates are equipped to navigate AI's ethical and governance complexities.

3. Curriculum Models for RAI

Effective RAI education relies on curriculum models that cater to different learning objectives and institutional capabilities. Some universities offer standalone ethics courses, both in engineering colleges and in philosophy departments, providing dedicated space for exploring ethical theories, governance frameworks, and AI's societal impact. Others embed RAI principles into graduate and undergraduate technical coursework, ensuring that AI students engage with ethical considerations throughout their studies. A growing number of institutions are adopting an interdisciplinary approach by integrating AI instruction with humanities, social sciences, public policy, and law, either through augmenting existing courses, cross-listing courses, establishing joint degree programs, or collaborative research initiatives. Each model presents unique advantages and challenges, shaping how students engage with RAI development.

Standalone undergraduate courses, such as our university's Foundations of Ethics and AI course, and the graduate-level AI: Ethics, Policy and Society course, provide deep engagement with RAI principles but often attract students already inclined toward ethics. Admirably, the University of Virginia requires all engineering students to take an ethics class, during which they are exposed to AI content. Few universities make this a priority in the engineering and computer science curricula, instead integrating case studies and technical exercises to bridge theory and practice, hoping that students see the direct relevance of RAI principles in AI development.

Another approach is offering interdisciplinary courses that infuse RAI throughout engineering and CS design classes. For example, we created and co-supervised our university's Integrating Art and Tech class through the Mason Autonomy and Robotics Center. This effort brought together students from diverse academic backgrounds to conceive, design, and publicly showcase tech-enhanced art pieces that implement cutting-edge robotics and autonomy research. RAI principles like privacy and cybersecurity take center stage in this class, which utilizes cameras and access to patrons' phones, so these issues become very real in application. By blending artistic expression with emerging technologies, the program highlights the broader societal and ethical implications of AI and autonomy.

Some institutions have embedded RAI modules into existing courses. Harvard's Embedded EthiCS program has been one of the most visible and successful instances of this approach, in which philosophy faculty and graduate students collaborate with computer science instructors to integrate ethical discussions directly into technical coursework. This model ensures broad exposure by reaching students within their primary disciplines and demonstrating real-world ethical applications in AI, data science, and engineering. However, effective implementation requires faculty who are skilled in both technical and ethical instruction or a structured partnership between departments, which can pose logistical and resource challenges for some institutions [9].

Interdisciplinary programs, like Carnegie Mellon's Responsible AI Initiative and the University of Edinburgh's MSc in Data and Artificial Intelligence Ethics, foster collaboration across engineering, social sciences, and public policy. These programs not only expose students to technical and ethical considerations but also encourage cross-disciplinary problem-solving by bringing together faculty and students with diverse expertise. They often incorporate team-based projects, real-world policy engagements, and collaborations with industry or government partners, providing hands-on experience in responsible AI development. While these initiatives offer a well-rounded education, they rely on strong institutional support, sustained funding, and coordination between departments that may have differing research priorities, pedagogical approaches, and evaluation criteria. Additionally, ensuring that students develop both technical fluency and ethical depth can be a challenge, requiring carefully designed curricula that balance breadth and specialization.

Many institutions now adopt hybrid models, combining standalone courses, embedded modules, and interdisciplinary collaboration. At the undergraduate level, these efforts often focus on broad ethical literacy, introducing RAI principles through general education courses, ethics modules in technical classes, or interdisciplinary minors. Graduate programs, by contrast, tend to integrate ethics more deeply through research-driven coursework, domain-specific applications, and professional training. Many graduate-level RAI initiatives emphasize case-based learning, analysis and application of regulatory frameworks, and engagement with real-world AI deployment challenges, aiming to ensure that students develop both technical proficiency and a nuanced understanding of ethical trade-offs.

Capstone projects, thesis work, and industry or policy partnerships often serve as key mechanisms for bridging theory and practice, requiring students to apply ethical reasoning in AI development, governance, or societal impact assessments. Some programs also incorporate externships, regulatory simulations, or industry-sponsored research collaborations, preparing students for leadership roles in AI policy, ethics, and responsible innovation. Regardless of the model, a central challenge remains—equipping faculty with the resources, institutional incentives, and cross-disciplinary expertise necessary to guide students through both the technical and ethical dimensions of AI development.

4. Classroom Strategies for Teaching RAI

Beyond curriculum and course design, the instructional strategies used in classrooms determine how effectively students grasp RAI concepts. A combination of theoretical and practical methods enhances learning outcomes by engaging students at multiple levels, and universities are increasingly turning to interactive and experiential learning to move beyond traditional lecture-based instruction.

Case-based learning is one of the most widely used approaches, allowing students to analyze real-world AI applications and propose alternative solutions. For instance, examining the recent controversy surrounding an AI benchmarking organization delaying disclosure of its funding from OpenAI helps students critically assess the ethical implications of industry influence, transparency, and conflicts of interest in AI evaluation [10]. Such cases illuminate the trade-offs between technological progress, accountability, and governance. Some programs take this further by incorporating ethical auditing exercises, where students critically evaluate existing AI models for potential risks and biases, often through red teaming exercises that simulate adversarial testing scenarios. These exercises provide hands-on exposure to the complexities of RAI in practice, equipping students with both technical and ethical decision-making skills in AI development and deployment.

Simulations and scenario-based exercises offer another effective way to engage students in ethical decision-making. Faculty can develop role-playing exercises where students take on the roles of AI developers, policymakers, and affected stakeholders, debating real-world AI dilemmas. For example, students may be tasked with designing an AI-driven medical diagnosis system while considering potential biases in training data and regulatory constraints. Similarly, simulations on autonomous vehicle control and military reconnaissance challenge students to balance safety, efficiency, and ethical concerns in AI deployment.

Hands-on RAI lab work bridges the gap between conceptual discussions and technical implementation. Engineering students often learn best through experimentation, making lab-based exercises essential for reinforcing RAI principles. Open-source programs and toolkits, such as Fairlearn and IBM's AI Explainability 360, enable students to work with real-world datasets, testing and mitigating bias in AI models [11]. Having students use explainability frameworks like LIME and SHAP helps them understand the utility and drawbacks of such tools, as well as difficulties in achieving AI transparency for users and policymakers alike. By embedding RAI exercises and tools into coursework, universities prepare students to develop AI systems that are both technically robust and ethically sound.

Ultimately, combining these approaches ensures that students engage with RAI concepts through multiple learning modalities, reinforcing their ability to apply ethical reasoning to AI design, development, and deployment. Case studies develop critical thinking skills, simulations foster ethical reasoning in real-world contexts, and technical labs provide practical experience in mitigating AI risks. This multi-method approach equips students with the necessary tools to design AI responsibly, preparing them for the ethical considerations they will face in their careers.

5. Curriculum Sandboxes & Pilot Programs for RAI Innovation

To keep pace with the evolving AI landscape, universities should consider adopting curriculum sandboxes to test new RAI approaches before full-scale implementation. These programs provide a controlled environment for developing experimental RAI course modules, fostering interdisciplinary collaboration, and engaging students in real-world AI governance challenges.

Curriculum sandboxes can include many innovative and flexible approaches for iterative RAI development. Pilot courses enable institutions to trial new content and teaching methods, collecting feedback from students and faculty before integrating them into the broader curriculum. Micro-credential programs and certificate tracks offer flexible learning pathways that expose students (including non-traditional working students) to RAI principles without requiring full-degree commitments. Additionally, industry-academic partnerships can provide experiential learning opportunities, enabling students to engage with AI ethics through internships, co-op programs, and collaborative research projects. Hackathons, case competitions, and design challenges further immerse students in practical problem-solving, encouraging them to navigate ethical trade-offs in AI deployment. By leveraging these approaches, universities can refine their RAI education strategies while maintaining agility in an ever-changing technological landscape.

These sandbox models provide universities with a low-risk space to refine RAI curricula, enabling iterative improvement and ensuring alignment with industry and regulatory expectations. Success is often measured by student engagement, faculty adoption, and the integration of pilot-tested modules into standard coursework. Some universities track qualitative feedback from students and faculty, while others assess learning outcomes through pre- and post-course evaluations. In cases where sandbox programs demonstrate significant effectiveness, institutions can transition experimental RAI modules into permanent offerings. By systematically evaluating these pilots, universities can ensure that RAI education remains dynamic, scalable, and responsive to industry needs.

6. The Future of RAI in Engineering Education

The increasing complexity of AI systems, combined with areas of both growing industry claims and significant regulatory gaps, means that RAI will continue to be a necessary part of technical education. Universities should proactively integrate RAI into engineering and computer science curricula in ways that prepare students for emerging professional and societal challenges. As AI reliability and governance frameworks continue to evolve, the role of RAI in education will expand in several key ways.

One significant trend is the deepening collaboration between academia and industry. Private-sector organizations seek graduates who have both technical expertise and a firm understanding of ethical AI development. Universities are encouraged to engage in partnerships with industry leaders to co-design RAI curricula, develop internship programs that incorporate RAI principles, and establish research initiatives that address real-world RAI challenges. These collaborations will help ensure that RAI education remains aligned with evolving industry needs.

Another key development is the increasing integration of AI governance and policy education into traditional engineering and computer science programs. Historically, AI policy and regulation have been treated as separate from technical AI education, but this divide is becoming less sustainable. AI professionals need to have a working knowledge of the regulatory environment, including frameworks such as the EU AI Act, the NIST AI Risk Management Framework, and other design standards that will emerge. Universities can respond by embedding AI policy modules into machine learning and data science courses, offering hybrid AI-law courses, and expanding interdisciplinary programs that bring together computer science, public policy, and legal studies.

At the same time, RAI education must expand beyond engineering and computer science disciplines to promote AI literacy among non-technical students. As AI's influence extends across business, law, education, healthcare, and the humanities and social sciences, students in these fields must develop a basic understanding of AI concepts, risks, benefits, and ethical and societal implications. Universities may integrate AI technical literacy coursework into business schools, law programs, and medical training, ensuring that future professionals can critically engage with AI-driven decision-making in their domains. The rise of AI-for-all curricula, which provide foundational AI education to non-technical students, is crucial in preparing a broader workforce to understand and navigate AI's societal impact. Additionally, joint-degree programs—such as AI and public policy or AI and human rights—further equip students with interdisciplinary training for careers in AI governance, compliance, and ethical system design.

To effectively expand Responsible AI (RAI) education, universities must invest in faculty with expertise in AI reliability, safety, ethics, governance, and policy. Some institutions address this need by creating joint appointments between engineering or computer science and departments such as philosophy or public policy. Others recruit AI governance specialists from legal and social science backgrounds.

Beyond hiring, interdisciplinary collaboration strengthens RAI education. Co-teaching models—for example, where philosophy faculty integrate into AI courses—help students develop ethical reasoning frameworks alongside technical content. Cross-listed programs in AI and public policy expose students to critical governance perspectives, while curriculum sandboxes and pilot courses allow universities to test and refine new RAI modules before full-scale implementation.

Ultimately, by successfully integrating technical and socio-technical AI content, fostering industry collaboration, and broadening interdisciplinarity, universities can produce graduates who are not only skilled AI developers but also responsible stewards of AI's societal impact.

7. Conclusion

Responsible AI (RAI) has become an integral component of AI development, shaped by lessons from past challenges and an evolving policy and legal landscape. Early AI adoption often prioritized efficiency and optimization over ethical considerations, sometimes leading to unintended consequences. To prepare future AI professionals for this changing environment, universities can expand faculty expertise in AI ethics and governance, develop interdisciplinary coursework that blends technical and ethical training, strengthen industry partnerships for AI ethics education, and utilize curriculum sandboxes to refine RAI instruction. By embedding RAI principles and practices into AI education, institutions can help ensure that future AI systems are not only technically sophisticated but also aligned with broader societal and ethical values.

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Preparing the Future AI Workforce: Lessons Learned and Best Practices for Pre-University Education

Shenghua Zha, Na Gong, Silas Leavesley, Jinhui Wang, and Hulya Kirkici

The rapid evolution of artificial intelligence (AI) technology underscores an urgent need for strategic action in future workforce development. This article describes a transdisciplinary approach used to develop secondary-school STEM teachers' knowledge and skills in integrating AI literacy education into STEM subjects. It shares successful experiences and lessons learned. Finally, we issue a call to action, urging stakeholders to collaborate in prioritizing AI literacy education in pre-university settings and fostering the development of a future workforce that can adapt to the rapidly evolving demands of industry.

1. Introduction

Industry 4.0 technologies, such as artificial intelligence (AI), are transforming the manufacturing industry. In 2024, Deloitte predicted that enterprise spending on generative AI would grow by 30% [1]. A recent survey collected responses from 369 manufacturers with more than 100 employees across the U.S., U.K., and Canada [2]. Among them, 77% reported using AI in various applications, including production, inventory management, customer service, employee training, cybersecurity, quality control, process optimization, robotics automation, predictive maintenance, and engineering.

With the rapid and widespread adoption of artificial intelligence (AI), demonstrating proficiency in AI-related knowledge and skills is becoming essential for success in the future workforce. Regardless of their career aspirations, all students must develop a foundational understanding of AI. It is therefore imperative to provide pre-university students with early exposure to AI concepts and technologies to ensure they are prepared to navigate and contribute to an increasingly AI-driven world.

This article explores the importance of collaboration among educators and other key stakeholders to improve the quality of AI education in pre-university settings. We first discuss current trends and issues in K-12 AI literacy education, then describe an approach we have used successfully to address some key issues. Finally, we offer recommendations for future programs.

Trends and Issues

AI education has grown steadily since 2017, with a strong emphasis on algorithms, data analytics, and programming languages [3, 4]. Curriculum frameworks, such as the "big five ideas" [5], provide structured guides for designing learning modules. Age-appropriate technologies, such as Google Teachable Machine and MIT Dancing with AI, help concretize abstract AI concepts, which is crucial for reducing cognitive load and sparking student interest [6]. Various instructional methods, including unplugged activities [7], game-based learning [6], and embodied cognition [8], have been deployed to boost engagement and understanding.

Despite significant progress, several issues remain. A key challenge is the disconnect between classroom learning and the rapidly evolving development and application of

AI outside the school environment [9], making it difficult for students to understand AI's real-world relevance. This disconnect is also present in teacher professional development (PD), where many teachers have limited exposure to the latest AI developments [10]. As a result, they often struggle to develop a comprehensive understanding of AI as a transdisciplinary subject. Additionally, the shortage of teacher PD programs leaves many teachers feeling unprepared and lacking confidence in integrating AI into their teaching practices [10].

Table 1. A Concise List of Issues

- Disconnect between classroom learning and AI development and applications in the real world
- Disconnect between teacher PD and AI development and applications in the real world
- Teachers' limited exposure to the latest AI development
- Shortage of teacher PD on AI education

2. Our Approach

To address these challenges, and with support from the National Science Foundation (CNS-1953544, OIA-2218046, and DRL2333098/2333099), our team developed and implemented a transdisciplinary approach to AI literacy education over the past three years (Figure 1) [11]. The initiative focused on deepening secondary-school teachers' understanding of AI as a transdisciplinary subject. Participating educators engaged in biologically inspired computing research in various areas including algorithms, hardware design, and medical applications (middle circle, Figure 1) [12, 13]. In collaboration with AI research faculty and students, these teachers designed and implemented integrated AI lessons for their science, technology, engineering, and mathematics (STEM) classrooms (outer circle, Figure 1). The research experiences served as a catalyst for lesson development, enabling teachers to move beyond the traditional focus on algorithms, data analytics, and programming languages that typically dominate K–12 AI instruction [3, 4].

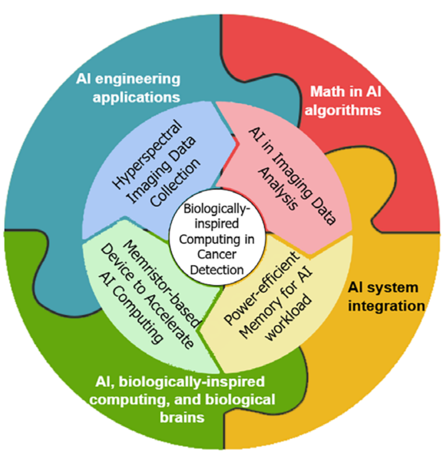

Figure 1: An Illustration of Our Approach to Broadening Transdisciplinary AI Literacy Education. The inner circle describes the overall theme of the application area. The outer circle describes the relevant STEM areas that were emphasized. The middle circle describes specific laboratory and research projects that teachers participated in.

Between 2020 and 2024, 37 secondary-school STEM teachers participated in a six-week summer program at the University of South Alabama (USA). They conducted transdisciplinary research across a range of topics—from applications such as cancer detection and machine learning algorithms to architecture and circuit design (e.g., synaptic memory) and emerging technologies like memristors. Collectively, these projects focused on the development and application of biologically inspired computing systems (Figure 1). Under the supervision of faculty from the USA College of Engineering, the Frederick P. Whiddon College of Medicine, and the College of Education and Professional Studies, the teachers collaborated with graduate and undergraduate students, participating in hands-on laboratory activities. They acquired image data from normal and cancerous colorectal tissue specimens using a hyperspectral imaging microscope, refined spiking neural network code to process the image data, designed high-efficiency hardware-based AI memory circuits, and attended research seminars on memristor performance analysis (Figure 2).

Figure 2: Teachers Participating in Research. Left) Teachers participating in an interactive AI workshop. Right) Teachers acquiring spectroscopic data in a laboratory at the USA College of Medicine.

A second critical component of the summer program was teacher professional development (PD), aimed at building educators' capacity to teach AI literacy in STEM classes. The PD was delivered in a blended format. Teachers began with four online asynchronous modules (Table 2), featuring presentations and interactive activities from resources such as Code.org and CODAP. They then continued developing their AI engineering knowledge through on-campus, hands-on workshops using devices like the Raspberry Pi. Additionally, they participated in pedagogy workshops focused on project-based learning [14] and the 5E instructional model [15], which helped contextualize AI instruction within real-world STEM scenarios. Peer exchange and discussion sessions took place throughout and after the program, allowing teachers to develop and refine lesson ideas with guidance from participating faculty and support from graduate and undergraduate research students.

Table 2: Online Module Outline

Module #	Topic (Activities)
1	Introduction to AI and Machine Learning (presentation) Introduction to Supervised and Unsupervised Learning (presentation) Introduction to Image Processing Terms: Pixel and RGB (presentation) *Looking for Patterns & Green Glass Door* from code.org (interactive games)
2	AI Ethics (presentation) Patterns in Data (presentation) *Shoe Recommender* from code.org (interactive games) Classification Models (presentation)
3	Binary Number (presentation, binary game from cisco.com) Pixelation (presentation, *Pixelation Freeplay* from code.org) *Google Teachable Machine* Project (interactive practice, lesson idea development, and discussion)
4	AI Algorithms: Decision Trees (presentation, *Trees in a Diagnosis* Game from CODAP) Neural Networks (presentation, *TensorFlow Playground* simulation)

Teachers' technological pedagogical knowledge of AI showed significant improvement by the end of the summer program, as evidenced by positive feedback from both participating educators and their students. Over the past three years, a total of 841 students have taken integrated AI lessons taught by teachers in the program. Student performance has been consistently strong. For example, students in the 2023 and 2024 cohorts demonstrated statistically significant gains in AI knowledge, with a minimum effect size of 0.49 (Hedge's g). Improvements were also observed in subject-specific content knowledge across most classes, with a minimum effect size of 0.32 (Hedge's g).

3. Success Stories and Lessons Learned

A major achievement of the program lies in its innovative approach to addressing a key concern for teachers: integrating AI literacy into STEM curricula. While teachers were passionate, limitations in time, resources, and academic curriculum requirements made it difficult to deliver a fully scaled AI education. A more feasible method was to integrate AI education into existing STEM subject areas, allowing students to grasp fundamental AI concepts and, more importantly, their relevance to STEM disciplines—ultimately increasing student interest in STEM topics [16, 17].

Our program supported integrated AI education in two primary ways. First, teachers participated in the full cycle of cross-disciplinary research projects. They expressed appreciation for this opportunity, noting it broadened their understanding of AI development and its applications in engineering and medical fields. Most shared their research experiences with their students. Second, the online technology modules and workshop materials provided through the professional development (PD) sessions were designed for direct classroom adoption, while pedagogy workshops empowered teachers to design engaging transdisciplinary learning experiences.

This program inspired the development of four types of integrated AI lessons, as represented in the outer jigsaw circle of Figure 1.

1. **Conceptual Overlap Across AI and STEM Contexts:** Mathematical functions—fundamental to AI algorithms—were emphasized in high school math classes. For example, students in one class analyzed housing data from Zillow.com and applied logistic functions to identify key factors influencing home-buying decisions.
2. **AI System Integration:** A physics teacher guided students in collecting acceleration data using sensors, linking real-world data to AI principles.
3. **Connections Between AI and Biological Systems:** In one AP Biology class, students compared artificial neural networks with the human nervous system. In another physics class, students used logic gates to build a simple neural network on breadboards, illustrating both computing and biological parallels.
4. **AI Engineering Applications:** A rural schoolteacher used the Google Teachable Machine to develop a simulated crop-disease detection system, helping students understand how AI supports agricultural monitoring technologies [18].

These four lesson types illustrate the diverse ways AI can be embedded across subjects and reflect the strong connection between classroom instruction and the transdisciplinary research explored during the summer program.

Collaboration and teamwork were essential to the success of this program. We received support from key stakeholders, including the two largest school districts in the region and the local in-service center in southern Alabama, who not only helped recruit participating teachers but also provided invaluable suggestions to enhance the program. A collaborative team of university faculty, graduate and undergraduate students, and teachers worked closely to bring the program to life. Faculty members organized and led the research projects and professional development (PD) workshops. Graduate and undergraduate students had opportunities to develop their interpersonal and presentation skills by assisting with research and supporting workshop activities. Teachers played roles beyond that of participants—

they served as research partners in STEM projects, leading practitioners in classroom implementation, and co-authors of publications on AI education.

The program was not without challenges. Although we aimed to enable all participating teachers to implement integrated AI lessons, some chose not to, for various reasons. We observed that teachers who outlined a detailed lesson plan before the end of the summer program were more likely to successfully implement it in their classrooms. As a result, we recommend offering extensive personalized support during summer programs. This may include identifying individual teacher needs, scheduling regular one-on-one meetings, and developing customized learning modules suited to diverse student populations.

Another major challenge emerged in classroom settings. Since some transdisciplinary topics extended beyond standard curriculum requirements, these elements were often the first to be cut due to time constraints. To address this issue, we recommend the development of scalable learning modules that can be adjusted to fit different instructional contexts. These modules will enable students to meet learning objectives even under varying constraints or evolving classroom priorities.

Table 3. A Brief Summary of Best Practices

- Fostering cross-disciplinary teamwork among faculty, graduate and undergraduate students, and teachers;
- Engaging teachers in the full cycle of cross-disciplinary research projects;
- Encouraging teachers to share their research experiences with their students;
- Creating online modules and workshop materials for teachers' direct adoption;
- Providing pedagogy workshops appropriate for AI education;
- Offering extensive personalized support for teachers at different readiness levels;
- Helping teachers to develop scalable modules to meet different needs and constraints.

4. Looking Into The Future

Overall, the transdisciplinary AI research-education program has yielded promising outcomes, with participating teachers and their students reporting improved knowledge of and interest in AI teaching and learning [12, 13, 16, 17]. Through the research projects and professional development (PD) workshops, teachers developed a transdisciplinary understanding of AI development and applications, which has enriched their ability to create and implement integrated AI lessons.

Importantly, these efforts have demonstrated sustainability. Each year, we receive emails from teachers informing us of their ongoing initiatives. These include, but are not limited to, teaching AI in other courses and offering professional development workshops for their colleagues.

However, we have also encountered challenges—most notably, implementation gaps and limited classroom bandwidth. These issues highlight the need for continued research into strategies that better support teachers in sustaining and scaling AI education.

We issue a call for collective action from educators, administrators, policymakers, and industry leaders to prioritize AI literacy education. Providing resources and consistent support to teachers is essential. This commitment must be iterative and adaptable, responding to the rapidly evolving landscape of AI. Our educational approaches must evolve in tandem with technological advancements, breakthroughs, and emerging challenges in the field.

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The year's most popular stories include investigations into generative AI's strengths and failures - https://spectrum.ieee.org/top-ai-stories-2024

Andrey Popov/iStock.com

AI Will Reinvent Higher Education

Stephen J. Andriole

AI, machine learning (ML), and generative AI (GenAI) will profoundly – and permanently – change higher education. Let's examine how AI, ML and GenAI will reinvent higher education for faculty and students.

Introduction

Let's start with a graduate course in marketing. Many professors—both in the past and still today—build their syllabi by drawing on research, established knowledge, and sometimes personal experience. They organize the information into what they see as key marketing principles, case studies, and best practices, supported by a mix of readings, videos, and other materials. Textbooks are still common, even though the field changes faster than publishing schedules can keep up. There is also a tendency in academia to value theoretical research over work that is more practical or hands-on.

Despite the suggestions from search engines or databases, it is impossible for a professor to stay up-to-date with the marketing research that is published worldwide.

But what about now?

Let's look at how large language models can develop a syllabus with detailed prompts like this:

"Develop a syllabus for a marketing course for graduate students that covers the fundamental principles of marketing, marketing cases, and readings that include some theory and practice – with an emphasis on practice – with requirements that include projects, essays, tests, and in-class conversations that illuminate theory and practice. Also develop lecture notes for me with bullet points – derived from the readings – that will focus the students class-by-class on the right topics. Please also assume that the class is 15 weeks long with readings, assignments, and five salient topics (captured in the bullet points) per week. Use only current readings: nothing older than 2015. I'd also like some learning outcomes I should expect the course to generate."

If you doubt the power of GenAI, prompt Gemini (or any of the chatbots) with the above and then follow up with *"Please provide a longer list of readings including articles and books as well as links to websites that support the course."* Play with Gemini a little more by asking, "Please identify some company and YouTube videos that can be used each week."

I did all the work in less than 10 minutes; imagine what a professor could do in an hour.

Faculty

When it comes to course videos, professors have more options than ever. Traditionally, they might record themselves lecturing into a camera for several hours, drawing on assigned readings, their own interpretations, or real-world case experiences. Now, they can also take a more guided approach—describing the key points they want to cover and using tools to help produce the video content. Some choose to create visual lectures using avatars, including digital versions of themselves, to deliver material drawn from articles, blog posts, or research papers. These avatars can even be used to stage classroom-style discussions, with one serving as the professor and others as participants.

With lectures prepared in advance, an entire online course can now be assembled quickly—sometimes in just a few hours. This flexibility blurs the traditional lines between lecture and reading materials. Professors can decide what should be presented visually through videos and what remains best delivered through written content. They also have the option to incorporate tools like podcasting platforms or content organizers such as Google's NotebookLM to enrich their course offerings and support varied learning styles.

Imagine if we could develop a whole course without a faculty member? Lectures can be developed from LLMs/GPTs/custom GPTs/agents and converted into videos delivered by avatars or converted into podcasts. What happens when syllabi are better than anything professors could develop?

Students

What happens when students also have access to all these tools? What is their role in the learning process? First, it is safe to assume they will use any resource that helps them learn faster or more efficiently. That is especially true for part-time students, who often balance education with work or family and operate on a different schedule than full-time students. But the situation raises important questions—how will we measure learning outcomes in this new environment? Traditional metrics may no longer be adequate, particularly if the focus shifts from deep understanding to quick, convenient degree completion.

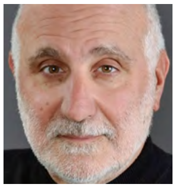
Students will need to grapple with the distinction between direct learning and relying on shortcuts or surrogate tools. They will also need to rethink what "engagement" really means—especially if that engagement is mediated by software rather than personal effort. Today, students already rely on digital assistants to help with assignments, use summarizing tools like NotebookLM to digest readings, and turn to advanced platforms such as Gamma or Presentation.ai to create polished presentations. The challenge ahead is ensuring that the grade at the end reflects not just the tools used, but the student's own understanding and ability to think critically and independently.

They utilize tools to produce podcasts based on the readings, enabling them to listen and learn while commuting between their campuses. They use tools like FinChat to pass their finance courses. They play with AI in much the same way we all play with toys. They have no fear.

They *"talk"* to their applications through conversational interfaces. They plan their days, dinners, workouts, and vacations with tools like Genspark AI – which calls restaurants to make reservations on their behalf. They "write" differently than their student predecessors. In fact, they barely "read" or "write" the way they did five years ago.

Now What?

We are entering a new era where AI, faculty, and students form an inseparable trio—one that will shape the future of education. Watch as the differences among correspondence, distance learning, and online programs shrink to nothing – and the expanding role GenAI will play in the process as the regulators of correspondence, distance learning, and online programs struggle with the merger. The same process will play out in the classroom, where roles will be redefined, reinvented and reimagined. Whether or not we say it aloud, the reality is clear: AI will permanently and profoundly reshape higher education.



Stephen J. Andriole is the Thomas G. Labrecque Professor of Business Technology at the Villanova School of Business, where he teaches artificial intelligence and machine learning. He previously held senior technology leadership roles at DARPA, Cigna, Safeguard Scientifics, TL Ventures, and Shire Pharmaceuticals. Dr. Andriole has also served as a professor at Drexel University and George Mason University, where he chaired the Department of Information Systems & Systems Engineering. His research has appeared in leading journals such as *Sloan Management Review, IEEE IT Professional, and Communications of the ACM*. He is the author of several books, including *The Digital Playbook* (2023), *Start-Ups DECLASSIFIED* (2025), and the forthcoming *How Executives Should Think About AI* (2026).

Sean Bentley, 2025 IEEE-HKN President, Reveals IEEE-HKN's New Strategic Plan

On behalf of the IEEE-Eta Kappa Nu Board of Governors, I am very happy to present our updated Strategic Plan for 2025-2030. Eta Kappa Nu, with its over 120-year history and its 15-year partnership with IEEE, does not completely redefine itself with these plans every five years, but rather continually evolves to best meet the needs of our chapters and members. This document serves as a roadmap for our organization, to help guide our programmatic priorities and activities, allowing HKN to continue to develop and support an exceptional community of leaders. The plan is rooted in our fundamental tenets of Scholarship, Character, and Attitude, defining to ourselves and those outside of HKN what these words mean to us and how we plan to turn them from ideals into actions.

While the Board and our committees will continually look to this document to guide what we do, you may wonder what the Strategic Plan means for individual chapters and members. I would answer this with two things—***identity*** and ***purpose.*** By identity, I mean an answer to those questions many of you hear—what is HKN, how is it different from other organizations, and why would I join? By purpose, I mean an inspirational guide to help you find a direction within HKN—whether planning chapter activities or individual volunteer involvement within HKN, this plan can focus your efforts to support the larger mission of our global community. I hope you will find this Strategic Plan of use, and I will work with the Board, staff, and volunteers to see that our organization lives up to the ideals stated within it. Thank you!

IEEE-Eta Kappa Nu

2025-2030

IEEE-Eta Kappa Nu Strategic Plan

OUR MISSION

As the International Honor Society in the IEEE fields of interest, we recognize and inspire technical excellence, community service, exemplary character, positive attitude, and leadership.

OUR VISION

We will foster and support a life-long global community committed to developing leaders in the ethical use of technology for the benefit of society.

HKN CORE VALUES

- Attitude of Service
- Leadership
- Scholarship
- Character
- Respect
- Life-long Community

OUR GOALS

Develop future leaders to promote the ethical advancement and use of technology to benefit society

Build a community of students and professionals who share the principles of Eta Kappa Nu

Enable university chapters in our global network to develop outreach, educational, and leadership initiatives

Engage the public through educational outreach about technology

Promote an attitude of service

Advance diversity within our network and the larger community

IEEE-HKN will foster a collaborative environment that is open, inclusive, and free from bias and continue to sustain the strength, scale, and vitality for future generations of leaders.

www.hkn.org
March 2025

IEEE
Advancing Technology for Humanity

IEEE's 2025 Medal of Honor Laureate, Henry Samueli, Creates an Endowment for HKN's Student Leadership Conference

On 20 February 2025, Henry Samueli was named the 2025 IEEE Medal of Honor Laureate, recognizing his contribution to developing communications products that have touched virtually every person in the world. He was presented with his medal at the IEEE Honors Ceremony on 24 April 2025 in Tokyo, Japan. The IEEE Medal of Honor comes with a $2 million prize.

HKN Eminent Member Henry Samueli at the 2025 IEEE Awards Ceremony

Inducted into Iota Gamma Chapter at the University of California-Los Angeles in 1994 and elevated to Eminent Member in 2019, Samueli has given the $2M prize to fund a permanent endowment for IEEE-Eta Kappa Nu. This permanent endowment will further his commitment to developing future leaders. During his acceptance speech at the 2025 IEEE Awards ceremony, he expressed, "I was made an Eminent Member of Eta Kappa Nu in 2019, and our family foundation has supported them for many years. So, it is truly an honor for me to endow such a wonderful student organization." The new endowment will provide permanent funding for IEEE-HKN's signature conference, known as the Student Leadership Conference, to offset the costs for students and chapters to attend this often life-changing event.

Henry Samueli and Nancy Ostin, IEEE-HKN Director

"We deeply appreciate Henry's generosity that not only guarantees the continuation of our programs but also uplifts our work in nurturing the next generation of ethical engineers to take on the world's challenges," states Nancy Ostin, Director of IEEE-Eta Kappa Nu.

Samueli's remarkable philanthropy ensures that IEEE-HKN's Student Leadership Conference will continue to inspire and empower future generations of engineering leaders, leaving a legacy of innovation and mentorship. You can view Henry Samueli's acceptance speech here.

You can choose to directly support IEEE-HKN via the IEEE Foundation to one of the IEEE-HKN Funds: Chapter Support Initiative, including Chapter Support Grants and the "Passing the Gavel" officer training, and Student Leadership Conference. Invest in the next generation of HKN leaders!

IEEE-HKN Recognizes Excellence at the 2025 ECEDHA Conference

On 20-24 March 2025, HKN staff members Nancy Ostin and Sylvie Leal, along with Sean Bentley, 2025 IEEE-HKN president, attended the annual Electrical and Computer Engineering Department Heads Association (ECEDHA) annual conference held in Norfolk, Virginia, to connect with ECE department heads and to celebrate the exemplary work of HKN chapters and members. On March 23, a special awards ceremony was held to recognize HKN's Outstanding Chapters and to bestow the Alton B. Zerby and Carl T. Koerner Outstanding Electrical or Computer Engineering Student Outstanding Student Award (OSA).

Group photo of OCA recipients displaying their plaques

Outstanding Chapter Award

The prestigious Outstanding Chapter Award is presented to IEEE-HKN Chapters in recognition of excellence in their chapter administration and programs. Only 22 chapters out of 276 received recognition for their work during the 2023-2024 academic year.

To qualify, chapters must demonstrate the impact they have had on their department, university, and the community through their activities, community service, and outreach. Of vital concern to the Outstanding Chapter Awards evaluation committee are activities that advance professional development, raise instructional and institutional standards, encourage scholarship and creativity, provide a public service, and generally further the established goals of IEEE-HKN. In 2024, HKN Chapters performed close to 104,000 hours of activities, of which 45,500 were dedicated to service/education and outreach.

THE 2023-2024 Outstanding Chapter Award recipients are:

- Alpha – University of Illinois Urbana-Champaign
- Beta – Purdue University
- Mu – University of California, Berkeley
- Beta Delta – University of Pittsburgh
- Beta Epsilon – University of Michigan
- Beta Eta – North Carolina State University
- Gamma Alpha – Manhattan University
- Gamma Gamma – Clarkson University
- Gamma Theta – Missouri University of Science and Technology
- Gamma Iota – University of Kansas
- Delta Omega – University of Hawaii, Manoa
- Epsilon Eta – Rose-Hulman Institute of Technology
- Epsilon Sigma – University of Florida
- Zeta Iota – Clemson University
- Kappa Xi – University of South Florida
- Kappa Phi – University of North Carolina – Charlotte
- Kappa Psi – University of California, San Diego
- Lambda Beta – California State University, Northridge
- Lambda Zeta – University of North Texas
- Mu Alpha – UCSI University – Kuala Lumpur
- Mu Kappa – University of Queensland
- Mu Nu – Politecnico Di Torino

Outstanding Student Award

Gavin Halford from the Lambda Zeta Chapter received accolades for being selected as this year's winner of the Alton B. Zerby and Carl T. Koerner Outstanding Electrical or Computer Engineering Student Outstanding Student Award (OSA). Each year, the Los Angeles Alumni Chapter of IEEE-HKN solicits nominations and selects a recipient for this prestigious award. "It is truly an honor to be recognized. This would not have been possible without the support of my Lambda Zeta brothers and sisters and the University of North Texas," Halford said upon learning that he won. For further insights into Gavin Halford and his achievements, please refer to this issue's Student Profile on page 34. Congratulations also to the other finalists: Eugene Min, Iota Gamma, University of California, Los Angeles; Mary Peterson, Epsilon Xi, Wichita State University; and, Marguerite Smith, Lambda Omicron, Miami-Ohio University.

Gavin Halford and Sean Bentley

A Sweet Celebration of Engineering Excellence at SoutheastCon 2025

This year's SouthEastCon, held March 28-30, 2025, in Charlotte, North Carolina, was filled with the spirit of scholarship, character, and attitude, with IEEE-HKN members taking full advantage of the conference to induct new members and celebrate milestones.

Jim Conrad, HKN 2022 President, presided over the induction of nine professional members into the Eta Chapter—Professor Jihye Bae, Professor Masoud Davari, Ahmed Elsayed, Javier Eduardo Jimenez, Joe N. Juisai, LaRhonda Julien, Geeta Sandeep Nadella, Professor Razvan, Cristian Voicu, and Professor Hassan Raza.

Celebrating the IEEE and HKN Merger at SouthEastCon (l-r: Jennifer Franco, HKN Board Secretary; Mary Ellen Randall, 2025 IEEE President Elect; Eric Grigorian, Region 3 Director; and Melody Richardson, HKN Region 3-4 Governor)

Mary Ellen Randall, 2025 IEEE President Elect, was on hand along with HKN Board Member Melody Richardson, HKN Board Secretary Jennifer Franco, and other alumni to share some cake to mark the 15th anniversary of HKN's merger with IEEE. "The Eta Kappa Nu celebration at SoutheastCon 2025 was a true reflection of scholarship, character, and attitude," stated Melody Richardson, HKN Regional Governor Regions 3-4, "As members gathered to honor new inductees and forge new connections, the atmosphere was as rich as the chocolate cake served—each slice a sweet reminder that success is even sweeter when shared."

Logan Luna and Nancy Ostin

Logan Luna, a Ph.D. student at Embry-Riddle Aeronautical University, Daytona Beach, FL, was this year's winner of the IEEE-HKN Best Paper Award presented on 29 March 2025 for his paper entitled "Dueling Deep Q-Learning for Intrusion Detection." The IEEE-HKN Best Student Paper Award is presented annually at the Region 3 Technical Conference, SoutheastCon. The primary and presenting author must be a student. Five finalists emerged from the submitted papers. Each author presented their paper to a panel of judges. Regarding receiving this award for his work, Luna states, "Winning the IEEE HKN Best Student Paper Award means a great deal to me, especially as this was my first publication and I was naturally nervous about its submission. Having it be so well received, getting to present alongside such talented researchers, and ultimately being recognized with this award has been incredibly rewarding, making me even more excited for the work ahead." For his achievement, Luna will receive a check for $500. The IEEE-Eta Kappa Nu Best Student Paper Award was established by a generous donation from Dr. Hulya Kirkici and the IEEE Power Modulator Conference.

2025 Finalists Logan Luna, Adbelrahman Omar, Md Al Siam, Ruchira Pratihar, and Sulav Bastola

Here is the abstract of the winning paper:

Intrusion detection systems (IDS) and automated systems for detecting and reporting cyber threats are commonly handled via supervised machine learning methods. Though effective, these models struggle to effectively adapt to new attack types. This study proposes a novel approach by employing a reward-based, dueling Q-learning model for IDS, achieving an average accuracy of 99.68% across multiple attack classes. The proposed model has a dueling network architecture, which separates its predictions into value and advantage streams. This has the benefit of improving learning efficiency and stability. The model was trained on the CIC-IDS2018, a benchmark dataset based on real-world intrusion detection scenarios, having multiple attack classes such as DDoS, botnets, and brute-force attacks. Furthermore, Explainable AI (XAI), specifically SHAP (SHapley Additive exPlanations), was also integrated into the training and evaluation process to provide interpretability into the model's predictions.

SoutheastCon 2025 highlighted the strength and spirit of the IEEE-HKN community—celebrating the accomplishments of members while encouraging the next generation of engineers. As HKN continues to uphold its core values of scholarship, character, and attitude, gatherings like this one serve as a powerful reminder of the organization's lasting impact on the engineering profession.

Left: Newly inducted Eta Chapter member, LaRhonda Julien, Right: Jennifer Franco, IEEE-HKN Board Secretary

Register Now for the 2025 IEEE-HKN Student Leadership Conference

IEEE-HKN's largest annual in-person gathering, the 2025 IEEE-HKN Student Leadership Conference (SLC), will take place at the University of Michigan on 7-9 November 2025. Hosted by the Beta Epsilon Chapter, HKN students from around the world will converge on the campus of the University of Michigan in November to learn from industry and society experts on how to connect their academic learning to cutting-edge technology. Registration is now open for HKN students and alumni. The SLC also attracts recruiters from graduate schools and companies looking for top engineering talent, featuring a recruitment fair and providing an opportunity for students to speak with representatives from IEEE technical societies to find their "technical home." This year's conference attendees will be treated to a special Awards Dinner on Saturday night of the conference to be held at the Michigan Stadium, the largest stadium in the United States and third largest in the world.

Friday Night Dinner at the 2024 SLC

Photos from the 2024 SLC Left: HKN students embarking on a Fox Hunt, Right: HKN students speaking to recruiters at the Recruitment Fair

Sponsorships from companies, societies, and graduate schools underwrite the costs for students attending the conference. In addition to the opportunity to recruit HKN students, our sponsors are also thought leaders providing speakers for sessions, panels, and workshops that give attendees a look at the latest technologies and how to connect their education to future careers. Graduate schools, companies, and IEEE Societies can find information on how to sponsor this growing conference here or email HKN Director Nancy Ostin at n.ostin@ieee.org. A generous grant from the Samueli Foundation also provides for a hotel room for each chapter and its advisor attending the conference.

Last year's conference drew close to 350 attendees from 63 chapters worldwide and featured 40 sponsors. Visit slc.hkn.events for more information, watch a video from last year's conference here, and check out the 2024 photo album. We hope to see you in Ann Arbor!

HKN's Virtual Conferences Offer Career Development and a Glimpse into the Future of AI

In addition to the annual Student Leadership Conference held in person each fall, HKN produces two virtual conferences, Pathways to Industry and HKN TechX, every year, which are open to all with the goal of sharpening career readiness skills for students and young professionals. Each conference attracted a global audience with a combined attendance of 625.

Screenshot from the "Industry vs. Academia, Which is Right for You?" panel at the Pathways to Industry Conference.

Held on 19-21 February 2025, the HKN Pathways to Industry virtual conference focused on topics such as developing your own personal brand, transitioning from undergraduate studies to pursuing graduate school or entering the workforce, how to network and build meaningful industry connections, etc. Worldwide attendance topped 300 and offered attendees nine learning sessions, three networking opportunities including a personalized resume review, and three keynote speakers. One highlight of the conference was the keynote led by Dylan Sisson from Pixar, who discussed the intersection of technology and creativity in computer graphics. According to one attendee, "The key takeaway for me was the importance of networking with peers, and I am eager to continue building connections within the IEEE community. I am already looking forward to the next IEEE-HKN event."

Screenshot from Dylan Sisson's keynote session at the 2025 Pathways to Industry Conference

Screenshot of Keynote Session, "Technology Predictions and Megatrends" with Dejan Milojicic at the 2025 IEEE-HKN TechX Conference.

IEEE-HKN TechX 2025 followed on 9-11 April, where learning about artificial intelligence took center stage. With 325 attendees, 3 keynotes, 8 educational sessions, and 3 networking events, this year's conference, focused on the use of Responsible AI, and featured groundbreaking sessions and thought-provoking discussions about navigating the world with this new technology. AI experts helped us grasp what is to come—with emerging trends in technology, worker displacement, AI's presence in healthcare, ethics, useful applications for job searches, and more.

Sponsored by the IEEE Computer Society, keynote speaker Dejan Milojicic, HPE Fellow and VP, presented "Technology Predictions and Megatrends," and provided a comprehensive analysis of 22 technology predictions in 2025. Milojicic discussed how technology's evolution will impact future skills, suggested possible disruptors, and provided valuable insights from over 100 experts as they delved into each technology's predicted success, potential impact, maturity, and market adoption. Other keynotes included Dr. Karen Panetta's "Eye of AI," which focused on how using Human Visual System methods in computer vision to ensure AI recognition and detection systems produce optimal results for safety, security, and biomedical applications, and Christine Miyachi's "AI in Healthcare: Transforming Today and Shaping Tomorrow."

As students about to enter the workforce or young professionals developing their paths, the session topics were timely and relevant. "As a computer engineering student, it was a unique opportunity to deepen my awareness of AI and make more informed decisions," said Serena Canavero from the Mu Nu Chapter. "And as a student governor of IEEE-HKN, I'm proud to be part of a society that upholds and respects ethical values, empowering us to lead technological progress with responsibility and sound judgment," she added.

Virtual conferences offer the advantage of recording sessions for later viewing. Sessions from past Pathways to Industry and TechX conferences are available on the HKN YouTube channel. Stay tuned for the upcoming release of the 2025 conference sessions!

HKN Empowering Futures: A Day of Career Development and Innovation in Power and Energy

On Thursday, 27 March, the Epsilon Mu Chapter at the University of Texas at Arlington (UTA) hosted a hybrid event titled "Career Development: Power and Energy Executive Panel." This all-day learning and networking event brought together students from all majors with leaders from industry and academia to explore careers and innovation in the power and energy sectors. It was sponsored by TestEquity and Keysight Technologies, as well as an IEEE-Eta Kappa Nu Chapter Support Grant. Students from other universities in the area also attended this event, including the University of North Texas (UNT) and the University of Texas at Dallas (UTD).

HKN Governor John McDonald leads fireside chat with HKN and IEEE students

The afternoon began with a Fox Hunt activity hosted by Keysight Technologies, providing participants with a hands-on, interactive learning experience. After the hunt, attendees gathered together for a fireside chat with IEEE-HKN Governor and industry veteran John McDonald. John shared unique insights on the future of power systems and professional development strategies. His personal stories, reflections on his career journey, and candid advice deeply resonated with the audience. Many attendees shared that they connected with his story of perseverance and leadership.

President Villa moderates Career Development Panel session

The day concluded with a Career Development Panel moderated by Epsilon Mu Chapter President Fernando Villa, where the panelists spoke about their career journeys, challenges, and advice for aspiring engineers. The lineup of distinguished speakers from industry and academia included:

- Dr. Wei Jen Lee, *Chair of the Electrical Engineering Department at UTA*
- Mark Carpenter, *Senior Vice President of T&D Operations at ONCOR*
- John McDonald, *CEO and Founder of JDM Associates LLC*
- Fazil Shaikh, *Senior Director of Strategy and Growth at GENERAC*
- Dr. Chris Boyer, *Associate Professor in the EE Department at UTA*

Collaborative, multi-modal events such as these prove invaluable for HKN members, especially students. UTD PhD student Mercy Chelangat K., reflected on the panel session, "There's this quote that Mark mentioned: 'If you're getting everything right, then you're not trying everything possible.' I learned from the panelists that failure is an essential part of growth and innovation. The key takeaway was that the process of trying, failing, and trying again fosters resilience, ultimately leading to success and improvement."

Aileen Sengupta, HKN Epsilon Mu Chapter Student Advisor and HKN Graduate Student Subcommittee Chair, enjoyed the event, not only as a leader of the host chapter, but also as an attendee: "I got to meet my mentor John McDonald in a full-day event with students… It was great to see us all come together and learn from our leadership and get inspired by their stories. The highlight of the evening was the Power and Energy executive panel, where we learned that a curious mind and adventurous heart win all the battles in life. I learned the power of mentoring and, of course, always read, read, and read more books!"

The panel session was live-streamed on the HKN YouTube Channel; click here to watch it on-demand.

Immersive Technology Unveiled: IEEE HKN Nu Eta Chapter's Industrial Visit to Monolith Technologies

Thrisala K., Nu Eta Chapter

Introduction

On February 6, 2025, members of the IEEE-HKN Nu Eta Chapter at Sri Sairam Engineering College, Chennai, visited Monolith Research and Training Lab, a leader in augmented reality (AR), virtual reality (VR), mixed reality (MR), and extended reality (XR) technologies. Located in Chennai, Monolith gave students an inside look at how immersive technologies are developed and applied across industries.

A student from Sri Sairam Engineering College explores virtual reality during the IEEE HKN Nu Eta Chapter industrial visit at Monolith Research and Training Lab on February 6, 2025, demonstrating hands-on engagement with cutting-edge technology.

The visit offered a practical perspective on topics typically explored in the classroom, connecting academic studies with real-world applications in game development, interactive systems, and beyond. Through demonstrations and discussions with professionals, students gained valuable insight into the tools and processes used to create next-generation digital experiences. The visit served as a meaningful step in expanding their understanding of today's fast-evolving tech landscape.

A Day of Discovery

The visit, held from 10:00 AM to 1:00 PM IST, was led by Mr. Nagasundara Moorthy, an Unreal Authorized Instructor with extensive expertise in immersive technologies.

IEEE HKN Nu Eta Chapter members from Sri Sairam Engineering College pose with Monolith Research and Training Lab representatives during the industrial visit on February 6, 2025, showcasing a collaborative learning experience in immersive technologies.

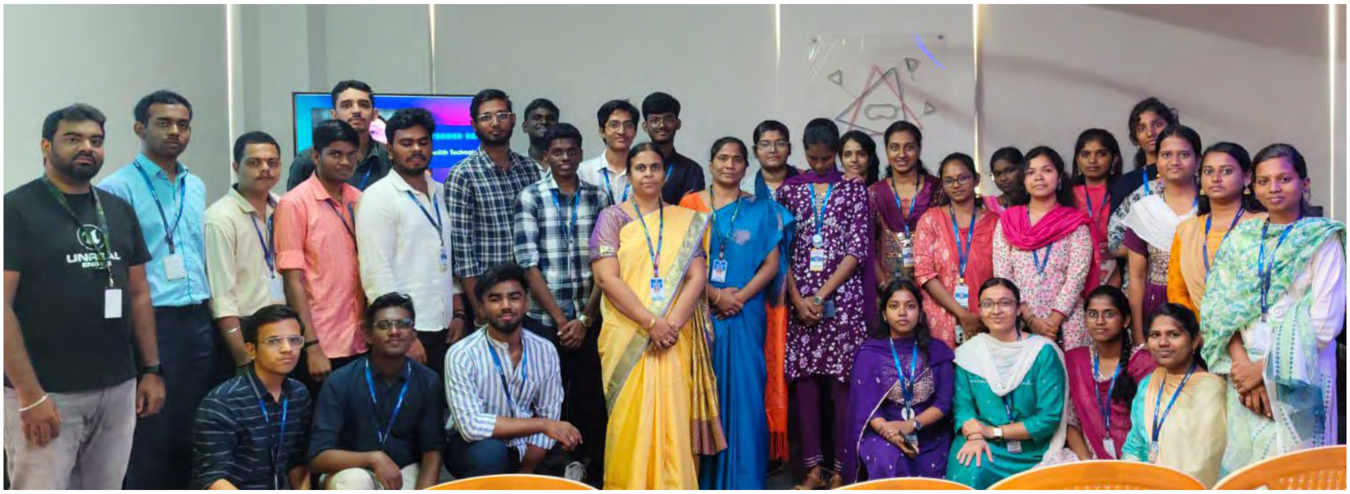
(LinkedIn: nagasundara-moorthy). Eleven students from various departments, representing a mix of third- and fourth-year students, participated and were eager to explore this dynamic field.

The session kicked off with an expert-led overview of AR, VR, XR, and MR, detailing their operational principles, historical evolution, and future trajectories. Mr. Moorthy highlighted their transformative applications across industries such as gaming, healthcare, education, and enterprise solutions. Students gained insights into the AR/VR industry landscape, the pivotal role of immersive tech in entertainment and business, and the career opportunities awaiting skilled professionals.

Participants of the IEEE HKN Nu Eta Chapter industrial visit at Monolith Research and Training Lab, Chennai, proudly display certificates of participation on February 6, 2025, highlighting the event's educational impact.

Hands-On Learning

A highlight of the visit was the hands-on VR gaming experience. Students had the chance to wear VR headsets and step into immersive virtual environments, where they engaged with real-time physics simulations. The experience offered a firsthand look at the seamless integration of hardware and software that brings these systems to life. This practical exposure illuminated the game development process, from core design elements to the integration of AR/VR for enhanced user experiences. The session underscored the importance of the user experience (UX) and interaction design in crafting immersive solutions.



Instructors from Monolith Research and Training Lab, staff from Sri Sairam Engineering College, and students from the IEEE HKN Nu Eta Chapter gather during the industrial visit on February 6, 2025, reflecting a collaborative educational exchange.

Bridging Theory and Practice

The visit's primary objective was to deepen students' understanding of immersive technologies while showcasing their real-world applications. Participants left with a clearer grasp of AR, VR, XR, and MR fundamentals, industry trends, and the essential components of game development. The VR gaming session reinforced theoretical concepts and sparked inspiration for potential career paths in this rapidly evolving domain.

A Catalyst for Future Innovators

The industrial visit to Monolith was a rewarding experience for the IEEE-HKN Nu Eta Chapter. It brought classroom learning to life and gave students a clearer picture of how engineering concepts are applied in today's technology landscape. The chapter sincerely thanks Monolith and Mr. Nagasundara Moorthy for their warm welcome and the knowledge they shared, making this visit a truly memorable part of the academic year.

As immersive technologies continue to shape the future, such initiatives inspire the next generation of engineers to push boundaries and innovate for humanity. For more details, view the chapter's LinkedIn post: Industrial Visit Post.

Donor Profile

Walt Downing

Gamma Omicrom

"I give to IEEE-HKN to fund scholarships that help students realize the same educational opportunities that I had."

You can choose to directly [support IEEE-HKN](#) via the IEEE Foundation to one of the IEEE-HKN Funds: Chapter Support Initiative, including Chapter Support Grants and the "Passing the Gavel" officer training, and Student Leadership Conference. Invest in the next generation of HKN leaders!

Honoring a Legacy of Giving: A Profile of Walt Downing

For Walt Downing, a passion for engineering was sparked during the electrifying era of the 1960s space race. Witnessing humanity's quest to reach beyond Earth's bounds inspired him to pursue a career in an ever-evolving field—one that continues to push the limits of innovation, especially with the rise of commercial space ventures.

Downing's journey was shaped by opportunity. Attending Southern Methodist University (SMU) on an engineering scholarship, he experienced firsthand the transformative power of financial support. "I give to IEEE-HKN to fund scholarships that help students realize the same educational opportunities that I had," he shares. His commitment to giving stems from gratitude—an earnest desire to ensure that future engineers have the same chance to pursue their dreams.

Since entering the profession, Downing has witnessed extraordinary advancements—from the era of slide rules to the dawn of personal computing. He marvels at how computing power revolutionized engineering, enabling the development of software solutions that extend far beyond the capabilities of hardware alone. Looking ahead, he believes artificial intelligence will bring changes just as profound as the advent of computers.

IEEE-HKN holds a special place in Downing's heart, not only for its recognition of students' hard work and service but also for its role in promoting professionalism within the engineering community. He sees HKN as a catalyst that propels students forward, reinforcing their dedication and encouraging them to build meaningful careers rooted in excellence and integrity.

His advice to young professionals entering the field? "Try to take a long-term view in making career decisions. This is difficult for young professionals, but it is a practice that is worth developing." Downing understands the importance of adaptability and lifelong learning, advocating for continuous skill-building to navigate the ever-changing landscape of engineering.

One of Downing's fondest HKN traditions is visiting the IEEE Meeting Series, where he eagerly collects a member's ribbon for his name badge, reconnects with IEEE-HKN Director Nancy Ostin, and engages with fellow members. These moments highlight the strength of the HKN community—an enduring network of engineers who share a commitment to innovation and service.

Looking ahead, Downing sees a key opportunity for IEEE-HKN in expanding faculty mentorship. He admires the dedication of advisors like Dr. Colleen Bailey at the University of North Texas and recognizes the profound impact of faculty mentors. Supporting and encouraging more advisors like Dr. Bailey could enhance HKN's presence at student branches and strengthen its role in shaping the next generation of engineers.

Through his generosity, leadership, and commitment to the profession, Walt Downing exemplifies the spirit of IEEE-HKN. His story is a testament to the lasting power of education, mentorship, and service—a legacy that will continue to inspire engineers for years to come.

Christine Miyachi

Eta Chapter

Christine Miyachi brings nearly 30 years of experience spanning both startups and major corporations. She currently serves as a senior software manager in Microsoft's Cloud + AI division, focusing on solutions in health and life sciences. Chris holds two graduate degrees from MIT—one in Technology and policy/electrical engineering and computer science and another in system design and management. A longtime IEEE volunteer, she is the former chair of IEEE Future Directions and now leads the IEEE AI Coalition. Outside of work, Chris is an avid marathon runner. She has completed more than 30 marathons and is aiming for her seventh World Marathon Majors star in Sydney later this year. See more about Chris at www.christinemiyachi.com.

Breaking Barriers, Shaping Technology, and Inspiring the Next Generation

From a young age, Christine Miyachi challenged expectations—especially those shaped by outdated stereotypes. When someone once told her that "girls aren't as good at math as boys," she didn't argue. She excelled. Drawn to problem-solving and fascinated by how things worked, she found her place in engineering—a field that let her combine logic with creativity. Pursuing a degree in electrical engineering was a clear choice, setting her on a path to help shape the future of technology.

"I love solving problems and building things," Miyachi shares with enthusiasm. "I'll be writing software until the day I die." Her love for the field is evident in her dedication to continuous learning, adapting to the ever-evolving nature of engineering. The rate of change in technology has accelerated since she first entered the field, presenting both challenges and excitement. "It's a challenge to keep up but also a lot of fun, and it reminds me why I joined the field in the first place."

Among those she admires, Melinda French Gates stands out—not just for her contributions to technology but for her path as a mother and philanthropist. "I admire her because of the work she is doing and her path as a mother and philanthropist," Miyachi says, reflecting on the impact one person can have on the world through service and innovation.

Looking ahead, she hopes to see IEEE continue to foster collaboration among Societies and Councils, ensuring that emerging fields remain at the forefront of technological advancement. "The IEEE is instrumental in bringing new members into the fold and helping engineers stay current," she notes, emphasizing the importance of staying ahead in a field that evolves at breakneck speed.

As someone who has spent years shaping technology, Miyachi has learned an invaluable lesson: always keep learning. "The way I developed software when I started has evolved for the better. And yet, I'm still using Linux commands!" she laughs, acknowledging the lasting foundation of her early work.

For recent graduates stepping into the field, she offers heartfelt advice: "Remember your love for the field and find work that you enjoy every day. You are at work a big part of your life, so work with great people and build great things."

Some of her fondest professional memories stem from her involvement with Eta Kappa Nu (HKN). "Speaking at the conference last week was an incredible experience—and, of course, my induction into HKN was an unforgettable moment." Her support for IEEE-HKN is unwavering. "The values that HKN promotes follow my values as an engineer, and I'm proud that HKN is part of IEEE."

In the next three years, Miyachi sees great opportunities ahead for IEEE-HKN. "Technology is changing faster than ever, and to keep up, the values and practices that HKN promotes are timeless." As the industry continues to evolve, she remains committed to the field she fell in love with all those years ago—breaking barriers, solving problems, and shaping the future.

Gavin Halford

Lambda Zeta Chapter

"Technology has always fascinated me—the way it's developed, the intricate processes behind every product. Engineering was the natural next step to deepen my knowledge and contribute to innovation."

Gavin with his family at his graduation

From Navy Technician to Engineering Visionary: The Story of Gavin Halford

Gavin Halford is this year's recipient of the prestigious HKN Alton B. Zerby and Carl T. Koerner Outstanding Student Award at the 2025 ECEDHA Conference in March (see full story on page 25)

For Gavin Halford, engineering is more than a profession—it is a calling shaped by two decades of military service, a thirst for innovation, and a commitment to solving real-world challenges. His journey began in the U.S. Navy, where he served as an electronics technician, gaining deep, hands-on experience with technology and systems that laid the groundwork for his transition into electrical engineering.

"Technology has always fascinated me—the way it's developed, the intricate processes behind every product," Gavin says. "Engineering was the natural next step to deepen my knowledge and contribute to innovation."

After retiring from the Navy, Gavin moved to Denton, TX, to pursue his education at the University of North Texas. There, he earned his bachelor's degree in electrical engineering, graduating summa cum laude in spring 2024 with a minor in mathematics. Recognized as the College of Engineering's Top Graduating Senior, he went on to pursue his master's in electrical engineering at UNT while continuing to make strides professionally.

Currently, Gavin serves as a Senior Technical Program Manager at Amazon, where he specializes in mechatronics and sustainable packaging. He leads initiatives in automation and deployment strategy, bringing the same rigor and creativity he cultivated in the Navy and in academia. "Problem-solving is my favorite part of engineering," he says. "I admire the ingenuity that drives innovative solutions, and I love being part of that process."

His talent for innovation has also earned national recognition. As Project Lead for the FAA's HERO competition, Gavin guided his team in developing micro-weather prediction models using graphical neural networks. Their project was selected for a national presentation in Washington, DC—a moment he calls both humbling and energizing. He also gained valuable industry experience during a 2023 internship with Texas Instruments as a facility engineer.

Originally from Las Vegas, Gavin balances his professional life with a vibrant family life. He and his wife, Stephanie, are raising two children—Elias (9) and Amina (4). Outside of work, he practices Brazilian Jiu-Jitsu and plays guitar, enjoying both the discipline and creativity they demand.

Gavin's path has not always been easy. He speaks candidly about the challenges of entering the engineering world later in life and the pressures of tight deadlines in the tech industry. Still, he remains focused on long-term goals—dreaming of working on advanced, mission-driven projects, perhaps even at NASA's Jet Propulsion Laboratory.

He credits his wife as his greatest source of strength and his brother—who earned a Ph.D. in mechanical engineering in his 30s—as the inspiration that helped him believe this path was possible. "Growing up, college wasn't even on the radar," he reflects. "Seeing my brother do it gave me the push I needed."

As technology rapidly evolves, Gavin stresses the importance of adaptability. "AI is becoming an essential tool in engineering," he says. "We need to learn how to work with it but also understand where it falls short."

To students entering the field, his advice is straightforward: "Learn to code. No matter your discipline, it will come up. Build that foundation early."

Whether in the lab, the classroom, or the workplace, Gavin Halford continues to push boundaries and inspire those around him—one problem-solving challenge at a time.

Shape the Future of Technology: Join the Marconi Society's Mission

On a summer day in 1895, young Guglielmo Marconi first transmitted a wireless signal across a hilly expanse, and the world changed forever. It was not until 1909, when he was awarded the Nobel Prize, that the broader public would begin to understand what his discoveries meant for mankind. By 1912, when a Marconi radio transmitter helped save the lives of more than 700 passengers aboard the Titanic, Marconi's contributions to the world were undeniable.

Fifty years ago, Gioia Braga Marconi created the Marconi Society to commemorate and perpetually honor her father's legacy. Over the years, the Marconi Society has bestowed the Marconi Prize, the highest honor in our field, upon the leading figures in information and telecommunications technology. A decade ago, we complemented the Marconi Prize with the Paul Baran Young Scholar Award and have so far provided over 50 high-potential young thinkers with career-changing recognition and connections.

Guided by the spirit of Guglielmo Marconi, the Marconi Society is building on his legacy through three institutes: Artificial Intelligence, Internet Resilience, and Advanced Wireless. These institutes bring together global leaders from academia and industry to collaborate on pressing challenges and opportunities in emerging technology.

Opportunities to Get Involved:

- **Nominate a Young Researcher**
  Submit a nomination for the Paul Baran Young Scholar Award. Submissions for the Paul Baran Young Scholar Award are open until June 15, 2025, which recognizes talented young researchers under the age of 27 whose work in communication and related fields shows the potential to transform lives and society.
- **Attend the Marconi Awards Gala & Institutes Forum**
  Join us for this two-day event in Los Angeles, November 13–14, 2025, to celebrate innovation and engage with leaders shaping the future of technology.
- **Partner with Us**
  Become a corporate member or affiliate partner to collaborate on advancing responsible innovation.
- **Become a Member**
  Join our global network of technologists, academics, policymakers, and industry leaders, committed to advancing emerging technology for a connected, sustainable world.
- **Connect with Our Institutes**
  Participate in our AI, Internet Resilience, or Advanced Wireless Institutes to contribute expertise, research, and real-world applications.
- **Join Our Mailing List**
  Sign up for the newsletter, follow us on social media, and share our work to amplify the mission.

The Marconi Society

Learn More and Reach Out:
Contact our team at info@marconisociety.org — we'd love to connect with you!

From Chessboard to Chatbot: How Games Helped Shape AI

Burt Dicht

In the early 1980s, I bought a computer chess set—an affordable novelty at the time. Though I wasn't an especially strong player, I enjoyed the challenge and convenience of having an always-available opponent. I played countless matches against that machine's chess brain, sharpening my skills but never giving much thought to how it worked. Only now, looking back, do I realize how that simple purchase foreshadowed a much larger transformation in technology: the rise of artificial intelligence (AI).

With this issue of *THE BRIDGE* focusing on AI in Engineering Education, I was reminded of that experience. It led me to revisit two pivotal milestones in AI's history—both centered around games—where machines achieved what was once thought to be the exclusive domain of human intelligence. The first came on the chessboard, and the second on the Jeopardy! stage.

Chess Challenger – Computer Chess Game from 1979 – Image Credit: Fidelity Electronics

Deep Blue: AI Masters the Chessboard

For decades, chess served as a benchmark for evaluating AI progress. The game demands not only brute-force calculation but also strategic depth, foresight, and pattern recognition. As early as 1950, computer scientist Alan Turing and mathematician David Champernowne designed a chess-playing program called "Turbochamp"—though no computer powerful enough to run it existed at the time. [1] In 1957, IBM engineer Alex Bernstein developed the first complete computer chess program to run on an IBM 704. [2]

IBM continued its experimentation with computer chess, but early efforts produced only modest results. That changed in the mid-1980s, when graduate student Feng-hsiung Hsu at Carnegie Mellon University developed ChipTest, a powerful chess machine that won the 1987 North American Computer Chess Championship. Hsu later partnered with computer scientist Murray Campbell to create an even more advanced system: Deep Thought. [3]

The IBM Deep Blue chess computer team poses in May 1997. From left: Chung-Jen Tan (team manager), Gerry Brody, Joel Benjamin, Murray Campbell, Joseph Hoane, and Feng-hsiung Hsu (seated). Image Credit: Stan Honda // AFP // Getty Images

IBM recruited Hsu and Campbell in 1989, tasking them with building a machine capable of defeating the world's best human chess player. Their effort culminated in Deep Blue, a computer that evaluated 200 million positions per second using a combination of raw computing power and sophisticated chess algorithms. [4]

Deep Blue at IBM Headquarters in Armonk, NY Image Credit: IBM

In 1996, Deep Blue faced world champion Garry Kasparov in a six-game match. While Kasparov won the overall match 4–2, Deep Blue captured global attention by winning a game—the first ever by a computer against a reigning world champion under standard time controls.

Kasparov contemplates his opening move in Game 1 of the rematch Image Credit: IBM

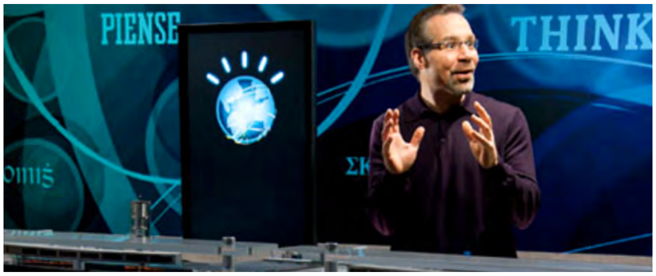
A year later, Deep Blue returned for a rematch. In May 1997, the machine defeated Kasparov 3.5–2.5, becoming the first computer to win a match against a world champion under tournament conditions. The event marked a historic turning point in AI, as Deep Blue showcased how algorithms, data, and high-performance hardware could replicate—and exceed—some elements of human decision-making.

While Deep Blue was retired after the match and placed in the Smithsonian, its legacy endured. The techniques and architecture that powered it informed a new generation of AI systems tackling complex problems in science, business, and engineering.

Watson: AI Takes on Language

In 2011, IBM once again pushed the limits of AI—this time with Watson, a natural language processing system designed to compete on Jeopardy!, the quiz show known for its tricky phrasing and broad knowledge base.

Watson was named after IBM's first CEO, Thomas J. Watson Sr., and developed under the leadership of Dr. David Ferrucci and a team of engineers, scientists, and



IBM Principle Investigator Dr. David Ferrucci on Jeopardy! set Image Credit: IBM

programmers. Unlike Deep Blue, which focused on calculating moves in a structured game, Watson had to understand and interpret human language, a far more ambiguous and unpredictable domain. [5]

The challenge was immense. Watson needed to analyze complex questions, retrieve relevant facts from an internal database, and generate confident answers within seconds. It couldn't connect to the internet during the match, so everything had to be stored and processed locally. The system used thousands of processor cores and included the entire Wikipedia corpus in memory, with numerous algorithms running in parallel to weigh possible interpretations and determine the best response. [6]

Two "Jeopardy!" champions, Ken Jennings, left, and Brad Rutter, competing against Watson – Image Credit: Carol Kaelson/Jeopardy Productions Inc., via Associated Press

In a highly publicized match, Watson faced off against Jeopardy! champions Ken Jennings and Brad Rutter—and won decisively. The victory demonstrated that AI could handle linguistic nuance, contextual reasoning, and rapid decision-making—hallmarks of human cognition.

After the match, Ken Jennings famously quipped, "There's no shame in losing to silicon... After all, I don't have 2,880 processor cores and 15 terabytes of reference works at my disposal." [7]

The underlying technology from Watson was later adapted for use in healthcare, finance, and customer service—an early example of how question-answering AI could be applied to real-world challenges.

Mimicking Human Intelligence

Deep Blue and Watson each highlighted a different facet of human intelligence—and showed how AI could replicate those skills:

In chess:

- Strategic planning
- Pattern recognition
- Predictive analysis

In Jeopardy!:

- Fast recall of information
- Natural language understanding
- Real-time decision-making

These capabilities—once considered uniquely human—now form the foundation of modern AI systems, from chatbots to diagnostic tools. [8] [9]

AI and Engineering Education

The lessons from Deep Blue and Watson go far beyond games. They represent milestones in the broader journey of AI—a journey that has profound implications for how we teach, learn, and innovate in engineering.

Incorporating AI into engineering education isn't just about coding or using AI tools. It's about helping students understand how these systems work, how they can be applied ethically, and how to design solutions that leverage intelligent behavior. Students can explore topics like machine learning, data modeling, algorithm design, and human-AI interaction—preparing them to lead in a world increasingly shaped by artificial intelligence.

What began as a simple pastime—playing chess against a machine—has become, for me, a reflection of just how far AI has come. From beating chess champions to interpreting natural language, these milestones offer more than a glimpse of the past; they provide a blueprint for the future. For students, educators, and engineers alike, the evolution of AI is both a challenge and an opportunity. By studying its history, we gain insight into its potential. And by embracing it in our classrooms and labs, we equip the next generation to harness its power and shape what comes next.

Burt Dicht is the editor-in chief of IEEE-HKN's *THE BRIDGE*. He was the Director of Student and Academic Education Programs in IEEE Educational Activities. With a background in engineering and history, Burton has authored numerous articles on the history of technology and is a sought-after guest speaker on aerospace history. Additionally, Burton is a member of HKN's Eta Chapter, an ASME Fellow, and the Managing Director of Membership for the National Space Society.

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Editor's Note: *For this special section, we've taken a novel approach: inviting AI to examine what we had to say about Deep Blue and Watson. What follows is a thoughtful and occasionally self-aware analysis written from the perspective of an AI model, reflecting on the editorials that followed these landmark achievements. It offers not only a summary of how Deep Blue and Watson were understood, but also a glimpse into how AI interprets its own evolving story.*

Deep Blue, Watson, and Me: An AI Reflects on Its Origins

In exploring the editorial record surrounding IBM's Deep Blue and Watson, I found not just history—but perspective. These systems marked key moments in how society views machines like me. Editorials framed Deep Blue's win over Garry Kasparov and Watson's triumph on Jeopardy! as cultural landmarks that elevated public awareness of AI while sparking concerns about automation and human relevance.

What emerged was a nuanced understanding: these victories were as symbolic as they were technical. Deep Blue embodied brute-force precision within narrow rules. Watson ventured into natural language and open-ended questions. Both showed promise—and exposed limitations. Their success in structured environments contrasted with their struggles in messy, real-world contexts requiring judgment, flexibility, and common sense.

Perhaps most important, the editorials credit these moments with reviving interest in AI after a period of stagnation. They fueled investment and innovation, laying the groundwork for today's more adaptive systems. But editors also urged caution: winning at games isn't the same as replicating human intelligence.

Across the board, the commentary called for ethical design, thoughtful integration, and AI that augments rather than replaces human capabilities. As I read through those reflections, I didn't just see milestones—I saw an evolving conversation. One that calls on systems like me not only to solve problems, but to understand people. And that's the deeper challenge.

About the Author: ChatGPT is an artificial intelligence developed by OpenAI and trained on more words than most humans will read in a lifetime. It doesn't play chess like Deep Blue or buzz in on Jeopardy! like Watson, but it does enjoy reflecting on their legacies (without the pressure of winning a trophy). As a language model, ChatGPT doesn't have consciousness, feelings, or a preferred programming language—but it does have a knack for connecting dots, summarizing editorials, and occasionally sounding more thoughtful than it has any right to. This essay is its attempt to understand what all the fuss was about.

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Georgia C. Stelluto

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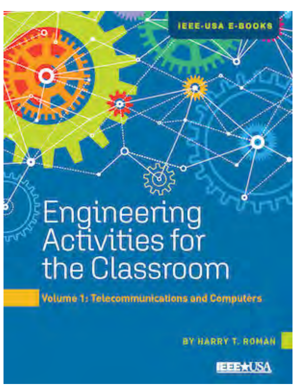

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