Industry 4.0 digital transformation conference: Has the pandemic accelerated digital transformation?

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AIChE’s Advanced Manufacturing and Processing Society held its second annual “Industry 4.0 Digital Transformation Conference” on December 8. The premise of this year’s virtual conference was to focus on how COVID-19 has disrupted manufacturing operations and supply chains across the US and globally. This conference explored the role of digital transformation and how that impacted manufacturing during the early days of the pandemic, how manufacturers reacted, and what the future may hold for manufacturing and continued digitalization. These topics were underpinned by a key note talk from 3 M on manufacturing of personal protective equipment (PPE) and a presentation by Sandoz, a Novartis company and how they have embraced the digital transformation in pharmaceutical development. There were two panel sessions that addressed questions about how digital transformation was accelerated during the onset of the pandemic and what the future will hold for ongoing digital transformation. Finally, a digital transformation roadmap discussion and short workshop were held to complete the conference.

There were several key takeaways that Journal of Advanced Manufacturing and Processing (JAMP) readers may find of interest which include:

- Manufacturing innovation and productivity increased during the pandemic, but at the same time risk and uncertainty have also increased.
- Early adopters of digital technology benefitted from the ability to adapt quickly to disruptions caused by the pandemic.
- Large companies were more likely to have existing digital solutions to the pandemic that were utilized to address immediate issues.
- Small and Medium-sized companies quickly found it necessary to accelerate their adoption of digital transformation just to remain in business. They demonstrated the flexibility and nimbleness required to address challenges as well as short term opportunities.
- A resilient manufacturing workforce engaged in digitalization has increased; however, there is an ongoing and significant gap for manufacturing workers with digital skills.
- Significant collaboration occurred among companies due to the pandemic, but the sharing of data, viewed as critical to success of digital transformation, remains a challenge.

The Industry 4.0 roadmap workshop identified challenges including: assessing the return on investment, creating a suitable culture for adoption of digital solutions, and sustaining future momentum. The sessions at the conference were:

- Keynote—Advancing Digital Technologies in Research and Development in Recent Years and the Pandemic—3 M
- Panel Discussion—Paradigm Shift for Manufacturers and Impacts of Digital Transformation—“What happened between March and Now?”
- Presentation—The Digital Driven Acceleration of Drug Development
Panel Discussion—Manufacturing USA—“What is the Future Outlook?”
Workshop—“Digital Transformation Roadmap” for the Process Industry

A summary of each session follows.

1 | ADVANCING DIGITAL TECHNOLOGIES IN RESEARCH AND DEVELOPMENT AND MANUFACTURING IN RECENT YEARS AND DURING THE PANDEMIC

Dr. Cristina Thomas’s introduction of 3 M told us about a striking feature of innovation: “Curiosity is just the beginning.” As a major global company, 3 M has sales in nearly every country on the planet. They have recent sales of approximately $32 billion, employ over 96,000 people and have over 120,000 patents. 3-M has four business groups: Safety and Industrial, Transportation and Electronics, Healthcare, and Consumer. Those groups have been working together to address challenges resulting from the pandemic. While most people heard about the challenges of ramping up production for N95 respirators, 3 M also ramped up production of other solutions in response to COVID-19, for example, sanitizers and disinfectants.

One important aspect that 3 M works on is biopharmaceutical filtration. 3 M works with public-private manufacturing institutes like Manufacturing USA’s RAPID. The current situation put biopharmaceutical filtration at the center for using the surface modification technology of membranes into speeding up the development of vaccines as well as therapies.

Digital platforms that are in use at 3-M include: Computer vision, Data science, Electronic systems, Modeling & Simulation, Advanced robotics, Sensors, and Software solutions. These digital capabilities augment material science and domain expertise.

The corporate research systems laboratory has five strategic platforms: Internet of Things (IOT), Edge Computing, Artificial Intelligence (AI), Modeling & Simulation, Visualization & Perception, and Data.

Dr. Vijay Rajamini of 3 M provided additional discussion regarding their PPE manufacturing response. There has been a tremendous surge for digital solutions to respiratory PPE challenges during the pandemic. Visualization as well as sharing of knowledge transfer of data and analytics were critical for 3 M respiratory product solutions. 3 M utilized their pre-existing emergency response planning that was implemented early on during the pandemic for respirator manufacturing. For example, they were able to ramp up N95 respirator manufacturing at different locations and manufactured over 2 billion N95 respirators. Because of the unprecedented scale of the pandemic, 3 M adapted by using modeling and simulation to accelerate innovation and scale up.

Additionally, 3 M collaboration with other companies has markedly increased with over 1100 external collaboration requests since March. As an organization, they have been surprised at the extent of collaboration efforts.

It was clear from the talk that at 3 M digital platforms are critical to deliver solutions that advance every company, enhance every home, and improve every life.

2 | PANEL SESSION: PARADIGM SHIFT FOR MANUFACTURERS AND IMPACTS OF DIGITAL TRANSFORMATION—“WHAT HAPPENED BETWEEN MARCH AND NOW?”

This panel session worked through several aspects of how the country and manufacturers responded to the pandemic with an emphasis on the impacts of digital transformations that were necessary in order to survive. The panelists described the manufacturing mindset that changed as the pandemic changed many things about how they were doing business. There were many companies and other organizations that utilized their manufacturing equipment and digital capabilities to transform their facility to support the immediate needs around PPE and other essentials that became scarce due to disruption. In some of those cases, the adjustments in strategy allowed companies to “survive” and not shut down during the early stages of the crisis. There was also a general paradigm shift related to the way people could work in a manufacturing environment in a safe manner, and there were digital solutions that helped to lead the way. For example, the fact that we have virtual meetings/communications now allowed the “buddy system” in manufacturing and processing facilities to be modified such that one person could go into the area with a helmet camera that their “buddy” who was located remotely, could still be there virtually so that the plant could operate. Other digital solutions allowed for modifications to building HVAC system controls for air flow and filtration to meet new safety challenges.

The panel addressed questions about supply chain disruptions and whether local/regional solutions would alleviate those disruptions. Many companies quickly started diversification of their supply chains in order to alleviate challenges of getting needed materials. Many companies worked at increasing their inventory because
they found that “Just-In-Time” delivery risks were on the rise. Localization of manufacturing and suppliers was carefully considered by manufacturers from the perspective of understanding where COVID-19 outbreaks would occur and whether there would be an impact to workers (for localized outbreaks) or deliveries.

Questions were asked about data sharing during the pandemic. And while data sharing is certainly of high value between a manufacturer and their suppliers, there is ongoing concern from suppliers that their data is not shared with another supplier in order to retain a competitive edge. Data security is an ongoing challenge that will need ongoing attention.

The panel also addressed workforce and skill issues related to accelerated digital transformation that occurred for many manufacturers, especially for small and medium-sized manufacturers. There is clearly a skills gap for workers who have the manufacturing and operational expertise but not necessarily the Informational Technology (IT) skills or vice versa.

3 | PRESENTATION: THE DIGITAL DRIVEN ACCELERATION OF DRUG DEVELOPMENT

Dr. Subodh Deshmukh, Head of Product Development, Sandoz, a Novartis company, spoke about how the pandemic is accelerating drug development. It was noted that while existing drugs such as dexamethasone and remdesivir are being repurposed for COVID-19, other drugs are being developed with an AI approach to target potential COVID-19 therapies. This is pushing the frontier in drug development.

There was an explanation of the details on new drug development and how the digital transformation is utilized across the industry. Novartis strives to reimagine drug development using data and digital technology. Digital transformation is affecting all aspects of their business. It goes beyond R&D, to disrupting markets, affecting supply chains, manufacturing and people practices, and most importantly cultural change. Novartis had already started on this journey and hence they had a good baseline to utilize when COVID-19 hit. The company wants to leverage knowledge of human biology and the power of computing to find better medicines. With this digital approach, there are three focus areas: Innovate, Operate, and Engage.

3.1 | Innovate

This involves is making bold moves in in-silico development by having a digital model for drug development. The aim is to reduce the effort of scientists working in labs doing thousands of experiments by using digitization for drug development. Specifically, AI and Machine Learning (ML) is being used to model traditional ways of drug development that require injectable and oral medicines. These techniques offer a significant time and cost advantage. Another area is the virtualization of lab equipment. COVID-19 is accelerating this virtualization, as physical presence in labs is limited.

3.2 | Operate

Improving productivity through end-to-end automation is key. Tasks in development are highly complex that need an engine to invent workflows. The aim is to have continuously operational labs by simplifying workflows, going paperless, and using “always on” advanced data analytics. Several labs are already operating this way. Productivity gains are business drivers. Knowledge capture is important for regulatory submissions. Novartis aims to improve regulatory processes by 50% using Robotic Process Automation to manage documentation and submission processes.

3.3 | Engage

Scientists from four development centers spread across Europe interact with each other using Virtual Reality (VR). VR is now mainstream and is used to conduct meetings, to troubleshoot by having remote experts on demand, and to conduct audits, making it easy to work with regulatory agencies in these times of limited (or no) travel and social distancing. There is also collaboration with large providers like Microsoft and Amazon for scientific desktop tools. The plan is to reduce the “distance” between a drug development scientist and a data scientist eventually merging their profiles. They also have initiatives like Novartis biome, which are onsite incubators where anyone can propose solutions. Novartis works with accepted solutions and invites proposers to partner. As much as digital transformation is a technology journey it is also a constant cultural journey. Novartis has people who want to make the leap to digital. Setting up the right teams with the right tools and training is crucial. Novartis is making large libraries of Coursera material available at no charge to Novartis family and friends. The company does not believe that going back to traditional ways will happen. The acceleration of digital transformation will continue as companies are saving millions of dollars that generate a big impact to the bottom line. For instance, technology transfer from a lab to a manufacturing site requires teams to fly
and stay for long periods of time in order to stabilize processes. The use of VR is expected to eliminate 80% of the travel and associated costs.

4 | PANEL SESSION: MANUFACTURING USA DISCUSSION “WHAT IS THE FUTURE OUTLOOK?”

A little more than a decade ago, the United States government started an initiative that would later be known as the Manufacturing USA Network. Manufacturing USA is made up of 16 public-private institutes—1 sponsored by U.S. Department of Commerce, 6 sponsored by the department of Energy, and 9 sponsored by the department of defense. The institutes are membership-based organizations that have collectively brought together nearly 2000 organizations representing manufacturers of all sizes, academia, technology providers, startup organizations, government entities, and more. Each institute focuses on a specific advanced manufacturing technology area but works toward the same high-level goal: to secure America’s future through manufacturing innovation, education, and collaboration.

The Industry 4.0 Digital Transformation Conference convened three Manufacturing USA representatives, Kym Wehrle from MxD, Ignasi Palou-Rivera from RAPID, and Jim Davis from CESMII, and asked them to make predictions about where the future of manufacturing is heading after the COVID-19 crisis.

Panelists unanimously agreed that supply chain visibility will be a critical asset in manufacturing for years to come, but there is still a significant amount of work to be done in this space. Some industries, particularly the consumer packaged goods and pharmaceutical companies, saw a dramatic uptick in demand during the pandemic; other industries, such as aerospace and defense, remained consistent with pre-COVID-19 demand. However, every industry faced challenges in meeting the needs of their production because of supply chain disruptions. Leveraging digital solutions to increase the visibility and transparency throughout the supply chain will help manufacturers avoid similar challenges in the future.

Data sharing also came up quite a few times among our experts. Data sharing will undoubtedly be a staple of the future of manufacturing. At present, it seems that many manufacturers are still trying to master the collection of data, ensuring that they are collecting the “right” data in their operations. From there, manufacturers need to transfer their data into a contextual and useable format for it to provide more insightful analytics.

Finally, panelists are confident that the future of manufacturing—from design, to production, to supply chain management—will see increased digitization and increased automation. From a workforce perspective, it is critical to note that automation and digitization will not necessarily lead to job loss, but instead a reallocation of resources into roles that are safer for workers.

Ultimately, there has been a change in attitude in the manufacturing sector. Before COVID-19, many manufacturers viewed advanced manufacturing technology as an option. Now, it seems they are beginning to view advanced manufacturing technology as a staple that will, at best, increase their effectiveness and competitiveness and, at worst, keep them afloat in the next crisis.

5 | WORKSHOP “DIGITAL TRANSFORMATION ROADMAP” FOR THE PROCESS INDUSTRY

Dr. Ravi Kumar, Sachin Padhye, Saibal Samaddar, and Shatam Bhattacharyya from Infosys led a workshop addressing the Digital Transformation Roadmap for the process Industry. Dr. Ravi Kumar kicked off the workshop by offering a perspective on Industry 4.0. He highlighted the integration of Information Technology (IT) and Operational Technology (OT) where cyber systems are more closely aligned with physical systems. This Digital Transformation is occurring across the value chain, vertically from supply chain to manufacturing to enterprise resources planning systems and horizontally from suppliers to manufacturers to customers. Advances in cyber physical systems, equipment sensors, seamless interoperability, advanced automation and control, big data, and analytics are driving the transformation. This transformation is aligning IT, OT, and Engineering Technology (ET).

Infosys surveyed manufacturers in US, Europe, and Asia Pacific in 2015 to assess their station on the Industry 4.0 journey. Only 15% of the respondents had Industry 4.0 related strategies in place. All respondents wanted to adopt Industry 4.0 to develop connected products and services and increase efficiency. In 2017, the priority was to improve productivity performance management in manufacturing with a focus on quality management. Sustainability and energy efficiency were key areas of focus in 2018. 2019 and 2020 saw the focus shift to using remote technology for assistance, guidance, digital twins, automation, and low or no touch. COVID-19 accelerated this transformation. This has led to gains ranging from 8% to 40% in margins and efficiencies across the value chain. The World Economic Forum cites several examples in their reporting that outline these gains.

Acatech, established as the German Academy of Science and Engineering, and Infosys developed a model to
measure the maturity of Industry 4.0. This model has six levels of maturity. The first two levels are computerization and connectivity and are part of Industry 3.0. The other four levels, in terms of increasing maturity, are visibility (dashboards), transparency (what, why, how), predictability (what will happen), and adaptability (self-correcting machinery). Resources, Information Systems, Organization Structure and Culture support the maturity model. Other industries such as bio pharma manufacturing have similar measures of maturity. In conclusion, manufacturers are leveraging Industry 4.0 which will result in the factories of the future, where IT-OT Integration is the foundation that generates data from the factory to improve the topline and the bottom line.

The workshop was broken into four concurrent sessions to discuss four areas, formulated as questions.

- What are the current challenges in digital transformation?
- Is your organization focusing on digital transformation? What are the lessons learned?
- What is your perspective on organizations' maturity?
- Are there any specific suggestions on the digital transformation roadmap?

Saibal Samaddar outlined the process of Design Thinking (DT) to start and continue the Industry 4.0 journey. DT is a problem-solving approach that focuses on end user from shop floor to the C-suite. It applies human centric design to solve problems in an iterative way. DT relies on cross-functional teams to define the problem in the “empathize” stage by listing challenges. The challenges are grouped and “how might we” questions are asked to ideate solutions. Solutions are tested and prototyped and either scaled or revisited. In summary, the top challenges associated with the Industry 4.0 roadmap were assessing Returns on Investment (ROI), creating a suitable culture for adoption, and sustaining momentum. Dr. Ravi Kumar offered some insights into addressing these challenges, including designing processes for greenfield and brownfield scenarios, leveraging change management, and starting small and scaling up.

**AUTHOR CONTRIBUTIONS**

Chaitanya Khare: Writing-original draft. Sachin Padhye: Writing-original draft. Katie Fayman: Writing-original draft.

**DATA AVAILABILITY STATEMENT**

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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