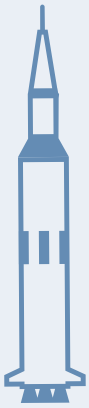
DASSAULT SYSTEMES

SOLIDWORKS

# ENGINEERING 4.0: THE NEXT PARADIGM OF PRODUCT DEVELOPMENT

## ENGINEERING 4.0 - (THE AUTOMATION AGE)



**2017**

NASA's largest rocket yet, the Space Launch System (SLS), will launch its first test flight, boosting143 tons to orbit

**2020**

The Internet of Things will include 26 billion internet-connected devices

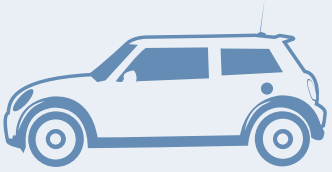
**2025**

30,000 drones will patrol U.S. airspace

**2029**

Computers will be cleverer than humans, accordingto Ray Kurzweil, Google's director of engineering

**2035**



11.8 million self-driving cars will be on the road

From the Industrial Age through the Information Age, engineering has undergone multiple waves of change. We have witnessed the transformation of engineering from manual drafting with paper and pencil, to automated 2D drawings, to powerful, affordable, easy-to-use 3D design solutions that feature integrated design, simulation and data management. All of these transformations have dramatically changed the role of the engineer and helped companies design and deliver better products faster and at lower costs. Fully understanding where we have been provides a better perspective on where we are headed, so here's a little background to set the stage for the next significant shift in the way engineering is performed by best-in-class companies.

## ENGINEERING 1.0 [1760 TO 1970]: MANUAL DRAFTING

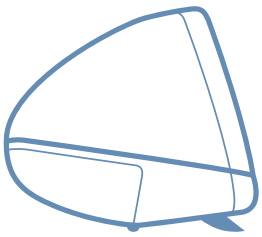
While certain elements of mankind's engineering prowess date back hundreds or even thousands of years from the invention of the wheel to Leonardo Da Vinci's inventions; modern engineering and manufacturing can be traced back to the Industrial Age. During this time, inventions such as the steam engine were designed and drawn up manually using pencil and paper. Over time, more durable media such as pencil and vellum and finally liquid ink on Mylar were used, but the basic methodology which included significant amounts of trial and error were constant. During this period, there were incredible breakthroughs and inventions, such as Thomas Newcomen's steam-powered atmospheric engine, the telegraph, the sewing machine, and hundreds of other fantastic engineering designs–all using basic non-intelligent media.

The Industrial Revolution, which took place from 1760 to 1840, was marked by the move from hand-production methods to machines, new chemical manufacturing and iron production processes, improved efficiency of water power, the increased use of steam power, and the development of machine tools. By the late 1800s, industrial-scale manufacturing required new processes and materials. Over the next 200 years, drafting tools improved, but everything was still very manual in nature. It was not until the advent of computers that the next dramatic shift in engineering was able to take hold.

James Watt developed a steam engine that rotated a shaft, producing a practical power plant

## ENGINEERING 2.0 [1970S TO 1995]: AUTOMATED 2D DRAWINGS

With the dawn of computers, a new engineering methodology was born. Named Computer-Aided-Design (CAD), this technology enabled a revolutionary change in the engineering industry. Designers, drafters, and engineers were able to lay out designs on a computer and make changes much more quickly and easily. This allowed many more alternative designs to be considered, and freed up time to enhance and improve designs, thanks to simple 2D tools such as move, copy, and erase. Using mainframes, mini-computers, and even personal computers, engineers were able to create 2D engineering drawings using circles, lines, and arcs. The first applications were rudimentary by today's standards, but over the years 2D drawing software became sophisticated enough to significantly increase design productivity because of its ability to perform complex mathematical calculations. Calculations, such as cross sections, centers of gravity, and moments of inertia were used to solve difficult geometry problems—like the creation of true views to show the dimensions of complex geometry—in a more efficient manner. Looking back, we've taken for granted some of the benefits of 2D CAD systems over the previous paper and pencil methods including faster design time, easier reuse of designs through the creation of symbol libraries, faster and easier drawing corrections, and design changes—without any erasing!. Despite these advances, challenges still existed. Engineers had difficulty communicating their designs using simply 2D views. As a result, they spent hours creating isometric views, hand renderings, and building physical prototypes to communicate and validate designs often leading to costly and lengthy design cycles.



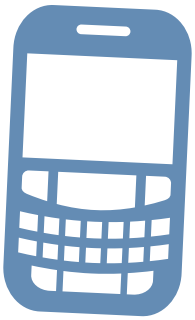
Apple Computer launched the first commercially successful computerto use a mouse andgraphical user interface

## ENGINEERING 3.0 [1995-2015]–THE POWER OF THREE: 3D CAD, SIMULATION, AND PRODUCT DATA MANAGEMENT

Leading up to the mid-1990s, 3D design technology was becoming available, but only to larger organizations that could afford the software and required hardware–generally mainframe computers costing millions of dollars. Once the personal computer gained power with advances in processor and graphics technology, 3D design became more affordable and available to the mainstream market. Parametric-based 3D modeling made creating and editing 3D models and associated 2D drawings simple. Engineers could easily change features like fillets, chamfers, and holes anytime during the design creation process and see their model automatically updated. 2D drawings could be semi-automatically created and automatically updated by changing dimensions in the 2D drawings or features in the 3D model.

In addition to 3D CAD, two other major pieces of design software became popular during this era: Simulation to allow engineers to test and validate their designs and product data management to allow them to more easily find, reuse and version their creations. These tools were designed to be powerful, affordable, and easy-to-use, which helped put them in the hands of more engineers.

Along with the technology changes, the role of the engineer has evolved from performing a single role to one that is more expansive in nature. Some engineers are responsible for engineering, design, simulation, and data management–tasks that may have been performed by multiple people in the past. Using integrated simulation tools, engineers can easily validate their designs electronically, saving time and money, and getting to market faster without the burden of creating physical prototypes. Data management allowed further productivity gains through the automated generation of mechanical, electrical, and electromechanical Bills of Materials (BOMs). These data management tools helped engineers keep track of their documents to ensure version control and to make sure everyone was using the most current design information. During these two decades, the internet became much more pervasive and accessible, contributing to a more global and non-centralized workforce requiring tools for greater remote access and collaboration which is solved using data management.



Ericsson was the first brand to coin the phrase "smartphone," with the release of its GS88

Today, many companies are fully leveraging the power of 3D CAD, simulation, and data management tools to design better products, reduce rework, improve productivity, and get to market faster. AMTRAK, America's intercity rail provider, is a great example of an organization that is benefiting from Engineering 3.0. The company currently uses SOLIDWORKS® 3D CAD to design its rail cars, SOLIDWORKS Simulation tools to analyze and validate part designs, and SOLIDWORKS Enterprise PDM (EPDM) to centralize and manage over 500,000 design files. With the help of SOLIDWORKS, AMTRAK has improved design productivity by over 60%, realized a 40% time savings, and significantly reduced design errors and quality issues.

## ENGINEERING PRODUCTIVITY LOSSES IN SERVICING DOWNSTREAM CUSTOMERS DRIVES NEED FOR CHANGE

In today's organizations, many departments are involved in the greater product development and manufacturing process. These stakeholders need engineering information on a regular basis to perform product development-related tasks, but they need data in the format most suited for their purpose. For example, purchasing needs information to plan sourcing of materials and parts, perform cost analysis and scheduling of raw materials and purchased parts, so they need a detailed BOM that quickly and easily conveys which parts are to be purchased versus made in-house. Shop floor production workers often ask questions of engineering to ensure they are machining, welding, or assembling correctly per the drawing and design intent, and to reduce errors that could lead to scrap and expensive rework. These demands on engineering for information create inefficiencies for both engineering and the downstream departments. At the same time, the increasing pressure of global competition has compelled companies to constantly find ways to become more efficient, get to market faster, and reduce costs as much as possible. Upon further scrutiny, there is inefficiency within the organizational product development process and supply chain. The advent of integrated 3D design solutions enabled organizations to more efficiently leverage their engineering data and solve many of these problems.

According to a recent study by Chad Jackson, an industry analyst and principal at Lifecycle Insights, engineers spend an average of 6 hours per week answering questions from downstream departments (including manufacturing) involved in the product development process. In addition, they spend 5.5 hours per week generating additional documentation for these same customers.[1]This totals more than 11 hours per week that engineers are performing non-design work—a 25 percent loss per week in design time (based on a 40-hour work week) alone. If you add in the productivity time lost by the downstream customers because they had to wait for information from engineering, or they had to manually fix errors due to incorrect information, this represents an even more significant productivity drain.

1 The State of Model-Based Enterprise Report 2014; Chad Jackson, Lifecycle Insights, 2014.

Combining the cost of lost productivity with lost revenues due to late market entry has prompted organizations to find ways for the whole organization to more efficiently leverage engineering information required for their roles throughout the product development process.

## ENGINEERING 4.0: LEVERAGING ENGINEERING DATA ACROSS THE ENTERPRISE

This issue of lost productivity has led to the next great shift in product development: Engineering 4.0, which is based on the concept of enabling downstream departments to access the right information, in the right format, delivered from a secure and centralized location.

The Internet of Things will include 26 billion internet-connected devices

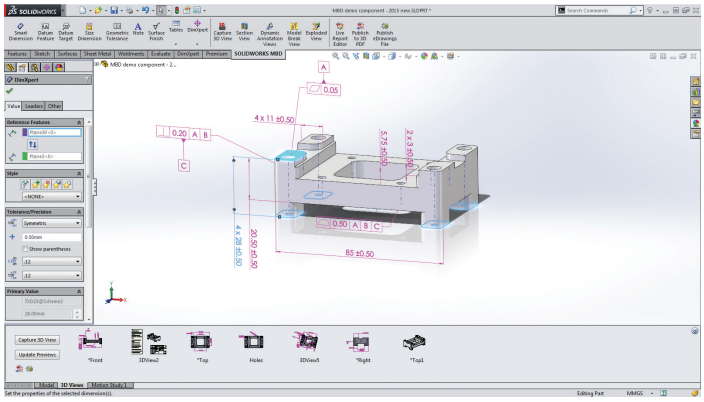
What if Sales or Purchasing could provide more accurate costing information earlier in the process? What if the Quality Assurance department could electronically generate their inspection drawings and reports and automatically know which product attributes were critical to test? What if the shop floor could have all the product manufacturing information (PMI) easily accessible in 3D and viewable digitally through the SOLIDWORKS eDrawings® Viewer or Adobe® Reader using monitors or tablets so that phone calls to engineering for up-to-date drawings, notes, and detailed conversations could be virtually eliminated?

The next key breakthrough in transforming the product development process has arrived–extending engineering data across the enterprise. 3D design solutions from companies, such as SOLIDWORKS, enable 3D model data to be accessed through a variety of tools in the format that is most useful to them. The benefits of Engineering 4.0 are very compelling—organizations increase productivity, become more efficient, design better products at lower costs, and reduce time-to-market. When engineering knowledge and data are leveraged with integrated tools, everyone benefits—Marketing, Sales, Purchasing, Quality, and Manufacturing. Downstream customers (other departments and suppliers) no longer have to wait for engineering to answer questions, provide documentation, or reproduce special drawings.

Many companies are leading the evolution to Engineering 4.0 and are starting to reap the benefits of a model-centric approach to product development. Transitioning all downstream departments within an organization takes time, so while not 100% deployed, these companies have increased productivity and reduced rework by gradually investing in tools which automatically provide design data.

## ENGINEERING 4.0 IN ACTION

There are many applications in the SOLIDWORKS 3D design portfolio that help capture, present, and store 3D design data so consumers of engineering data across the organization can securely get the right information, in the required format, at the right time.  For example, SOLIDWORKS Inspection automates the inspection process so quality assurance becomes more efficient. SOLIDWORKS Composer and SOLIDWORKS PhotoView 360 help Marketing personnel create content to help visually promote and document the product. SOLIDWORKS Costing can help the Sales and Purchasing departments provide the most accurate up-to-date pricing information to their prospects and customers. SOLIDWORKS MBD (Model-Based Definition) helps the shop floor become more efficient as they can leverage all the 3D PMI, along with engineering notes and visual cues for smooth production and assembly.



**Here are some examples of SOLIDWORKS customers who are starting to extend their engineering data within their organizations.**

### Wuzhong Instrument Co., Ltd (WZI)

Wuzhong Instrument Co., Ltd (WZI) is a leading global manufacturer of industrial control valve products—including ball valves, butterfly valves, and specialty valves—which are used for automation purposes in the petroleum, natural gas, chemical, power, metallurgy, paper, pharmaceutical, food processing, and environmental protection industries. WZI has implemented the SOLIDWORKS 3D product development platform to extend 3D data throughout its organization to gain efficiencies and lower costs. Using SOLIDWORKS 3D design software at the core of its processes, WZI has extended the benefits of 3D into its production operations by taking a model-based definition approach to manufacturing.

According to Zhang Jingwen, Project Manager for WZI, "We decided to define everything in 3D, populate our 3D models with product manufacturing information–such as tolerancing, dimensioning, process card, and routing sheet information–and output SOLIDWORKS models to automatically generate NC code and SOLIDWORKS eDrawings instead of paper to more efficiently drive production."

By using SOLIDWORKS software to drive model-based definition manufacturing, WZI has automated and accelerated production, reducing NC code generation time by 80 percent, cutting dimensioning time by 40 percent, and streamlining the handling of engineering change orders (ECOs), all while completely eliminating 2D tasks and the company's reliance on paper drawings.

Learn more about WZI at www.wzyb.com.cn/English/main.asp

### Automatic Handling International

Automatic Handling International is another SOLIDWORKS customer that is on its way to achieving the benefits of Engineering 4.0. A worldwide manufacturer of custom handling and packaging systems, serving leading companies in the pulp & paper, tissue & towel, nonwovens, fiberglass, agriculture, stone, and steel industries, Automatic Handling has reduced costs and increased efficiencies across its development, manufacturing, and assembly operations, by taking a model-based definition approach to production. In addition to using SOLIDWORKS 3D CAD and Simulation solutions to create and validate its product designs, Automatic Handling has extended 3D design data beyond product development. By using the SOLIDWORKS open Application Programming Interface (API) with SOLIDWORKS EPDM to automate workflows and revision control, Automatic Handling has cut manufacturing release times by 80 percent. They have also reaped benefits in their production operations by eliminating 2D drawings on the shop floor with the help of SOLIDWORKS eDrawings software embedded with product manufacturing and assembly instructions.

"In the past, an engineer could spend a day or two just printing off engineering drawings," Nathan Pienta, Media Group Manager at Automatic Handling, notes. "Now, the release process is instantaneous, and production personnel receive the information that they need via 30 computers with 50-inch monitors on the shop floor. The process is not only faster and more accurate, leading to improved quality, but also eliminates printing, paper, and administrative costs."

Automatic Handling also uses SOLIDWORKS Composer to quickly and accurately create their technical documentation and assembly instructions using 3D design data.

Learn more about Automatic Handling at www.automatichandling.com

## CONCLUSION

As the world economy continues to expand globally and competitive pressure grows from all sides, companies that embrace the principles of Engineering 4.0 by extending the use of their design data, they will position themselves well to maximize productivity, get to market faster, design better products, and squeeze wasteful costs out of their product development process. Leveraging engineering knowledge and data across the enterprise can be strategic differentiators that can help companies compete more effectively. Many companies are already actively making this transition. Why not yours?



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