



Digital Transformation: Driving Competitive Advantage

Courtesy of Autodesk

Takeaways

What you need to know

Takeaway #1

Manufacturers of all sizes are facing increased complexity amid continually evolving customer and market requirements.

Takeaway #2

Successful companies must digitally transform their business to create and sustain their competitive advantage, as well as to build customer and brand loyalty or fall victim to competitors that are transforming their businesses.

Takeaway #3

Successful digital transformation is more than just digitizing information—it requires a change in how a business operates, eliminating information silos and creating a digital thread that spans the value network.

Takeaway #4

Digital transformation is not a one and done—it is a continuing evolution.



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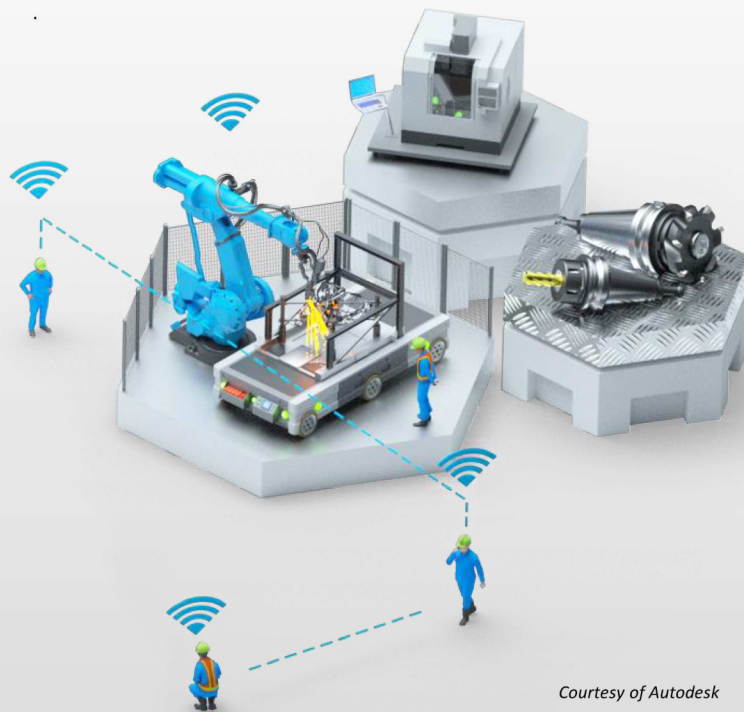
Manufacturers must evolve to meet today's challenges

Manufacturers today must deal with continuing complexity in their business. Customers are demanding smarter, more connected, and eco-friendlier, products and solutions tailored to their unique needs that are often able to operate autonomously. These smart, connected products and systems are themselves becoming more complex with functionality and differentiation being driven by software and electronics. This is requiring more intelligent production environments and connected in-service operations. And manufacturers must deal with increasing regulatory oversight from agencies in multiple countries if they want to sell and service their products globally.

Companies must be able to implement and work effectively within complex global value networks regardless of whether they are an OEM, a partner, or a Tier-N level supplier to achieve faster ramp-up to production, reduced time to market, and better adaptation to changes in global and local markets. Product and process information resides in diverse, distributed repositories throughout the value network. Users at all levels anywhere in the value network require rapid access to clear, concise, and valid information presented to them in context so they can make better-informed decisions, faster.

Technology is evolving and converging rapidly and must be incorporated into products and business processes faster than ever. Creating and sustaining business success requires executives in companies of all sizes to have maximum flexibility and leverage on their technology and product investments to improve business performance and profitability to shorten product development time and get the right products to market. Every business must achieve the expected quality and operational efficiencies no matter where or at what volume their products are produced. Businesses must be able to quickly and effectively deal with change—change in product, change in production, change in service, and change in customer demands and expectations.

Meeting this array of challenges requires companies to digitally transform their businesses.



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Digital Transformation Drives Competitive Value

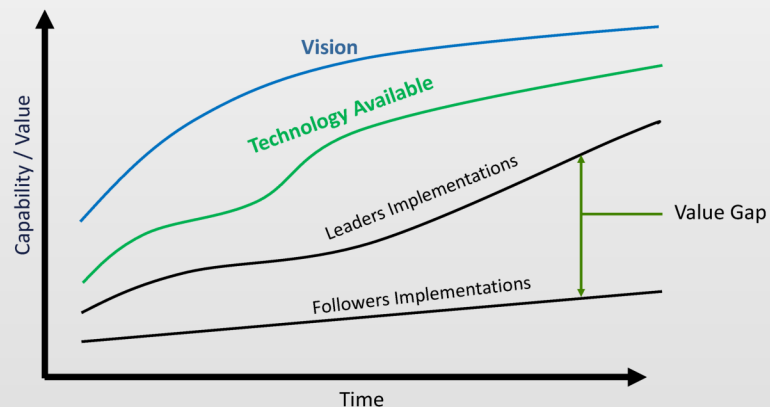
The pace of technology adoption differentiates leaders from followers

Companies must transform their businesses to be more flexible and respond faster to changes in their markets and their customer's requirements—delivering innovative products and services in a more innovative manner. They must create and participate in flexible value networks with their trusted partners and suppliers—for both material and components as well as development, production, and service technologies and applications. And they must be more efficient—using tools and processes that provide their staff and their organizations with more productivity and flexibility while removing non-value-added activities.

Achieving these goals requires a digital transformation—adopting and applying digital technologies in new ways. This is more than just moving to digital documents. It is a new method of working—leveraging digital technologies and applications to transform how the company operates. CIMdata's research has shown that a "value gap" exists between companies that are leading adopters of digital technology and solutions, e.g., Product Lifecycle Management (PLM), and driving digital transformation versus those that are followers.

- **Leaders**—Companies that have broad visions of how information and digital technology can help their business. These companies put in place initiatives that continually review and expand their technology environments and solutions and update their processes—driving continuous improvement and the digital transformation needed for success.
- **Followers**—Companies that have narrow visions, i.e., don't take an enterprise view of what digital technologies can do for them. They are slower to adopt (or only adopt in selected departments and processes) and deploy these new technologies and solutions. They don't sustain their investment—gaining some benefits but not driving their overall business—and fail to keep up with the ongoing technological evolution.

This difference in adoption scope and rate creates a "value gap" in technology use and capabilities between the leaders and the followers. Leaders aggressively digitally transform their business to better create the products and services their customers demand, while the followers lose ground and try to catch up. Because of their strategy and commitment, leaders continue to expand the value gap while followers fall further behind—at some point they will have to invest significantly to close the value gap or continue to become less competitive.



Failure to Digitally Transform Creates a Value Gap Between Companies

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Digital Transformation Drivers

Factors driving companies to do a digital transformation

Discrete manufacturing companies need to change how they operate to develop more innovative and competitive products and services. In addition to creating smarter, more innovative products, successful companies need to implement new, innovative business models that will improve brand recognition and customer loyalty.

Multiple factors and initiatives are driving the need for manufacturing companies to undergo a digital transformation. One of the most widely known is Industry 4.0. This initiative originated in 2011 from a project to develop a high-tech strategy of the German government, to promote computerization of manufacturing. Called the Fourth Industrial Revolution, it is the ongoing automation of traditional manufacturing and industrial practices, using modern smart technology. Large-scale machine-to-machine communication (M2M) and the Internet of Things (IoT) and the Industrial Internet of Things (IIoT) support increased automation, improved communication and self-monitoring, and production of smart machines that can analyze and diagnose issues for performance management and predictive maintenance without the need for human intervention.

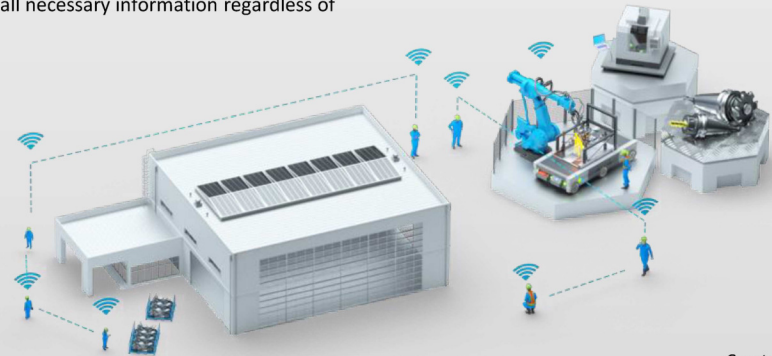
Companies need to be able to rapidly select and collaboratively interact with suppliers who have special expertise in support of new product development. This requires having flexible product management environments architected using

modern information technologies that enable rapid integration with and interact with the systems of their partners.

Another key factor is secure collaboration across the extended value network. As more information is created, shared, and re-used with partners and suppliers, the need for extensive IP protection becomes more critical. Companies working with partners who are also competitors (a process called cooperation) must be able to not only find and use information maintained in distributed repositories (some of which may reside within their partners' environments), they must do so while protecting both their own and their partners and suppliers IP. Users at all levels working in organizations across the value network need the ability to access and "see" all necessary information regardless of

where and how it was created and stored. Users need to be able to easily and securely collaborate on the creation and use of that information. To enable this secure collaboration, manufacturers need to enable full lifecycle management. This requires enablement of an end-to-end digital thread and digital twins.

Last, but not least, companies need to create environments that can respond to the rapid emergence, evolution, and convergence of technologies. Creating these flexible environments requires deploying business platforms (e.g., Product Innovation Platform, Manufacturing Enterprise Innovation Platform) that enable implementation of tailored solutions as required by each company.



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Lifecycle Digitalization

Digitalization is the foundation for digital transformation

There are several elements of digital transformation that need to be considered. Key is lifecycle digitalization, which requires digitization. First a company must put appropriate assets into a digital format. This enables the company to better manage, use, and re-use those assets, and create more efficient processes that can be automated by digitalization. Once the assets are in a digitized format, a company must create transparent, seamless information flows across the lifecycle and value network—creating a digital thread of connected information and processes.

The digital thread enables extensive access to information by technical and non-technical users at all levels of an organization. With shared information access and knowledge, all users can collaborate more effectively—sharing ideas and work tasks while eliminating redundant and error-prone non-value-added activities. This can significantly improve both individual and organizational flexibility, productivity, and creativity. This improved collaboration will drive innovation in product development, production, and service, and other lifecycle processes, e.g., sales and marketing, procurement, quality, etc.

Users at all levels across the value network often spend non-value-added time searching for needed

information and trying to find and connect with the appropriate personnel with whom to collaborate. Establishing better information integration and access, e.g., the digital thread, empowers collaboration and enables personnel and organizations to work more effectively.

The result of successful digitization and then digital transformation means that all areas of an organization will have been impacted—from the way it operates internally developing, producing, and delivering services, the customer experiences, to the value customers receive. Through digital transformation, manufacturers will be better able to increase the development and delivery of innovative products and services, effectively increasing what they're able to produce today. Creating better collaborative environments built on broader, more efficient data access enables companies to more flexibly and quickly respond to changes in customer and market requirements and make more agile use of their resources (human, financial, and physical).

This is more than just a change in the technological or operational solutions of a business, it's also drives a cultural shift in the way the company and its personnel work and interact with its suppliers, partners, and customers.

Digital Transformation Terminology:

- Digitization is the process of moving information from paper to digital forms (e.g., computer files, connected data elements representing a product, managing a configuration and all its dependencies). Basically, the process of changing from analog to digital form.
- Digitalization is the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business. information work for you.
- Digital transformation is the transformation of business activities, processes, products, and business models to fully leverage the opportunities of digital technologies. The primary goals are to improve efficiency, manage risk, and enable new business models and operational paradigms. Digital transformation means doing things in a new (digital) way.
- CIMdata defines Digital Transformation as the adoption of digital technologies to transform a business' products and services.

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A digital thread and digital twins enable success

Competitive manufacturers need integrated, flexible information flows and processes that can easily and quickly adapt to product and business changes such as changing business priorities, customer demands, regulatory requirements, and monetary issues. Companies must also enable effective lifecycle information access and collaboration between both internal and external organizations. Key to enabling this comprehensive collaboration and information sharing is an extended value network digital thread. A digital thread provides the information integration and use that spans all appropriate organizations and data sources. It is key to maintaining comprehensive, accurate, up-to-date digital twins. The digital thread provides the basis for effective collaboration across the product lifecycle and value network. It also provides the foundation for effective value network data management. The Digital Thread is PLM-enabled and supported by a robust end-to-end connected systems model and Model-Based Systems Engineering (MBSE) processes.

Enabled by the digital thread, digital twins provide the virtual representation of the product, production, and performance of the physical item. It maintains the accuracy and fidelity to predict physical behavior and even optimize the performance of the physical asset (i.e., the product or process) it represents. The digital twin provides both the history (previous versions can be saved for later use) and the current state of a product or system and can be used to accurately simulate past and future operational scenarios. A Digital Twin can be created for a variety of different areas each of which needs to be created and linked to the others including:

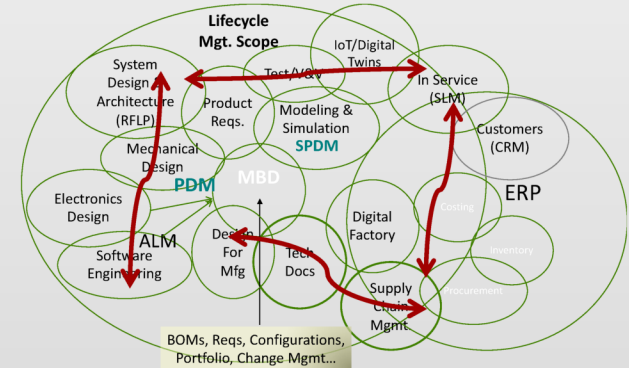
- Product development—the product twin
- Manufacturing engineering and production operations—the production twin
- Product simulation and utilization throughout operation—the performance twin
- Other areas, e.g., the financial twin

Using digital twins help companies improve the customer experience by better understanding customer needs and develop enhancements to existing products, operations, and services.

CIMdata definitions:

A **digital thread** is a communication framework that connects data flows; one which can be used to produce an integrated, holistic view of an asset's data from physical and virtual systems (i.e., its digital twin) throughout its lifecycle across traditionally siloed functional perspectives.

A **digital twin** is a virtual representation (i.e., digital surrogate) of a physical asset or collection of physical assets (i.e., physical twin) that exploits data flow to and from the associated physical assets, continually evolving as it accompanies its real-world physical companion throughout its lifecycle.



Example of the Digital Thread—Connecting Multiple Information Streams



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Factors for successful digital transformation

Many companies still use siloed tools, both paper and digital, throughout their business. Data created in the siloed solutions is not readily available to all the users in the product lifecycle value network. Companies need to implement digital solutions and environments in which data can be easily accessed and linked so that personnel at every level can make faster and better-informed decisions to do their work tasks. This is one of the keys of successful digital transformation—making the right information available to the right person at the right time in the right form based on the context of the user and their role.

One of the enabling solutions that supports digital transformation is PLM. However, companies need to think of PLM as an enterprise solution—enabling digital transformation across the value network—not just a solution for engineering and R&D. Modern PLM solutions and environments span and are used by many organizations within a company as well as interacting with suppliers, partners, and customers. It is the enabling technology for creating and maintaining the digital thread and supporting cross domain collaboration. This can enable companies to use (and re-use) their data more intelligently across all aspects of their business, including better supporting their customers.

A key part of a successful digital transformation is enabling comprehensive data and process management to organize, standardize and connect

the data residing in distributed repositories throughout a company. Companies must effectively organize and manage both that data and the processes used to create and manage that data. As described earlier, companies need to implement a digital thread that spans their extended value network, enables implementation of a comprehensive digital twin and provides closed-loop feedback between functional domains.

A major challenge manufacturers face is that any effective digital transformation must continually incorporate new and rapidly evolving technologies into both their products and processes. Supporting and evolving solutions and applications are

incorporating a wide range of technologies. These include augmented/mixed/virtual reality (AR/MR/VR), machine learning (ML), artificial intelligence (AI), big data and data analytics, the Internet of Things (IoT) and the Industrial Internet of Things (IIoT), e.g., mobility, social media and solutions, and more. Being able to manage this rapid technological evolution requires implementing platform-based business solutions built on flexible, open, architectures that support hybrid environments with on-premise and cloud-based delivery and SaaS delivered applications.



Courtesy of Autodesk



Key Elements of Digital Transformation (2 of 2)

Collaboration, convergence, and automation drive the need for digital transformation

Three important evolutions (collaboration, convergence, and automation) are also driving the need for digital transformation. The need for better, more effective, more comprehensive personal, organizational, and automated collaboration built on a digital thread is described throughout this eBook

Increasing areas of convergence are challenging manufacturers to maintain their market position. Companies must deal with convergence between industries, design and manufacturing, and technologies (e.g., Information Technology, Operational Technology and Embedded Technology) all being driven by digitalization. Data is the digital thread driving this new wave of convergence. Companies need to creating a common user data experience that provides a complete view of products and processes and offers actionable insights across the entire value network.

The manufacturing industry is undergoing a move to more modern development paradigms, e.g., model-based design, model-based enterprise, systems engineering, generative design, hybrid manufacturing. These new paradigms are all built on the use of digital data and models, increased interaction between functional activities and domains, more and more collaboration, and increasing automation of data creation, movement, and use. Automation eliminates the delays of working manually and can exponentially accelerate product development across all departments. Product models, structure definitions, materials specification, and other data are being automatically created and transformed into the formats needed by users and applications in each of these domains and moved as required, in context driven by new business processes. For example, generative design uses AI to automate the creation of multiple validated designs as well as the design to manufacturing process. Other areas being improved via automation include additive manufacturing and robotics.

And this evolution is spreading beyond a company's borders as data exchange & standards are being established to define and manage the interaction between the company and its suppliers, partners, and customers. New digitally-driven processes are being implemented for evaluating and selecting the best partners (suppliers and technology) for long term evolution and flexibility of a company's business model, products, and services.



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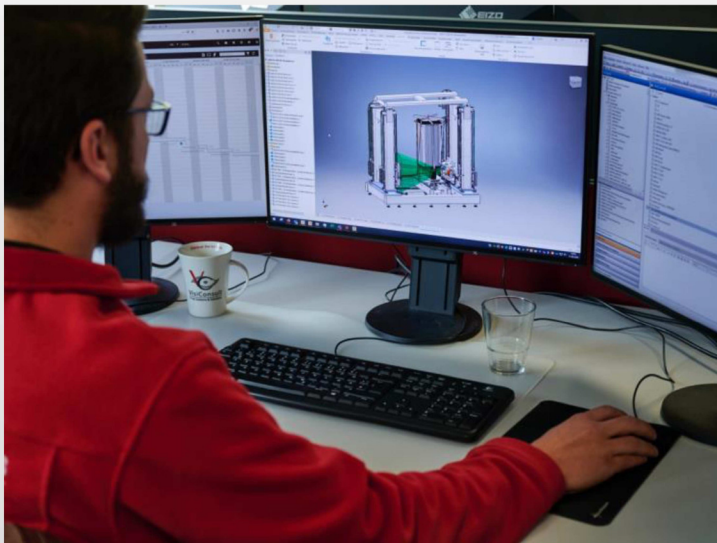
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A digital transformation case study

VisiConsult X-Ray, a specialist provider of x-ray and computer tomography inspection solutions, builds customized cabinets to match each customer's needs. It is a world-leader in x-ray inspection equipment, switching first from authoring software to designing and manufacturing machines. Now, under the joint leadership of founder Hajo Schulenburg and his son Lennart, the company is on a digital transformation journey. New automated evaluation processes replace physical and analog inspections, resulting in more efficient and cost-effective product validation.



Courtesy of VisiConsult/Photo by Chris Mueller

The company uses computer tomography (CT) imaging to produce a “digital twin” of the inspected part. These can be interrogated remotely, anywhere in the world, by customers’ and VisiConsult’s engineers to spot and correct faults on the digital twin, before conveying the corrective action to the customers’ sites. In the past the imaging process required physical analog film and software to inspect parts at a micro-scale. This has now been replaced with a range of digital detectors that perform automated image evaluation with image processing on top of the X-ray images, much faster than analog film.

Hajo and Lennart saw they had to be more efficient, to lower costs and prices, but also be more sustainable. Therefore, they invested in Autodesk’s Product Lifecycle Management (PLM) software Fusion Lifecycle. This enables control of new product information in an automated machine-building process and connects VisiConsult with the customer before the X-ray cabin has been built, ensuring they get the specifications they want. “This is where PLM is such a critical tool to have,” says Lennart. “It makes processes clearer and more transparent and speeds everything up.”

Now this innovation champion has begun the next chapter of its digital transformation, offering images and even image interpretation as a service. “The pay-per-image or even pay-per-evaluation strategy is a great example of digital transformation because it goes far beyond business processes into the business model, and asks what we are and what we do.” Lennart Schulenburg, Managing Director, VisiConsult X-ray Systems & Solutions GmbH.

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Providing the tools you need for effective digital transformation

At the heart of Autodesk's vision for digital transformation are Convergence, Collaboration, and Automation. The convergence of technologies, of industries, and of design and manufacturing disciplines is the cornerstone of digital transformation. Collaboration enables personnel throughout the value network to share data and work concurrently. Automation accelerates performance and eliminates non-value-added work.

Digital Transformation begins with the convergence of design and manufacturing disciplines, putting Data at the Center to connect your whole organization, enable collaboration across the value network, and unlock the power of automation. Autodesk is building a simple way for different disciplines and teams to converge into one product development and manufacturing environment. Connected data creates the digital thread that ties it all together and drives this convergence. Creating a common data experience gives you a complete view of your products and processes. It creates transparency at a global scale to offer actionable insights across your entire organization so everyone can make better decisions, faster. The digital thread provides the data integration and flow that enables creation and use of up-to-date, complete digital twins..

The key to better Collaboration is intelligently connected data. It breaks down silos between departments and makes sure the right people have the right information at the right time. With Data Management tools like Autodesk Vault PLM and its intelligent search capabilities, a user can quickly find and reuse data. Changes, revisions, and design history are tracked automatically as you work; reducing waste. Teams need to be able to Collaborate regardless of their physical location or where they sit in the product lifecycle. Autodesk cloud-delivered PLM solutions help you bring teams together in a virtual collaborative environment. And this collaboration doesn't have to stop within your own

walls. When everyone is working from a secure cloud platform, you can stay connected 24/7 to your entire supply chain.



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Solutions that power your business

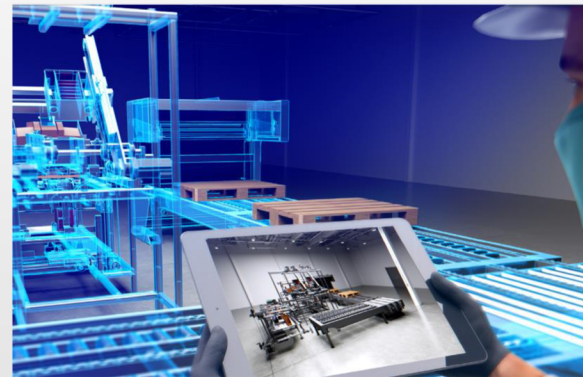
Once you're connected and collaborating effectively, the next leap forward is to Automate - eliminating the delays of working manually and exponentially accelerating product development across all departments. Automation also helps to provide "consistency" which promotes quality, improved understanding and performance. Autodesk is making automation accessible to everyone, building automation technology directly into its platforms. Incorporating technology like artificial intelligence (AI) automates generative design so engineers and manufacturers can define their problem statements and objectives and let the AI automate creation of multiple, validated design options. They can then select the option that best fits their preferred manufacturing methods and facilities to achieve optimum cost-to-volume ratio and performance.

In today's 'new normal' of distant working, the cloud has become a necessity for collaboration - no longer an option, but rather a critical component to keeping your teams connected and your business operational. For more than a decade, Autodesk been building a cloud-enabled platform that empowers a virtual workforce, that connects the product lifecycle from initial concept to customer delivery, and that enables connection/collaboration across the entire manufacturing ecosystem.

Autodesk solution platforms and technologies are vendor agnostic, can connect all the applications and data in the business seamlessly, regardless of vendor

origin, and function as the backbone of a company's IT architecture. These flexible, adaptable platforms give Autodesk's customers effective control over the scope and pace of their digital transformation journey.

To learn more see: www.autodesk.com/solutions/digital-transformation



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