

## Digital Prototyping: Questions and Answers

### 1. What is a digital prototype?

A digital prototype is created with Autodesk® Inventor® software and is a digital simulation of a product that can be used to test form, fit, and function. The digital prototype becomes more and more complete as all associated industrial, mechanical, and electrical design data are integrated. A complete digital prototype is a true digital representation of the entire end product and can be used to visualize and simulate a product to reduce the necessity of building expensive physical prototypes.

### 2. What is Digital Prototyping?

Digital Prototyping gives conceptual design, engineering, and manufacturing departments the ability to virtually explore a complete product before it becomes real. With Digital Prototyping, manufacturers can design, visualize, and simulate products from the conceptual design phase through the manufacturing process, boosting the level of communication with different stakeholders while getting more innovative products to market faster. By using a digital prototype created in Inventor, manufacturers can visualize and simulate the real-world performance of a design digitally, helping reduce their reliance on costly physical prototypes.

### 3. What is the Autodesk solution for Digital Prototyping?

Autodesk Inventor software takes manufacturers beyond 3D to Digital Prototyping. With Inventor, you can create a single digital model that gives you the ability to design, visualize, and simulate your products:

- **Design:** Integrate all design data into a single digital model, streamlining the design process and increasing communication.
- **Visualize:** Create a virtual representation of the final product to review design intent, secure early customer validation, and market products before they're built.
- **Simulate:** Digitally simulate the real-world performance of your product, saving the time and money required to build multiple physical prototypes.

Inventor enables manufacturers to create a digital prototype, helping reduce reliance on costly physical prototypes and get more innovative products to market faster. The Autodesk solution for Digital Prototyping brings together design data from all phases of the product development process into a single digital model created in Inventor.



### 4. What pain points does Digital Prototyping address?

The manufacturing product development process today is dominated by islands of competency, each presenting its own technical challenges:

- In the conceptual design phase, industrial designers and engineers often use paper-based methods or digital formats that are incompatible with the digital information used in the engineering phase. A lack of digital data, compatible formats, and automation keeps this island separate from engineering—the conceptual design data must be recreated digitally downstream, resulting in lost time and money.

- In the engineering phase, mechanical and electrical engineers use different systems and formats, and a lack of automation makes it difficult to capture and rapidly respond to change requests from manufacturing. Another problem in the engineering phase: the geometric focus of typical 3D CAD software makes it difficult to create and use a digital prototype to validate and optimize products before they are built, making it necessary to build multiple costly physical prototypes.
- Manufacturing is at the downstream end of all the broken digital processes—the disconnection between the conceptual design phase, the engineering components, electrical, and

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mechanical—and they receive this analog information in the form of drawings. The result is a heavy reliance on physical prototypes and the subsequent impact on productivity and innovation.

- Disconnected product development processes make it difficult to bring customer and marketing requirements into the process early so customers can see exactly what the product will look like and validate how it will function before it is delivered. The inability to involve the customer early in the product development process means that the customer can't validate a design before the product goes to manufacturing. Customer requests for changes become exponentially more expensive to address the further along the product is in the manufacturing process. The result: companies have to build multiple physical prototypes for customer validation.

## 5. Hasn't the concept of Digital Prototyping been around for years?

Although there has been talk about the benefits of Digital Prototyping for years, the budget for the tools required to build and test a true digital prototype has been out of reach for most manufacturing companies. Digital Prototyping solutions are usually expensive, customized installations for large enterprises. Most out-of-the-box 3D modeling applications provide only part of the functionality needed to create a complete digital prototype.

## 6. What is unique about the Autodesk approach to Digital Prototyping?

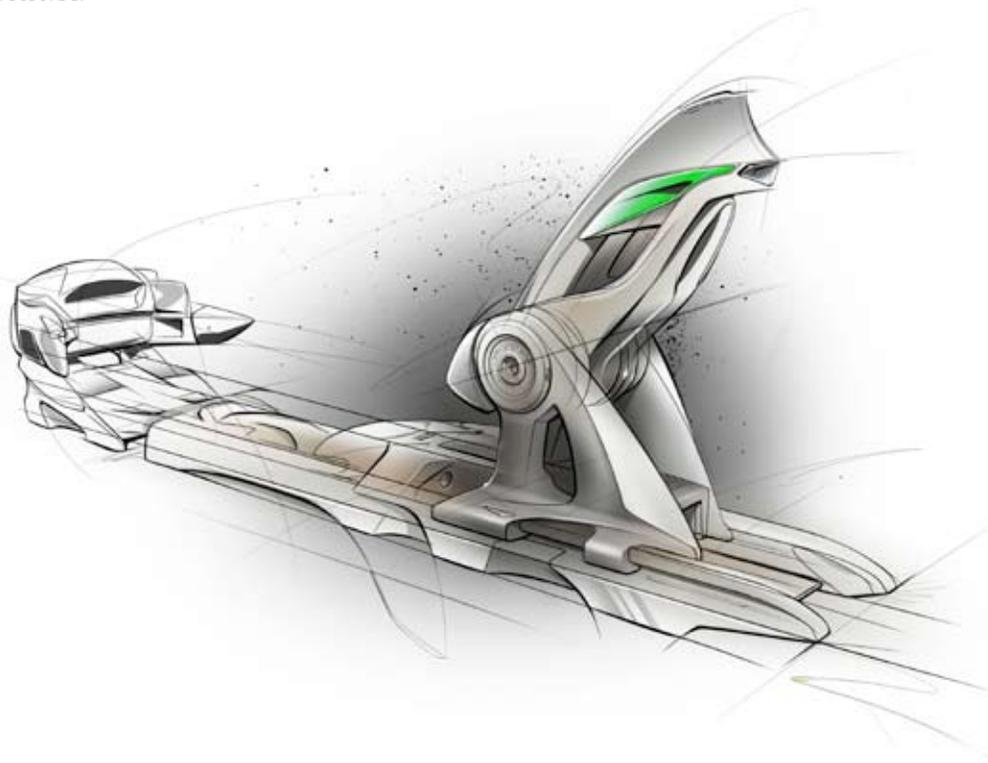
- **Scalable:** The Autodesk solution for Digital Prototyping is scalable, flexible, and easy to integrate into existing business processes. Using Inventor to create a single digital model, manufacturers can realize the benefits of Digital Prototyping at their own pace, with minimal disruption to existing productive workflows.
- **Attainable:** The Autodesk solution for Digital Prototyping provides an easy to deploy and manage solution for mainstream manufacturers to create and maintain a single digital model that can be used in all stages of production.
- **Cost-effective:** Delivering cost-effective software for design and manufacturing workgroups, an Inventor-based Digital Prototyping solution delivers the fastest path to ROI. Autodesk has a proven record of making powerful desktop technology available to mainstream manufacturers.

## 7. How do the Autodesk Manufacturing products and technology drive Digital Prototyping?

Inventor takes you beyond 3D to Digital Prototyping. The Autodesk solution for Digital Prototyping enables manufacturing workgroups to develop a single digital model, created in Inventor, that can be used in every stage of production—bridging the gaps that usually exist between conceptual design, engineering, and manufacturing teams. This single digital model simulates the

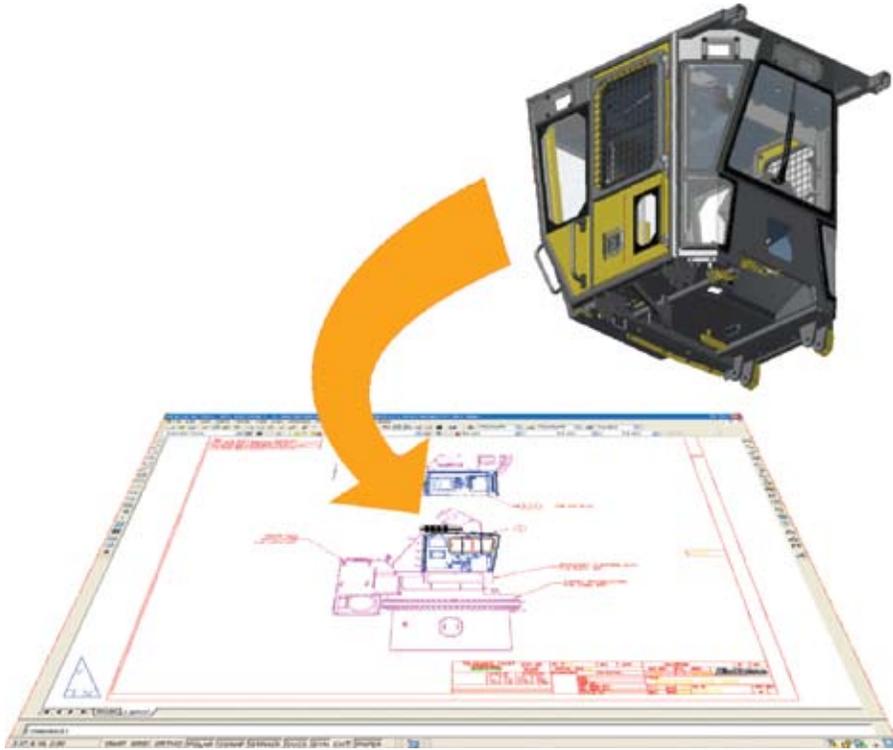
complete product and gives engineers the ability to better design, visualize, and simulate their product with less reliance on costly physical prototypes—thereby improving time to market, and increasing competitive advantage. Autodesk provides the interoperable tools required to create a complete digital prototype from the conceptual phase of a project through manufacturing:

The **Autodesk® Alias®** product line enables you to work digitally from project outset using best-in-class industrial design tools. Capture ideas digitally—from initial sketches to 3D concept models using products in the Alias product line—then share those designs with the engineering team using a common file format, allowing a product's industrial design data to be incorporated into the digital prototype created in Inventor. Today, the look and feel of a machine or device is more important than ever for consumers, so industrial designers and engineers must share housing and user interfaces early in the process.



With **Autodesk® Showcase®** software, you can quickly evaluate multiple design variations by creating realistic, accurate, and compelling imagery from 3D CAD data—helping reduce the time, cost, and need for building physical prototypes. You can then interactively view the digital prototype in realistic environments, making it faster, easier, and less expensive to make design decisions.

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**Autodesk Inventor** software moves engineers beyond 3D and enables them to develop complete digital prototypes of their products. The Autodesk Inventor family of software provides the powerful—yet cost-effective and easy to learn—desktop technology engineers need to take advantage of Digital Prototyping. Autodesk Inventor software enables engineers to integrate AutoCAD® drawings and 3D data into a single digital model, creating a virtual representation of the final product. Using this single digital model, you can design, visualize, and simulate products digitally. The model serves as a digital prototype that is refined and used to validate design functions, helping to reduce reliance on physical prototypes and minimize manufacturing costs.

- **Functional Design:** Autodesk Inventor software products combine an intuitive 3D mechanical design environment for creating parts and assemblies with functional design tools that enable engineers to focus on a design's function, not geometry creation—letting the software drive the automatic creation of intelligent components such as plastic parts, steel frames, rotating machinery, tube and pipe runs, and electrical cable and wire harnesses. Reducing the geometry burden helps engineers spend more time rapidly building and refining digital prototypes that validate design functions and help optimize manufacturing costs.

- **DWG™ Interoperability:** Inventor provides direct read and write of native DWG files while maintaining full associativity to the 3D model without risking inaccurate translations. (DWG from Autodesk is the original format for storing and sharing design data when working with AutoCAD software. With billions of DWG files circulating throughout every industry, it's one of the most commonly used design data formats.) This gives engineers the freedom to safely reuse valuable 2D DWG files to build accurate 3D part models, then communicate insights gained from Digital Prototyping with partners and suppliers that rely on AutoCAD software.

- **Dynamic simulation:** Autodesk Inventor delivers the best integrated simulation tools in the industry. Tightly integrated tools for calculation, stress, deflection, and motion simulation make it possible for engineers to optimize and validate a digital prototype before the product is built. Simulation is performed based on real-world constraints, so you know you can rely on the simulation results. The dynamic simulation tools in Inventor enable engineers to evaluate multiple potential solutions to a motion problem, making it possible to make the best design decisions and avoid costly mistakes.

- **Documentation:** Autodesk Inventor software includes comprehensive tools to generate engineering and manufacturing documentation directly from a validated 3D digital prototype,

helping design teams communicate more effectively. Inventor combines the benefits of associative drawing views, so any changes made to the model are reflected in the drawing—with the power and widespread acceptance of the DWG format to help reduce errors and deliver the design in less time.

- **Routed Systems:** Inventor software's automated tools for designing routed systems, including complex tube and pipe runs, and electrical cable and harness design, allow you to create and validate a more complete digital prototype, which helps reduce errors and ECOs prior to manufacturing and get to market faster.
- **Tooling:** The tooling capabilities of Inventor software give designers and engineers intelligent tools and mold base catalogs to quickly and accurately generate mold designs directly from a digital prototype. Using the Inventor digital prototype, mold, tool and die manufacturers can validate the form, fit, and function of a mold design before it's built, reducing errors and improving mold performance.

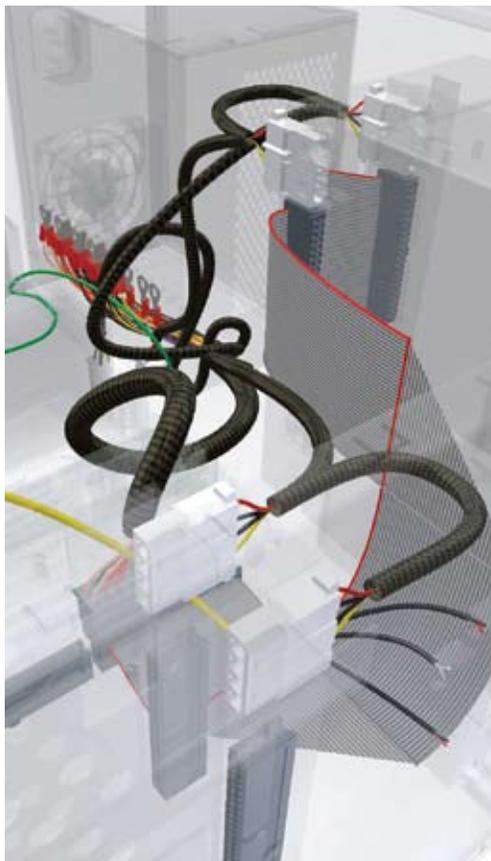
To help validate and optimize designs before manufacturing, you can use the broad range of finite element analysis (FEA) and simulation tools in Algor® simulation software, which will enhance the Autodesk solution for Digital Prototyping.



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**AutoCAD® Mechanical** software is built to help mechanical designers and drafters simplify complex mechanical design work, enhancing productivity. Quickly detail production drawings using industry-specific manufacturing tools, reducing errors and saving hours of time. **AutoCAD®**, one of the world's leading design and professional drafting software, plays an important role in Digital Prototyping workflows. AutoCAD gives you the power and flexibility to explore, document, and communicate ideas. Both AutoCAD Mechanical and AutoCAD software enables engineers to accurately document digital prototypes created in Inventor, and communicate insights gained from Digital Prototyping with colleagues, partners, and suppliers that rely on AutoCAD software.

**AutoCAD® Electrical** software passes electrical design intent information for cables and conductors directly to Autodesk Inventor software, adding valuable electrical controls design data to the digital prototype created in Inventor. Inventor users can pass wire-connectivity information to AutoCAD Electrical and automatically create the corresponding 2D schematics. The smooth integration between Inventor and AutoCAD Electrical helps your electrical and mechanical teams work collaboratively and efficiently on 2D and 3D mechatronic product designs.



To optimize plastic part and injection mold designs, use **Autodesk® Moldflow®** injection molding simulation software.

**Autodesk® 3ds Max®** software enables you to leverage engineering data to create advanced software-rendered and -animated visualizations of digital prototypes created in Inventor. 3ds Max contains a complete suite of CAD data preparation, modeling, effects, and rendering tools to create the highest quality photorealistic and stylistic still and animated visualizations.

**Autodesk® Navisworks®** software for manufacturing enables manufacturing companies to visualize complete manufacturing facilities, industrial machinery, factory floor models, and production lines in a single environment. The software supports complete assembly visualization and optimization, and enables you to combine CAD

data from various design systems regardless of file format or size.

Autodesk's data management tools allow design workgroups to manage and track all the design components for a digital prototype, helping you to better reuse design data, manage bills of material, and promote early collaboration with manufacturing teams and clients. With the **Autodesk® Vault** family of data management applications, design, engineering, and manufacturing workgroups can manage the Digital Prototyping process by helping reduce time organizing files, avoid costly mistakes, and more efficiently release and revise designs. You can further facilitate Digital Prototyping workflows with **Autodesk® Design Review** software, the all-digital way to review, measure, mark up, and track changes to designs—all without the original creation software.



## 8. What can customers do with the Autodesk solution for Digital Prototyping today?

Industrial designers use Autodesk Alias products to digitally sketch design ideas and create 3D digital concept models for validation that then can be shared with engineering or manufacturing teams.

Engineers use Autodesk Inventor to explore ideas with simple, functional representations that help generate a digital prototype. Inventor software delivers the best bidirectional interoperability on the market between 2D and 3D mechanical and electrical design applications. Integrated stress analysis and motion simulation help engineers optimize and validate complete designs digitally and confirm that customer requirements are met even before a product is built.

Manufacturing teams benefit from accessing the most current and accurate data (release drawings,

models, and BOMs)—avoiding mistakes caused by using outdated documents. They can provide expertise earlier in the engineering process by sharing the digital prototype with Autodesk's DWF™ (Design Web Format) technology to communicate, mark up, and measure designs—moving one step closer to true paperless manufacturing processes.

## 9. What are the business benefits of Digital Prototyping?

According to an independent study by the Aberdeen Group, best-in-class manufacturers use Digital Prototyping to build half the number of physical prototypes as the average manufacturer, get to market 58 days faster than average, experience 48 percent lower prototyping costs, and ultimately drive greater innovation in their products. The Autodesk solution for Digital Prototyping helps customers achieve results like these.

## 10. How does the Autodesk solution for Digital Prototyping help get customers to best-in-class?

By giving you the tools to develop a complete digital prototype, Autodesk helps you build fewer physical prototypes—and ultimately get to market ahead of the competition with more innovative products. Autodesk's position is that moving to 3D is only the first step in creating a digital prototype. In today's increasingly competitive global market, being best in class means using technology to stay ahead of the competition—incorporating Digital Prototyping into the product development process gives you that edge. Autodesk provides this functionality through a complete, easy-to-learn set of design applications and a wide range of partners for consultation regarding what is needed to make Digital Prototyping a reality.

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“Before Inventor, it would typically take me 18 months to bring a new design to market,” Jason Faircloth, product manager and designer for Marin Bikes, Inc. says. “The finite-element and motion analysis software have enabled me to almost eliminate physical prototypes. With the software, it’s now nine months, and getting faster—and the product is better. This is our future.” The CAE capabilities of Inventor Professional enabled Faircloth to produce multiple “digital prototypes” so that the time-consuming process of physical prototyping was reduced or eliminated.”

—**Desktop Engineering**

## 11. What is the market saying about Digital Prototyping?

“To be best-in-class is not just about moving from 2D to 3D, but rather to push ahead to digital prototyping to answer questions about your product before you start to build it.”

—**Start-IT**

“IDC believes that with its new definition of digital prototyping, Autodesk is offering a product development solution to SMBs that will strengthen their competitiveness and give them the functional tools and processes required to achieve product excellence and profitability for years to come.”

—**Gisela Wilson and Michael Fauscette, IDC**

“One of the primary reasons manufacturers aim to capture more product information electronically is to digitally prototype their product. As a result, they can reduce physical prototyping and in turn, save time and development costs.”

—**Aberdeen Group**

“It [Autodesk] provides a comprehensive range of software solutions for the manufacturing industry including its flagship 3D design offering, Autodesk Inventor. The solutions redefine product design process by supporting and connecting all disciplines of product development, from industrial design to mechanical and electrical engineering, and manufacturing.”

—**Design News**

“The ability to not only visualize product development in 3D but also to simulate how that product would perform in the physical world are among the benefits assigned to digital prototyping. Research from consulting firm Aberdeen Group, in fact, shows that the use of digital prototypes for top-performing companies both reduces their product development costs and speeds up how quickly products get to market.”

—**IndustryWeek**

“The latest Autodesk manufacturing solutions redefine the product design process by supporting and natively connecting all of the disciplines involved in product development, from industrial design to mechanical and electrical engineering and manufacturing.”

—**The Manufacturer**

“The Digital Prototyping approach is now embraced by some important manufacturers who once promoted enterprise PLM, including Boeing. Its new 787 Dreamliner, like the 777 before it, was digitally designed, but the digital definition from engineering was pushed into manufacturing via new processes that replaced DCAC/MRM.”

—**Nancy Rouse-Tally, Desktop Engineering**