

Technology Convergence for a Smarter, More Connected World: Market Trends

CIMdata Commentary

Key takeaways:

- *Manufacturing companies as well as government organizations are in the early adoption stage of a significant acceleration in the use of multi-disciplinary digital models combined with operational information to support the design, development, manufacture, and operation of cyber-physical “smart systems.”*
- *The convergence of IoT, IT, and computational science technologies such as big data analytics, Artificial Intelligence/Machine Learning (AI/ML), cloud computing, and high-performance computing (HPC) with multi-physics, multi-domain, and multi-scale modeling and simulation technologies will enable the cost effective use of predictive digital twins in a wide range of industrial applications across the entire product lifecycle from conceptual ideation to re-cycling/re-use.*
- *Software provider conferences typically focus on customer applications of their software offerings combined with technical sessions on software features and future product plans. Altair broke away from this norm to explore “Future of” macro trends and technologies during their annual Global Altair Technology Conference (GATC). Together with industry and academic thought-leaders, the conference highlighted the growing convergence of data analytics, computational science, and cloud HPC technologies and their relevance to product and process innovation, academic instruction, tomorrow’s innovators, and society.*
- *A market survey conducted by CIMdata in conjunction with the Altair GATC event explored the role of these key technologies and their perceived impact today as well as in the future, with a view of adoption from both the management level in the participating organizations as well as at the engineer/technologist level.*

Today’s Market Drivers and the Need for Change

Manufacturing enterprises are facing many new business and product development challenges that require changes in long-established business practices and engineering processes to remain competitive and viable in today’s globally connected environment:

- Enterprise level digital transformation and digital thread business initiatives to enable new product innovation and product quality while also reducing time to revenues and total product lifecycle costs including in-service operations.
- New business challenges and revenue opportunities in the context of Industry 4.0 and the emergence of physics-based digital twins being applied to manufacturing, operator training, and in-service operations.
- New generative design approaches driven by the availability of advanced manufacturing processes (both additive and subtractive) and new hybrid materials enable the creation of innovative and highly cost-efficient products.
- The continued rapid expansion in the global availability of affordable and scalable computing resources and associated product development software solutions for the engineering desktop, in the cloud, and in HPC environments.
- Increasing product complexity of “smart connected” cyber-physical systems (hardware, electronics, software, sensors, controls, biological/chemical, etc.).

- The design and development of such complex “smart systems” requires integrated multi-disciplinary capabilities for cross-domain design, simulation, analysis, test, and optimization augmented by big data analytics and AI/ML.

Key Results and Findings from CIMdata/Altair Market Survey

The Altair Technology Conference was a global virtual event conducted over a 3-day period in early October 2020 with sessions attended by over 2,500 industry professionals, technologists, and academic researchers. While Altair is known primarily for being an engineering modeling and simulation company, they have expanded their product scope and customer base significantly over the past decade into complimentary technologies in conceptual design, additive manufacturing, scalable high performance computing, big data analytics, and physics-based simulation enhanced via the application of AI/ML technologies. As a result, the attendees of the GATC virtual event were a diverse group spanning the engineering, IT, and computational sciences domains with a balanced representation of both management and technical practitioners.¹

For those who are interested in viewing the Altair GATC presentations and panel discussions, they can be accessed at <https://www.altair.com/global-atc-2020/>.

In conjunction with the Altair event, CIMdata collaborated with Altair senior staff to develop and conduct a market research survey provided to the GATC attendees. CIMdata also conducted the same survey with a subset of our industry contacts. Besides gathering background information on the respondents (title/role, industry, geography, size of company by revenues, number of employees, number of engineers), the survey posed questions covering the individual’s perspective on the current and future adoption of key technologies across the engineering product lifecycle such as AI/ML, predictive analytics, physics-based simulation, and digital twins. The impact of the COVID-19 pandemic on business practices was also explored. A total of approximately 400 survey responses were received and analyzed. The survey results were analyzed for the entire data set as well as by the title of the participants grouped into a management role (45%) vs. a technical end user role (55%). As anticipated, the background information responses were weighted towards the Americas (67%) and EMEA (20%) but the responses by industry segment and size of organization were in line with the overall engineering software industry profile based on CIMdata’s experience with performing similar PLM market surveys for many years.

A summary analysis of the technology trend results and selected charts are provided below. We have highlighted those areas where the results were significantly different between the management level and technical end user groups.

Since the global pandemic has profoundly impacted our world during 2020, we’ll address those results first (see Figure 1). While there were some differences in opinion between management and technical staff, 50% of the respondents in both groups believed that the COVID-19 pandemic will lead to an overall increase in IT projects and budgets. Two-thirds of both groups felt that when the pandemic subsides, the majority of their company will work in the office again, albeit with a significant increase in the percentage of effort working from home (WFH).

¹ Research for this commentary was partially supported by Altair.

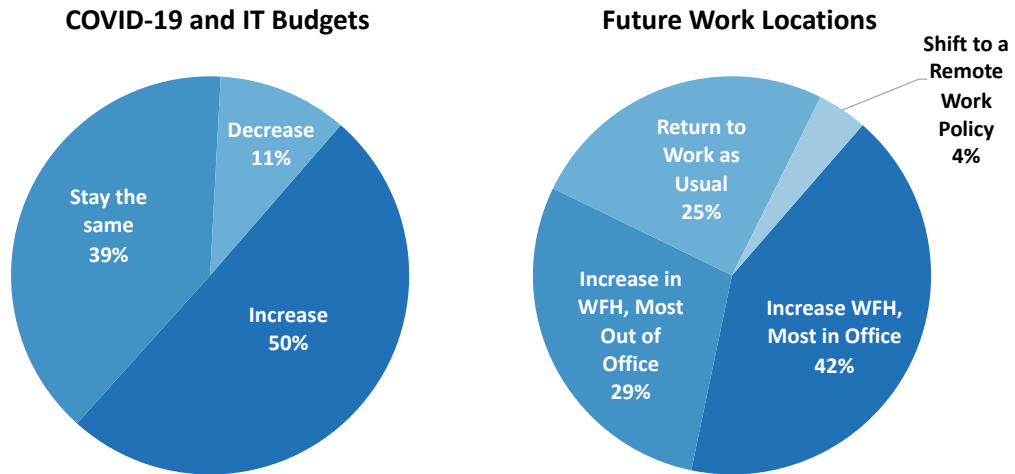


Figure 1 – The Impact of the COVID-19 Pandemic

Data Analytics, AI and Machine Learning

Not surprisingly, both groups were in agreement that the use of data analytics and AI/Machine learning will play a much greater role in providing business and engineering insights going forward. The use of mature AI/ML applications in decision making is expected to grow from less than 5% today to approximately 20% within 5 years. The development and use of early stage AI/ML apps is estimated to grow from less than 15% today to up to 25-30% within 5 years. Management was actually a bit more bullish than the end users in the application of these two Artificial Intelligence/Machine Learning areas combined over a 5-year period. This could perhaps indicate a lack of hands on knowledge by management in the degree of difficulty of implementing AI/ML technologies within their organizations.

Cloud

The survey posed the question: How aggressively has your company embraced moving data analytics and simulation activities to the cloud? Both groups predicted that their company’s usage of data analytics and simulation tools in the cloud would be increasing from ~15% today to 35% in the cloud over 5 years, with 30% used in a hybrid cloud/on-premise environment. Both groups forecast that the remaining 35% of usage would remain mostly or all on-premise.

Smart, Connected Products and IoT

As the world continues to transition to smart, connected products, we asked the respondents how linked their company’s IoT strategy is to their mainstream product development activities. While only 11% of the technical end user group felt that these strategies were tightly linked today versus 22% of the management group, both groups projected that these strategies would be either tightly linked or coupled within 5 years (57%). Perhaps indicating again that the management group is overly optimistic about the reality of where things really are today in their organizations but nonetheless encouraging that both groups are in agreement on the future.

Digital Twins

There are many types of digital twins that span the entire enterprise, including not only product development and engineering functions but also business and financial functions as well as manufacturing and in-service operations. To date, data-driven only digital twins (i.e., physical

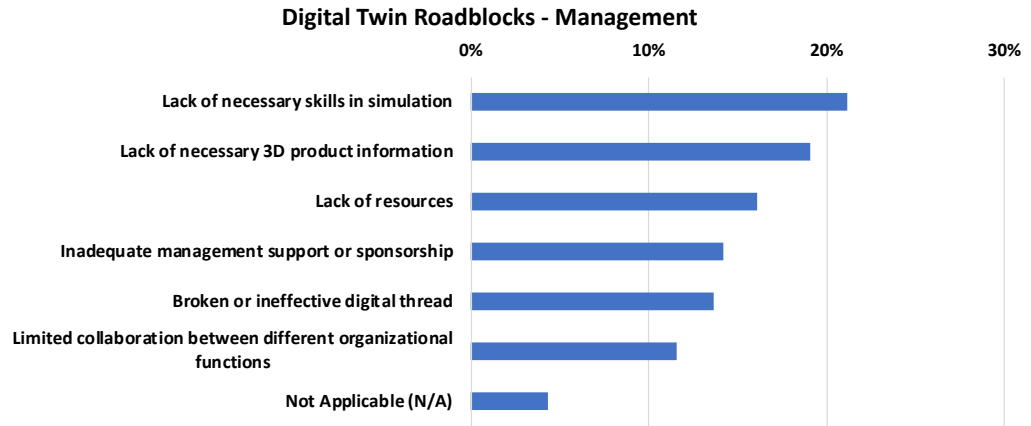
asset data is used but is not directly connected to physics-based models of the asset) have been the dominant application of IoT, data analytics, AI/ML, and digital twin technologies.

While almost 50% of the respondents indicated that they were investigating the use of digital twins, the two groups differed on the assessment of whether their companies have some form of digital twin technology in production use today. The technical end users felt that figure was less than 15% today while the management group said it was almost 25%. And while both groups project a significant increase in use of digital twins in the next 5 years, management’s view was significantly more bullish (42%) than the view of the technical end users (32%). These two areas perhaps uncover a disconnect between the two groups in terms of the criteria for “in production use” vs. “in pilot stage” and the amount of effort and resources required to effectively implement a mature and production worthy digital twin strategy (see Figure 2 below).

The digital twin functional areas where the respondents expected the greatest business impact within the next 5 years were as follows (ranked in order of % of responses):

- 1) Manufacturing (24%)
- 2) Engineering Data Analytics (21%)
- 3) Physics-Based Engineering (21%)
- 4) Maintenance (14%)
- 5) Operations (12%)
- 6) Financial (5%)

There were also some interesting differences in the rank ordering between the management group and the end user/technical group. The management group reversed the order of #1 and #3 above with Physics-Based Engineering digital twins at #1 at approximately 23% of respondent and Manufacturing digital twins ranked third at 19%.



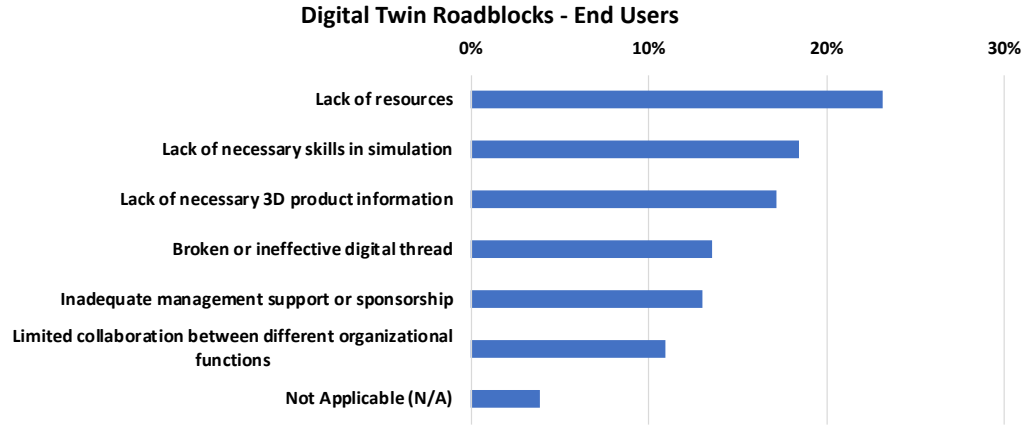


Figure 2—Organizational Roadblocks to Achieving a Digital Twin Vision

While the perceived business benefits of implementing digital twin technologies were relatively consistent between the two groups (i.e., better product understanding and cross-functional collaboration yielding more “right first time” products), the perceived roadblocks to achieving the business benefits of developing and using digital twin technologies were fairly different between the management and technical user groups (see both charts in Figure 2). As mentioned previously, there seems to be a bit of a disconnect from managers in what the technical end users view as the most important impediments to realizing a mature and production-worthy digital twin vision, with the lack of resources and technical skills being the most critical areas of difference.

For those interested in more information on the CIMdata survey questions and the results, please contact CIMdata at info@cimdata.com.

Conclusion

CIMdata believes we are still in the early adopter stages of implementing these IoT, digital twin, IT/data analytics, and AI/ML technologies with respect to the design, development, manufacture, and sustainment of complex cyber-physical systems (i.e., smart, connected products). As the survey results indicate, there is still much work to be done but there is also great opportunity and tangible business impact to be realized by industry in effectively implementing these emerging technologies in engineering and product development as well as other domains such as manufacturing, quality assurance, maintenance, and in-service operations.

To date, the impact of COVID-19 on engineering software and services market growth appears to have been less than was feared and certainly less than the major economic disruption/depression of 2008-09. In fact CIMdata’s experience shows, the pandemic has been a positive business factor for selected industry segments and agile companies that were positioned to respond rapidly to the changing global market dynamics and customer needs.

Business agility, creativity, and product innovation will always prevail. The business challenge is enabling smart people, augmented by the effective use of digital technologies, to achieve the business objectives of private enterprise as well as benefiting society as a whole.

Altair is investing heavily in these areas as a cornerstone of its business vision and strategy. CIMdata looks forward to following the progress of Altair and their customers in realizing the business impact of a smarter, more connected world.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM). CIMdata provides world-class knowledge, expertise, and best-practice methods on PLM. CIMdata also offers research, subscription services, publications, and education through international conferences. To learn more about CIMdata's services, visit our website at <http://www.CIMdata.com> or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 734.668.9922. Fax: +1 734.668.1957; or at Oogststraat 20, 6004 CV Weert, The Netherlands. Tel: +31 (0) 495.533.666.