AMPLIFYING HUMAN POTENTIAL WITH ROBOTIC AUTOMATION

Industry 4.0 is the holy grail of manufacturing. As we brace ourselves for an impending revolution, **Nampuraja Enose**, Principal Consultant – Industry 4.0, at Infosys, reached out to **Michael Haag**, Senior Vice President, Research and Development, KUKA Roboter GmbH, for insights into the future of manufacturing, the paradigm of digital services, and the role of robotics automation in bringing about the next industrial revolution.

Q Nampuraja Enose

A Michael Haag

Q: *Welcome, Michael. Let me begin by shining a light on how business-to-consumer (B2C) industries such as media, retail, and financial services have been transformed by digital technologies in the last decade. How do you see core engineering industries being influenced by digital technologies, more so in the context of Industry 4.0, over the next 10 years?*

A: Very true. Let me first set the B2B context in the light of the B2C landscape. We have seen disruption in the areas of music, movies, and books by digital transformations. Let me, for a moment, shift your attention to the music industry. It has been turned on its head — across recording, storing, sharing, and commercialization — music is a stellar example of innovation via digital.

The manufacturing industry, on the other hand, operates in a parallel universe; except that the physical product itself cannot be completely digitized like music, but can be 'enhanced.' With a digital underpinning, manufacturing enterprises can streamline processes, ensure flexible operations, incorporate automation to deliver unmatched quality, and boost productivity on the edges of the supply chain.

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Digital technology will therefore determine the trajectory of Industry 4.0 in a profound manner. A digital thrust will influence how machine intelligence and automation shape the assembly line. Only manufacturers with robust digital capabilities will be able to sustain their competitiveness and ensure that production is flexible as well as cost-effective.

If I have to contextualize this ecosystem, we see an interesting scenario where technologies unveil production paradigms in a milieu of digital services. Take, for instance, robots. Mobile and sensitive robots interact directly with humans to ensure smart and flexible production. This human-machine interaction and collaboration provides a stimulus for a nimble assembly line, which is an imperative in industries such as mobile phone manufacturing, where new phones have a shelf life of barely six months. Now, add a digital layer and it accelerates the journey towards lean and smart manufacturing.

Q: *Michael, you therefore allude to OEMs having an important role to play in industrial digitalization. Do you also see a new business model emerging, characterized by a shift from 'product innovation' to 'service innovation?'*

A: I foresee new business models emerging with the confluence of technology, smart production, and digital services. Let me explore this paradigm by charting the evolution of industrial robotics.

On the surface, a robot manufacturer provides systems to ensure modular, predictable, and sustainable manufacturing. However, fundamentally, a robotics major continues to be a key stakeholder in ensuring productivity of the factory floor.

Technically, a robotics enterprise can easily manage the production facility of an automotive company, end-to-end. But rather than selling a commoditized product, the robotics manufacturer can now adopt a business model where it is paid for each automotive component and part of the vehicle that is produced.

You can go further and explore another model, wherein the robotics company is tasked with driving efficiency and productivity on the factory floor. In this business model, the automotive major continues to own the manufacturing side of the business. The robotics company, on the other hand, is a stakeholder with a mandate to enhance quality and boost productivity. It is an opportunity to alter the dynamics of manufacturing by incorporating automation and machine learning into the assembly line. This would essentially be similar to how cyber systems enable systematic innovation, from products to services to outcomes.

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Q: *It is a fascinating premise where OEMs gravitate towards selling uptime, availability, and performance! In this context, what is the role of technology, and more specifically, what is the role of software platforms?*

A: True, platforms provide us with an opportunity to create ecosystems. Software platforms will better facilitate data capture, aggregation, and exchange across an ecosystem. We can develop interfaces on the platform that allow stakeholders to join and enhance the platform's capabilities. However, let me temper my enthusiasm for platforms with a word of caution: You need a stable and scalable platform — Apple iTunes comes to mind — that is architected in a robust manner and is agile enough for partners to build on a strong foundation.

There are several dimensions to the enormous amounts of data collected through such platforms. You can use machine learning and artificial intelligence to solve very complex problems which you otherwise cannot model in an explicit way. In many cases today, 'production' is so complex that the relationships between all the variables require dimensions of statistics, so that they can learn from 'behavior' instead of explicitly 'modeling.'

Q: *Indeed, software platforms are better placed to facilitate the capture, aggregation, and exchange of data. In a sense, this marks a shift towards open source. What are your thoughts on the adoption of open source?*

A: I believe that the adoption of open source is becoming more widespread because technology is evolving at a fast clip. If I invest in a technology today, it may become a hindrance for my enterprise in a matter of months because the technology might become obsolete. Therefore, even if I need to leverage a new technology, I should be able to incorporate it by making changes to the platform. This way, it spares the enterprise from having to make course corrections and saves it significant effort, as well as the cost of migrating to new systems and technologies.

Additionally, the efficacy of platforms lies in the fact that they provide open interfaces that can help develop complete ecosystems. There is not one company that can solve all of the industry's problems on its own. However, companies can rely on various partners, who can together address extreme complexity on the production floor, where there are several moving parts and inter-relationships today.

Q: *You touched upon a broad range of topics: Artificial intelligence, machine learning, robots interfacing with human beings, and more. Does it all open up a new paradigm where 'pure play' engineering enterprises will be able to deliver a new genre of products from a digital marketplace?*

A: Let me address your queries by making two points: Firstly, we need to adroitly manage the interface between the physical and digital spheres. In the digital universe, you have ample flexibility in the methodology of the software program and its outcome. The physical domain, however, is more complex. You need the right tools to manage a process. For instance, you need a welding gun to perform welding. Similarly, you require a host of tools and machines to accomplish diverse engineering tasks.

Therein lies the efficacy of the robot. It is a versatile machine that can perform multiple tasks. You only need to attach the right tool to the robot for it to undertake one task after another. The robot offers you the flexibility to serve as the interface between the physical and digital worlds.

Now, let me address the crux of your question: If the robot is expected to perform tasks that are beyond its capability, it needs to learn new skills. How about the ability to download these skills from a digital marketplace to enhance the functionalities of a robot?

A digital marketplace can address a broad spectrum of requirements. For example, clients can seek critical support in diagnostics and maintenance of industrial equipment. When systems malfunction, they can access an expert database that offers a solution to mitigate issues based on historical events.

Similarly, a digital marketplace can enhance availability when production is on a downward spiral. Clients can access an expert database to arrest downtime and resume production at the earliest. This service can also facilitate predictive maintenance and condition monitoring.

Q: *Interesting perspective. You are making a case for the software platform offering value-added services that go beyond the plain vanilla service that is the norm.*

A: Yes, there will be a distinct shift from engineering services to a knowledge-based engineering services model. Remember, a machine builder possesses a rich repository of knowledge about production. The domain knowledge can be exploited to optimize production and enhance process integrity, and all of it can be delivered as a digital offering in order to create customer value.

Q: *So, will product development become increasingly digital-centric? How do mechanical, electronics, and software engineering fit into this digital landscape?*

A: I believe that mechanical engineering will never lose its importance. Let me use the example of a robot to illustrate my point. A robot has an inherent capacity to operate without interruption, in a safe manner, while consuming minimal energy. It embraces a mechatronic philosophy, which blends mechanics, electronics, and software.

At the same time, product development cannot operate in silos. You need robust mechanics, electronics, and smart software working together. Significantly, you need engineers in these disciplines to collaborate for the development of a successful product.

Q: *In such a services revolution, what and when is the next inflection point?*

A: Looking at the industry from the inside out, I reckon that it is still evolving. It is a continuum of subtle as well as seismic shifts that are transforming the manufacturing landscape.

In the previous industrial revolutions, there have been key technologies that boosted productivity to the next level; technologies like steam power, electrical power, and the computer. In retrospect, it turned out that these technologies really caused the industrial revolutions.

In my view, as compared to the previous industrial revolutions, Industry 4.0 with cyber-physical production systems as the key technology is predicted *a priori*, which means that the potential use cases and the future archetypes are just evolving. This provides various opportunities for innovative companies and research institutes to actively shape the future.

Q: *How should clients and OEMs respond to this services revolution?*

A: Machine builders should capitalize on the opportunities that data provides them. They should unlock the value of data and extract insights from machines embedded with sensors. Being data custodians, machine builders should also capture and digitize the knowledge of professionals across the enterprise. Clients, on the other hand, will become more digital-centric enterprises when they experience the productivity gains from this services journey.

Q: *We are also seeing robotic applications extending beyond the factory floor. How do you see the union between robots and humans evolving?*

A: A robotics company should realize that humans have a central role to play alongside robots, in manufacturing. When professionals work with robots, both partners bring in complementary skills and capabilities that amplify the potential of this human-robot dynamic. A human being brings creativity and problem-solving skills to the production environment, while a robot can achieve precision and automate tasks that are repetitive and unergonomic.

Q: *You discussed how robotics automation can deliver the promise of Industry 4.0. On the flip side, what are the gray areas and challenges in realizing this vision?*

A: I think the lack of uniform standards is a barrier to realizing the potential of Industry 4.0. Let me provide an example, in the context of the interface between cyber and physical systems. Multiple devices can interface with each other, only when communication protocols are aligned with each other at protocol as well as semantic levels. It is imperative for engineers to design devices so that they integrate with the ecosystem. The industry also needs to ensure that the standards evolve to global levels in terms of application. Remember, the telecom industry touches billions of lives today because telephony protocols have been standardized globally, since the invention of the humble telephone.

Nampuraja Enose: *Michael, thank you for your time and insights.*

About the Participants

Michael Haag

Senior Vice President, Research & Development, KUKA Roboter GmbH

Michael Haag studied Computer Science at the Karlsruhe Institute of Technology (KIT) from 1990 to 1995. In September 1997, he received the Springer 'Best-Paper-Award' during the 21st German Conference on Artificial Intelligence. In 1998, he received his Dr.-Ing (Doctor of Engineering) in automated video sequence evaluation at the Institut für Algorithmen und Kognitive Systeme (Prof. Dr. H.H. Nagel). In 1999, he started his career as assistant to the chief technology officer (CTO) of IWKA Aktiengesellschaft, Karlsruhe. In 2004, he joined KUKA Roboter GmbH, Augsburg, and was responsible for innovation management, headed a team for robot applications in logistics, and managed Planning and Technology within R&D. He coordinated the development of the new robot control generation KR C4. Currently, he is Senior Vice President, R&D, at KUKA Roboter GmbH and Head of the Competence Centers. He also gives lectures in robotics at the University of Karlsruhe - Technology and Economics (University of Applied Sciences).

Nampuraja Enose

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Nampuraja has 15 years of research and industry experience. He currently manages the innovation opportunities focusing on the adoption of emerging technologies in the asset-intensive industries, which also involves co-creation engagements with the clients and academia. This includes the focused initiative on Industry 4.0, enabled by the convergence of IT and OT (operation technology) in cyber-physical systems, where Infosys has strategically partnered with FIR (Institute for Industrial Management) at the RWTH Aachen University in Germany. He is an active participant in conferences and forums, and focuses on efficient management of assets and their associated performance.

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