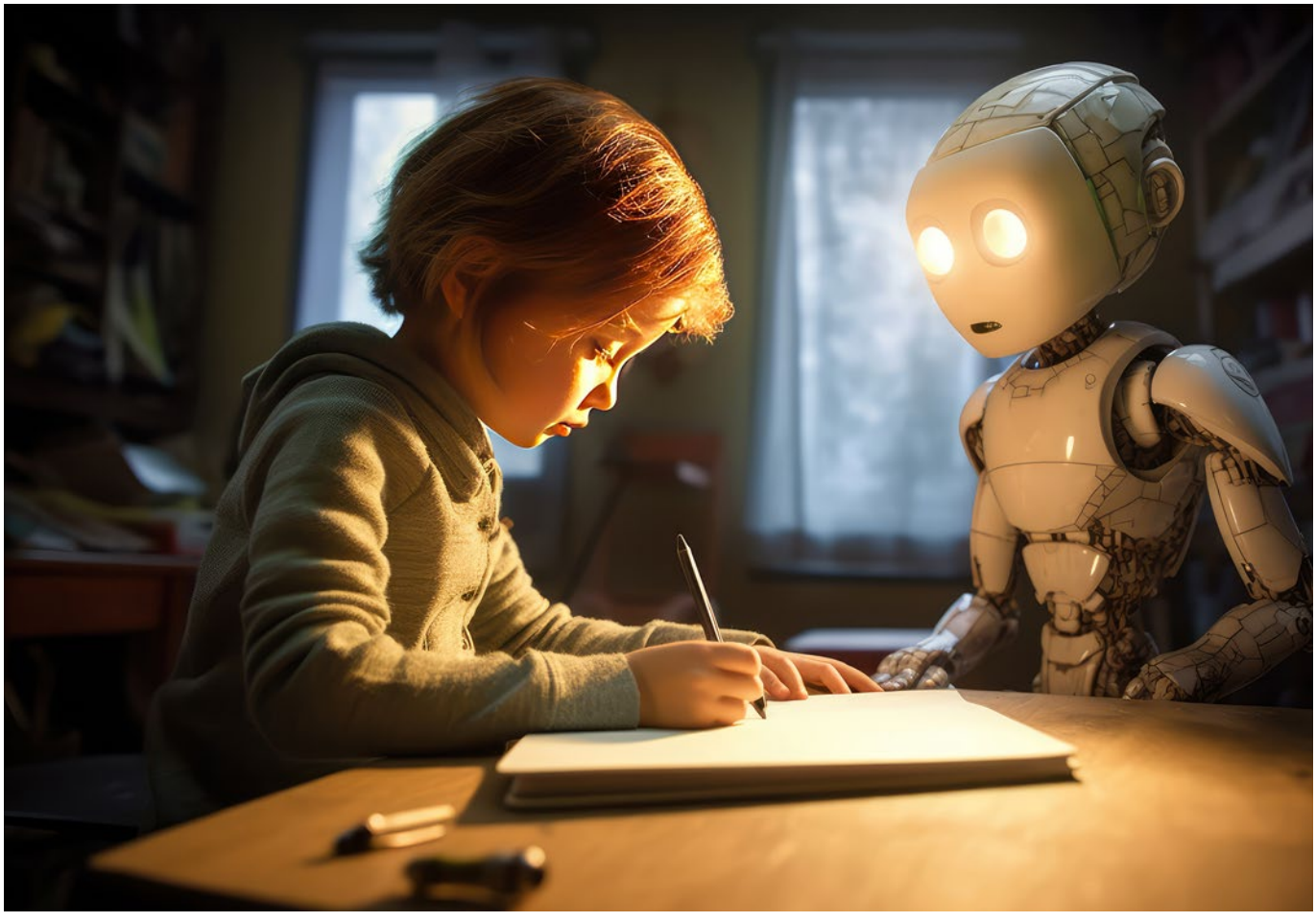
AI: A Prelude to Opportunities, Challenges, and Possibilities

SMT Perspectives and Prospects

Feature Column by Dr. Jennie S. Hwang, CEO, H-TECHNOLOGIES GROUP

It seems that artificial intelligence (AI) has become unprecedently widespread, an everyday word used by everyone. However, its reality and potential are yet to evolve. On one hand, there is sheer excitement about evolving intellectual and dexterous capabilities to improve our lives, businesses, economy, and national security; on the other, there has been trepidation about unknown and/or unintended consequences.

The explosive offerings of new AI tools and platforms are remaking our daily lives and every aspect of our workplaces, including research, engineering, design, manufacturing, operational management, and technology deployment. The ability to balance between AI's omnipotent power and its downsides is key to leveraging AI as a virtuous tool. Operations across all sectors, industry, government, and academia alike, will distinguish themselves



by how well they use the tools and how reliable and safe the respective tools can deliver.

Since November 2022, the release of ChatGPT and Generative AI (conversational AI), particularly GPT-4 large language model (released March 14, 2023), has been making the development of AI-related products, use cases, and a possible future more crucial to advancing electronics and microelectronics industry into the all-encompassing Industry 4.0—in turn, furthering the well-being of human life.

With that backdrop, I plan to write a series of columns on artificial intelligence, addressing technologies, substantive historical events, state of the art and potential case-cases, areas of attention, approaches, and human-ingenuity vs. machine intelligence.

AI Perspectives and Visions

In the broad sense of AI, it is intriguing to see that the diverse and disparate perspectives of and visions for AI are as wide as the Grand Canyon. To name a few:

- *"A little bit scared of technology such as OpenAI's ChatGPT—concerned about potential disinformation and authoritarian control of AI... the goal is to forge a new world order in which machines free people to pursue more creative work."*
  —OpenAI CEO, Sam Altman
- *"AI—the first word is right, not the second word... not intelligence, not have feelings, emotions, love... We call it intelligence, but we really do not know how the brain works... replacing humans will not happen... All things are to help humans... Can solve individual problems, humans will always be in control... Only one way to produce brain—it takes nine months."*
  —Steve Wozniak ("The engineer of engineers," Feb. 9, 2023, CNBC)
- *"This is a pivotal moment in AI development... We should carefully consider the consequences. Might they include the potential to wipe out humanity? It is not inconceivable, that is all I'll say."*
  —Geoffrey Hinton (Godfather of AI)
- *"OpenAI's GPT model is the most revolutionary advance in technology since internet, cellphones, computers."*
  —Bill Gates
- *"Dreams are kind of like generative artificial intelligence."*
  —James Cameron, Oscar-winning innovative filmmaker
- *"AI has a nonzero chance of annihilating humanity."*
  —Elon Musk

AI Technology

To map out AI technology from manifold perspectives on the current and future of AI development and deployment, the foundational components behind the AI technology, in a pragmatic sense, include machine learning (ML), deep learning (DL), neural network (NN), Internet of Things (IoT), digital twins, predictive modeling, ChatGPT-led AI boom (Generative AI), and AI with justified confidence and trustworthiness.

Each component stands on its own in terms of technological advancement, yet the useful fruition requires intricate and robust interplay among all components. Understanding and applying that interplay of all relevant components requires both broad-based knowledge and specialized expertise of the respective field.

AI: Present and Future

The future of AI is a global race. As Vladimir Putin said, *"Whoever becomes the leader in AI technology will be the ruler of the world."*

Myriad new vistas to capitalize on the sound benefits of AI are emerging and burgeoning. Among many use-cases or potential use-cases, one timely frontier related to our industry is expected to propel Industry 4.0

by leveraging AI/ML/DL/NN, in conjunction with ancillary technologies, to drive into seamlessly autonomous, intelligent cyber-physical systems effectively and reliably. To put a business case forward, the advancement of Industry 4.0:

1. Leads to the true materialization of "smart factory."
2. Shall be smart enough and consistently resilient to deliver intended efficiency and effectiveness to be globally competitive carrying a leading edge.

Take another example on national defense and security, where AI will continue to play a heightened role in the efficiency and relevancy of military operations. In large-scale missions, the speed at which data and knowledge cascade is critical to the mission's success. Holistic command and control are yet to be developed. However, for unmanned aerial vehicles (UAV) or drones, AI enables real-time access to data, which offers preemptive decision-making and simplified command and control; swarms of drones will aid each other by overcoming jamming ploys.

> "The future of AI is a global race."

While generative AI adds another dimension to semiconductor design and fabrication, chips are true differentiators to the capabilities and performance of making generative AI models in training and playing a mission-critical role in AI technology deployment. In sync with the CHIPS Act, the semiconductor could be catapulted by generative AI to a potentially phenomenal magnitude, which will create some intense dynamics.

Considering the unparalleled velocity of AI development to harvest the tangible benefits from academia, national laboratories, and industry in a timely manner, the transitioning of scientific research and technology to real-world end-uses calls for an approach that is both creative and bold.

AI Talents

It's vital to fill key roles in AI development yet demand currently exceeds supply. We must embrace AI technology and stay in the core knowledge zone to nurture the proficient and competitive engineering workforce. The broad-based general knowledge of AI technology offers a consequential opportunity to our industry.

To this end, I have developed a professional development course, "AI—Opportunities, Challenges, and Possibilities," with the goal of disseminating AI technology to the workforce and provide continuing education to the workforce of our industry. This short course will debut at SMTA International Conference & Exhibition on Oct. 9, offering holistic coverage of AI in its systematic hierarchy with high-level overviews, as well as specific component technologies/techniques and use-cases. The course topics include:

- Background and diverse perspectives on AI
- Current state of AI
- Justified confidence in AI
- Machine learning, deep learning, neural network, digital twin, IoT, and use cases for
- Generative AI, Edge AI, OpenAI—ChatGPT, ChatGPT-4
- How transformers work and diffusion model
- Scientific machine learning and examples in industry applications
- Use cases for modeling/simulation, and digital twin

- Deep learning NN architectures and expressive programming frameworks
- AI's uncertainty quantification
- New technologies: SNN, dynamic reasoning, continual learning (multitasking)
- Examples of global leaders and competitiveness
- Artificial general intelligence
- Brain, mind, and intelligence
- Future of AI
- Concluding thoughts

The objectives of the course are to build and to stay in the knowledge zone; to spur innovative ideas and inspire new vistas for new opportunities; to highlight what it takes to achieve AI with justified confidence/trust; to balance between AI's power and downsides; and to leverage AI as a virtuous tool to facilitate individual on-the-job efficiency and effectiveness, and enterprise business growth. **SMT007**

Resources

1. "The Fourth Industrial Revolution (Industry 4.0): Intelligent Manufacturing," by Jennie Hwang, *SMT007 Magazine,* July 2016.
2. "Artificial Intelligence: Super-Exciting, Ultra-Competitive," by Jennie Hwang, *SMT007 Magazine,* September 2018.
3. "Smart Factory Implementation: How Smart Is Smart Enough?" by Jennie Hwang, *SMT007 Magazine,* April 2020.

Jennie Hwang, chair of AI with Justified Confidence for DoD Command and Control study, chair of AI Committee of the National Academies, and External Review Panel of NSF National AI Institutes, brings broad-based knowledge to her writing through an integrated perspective. An International Hall of Famer of Women in Technology and a member of National Academy of Engineering, she is author and co-author of 10 internationally-used textbooks and 700+ publications/editorials; a featured speaker in innumerable international and national events; has received numerous honors and awards; served on Board of NYSE Fortune 500 companies and on various civic, government, and university boards and committees (e.g., DoD—Globalization Committee, DoD—Forecasting Future Disruptive Technologies Committee, National Materials and Manufacturing Board, Board of Army Science and Technology, and Technical Assessment Board of NIST).

Dr. Hwang has chaired the National Laboratory Assessment Board, Assessment Board of Army Research Laboratory, and Army Engineering Centers. Her formal education includes Harvard Business School Executive Program and four academic degrees (Ph.D. M.S., M.S., B.S.). She has held various senior executive positions with Lockheed Martin Corp., among others, and is CEO of International Electronic Materials Corp. She is also an invited distinguished adjunct Professor of Engineering School of Case Western Reserve University and has served on the University's Board of Trustees. To read past columns, click here.

Appearances

Dr. Jennie Hwang and Dr. George Karniadakis of Brown University/MIT will instruct a Professional Development Course titled "Artificial Intelligence—Opportunities, Challenges and Possibilities," Oct. 2, at the International Symposium on Microelectronics (IMAPS) in San Diego, and on Oct. 9, at SMTA International, Minneapolis. Dr. Hwang also will instruct a course titled "High Reliability—Role of Intermetallic Compound and Tin Whisker," Oct. 2, and a course on "Solder Joint Reliability—Principle and Practice" on Oct. 10.

Dr. George Karniadakis