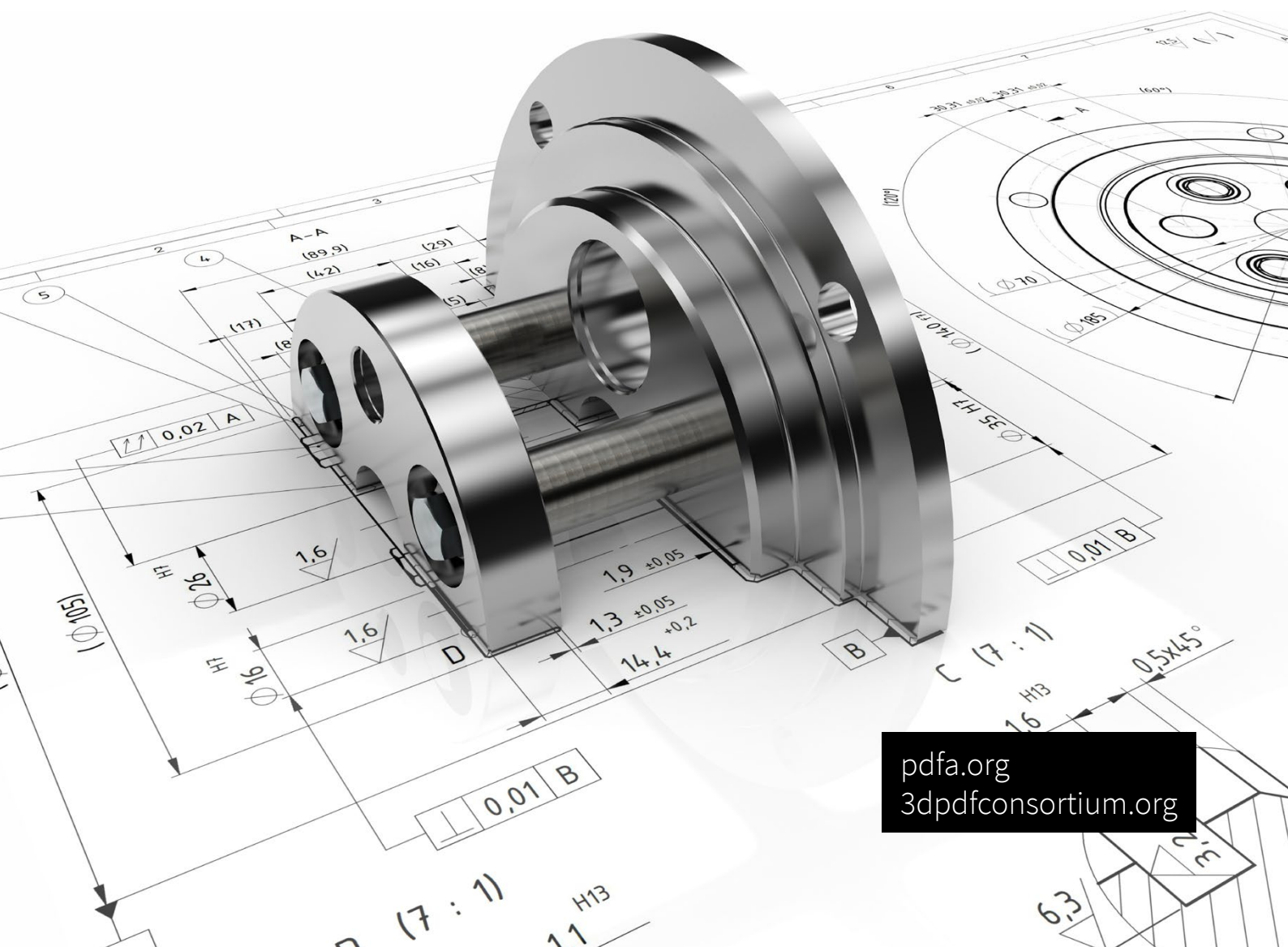


PDF in manufacturing

The future of 3D documentation



pdfa.org
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PDF in manufacturing

The future of 3D documentation



IMPRINT

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PDF in manufacturing

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A brief history of documents in manufacturing

For millennia of prehistory, manufacturing objectives, plans and processes were entirely contained within the mind of the artisan, possibly with a few assistants. Training was by apprenticeship, with skills communicated orally and by demonstration. It was not until the 18th century that the factory model first adopted in Britain at the beginning of the Industrial Revolution began to transform manufacturing worldwide.

The principal feature of factories distinguishing them from other modes of manufacturing is machinery. Machines require extensive, detailed workflows and processes, precisely engineered tooling and elaborate jigs to perform specialized, often one-of-a-kind tasks. Accordingly, a critical enabler for any manufacturing concern is the ability, as the immortal expression goes, for all concerned to be “on the same page”.

As manufacturing developed in the 19th century new factors emerged that demanded more and better means of developing, creating, sharing, annotating and using manufacturing information. Modern manufacturing, with its centralization, economies of scale and standardization of interchangeable parts,

requires larger organizations, more complex instructions, diverse skill sets, comprehensive quality-control and extensive field maintenance. Since the onset of the industrial revolution, each enhancement in productivity has come with entirely new requirements for the creation, conveyance, handling and management of manufacturing information.

Manufacturing, in other words, requires lots of documents.

Technical Drawings

Even in the days of artisanal manufacturing, drawings were frequently necessary in order to convey a customer’s wishes or to train a new apprentice (see [Figure 1](#)). The evolution of factories required highly structured technical drawings, fostering a vast range of systems and practices to represent physical settings, structures, machines and processes. Of course the factory’s own documentation relied on the equally vast range of drawings required for parts, subassemblies and finished products.

Technical drawing creation and management skills became essential for communicating throughout research, engineering and industry.

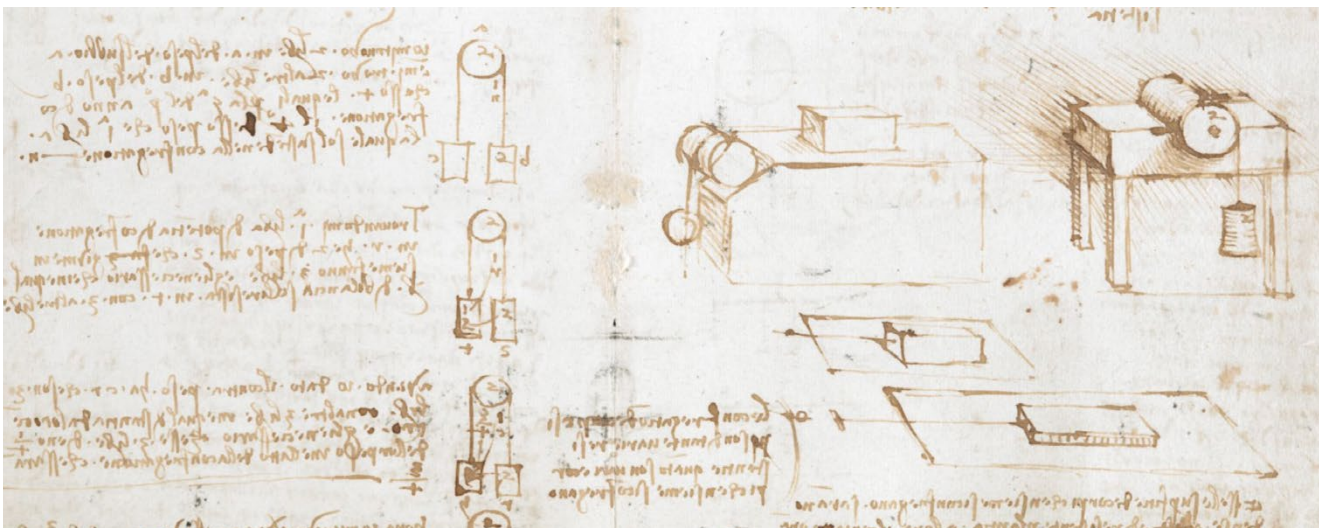


Figure 1: Leonardo da Vinci, *Notes and diagrams on mechanics*, c. 1500-1505

The need to unambiguously convey precise and complete information rapidly and accountably led to the development of many classes of units, symbols, notations, systems for expressing perspective, styles in representation and layout.

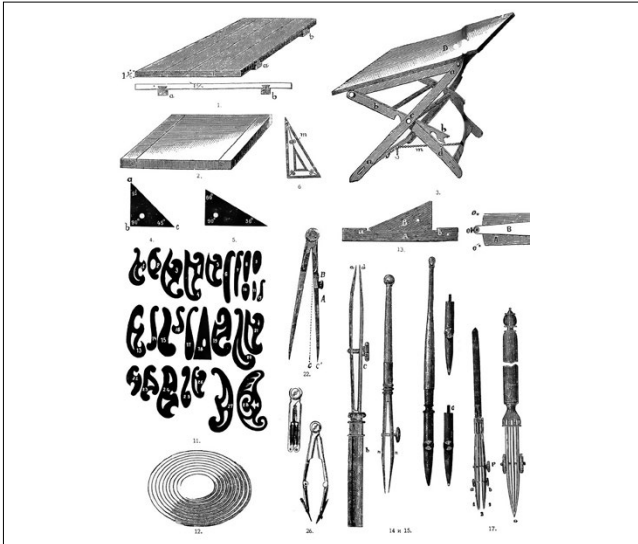


Figure 2: Technical drawing tools

Through the 19th and into the 20th century these systems evolved together to emerge as a visual language, much of which is now codified in a variety of ISO and other industry standards.

As mechanisms became more complex the volume of documentation exploded throughout the entire product lifecycle, from research and development to engineering, tooling, design, manufacturing, marketing and maintenance. By the 1940s large institutions and manufacturers were building warehouses and developing elaborate systems to maintain their technical drawings and other documentation.

It would take another 40 years before technology began to provide a revolutionary new answer.

Digital transformation begins with CAD

As manufacturers discovered, the cost (in both time and money) and inflexibility of hand-drafted drawings represented a major drag on every facet of manufacturing, from conceptualization to development, from the supply chain to the production line, and even to marketing.

Beginning in the 1980s the first two-dimensional (2D) Computer Aided Design (CAD) systems, AutoCAD and MicroStation, quickly replaced the discipline of drawing on paper (see [Figure 4](#)).

Although they allowed for rapid revisions and thus substantially reduced the need for expensive skilled labor the advantages of CAD over hand-drawing were limited because these systems were fundamentally two dimensional electronic drawing boards. Innumerable opportunities for errors remained in producing cross-sectional views, first and third angle orthographic and auxiliary projections. The principles of parametric design, introduced in the early 1990s, helped mitigate errors by leveraging the logic of the object to influence specifications.

Content Management

Boeing, GE, Cisco, Ericsson, TE Connectivity, Lockheed Martin and the US DoD require improved technical data access, collaboration, and real-time decision making throughout supply-chain, manufacturing and field service operations. Proprietary or ad-hoc tools and technologies are difficult to manage, driving the need for more effective standards-based, automated solutions to consistently create and manage the many thousands of Technical Data Packages (TDPs) and other content items these organizations need to share with knowledge workers along the Digital Thread.

Solution: Anark's Intelligent Information Management and Visual Collaboration platform enables manufacturers and their supplier communities to easily transform, publish, and manage critical engineering, manufacturing, and operational data within open standards based 3D PDF and browser-based TDPs and digital workflows.

[Anark Corporation \(anark.com\)](#)



Connecting The Digital Thread™

- ✓ **Easily transform, publish, & manage** CAD, PLM & ERP data as role-specific technical data packages (TDPs) & connected digital workflows accessible from virtually any device.
- ✓ **Unite cross-functional teams** for improved data access, collaboration, and real-time decision making throughout supply-chain, manufacturing & field service.
- ✓ **Connected, secure, traceable visual collaboration**, with robust support for 3D MCAD (with high-fidelity MBD), 3D ECAD, 2D drawings, tabular data, text, video, audio, images & more.
- ✓ **Most advanced & complete support for automated MIL-STD-31000B** compliant 3D TDP generation.
- ✓ **Flexible deployment**, with on-premises, private & public cloud options.

Supply Chain



Manufacturing



Field Service



Intelligent Information Management
www.anark.com

The most significant limitation of 2D CAD for manufacturing purposes, however, was straightforward: it provides no means of establishing whether parts will fit, or even that it's physically possible to assemble them.

Introduction of 3D models in design processes

Three-dimensional (3D) CAD systems allow phones, cars, aircraft, ships, bridges and buildings to be modeled, assembled, and otherwise simulated and validated before technical drawings are released for manufacture.

In the 1990s, 3D systems made it possible to fully define a component's geometry within the software, so assembly errors could be eliminated in principle. The orthographic, projected or sectioned drawings

that result from such systems are user defined views of that geometry; 3D viewing systems allow these views to be manipulated to accommodate diverse needs across the manufacturing organization.

PDF: a universally-accepted format

In the late 1990s Adobe's Portable Document Format (PDF) was adopted worldwide as the *de facto* digital document format. PDF's core capabilities – including fundamental reliability, support for large page sizes, pixel-accurate renderings and free viewing software – helped drive adoption in documentation, including technical drawings.



Today, almost all 2D drawings are authored in the DWG (drawing) format but shared as PDF. The advantage of making and sending a PDF file versus printing and shipping paper are too obvious to ignore.

But why PDF rather than one of the many competing digital document formats developed during the 1980s or 1990s? The answer lies not in any single aspect of PDF technology but in the collection of a specific set of features into a single format. At a high level the critical PDF feature-set for sharing engineering information depends on a few key attributes of the Portable Document Format:

- **PDF's rendering model** is multiplatform, broadly implemented and rock-solid. Different vendors can and do achieve identical results while meeting engineering requirements for accuracy.
- **PDF's document model** (e.g. resources, pages, interactive elements, semantics and metadata) is likewise broadly understood and appreciated; users know the format is far more than a TIFF image.
- **PDF's wide-ranging set of features**, from annotations to metadata to digital signatures, PDF technology integrates a wide variety of functionality directly into the document format, so they are fully interoperable between diverse software applications.

Sika: Specialty Chemicals Company

Sika is a globally active Swiss specialty chemicals company. The company is subject to strict documentation requirements for products used in construction and has to be prepared to prove test results and laboratory reports at any time. Documentation is maintained in a project management system which holds for each project the main data as well as various related files in different formats, e.g. MS Word, MS-Excel.

It is important for Sika to have access to complete project data outside of the project management system. While this is straightforward for the documents file relations require a more powerful format. The solution is PDF/A-3, which can combine associated files into an archive-compatible PDF/A file. Office files are embedded with an additional PDF/A rendition. PDF/A-3 creation is integrated into automated processes in the project management system, and relies on callas pdfaPilot.

[callas software \(callassoftware.com\)](https://callassoftware.com)

callas pdfaPilot, the missing link in your digital workflow

CHECK OUT
ONE OF
THE UNLIMITED
COMBINATIONS!

START

Document
conversions

Embed
drawings

Add
watermarks

Online
(PDF/A)

Print
(PDF/X)

Publish

END

Robotic Process Automation

without limits and as easy and intuitive
as drag-and-drop!

- ✓ Integrates with your existing document workflow processes
- ✓ Automates your PDF workflow
- ✓ Visualizes your PDF workflow



pdfaPilot

PDF is more powerful
than you think.

Try it out and see for yourself:

www.callassoftware.com/pdfaPilot-trial



- **PDF's royalty-free nature** is a key enabler of the technology. Adobe's original choice in 1993 to not only publish the PDF specification but allow 3rd parties to implement it freely allowed developers worldwide to integrate PDF capabilities into their solutions.
- **A free reader** has been a critical element of PDFs success since Adobe chose to ship Reader for free a few months after PDF's initial release. The free PDF viewer allowed users everywhere to consume PDF files, creating the marketplace for Adobe's (and everyone else's) software to create, modify, annotate and digitally-sign PDF documents.

As manufacturing systems and product designers began to invest in digital distribution to share printable drawings and plans throughout their supply chains it became clear that PDF's impact on compressing document distribution time and cost was substantial.

What else could PDF do?

Digital distribution & annotation

In manufacturing, master files are fundamental. Before the digital revolution, maintaining expensive drawings required elaborate systems of paper-based annotations to precious paper master files, then endless copying and redistribution of changes.

Even after the advent of CAD and related design software, users could not, in many cases either af-

ford or use full-blown CAD systems. Drawings might be transferred electronically, then printed locally for distribution and by designers and engineers. The challenge remained: how to bring all these annotations together; to manage and maintain documents throughout their entire lifecycle without warehouses of paper and the accompanying labor costs.

When PDF was introduced into manufacturing design and workflow, those creating PDF documents originally envisioned that they'd eliminate shipping and offload printing costs to their end users.

Those accepting PDF documents originally assumed that they would simply print what they received.

For both creator and consumer, PDF's accuracy in reproduction, and the relative speed and cost of email vs. overnight delivery, made digital delivery for local print a worthy solution in itself.

But PDF offered much more. Users discovered that the same software they used to create PDF files (in the 1990s, this was almost exclusively Adobe's Acrobat) was also capable of adding comments to PDF pages.

The ability to include comments and other markup in PDF files enabled an entirely new model for design and engineering workflows, in which designers were empowered to not only rapidly disseminate their con-

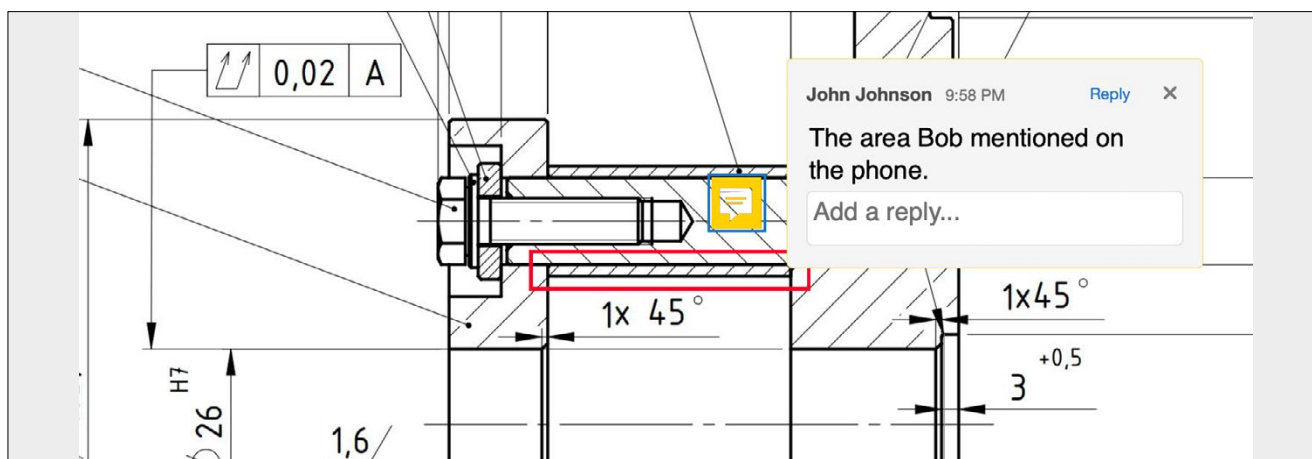


Figure 3: A PDF comment (annotation)

tent, but were could also receive recipients' feedback and comments using the same low-cost PDF technology and methods (see [Figure 3](#)).

PDF documents enabled two-way and multi-point communication. Besides text comments PDF users could add shapes, boxes, arrows, text-corrections and highlighting, and return them to the originator, or pass along to others for review.

2010s: design engineering goes 3D

Driven by the wide range of commercial and open source CAD software and increasingly powerful desktop computers, following the 2009 economic downturn the the manufacturing sector was characterized by wholesale adoption of 3D technology in design engineering.

Today, 2D drawings have become relegated to highly specific applications and tasks. It's now commonplace for complete manufacturing design, specification, outsourcing, testing, subassembly, final assembly, packaging and documentation to be scoped, planned, designed and tested within 3D systems before any physical product is made at all.

2020s: PDF extends 3D throughout the product lifecycle

Although 3D technology has fully penetrated design and manufacturing processes themselves, outside of limited high-value applications, 3D has yet to be applied elsewhere in the product lifecycle.

This is where PDF, which solved the digital distribution of drawings problem in the 1990s and 2000s, returns to meet current needs for distributing 3D information beyond CAD users.

By delivering interactive 3D models of arbitrary complexity in a 2D document context with ubiquitous free reader support, product designers and managers can drive new workflows and innovations in a wide variety of contexts, including:

- Transmitting 3D specifications to subcontractors
- Distributing 3D training content to production line workers
- Incorporating 3D models into 2D planning or instructional content
- eCommerce
- AR/VR
- Geospatial applications

The future of manufacturing is 3D PDF

3D design tools are too heavyweight and cumbersome for the majority of 3D consumers, including information consumers in the manufacturing space. PDF offers a complete deliverable package for manufacturing information that meets users' needs across a broad spectrum of applications across the product lifecycle, from product and assembly development to training and disposal.

PDF 2.0 (ISO 32000-2) supports both U3D and PRC 3D formats directly within PDF's framework for 3D constructs on PDF pages, while extensions to support STEP AP 242 (ISO 10303-242) and glTF data are under development.

PDF isn't just a container for 2D and 3D information; it's an archival solution for final-form content. PDF/A-4, a subset of PDF 2.0 supporting long term preservation of PDF files, allows 3D content and associated JavaScript, making it a viable solution for archiving manufacturing content.

Manufacturing is getting smarter, with more automation and streamlining added every day. The theory and practice of making things will always rely on broad teams of designers, modelers, engineers, marketers, production-line supervisors, assemblers, line workers, maintenance personnel and decommissioning experts. PDF, and 3D PDF in particular, provides the path forward to a fully-integrated platform of technologies capable of meeting every workflow and documentation requirement.

From drawings to Model Based Definition (MBD)

PDF and drawings

Engineers have traditionally used graphic drawing sheets (“drawings”), to fully define a product for engineering processes such as inspection, manufacturing and assembly, etc. These drawings are two-dimensional representations of three-dimensional objects. Additional information about the form, fit and function of the object is added to the drawing to detail all the product information necessary for a manufacturing process. This information is collectively known as Product and Manufacturing Information (PMI). Engineers and machinists use the PMI associated with an object as a visual map accurately manufacture and inspect an object.

Drawings are often the final deliverable for many engineering processes. They represent a contract between design and manufacturing, so accuracy is

critical. Drawings are intended to be read and interpreted by an engineer, so they include engineering specific terminology and symbols that identify and describe all relevant aspects of an object.

PDF is an ideal format for drawings because it can accurately represent all the disparate data contained in a drawing. Drawings are typically created using a CAD system, such as AutoCAD, SolidWorks, Sketchup or others.

Sharing a drawing either requires the recipient to use the original CAD software or for the drawing to be converted to a format suitable for sharing.

Drawings can be shared as “dumb” raster images (a rectangular grid of colored pixels) or as “smart” vector graphics and text that can be measured and searched (see [Figure 5](#)).

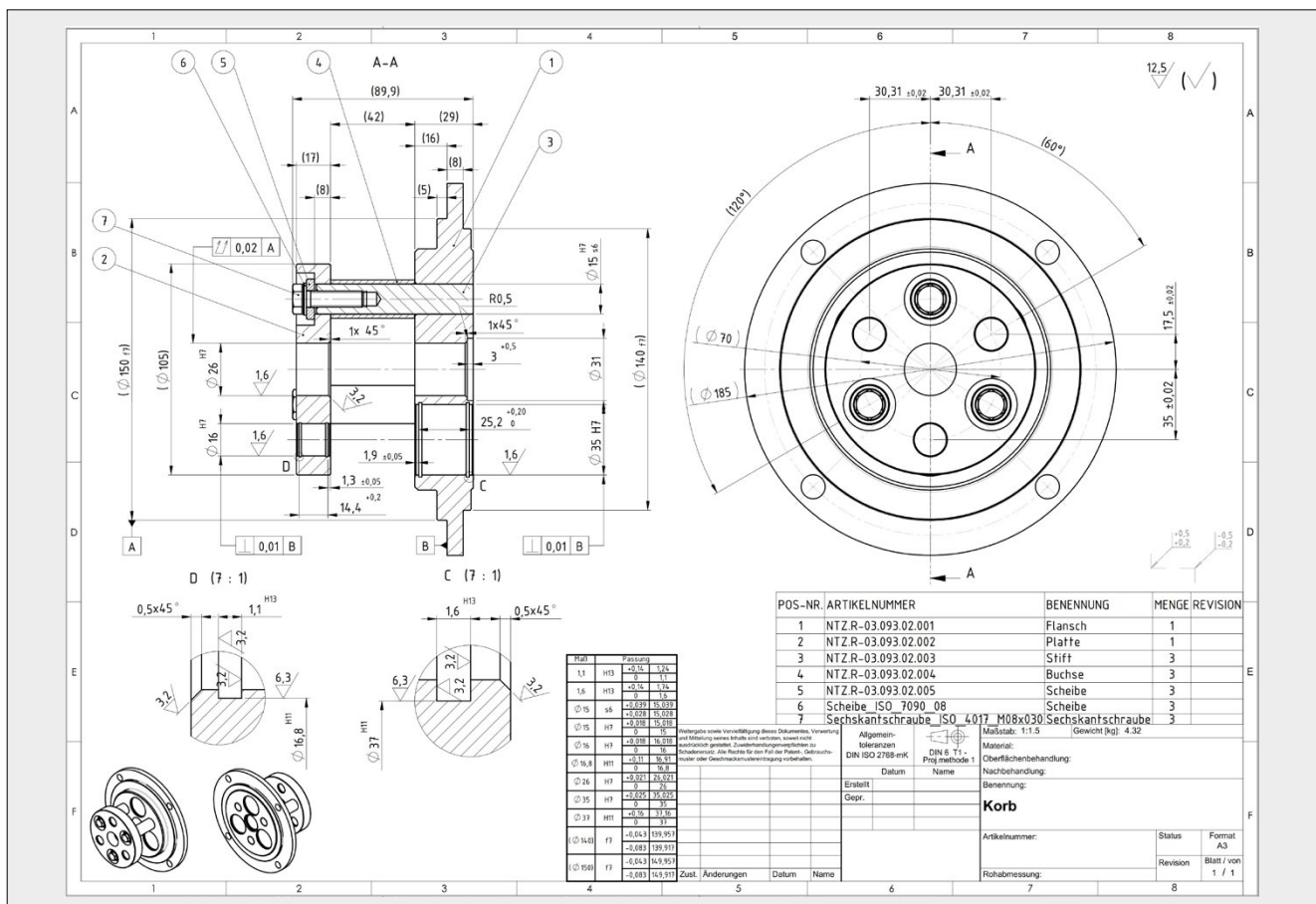


Figure 4: CAD drawing

Table 1: Software support for 2D and 3D PDF export

Company	Software	PDF Export	
		2D	3D
Anark	Anark Core MBEWeb	X	X
	Anark Core Server	X	X
	Anark Core Workstation	X	X
Aras	Aras Innovator Visual Collaboration	X	X
Autodesk	3ds Max	X	
	AutoCAD	X	
	Fusion 360	X	
	Inventor	X	X
	Maya	X	
	Revit	X	
Bentley Systems	Microstation	X	
Bricsys	BricsCAD	X	X
Dassault Systèmes	3D Experience	X	
	CATIA V5-6	X	
	SOLIDWORKS	X	X
Datakit	CrossCad/Plg	X	X
	CrossCad/Ware	X	X
	CrossManager	X	X
Elysium	ASFALIS		X
	DirectTranslator		X
	Data Package Studio		X
	CADvalidator		X
	PDQchecker		X
Graebert	Ares Commander	X	
ITI, a wipro company	CADIQ	X	X
	DEXcenter	X	X
Nemetscheck Group	Allplan	X	X
	Graphisoft	X	X
	Vectorworks	X	X
PROSTEP	PDF Generator 3D	X	X
PTC	Creo	X	X
	OnShape	X	
Siemens PLM	NX	X	
	Solid Edge	X	X
Tech Soft 3D	HOOPS Exchange	X	X
	HOOPS Publish	X	X
	Tetra4D Automate	X	X
	Tetra4D Converter	X	X
	Tetra4D Enrich	X	X
Theorem Solutions	Publish 3D	X	X
Trimble	Sketchup	X	

PDF can store drawings in either raster or vector format. Raster drawings are useful for sharing when data security is a concern because they contain no structure or geometry. Vector drawings are better suited for interactive viewing and markup; as they contain actual geometry and text so users can select

individual objects, measure curves and distances and perform searches within the drawing.

PDF includes additional features that make it easy to share CAD drawings in either raster or vector formats, or even combine them as needed.

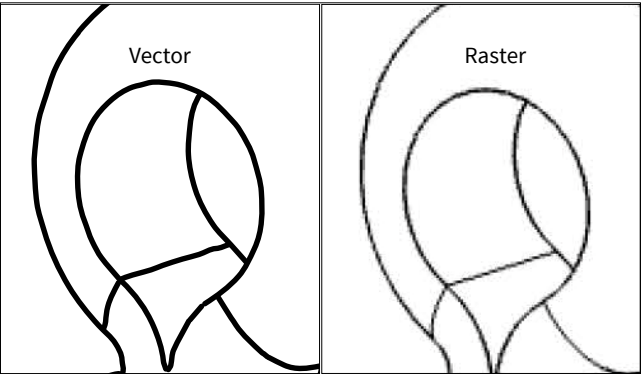


Figure 5: Vector vs raster image

Hyperlinks and bookmarks can be included for document navigation. Document access can be controlled using passwords, certificates or dynamically using digital rights management (DRM). Supporting documentation can be attached to a PDF file and the entire contents can be compressed. Individual elements of content that cannot be shared can be redacted. And when you need a paper copy, PDF files can be accurately printed as multiple-sheet drawings of varying sizes.

PDF and models

Manufactured products were originally designed and drafted using two-dimensional drawing tools. Products today are designed using three-dimensional, solid modeling applications. Engineers

use advanced 3D applications to create complex three-dimensional models that are accurate, complete and unambiguous. These models can be used directly by CAE (Computer-Aided Engineering) and CAM (Computer-Aided Manufacturing) software to precisely analyze and manufacture a finished part.

Support for complex 3D data was added to PDF 1.6 in 2004 and in the process opened a new way to think about leveraging 3D in engineering documents. In the PDF context, 3D models are referred to as *3D artwork* (ISO 32000:2, 13.6). PDF files containing 3D artwork are commonly known as *3D PDF* files (see Figures 6, 7, 8, 9 and 10). 3D PDF files are powerful documents that support the following features:

- 3D artwork is visualized or printed as part of a page
- 3D artwork can be interactive and programmatically manipulated using JavaScript
- 3D artwork can be displayed, or instantiated, in multiple places in a document
- 2D PDF content such as title block, revision block, list of materials, and other information that must be placed on a drawing sheet can be overlaid on 3D artwork

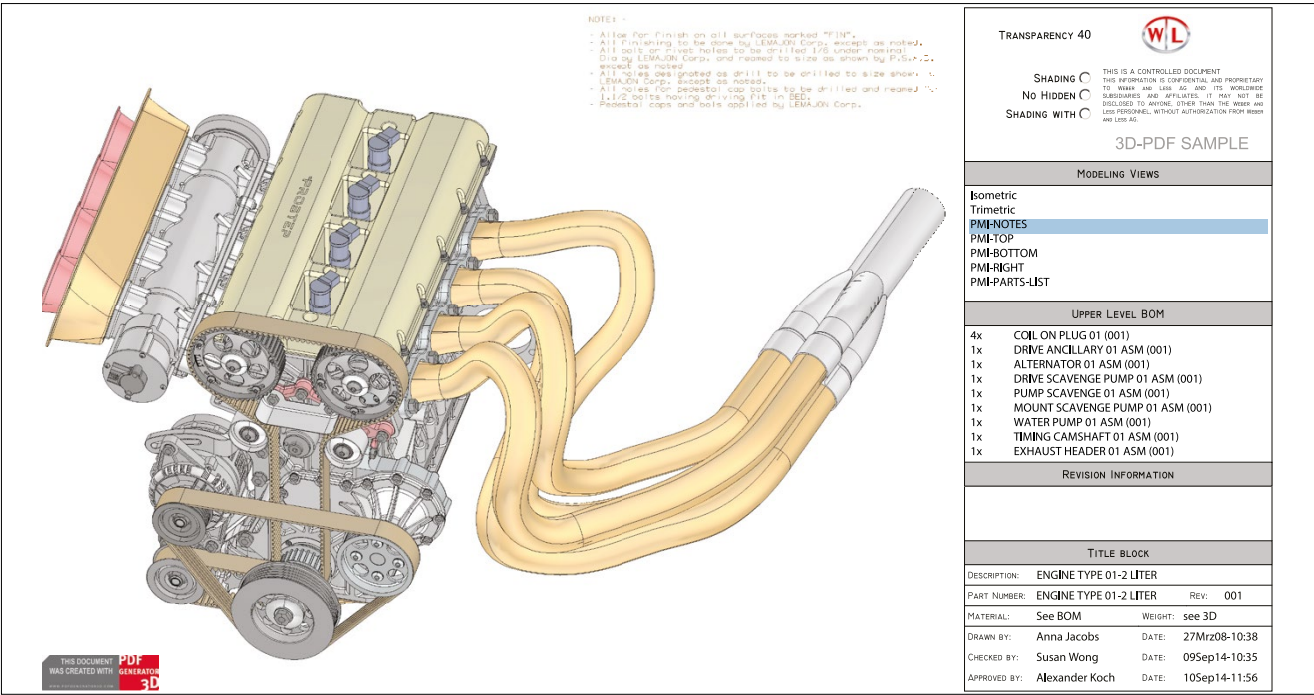


Figure 6: Paperless Process 3D PDF - courtesy of PROSTEP AG

PDF allows authors to combine dynamic, rich 3D artwork with metadata, text, images, video and forms in a 3D PDF document. Because they are PDF, 3D PDF files are compact, secure and easy to share. 3D PDF documents are completely interactive and can be annotated and measured. This powerful, easy to use format is transforming how we communicate engineering data today.

Most 3D CAD applications have some level of support for creating 3D PDF files. Additionally, there are a number of applications that can create 3D PDF files from the most popular 3D CAD formats without requiring an expensive CAD software license (see [Table 1](#) for a list of PDF support in popular applications).

PDF and product data

While product design has made the transition to 3D, manufacturing still relies on 2D drawings to define how a product is made. Even though modern machining systems can use a model's 3D geometric definition directly there are certain situations where technical drawings are still beneficial:

- When a design contains threads
- When specific tolerances and dimensions are necessary
- When surfaces require a specific finish

The process of creating a 2D drawing from a 3D model is commonly referred to as detailing. Detail drawings contain all the information required to manufacture the object represented in the drawing, including the dimensions, tolerances, surface finish specifications, material specifications required for the current stage of manufacturing. Engineers and machinists use these drawings as a visual means of defining a product and how it is manufactured and assembled. Many machinists continue to prefer to use a 2D drawing because:

- It is easy to identify the dimensions and critical features
- It is easy to see the machining operations needed to manufacture the part
- Technical drawings often define a legal contract

3D PDF is the perfect format for sharing 3D models and 2D drawings because models and drawings can easily be placed together in a single document that can be securely viewed, marked up and printed. All these features are supported in a single file that does not require anything other than a 3D capable PDF reader for sharing.

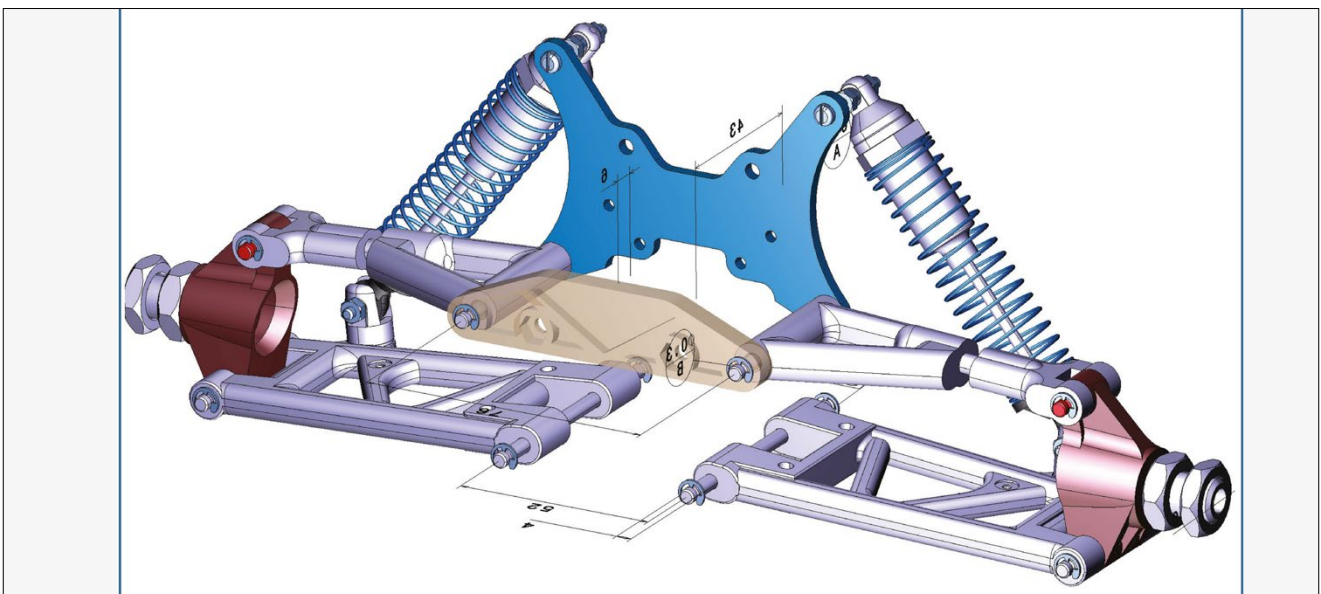


Figure 7: 3D PDF - courtesy of Theorem Solutions

Applications

Model Based Definition (MBD) / Drawingless manufacturing

With current advances in CAD capabilities, product definition data previously shown on a drawing sheet can now be defined and displayed with a 3D model using a combination of annotations and views. This allows the 3D model to remain as a master source for product definition data and eliminates the need for independent drawings. This approach is commonly referred to as model-based definition (MBD).

In the MBD world, the 3D model comprises the entire design and a lightweight 3D PDF exported from the CAD system serves the same role as a 2D drawing. Downstream users of the MBD data need the 3D data but often do not require or want the full capabilities of a CAD system. A lightweight 3D PDF model created from a 3D CAD model can support these uses while avoiding the cost and complexity of requiring a CAD system.

Processes such as fabrication, assembly and installation, quality inspection and in-service support and maintenance require data in the engineering model and the 3D PDF meets their needs. Some examples:

- A quality inspector will verify that a product conforms to requirements in the engineering design, and thus needs access to the 3D shape, tolerances, process notes or other data from the MBD model to perform the inspection. A 3D PDF created from a MBD CAD model provides this information affordably to the consumer on a wide variety of platforms.
- The author of a maintenance instruction needs to understand the engineering requirements for assembly when developing the maintenance procedure documentation. The 3D PDF provides this information with the added benefit that it is in a form that may be directly repurposed into the maintenance documents.

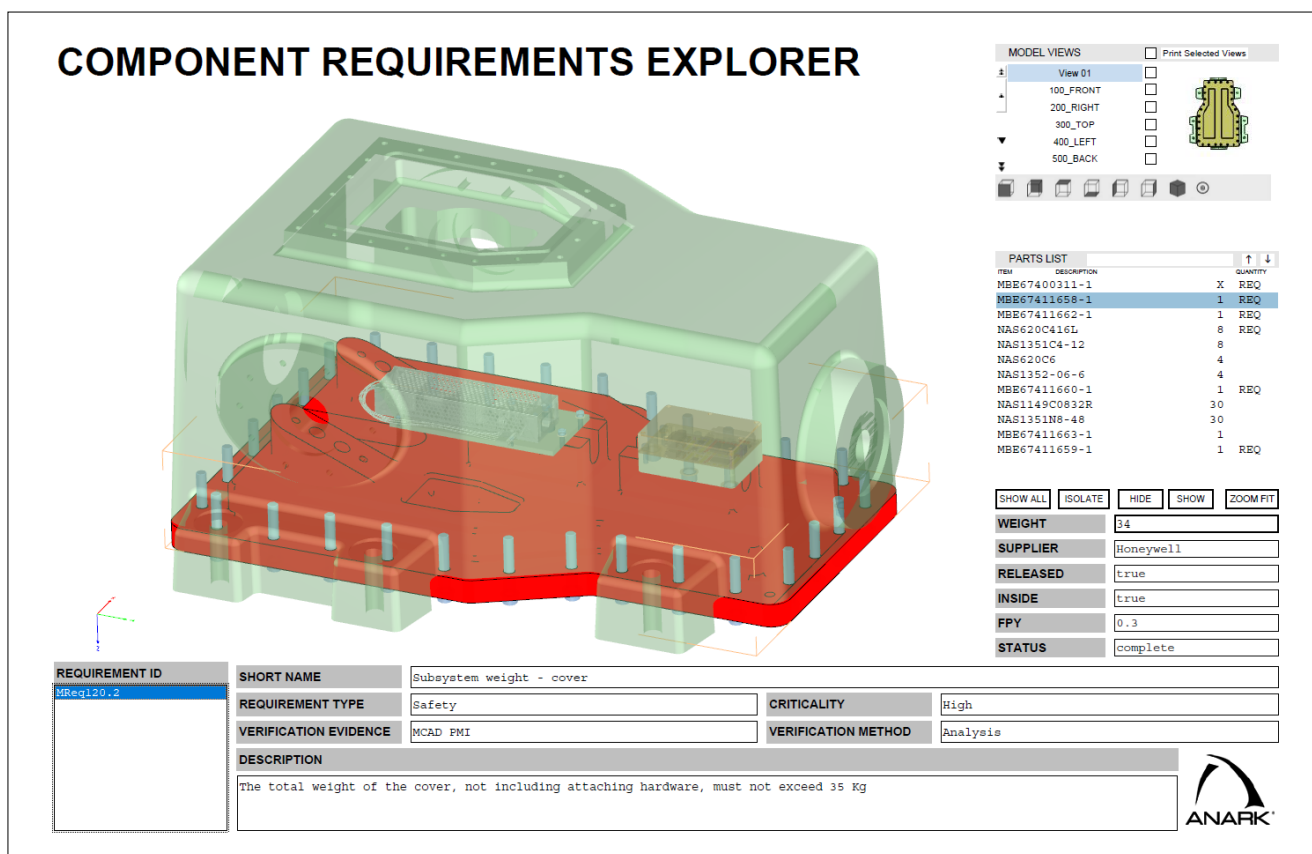


Figure 8: 3D PDF Technical Data Package courtesy of Anark

Using iText to create and archive ophthalmic reports

As specialists in ophthalmology, microsurgery and other medical growth sectors, ZEISS manufactures innovative products such as their range of ZEISS ophthalmology devices. These consist of products and solutions to enable efficient diagnosis and treatment of cataracts, glaucoma and other retinal disorders.

An important focus for ZEISS is the networking of systems and integrating data management to improve medical workflow efficiency. To enable this, ZEISS developed their FORUM family of software applications. FORUM is a scalable and flexible data management system that evaluates clinically relevant data from diagnostic devices and gives direct access to the full examination history of patients.

iText was chosen as the PDF generation engine for FORUM due to its strong PDF/A capabilities, a requirement for the DICOM (Digital Imaging and Communications in Medicine) standard which defines the formats for exchanging medical images.

Patient diagnosis reports must comply with the DICOM standard to allow them to be shared and archived on a long-term basis. ZEISS has integrated iText in FORUM since its initial development

in 2011, and it is a vital component of the application's functionality. FORUM integrates data from both DICOM compliant and non-compliant devices. When a patient undergoes an eye analysis such as a visual field examination or an angiography, iText is used to format and combine images and other data from the analysis into a PDF report.

iText can also combine data from multiple sources and create custom reports as required. The results can then be reviewed by medical professionals, and as reports are produced as PDF/A they can be archived as required by the DICOM regulations.

PDF/A compliance is a particular strength of iText, and it supports all current conformance levels of the PDF/A specification (PDF/A-1, PDF/A-2, and PDF/A-3).

ZEISS recently upgraded to iText 7, taking advantage of its enhanced features such as the improved document model and layout engine.

“We’re very happy with the PDF/A functionality provided by iText, and it forms an essential part of our DICOM-compliant reporting framework.”

Robert Hien, Lead Software Developer: ZEISS

About iText

iText is a leading technology company in the digital documents space. The company's flagship product is an open source software library to create and manipulate PDF documents in Java and .NET (C#).

There are currently millions of iText users, both open source and commercial. iText's customers (software developers, technology vendors, software integrators) span the fields of technology, financial, public, government and health care sectors including many of the Fortune 500 companies.

iText has dedicated international teams with offices in Belgium (Ghent), Singapore, South Korea (Seoul) and in the USA (Boston).



Get in touch!



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Compared to traditional drawing based workflows, MBD reduces time spent on documentation, quality/inspection and manufacturing. Because the complete product is defined in 3D, the digital definition always matches the visual definition, which is much harder to guarantee with drawings. Further, annotated 3D models are easier to orient and understand than drawing sheets, reducing the chance for engineering and manufacturing errors.

Supply Chain Management (SCM)

Industries today are more interconnected than ever via sophisticated global supply chains. Supply chain activities include activities from design and procurement to installation. Product information is the lifeblood that moves between the various stakeholders in a supply chain. This information sharing can often be a problem as supply chains are fragmented and data sharing typically involves information from disparate systems and disciplines. Easy flow of data both inside and between companies is critical to the success of product development and manufacturing. Data sharing often requires users to use the same software applications or convert their data to a format that can be understood by disparate apps.

CCS

Construction Computer Software (CCS) delivers innovative estimating solutions to improve productivity and visibility across construction projects. Their Business Challenge: CCS integrated an add-on to its flagship estimating package that would let users do quick estimates from drawings on screen. Initially, CCS went with an open-source document SDK. But customers uploaded bigger and more complex drawings that would crash the viewer or load slowly. Their Solution: In 2018, CCS solved issues with reliability and UX, and enhanced the competitiveness of its flagship software by upgrading to a commercial-grade PDF SDK.

PDFTron Systems, Inc. (pdftron.com)

Having information available as needed is critical for the supply chain. Information sources can be internal or external to an organization, saved in different formats and used on different hardware platforms. Putting that information in a single, purpose driven, viewable document has great benefits. The entire supply chain can ex-

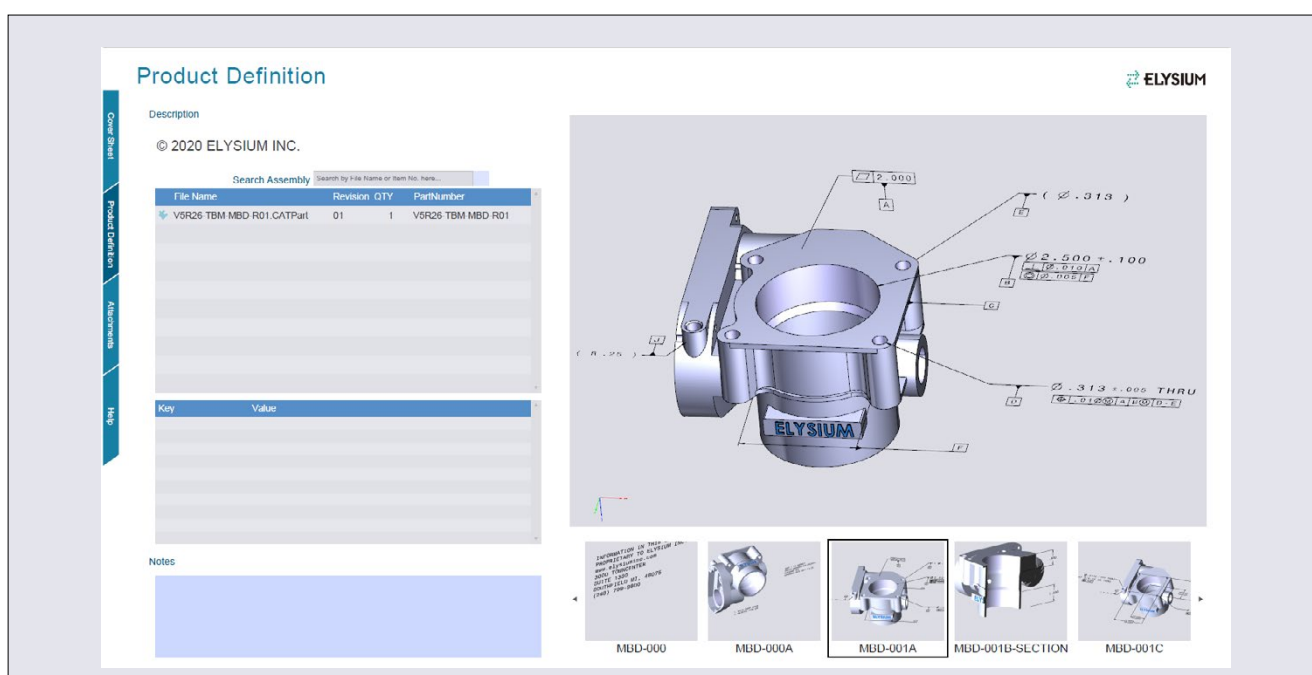


Figure 9: 3D PDF Product Definition – courtesy of Elysiium

change and re-use the same product data without loss, to increase their efficiency and productivity.

PDF's broad feature-set enables the format's support for rich, highly-structured data throughout the supply chain.

Viewing

PDF allows you to view the complex network of tables, images, documents, drawings and models needed to fully define a product.

Measurement and markup

PDF supports comments and vector markup of drawings and models. PDF viewers like Adobe Acrobat provide tools for measuring 2D drawings and 3D models. Comments, measurements and markups are saved as annotations that do not affect the underlying data. Named 3D views (which can include a specific model orientation, zoom level, lighting, rendering mode, etc.) allow users to see a model exactly the way it was viewed when an annotation was created.

PDFTRON

Case Study :

Fast & Reliable PDF Rendering for the AEC Software Industry

Construction Computer Software (CCS) delivers innovative estimating solutions empowering companies to increase productivity and visibility, and manage risk across Architecture, Engineering, and Construction (AEC) projects

CCS integrated an add-on to its flagship estimating software Candy QTO3 powered by the PDFTron SDK and that would let users do quick estimates of materials and labor from construction drawings on screen, a process known in the industry as quantity takeoff.

Initially, CCS went with an open-source document SDK. But due to rapid innovation in CAD and BIM software, customers started to upload bigger and more complex drawings that would crash the viewer or load very slowly due to application memory issues.

In 2018, CCS sought an upgrade that would solve issues with reliability and the UX. And after carefully evaluating PDF SDK vendors, it chose PDFTron SDK for its unsurpassed memory efficiency and reliability, accurate rendering, and full-featured cross-platform offerings.

“

If you're looking for a PDF reader for the first time, you better make sure it can read 100% of your PDF files. Because if your clientbase starts relying on that PDF reader, exactly what happened to us, they still want the absolute best quality. With PDFTron, I absolutely feel we're in a better position to handle all our present and future PDF requirements.

”

Tony Cornwall

CCS Product & Development Manager

Business Challenges

Industry evolving towards bigger and more complex drawings
Slow performance and crashes causing user dissatisfaction

Business Outcomes

Improved load times and eliminated crashes
Increased competitiveness of CCS's flagship estimating package

Learn more about how we solve customer challenges by visiting

pdftron.com/customers



Associated files

Any necessary data file can be attached to a PDF file, making a complete Technical Data Package (TDP). This enables a PDF file to contain all the data needed for the recipient to perform a process or procedure.

Metadata

Product information data can be easily added as metadata to a PDF file. The metadata can be visualized, saved to an XML file, or processed by an application. Including metadata in PDF files can enable substantial automation in workflows.

Signing and security

Design and manufacturing data are intellectual property and should always be protected. PDF has several security features including access control, digital signatures, password protection and encryption.

Architectural Design Review

The construction industry is achieving digitalization through a process known as Building Information Modeling (BIM). The BIM process is centered around a 3D model of the structure, including all the supporting information necessary to support a facility throughout its lifecycle. This is similar to the move to MBD in the manufacturing industry.

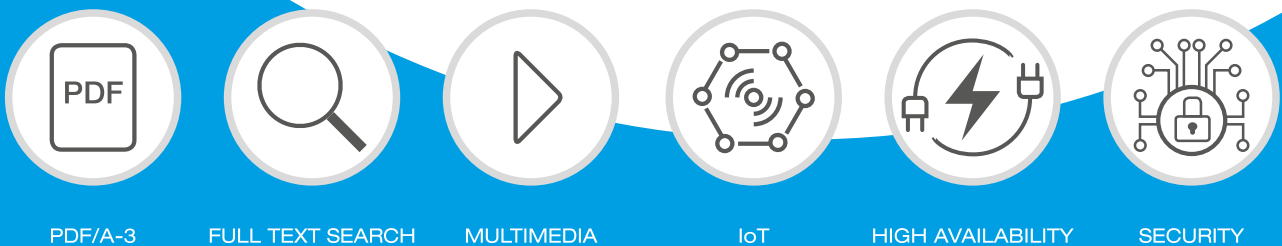
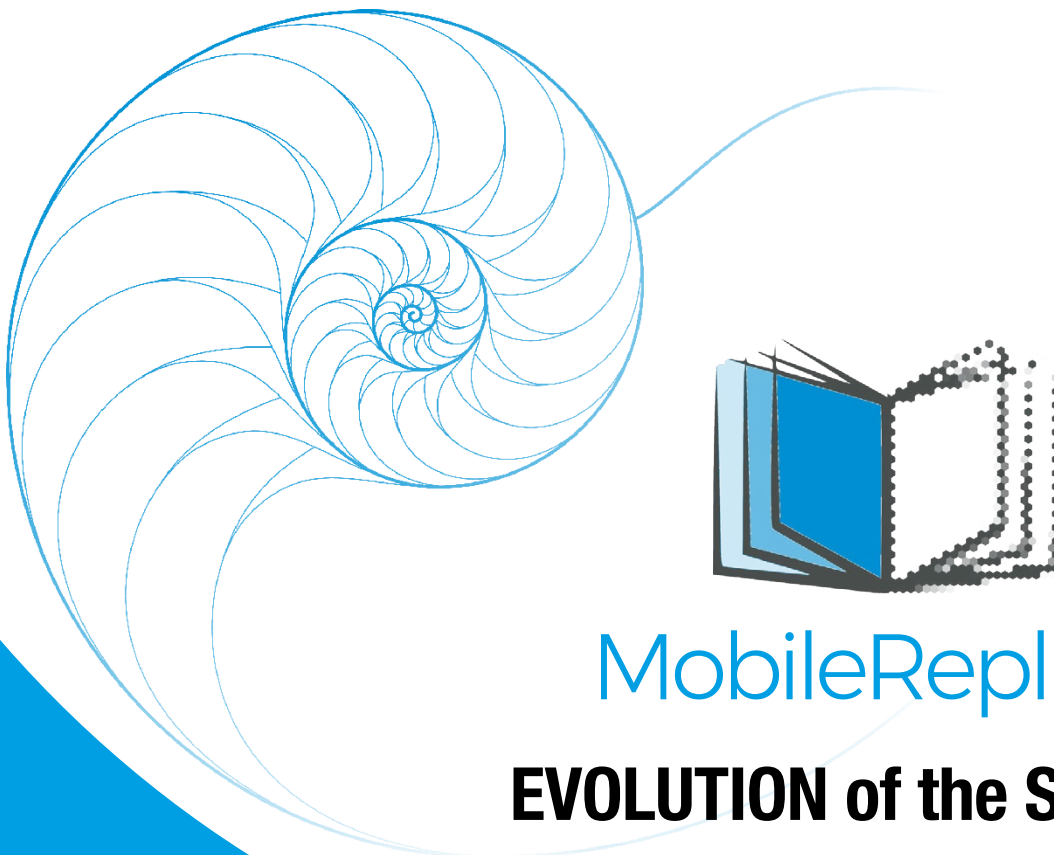
Modern facilities are designed and documented using BIM. All the facility definition data is captured in BIM. Because BIM is built around a 3D model, facilities can be visualized and analyzed at each stage of their lifecycle, from planning to design to building to operating.

All architecture projects involve multiple stakeholders from different organizations. PDF provides a common, interoperable format that works well with all the various data sources and processes.

PDF files can contain complex architectural, engineering and construction (AEC) component models and drawings that can be viewed and understood by all stakeholders, including those that may not have AEC backgrounds. PDF's ability to contain diverse data types enables it to capture the architectural, structural and mechanical, electrical and plumbing (MEP) features that are required to define a facility throughout its lifecycle.

Once project data is stored in a PDF file, it can be electronically distributed, viewed and anno-

tated, or marked up, without changing the original model or drawing data. Because PDF saves camera information with annotations, anyone reviewing product manufacturing information from the authoritative MBD CAD model sees the same scene as the creator of the annotation. This capability provides a powerful collaboration tool for use in all phases of building construction. Accordingly, PDF technology can be used for documenting design changes, spatial planning, approval/sign off and recording of as-built structures.



The documents you need, anywhere and anytime.

Key industry segments

Architecture, Engineering and Construction (AEC)

The AEC industry tackles some of the most complex and difficult engineering and construction problems in the world. Such as skyscrapers, nuclear plants and harbors can be exceptionally large and complex. There are many stages in the lifecycle of a building project, from plan, to design, build, operate and finally deconstruction. There are typically one or more owner/operators and many different companies/contractors working on a project. With so many moving parts, efficient and accurate communication is critical.

PDF is a common and accepted format in AEC. Drawings are most commonly saved in the PDF format and these PDF files are then used in every stage of the design and construction process. Because PDF is portable, it can be used at the office, factory or jobsite, even in remote locations that don't have internet access. PDF files can be used by anyone, without requiring expensive CAD software and training.

The worldwide AEC industry is moving to BIM as a way to capture intelligent 3D design and build it in smarter, more efficient ways. Using 3D models means that accurate information is available at each stage of the building process. Accurate information saves time, effort and materials. Efficiencies achieved using BIM provide the means to keep up with an increasingly demanding world.

3D PDF is a great format for BIM. It can be used to collect drawings, 3D models and other documents into a portable, viewable file format. PDF is easily shared and marked up, making it ideal for many different construction workflows such as design and submittal reviews, requests for information (RFI), quality control (QC) and design handover.

Aerospace

The aerospace industry is one of the largest and most demanding industries in the world today. Planes, helicopters, rockets, etc. have thousands of parts that need to be managed in a highly regulated environment. Manufacturing of all these parts requires one of the world's largest supply chains. For this supply chain to be efficient, data has to be safe, reliable and easy to use. This is an area where 3D PDF can be a real solution today.

The aerospace industry is always looking for ways to reduce costs and improve efficiency. As a result, they have been one of the early industry adopters of MBD. Today, most aerospace companies design their parts using 3D MBD. When it comes time to release those parts to the supply chain, the most efficient way is to release those parts in a format that can be used to store and view 3D data (solid mod-

Landing gear kinematics

Collins Aerospace Landing Systems need to present Landing Gear Design Concepts to colleagues and customers. The concepts are modeled as CATIA PLM kinematic mechanisms to prove the geometry and calculate loads during motion. Previously the designs were exported as large movie files and had limited use.

Solution: Design engineers now prefer 3D PDF for sequence animations of moving mechanisms or fly-throughs. The compact PRC file size where a model can be rotated, certain parts isolated in the mechanism, while playing its range of motion has been a game changer. Adding measurements on animation frames easily shows data tied to the mechanism's movement.

[PDF3D \(pdf3d.com\)](http://pdf3d.com)

els, PMI, views, etc.) as well as all of the business/product data associated with a part. PDF is one of the few formats that can do all of that.

PDF is also commonly used in aerospace for work instructions and service support documents. These types of documents often include:

- Task instructions and sequences
- Dimensions, tolerances, surface finish
- Notes
- Specifications
- Photos
- Drawings
- Models
- Video / Audio / Animation
- Weld symbols

3D PDF libraries

3D PDF is increasingly being used to share CAD design information among top manufacturing companies around the globe. Software developers like [Anark](#) and [Theorem](#) help users leverage the power of 3D PDF to share data rich, 3D annotated models (MBD) via technical data packages (TDPs). There are a variety of tools to help software developers create 3D PDF documents. How can companies like Anark and Theorem be guaranteed that their PDF files are 100% compatible with Adobe Reader?

Solution: Tech Soft 3D is the exclusive provider of the 3D PDF Libraries developed by Adobe.

Tech Soft 3D (techsoft3d.com)

[illegible]

Again, PDF can contain all of this information in a secure, easily shared document.

Some of the new work being done in PDF standards will also benefit the aerospace industry. For example, the upcoming PDF/A-4 standard will include a conformance class that allows 3D data in a PDF/A-4 file. A forthcoming Technical Specification under development that will add STEP AP 242 (ISO 10303-242) as an approved format for 3D data in a PDF file. This will enable MBD data to be archived in a viewable, self-contained and self-described digital container.

Defense

The largest purchasers of aerospace products are the defense departments of the world's governments. In the U.S.A., the Department of Defense (DoD) manages the acquisition and manufacturing of millions of military items. Efficient

management of the DoD supply chain is critical for supporting armed forces while helping to ensure that the DoD spends taxpayer money effectively.

The DoD developed the MIL-STD-31000B standard to help standardize the distribution of manufacturing data, including requirements for a technical data package (TDP). A TDP is defined as “the authoritative technical description of an item. This technical description supports the acquisition, production, inspection, engineering, and logistics support of the item.

The TDP defines the required design configuration and/or performance requirements, and procedures required to ensure adequacy of item performance. It consists of applicable technical data such as models, engineering design data, associated lists, specifications, standards, performance requirements, quality assurance provisions, software documentation and packaging details.

Technical Data Packages can either include drawings (2D), models (3D) or both. The most recent version of the standard, MIL-STD-31000B, is oriented towards using model based definition and is even published as a 3D PDF file. TDP files that conform with the standard can include, but are not limited to:

- Models
- Drawings
- Associated Lists
- Specifications
- Associated Standards
- Quality Assurance Provisions
- Software Documentation
- Packaging Details

MIL-STD-31000B is used by the US Defense Logistics Agency (DLA) to specify TDPs used in the management of the global supply chain for the US

Spare parts catalogs

Finding the right spare or wear parts in a maintenance manual is time-consuming and prone to errors. Digital spare parts provisioning makes maintenance technicians' work easier and provides companies with an incentive for ordering spare parts directly from the manufacturer of their machines or systems.

The 3D PDF solution from PROSTEP makes it possible for manufacturers to automatically create electronic spare parts catalogs that contain all the information relevant to service regardless of the system in which this information is stored. The solution also allows their customers to place their orders for parts from directly within the catalog.

PROSTEP AG (3dpdf.com)

Army, Marine Corps, Navy, Air Force, Space Force and Coast Guard. The DLA sends MIL-STD-31000B TDPs to suppliers when they contract to acquire parts. Using 3D PDF files provides the DLA and their suppliers the ability to easily view their design and manufacturing information, including PMI. Attaching a fully validated STEP file to the fully-validated 3D PDF file provides a full digital and visual product definition that can be used to create machine code for automated manufacturing. Using PDF for procurement has allowed both the DLA and their suppliers to access, review and share 3D technical data without the need for large investments in CAD software and associated training programs.

Manufacturing

Manufacturing is in the midst of a digital transformation commonly referred to as “Industry 4.0”, representing the fourth revolution in manufactur-

ing. The first industrial revolution started in 1760 with the introduction of mechanization through water and steam power. The second industrial revolution in the late 1800’s used electricity to create mass production and assembly lines. The third industrial revolution saw the digitalization of manufacturing in the late 20th century. In 2020 we stand at the beginning of the fourth industrial revolution where manufacturing is evolving to smart and autonomous systems driven by data and machine learning.

Industry 4.0 combines digital and physical technologies such as additive manufacturing, robotics and artificial intelligence to create intelligent automated systems. Products are digitally modeled in 3D and reused in each step of the manufacturing process. The model is modified along the way to always accurately represent the state of the physical product. Machines can evalu-

NAVAIR

Case: U.S. Department of Defense Program Offices such as Naval Air Systems Command (NAVAIR) H-53 Heavy Lift Helicopters are transitioning to Model Based Enterprise (MBE) processes which requires modern approaches to receiving, generating and validating Technical Data Packages (TDPs). These standards-based 3D TDPs are less expensive to manage and more effective than traditional 2D drawings or proprietary formats. Additionally, the Defense Logistics Agency that manages program data for future provisioning and sustainment needs requires standard formats to ensure long term accessibility.

Solution: Anark Corporation was a key participant in a Naval Shipbuilding Advanced Manufacturing Center project to develop an automated system for the creation and validation of TDPs. These ISO standard 3D PDFs adhere to MIL-STD-31000B, and provide detailed engineering and manufacturing information for effective model-based collaboration.

Significant cost savings were attributed to diminished reverse engineering and rework as well as consistent TDP creation resulting in fewer errors and improved requirements communications. This Anark Core-enabled approach is being applied to other DoD programs in addition to non-defense clients with similar benefits.

Anark Corporation (anark.com)

ate the digital model in order to make more informed decisions during each stage of the manufacturing process to produce higher quality and better performing end products.

The digital transformation of manufacturing does not happen by just implementing new technologies and letting them run. Real digital transformation touches many parts of an organization, including strategy, talent and processes. It provides the capability to have the right information available to the right people at the right time. PDF is the perfect format for delivering that critical information. PDF can collect data from multiple, disparate 2D and 3D sources and assemble that data into a document that can be used by both humans and machines. PDF files designed for custom manufacturing systems can still be easily shared and viewed using ubiquitous, free software anywhere it is needed: land, sea, sky or space.

Aerospace assurance

Modifications to aircraft parts require a rigid design, manufacturing and quality assurance process. Every process step leads to a dedicated approval process which is still often paper-based, with stamps or wet ink signatures. Such approval processes can involve multiple signees at various sites. Additionally, the quality of the signature needs to comply with regulatory requirements specifying a high degree of assurance.

Solution: With Sign Live! Cloud suite, **Intarsys** gears a component based solution for pure web-based signing with the highest assurance level (qualified electronic signature) available for workstations (Windows, Linux or macOS) or mobile devices (iOS, Android). The unique feature of this cloud signature solution is that the typically highly confidential documents to be signed never leave the company's private cloud infrastructure.

[Intarsys \(intarsys.de\)](http://Intarsys(intarsys.de))

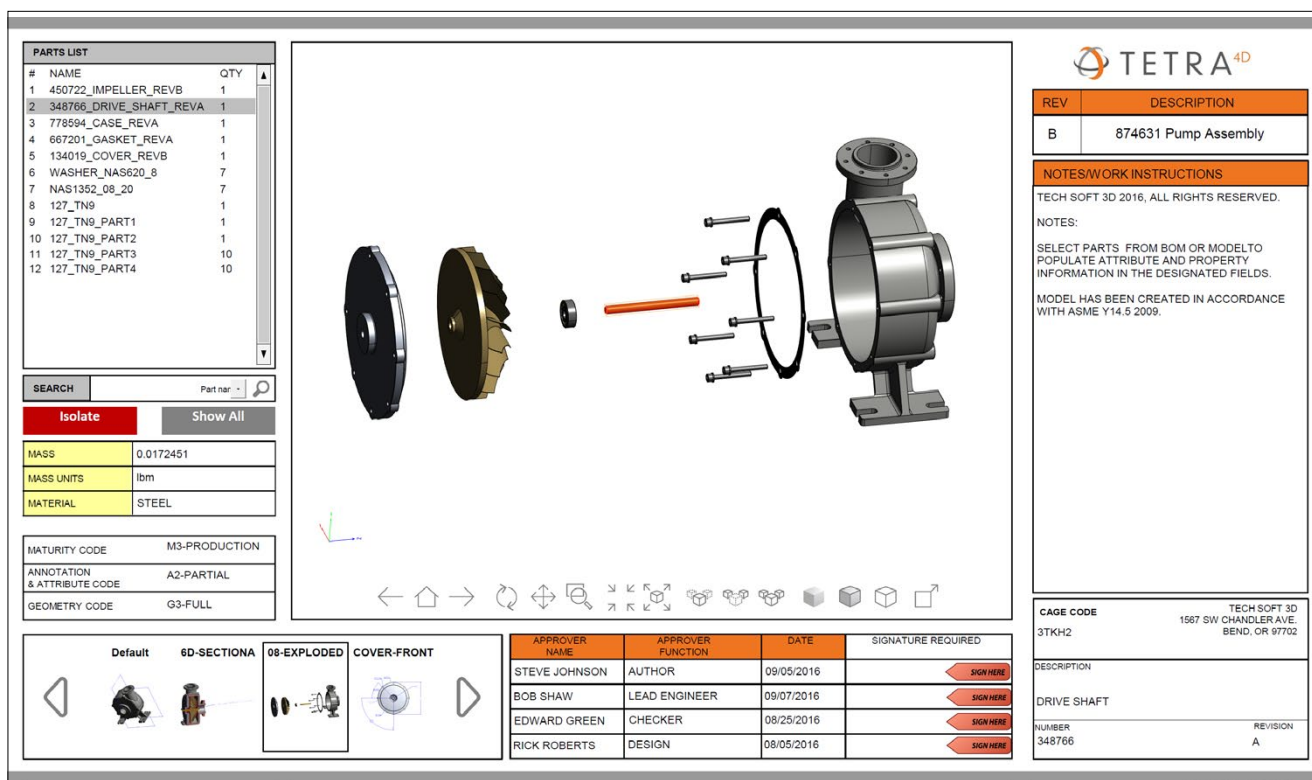


Figure 10: 3D PDF Technical Data Package - courtesy of Tetra4D

PDF features, a glossary

PDF includes a vast array of features, many of which we take for granted: reliable printing, text-extraction and other “everyday” PDF capabilities. However, PDF also includes specific capabilities of interest to the manufacturing community. This glossary provides a brief introduction and reference for technical investigation.

Print scaling control

Defined in: ISO 32000-2, 12.2 “Viewer preferences”

When added to PDF: PDF 1.6 (2004)

Description: The PrintScaling feature allows an author to ensure that a drawing or document will print at full size.

PDF delivers pixel-accuracy irrespective of operating system or application, and even makes possible

1:1 scale drawings of large structures such as aircraft and buildings.

Suitability: Not all PDF processors support the PrintScaling feature, but mainstream desktop software does.

Applications

- Physical systems documentation
- Reprographics

3D PDF support

Defined in: ISO 32000-2, 13.6 “3D Artwork”

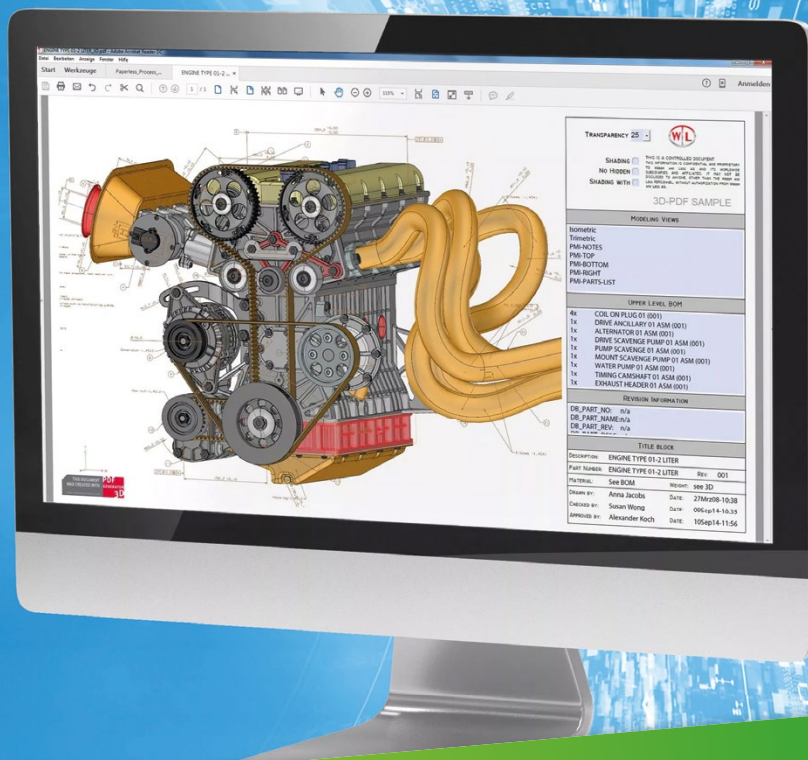
When added to PDF: PDF 1.6 (2004)

Description: In the PDF context, 3D models as used by CAD software are referred to as “3D artwork”. PDF’s support for 3D artwork includes the following features:

PROSTEP
integrate the future

3D PDF

PRODUCT INFORMATION WITH ADDED VALUE



For more information visit www.3dpdf.com or scan the QR-Code

www.prostep.com

Follow us on social media.



- 3D artwork renders within a page; that is, not as a separate window or user interface element.
- Views of 3D artwork may be specified, including a default for initial display, and other selectable views may be presented in and printed from a user interface.
- Authors of 3D artwork can specify rendering, coloring lighting and cross-sectioning as well as apply states to individual elements in the 3D artwork, such as visibility, opacity, position, or orientation.
- If the viewer includes 3D PDF JavaScript support, users can manipulate objects in the artwork, creating dynamic presentations in which objects pan, zoom, rotate, appear, and disappear, allowing users to examine complex objects from any angle, orientation or context, including keyframe animations played in specific styles and timescales.
- Conventional (2D) PDF markup annotations may be applied to specific views of the 3D artwork.

3D maintenance manuals

Breton is a leading supplier of stone processing systems at a global level. Their machines are accompanied by thousands of multilingual use and maintenance manuals, whose production and distribution is a long, challenging process.

Solution: Breton was looking for an all-digital process compliant with regulatory requisites governing the safety and usability of contents, and chose the ECM **MobileReplica®** for the DocMobile suite installed in all the systems. All the manuals are filed as PDF/A-3, ensuring they can be opened and printed over time, and can include additional content such as 3D geometries, multimedia files and metadata. The ECM uses semantic analysis and deep learning to create powerful search indexes, offering users quick access to contents from consoles, tablets and PDAs.

GEAR.it s.r.l. (gear.it/mr)

Suitability: At the time of this writing complete 3D PDF viewing including JavaScript is primarily supported in Adobe's PDF Reader for Windows and Mac.

Applications

- Design and development
- Communications with subcontractors and suppliers
- Product, tooling and facility design

Annotations

Defined in: ISO 32000-2, 12.5 "Annotations"

First added to PDF: PDF 1.0 (1993)

Description: The annotation mechanism associates an object such as a note, link, a comment or a 3D object or movie, with a location on a PDF page. Annotations generally provide a means of interaction, e.g., text-entry, clicking a button or highlighting text.

When first introduced in 1993, only two annotation types – text and link – were supported. PDF 2.0, published in 2017, defined 28 distinct types of annotations including 3D, RichMedia and Polygon, many with direct applications in manufacturing.

Many of the standard annotation types may be displayed in an open or closed state. When closed, they appear on the page: an icon, a box, or a rubber stamp, depending on annotation type. When the user interacts with the annotation it exhibits its associated object, such as by opening a small popup window displaying a text note, or by activating 3D controls, or by allowing the user to add a reply to an existing note.

Suitability: PDF annotations are well-supported most PDF viewers, even if creation or editing tools aren't provided. It's often possible to add basic annotations using free viewers.

Applications

- 3D content and rich media content (audio / video)
- Text, drawing and redaction markup
- Collaboration and interchange

Associated files

Defined in: ISO 32000-2, 14.13

When added to PDF: PDF 2.0 (2017)

Description: The associated files mechanism is a means of a) associating content in other formats with objects in a PDF document, and b) identifying the relationship between the PDF document and the associated objects. A wide variety of PDF objects may be associated, including the PDF file itself, or specific pages, graphics objects, structure elements (tags) or annotations, including 3D annotations.

Suitability: PDF 2.0 or PDF/A-3 software is required to fully leverage the associated files mechanism.

Applications

- Drive workflow processes
- Facilitate indexing, search, data mining, extraction and archiving
- Facilitate content reuse

Digital Signatures

Defined in: ISO 32000-2, 12.8 “Digital signatures”

When added to PDF: PDF 1.3 (2000)

Description: Digital signatures are useful in verifying a document’s integrity by leveraging verification information generated by a signer. The signature may be mathematical or biometric in nature, including a handwritten signature, fingerprint, or retinal scan. The method of authentication is implemented by a signature handler.

Digital signature support in PDF enables several types of activities:

- adding one or more digital signatures to a document
- verifying the validity of a previously-signed document
- Tamper-proofing



Digital Signature and PDF Sign Live! cloud suite gears



- ✱ ETSI and eIDAS compliant electronic signing of PDF and PDF/A documents (CAAdES, XAdES, PAdES and DTS)
- ✱ Longterm validation profile (LTV, Evidence Records)
- ✱ Pure web-based solution (zero installation)
- ✱ Support for smartcards, HSMs and remote signature services
- ✱ Support of Cloud Signature Consortium API

- ✱ Highly scalable architecture
- ✱ Documents to be signed never leave your company realm
- ✱ Powerful Web service API for easy integration with business applications

www.intarsys.de

Founding member of Cloud Signature Consortium



Suitability: Digital signatures are supported on several mainstream desktop applications.

Applications

- Sign-offs
- Authoritative logging transmission or receipt of documents, drawings, etc.
- Records management

Encryption

Defined in: ISO 32000-2, 7.6 “Encryption”

When added to PDF: PDF 1.1 (1994)

Description: A PDF document can be encrypted to protect its contents from unauthorised access. The PDF specification provides a number of options for the encryption handler to cover a range of backwards-compatibility scenarios and other options. Encryption can be managed via passwords or certificates.

Suitability: Most PDF processors support PDF encryption with at least older key specifications such as AES 128-bit. PDF 2.0 processors support AES 256 bit encryption.

Applications

- Distribution of sensitive content
- Distribution of secured content within an “unencrypted wrapper”

Embedded files

Defined in: PDF 2.0, 7.11.4 “Embedded file streams”

When added to PDF: PDF 1.3 (2000)

Description: This feature allows arbitrary files to be embedded directly within the body of the PDF file, turning the PDF file into a self-contained unit that can be stored or shared as a single entity.

Suitability: Although inappropriate for delivery of executable content, embedding files of various types in “container” PDF documents is a common modality for retaining 3D and other content (Excel spreadsheets, movies, subassembly documentation, etc.) within a single PDF for use in a wide variety of manufacturing workflows.

Digital signatures

The Smart Certificate 2.0 platform developed by CVTrust utilizes iText’s advanced PDF technology to integrate blockchain-verified digital signatures into documents. It enables their users to check documents in a click or via QR codes to verify the information is certified and can be trusted.

Solution: Offering a safe and secure way to authenticate documents, digital signatures can be essential for manufacturing contracts, invoices, NDAs etc. iText 7 enables mass generation of PDF documents and handles the addition and appearance of digital signatures inside the PDF. With PDFs digitally signed with iText, it’s a cinch to share certified and trusted documents with the people that need them, wherever they might be.

iText Group (itextpdf.com)

Applications

- Supplemental (including source file) delivery
- Machine-readable delivery
- Case files (collations of arbitrary content)

Forms

Defined in: ISO 32000-2, 12.7 “Forms”

When added to PDF: PDF 1.2 (1996)

Description: In PDF, an interactive form is a collection of fields and controls across one or more pages that allow for gathering information from users and importing or exporting data from the document. PDF forms are often augmented with JavaScript to validate user data, perform calculations, show or hide individual fields or buttons, and more.

Suitability: Although PDF forms themselves are generally supported in most desktop and server applications, support for PDF’s JavaScript capabilities is less widespread.

Applications

- Collecting inputs from end users
- Transacting data with remote servers
- Interactive visual effects on PDF pages

ISO-standardized PDF

As of 2020 ISO standards for PDF technology include:

Table 2: PDF Standards

Standard	Common name
ISO 32000	“the PDF specification”
ISO 19005	PDF/A “archival”
ISO 14289	PDF/UA “universally accessible”
ISO 15930	PDF/X “exchange” for prepress
ISO 16612	PDF/VT “variable and transactional”
ISO 24517	PDF/E “engineering”
ISO 23504	PDF/R “raster”

Description: After 14 years of development

as a proprietary format, Adobe turned the “PDF Reference 1.7” over to ISO in 2007. This document, adapted to meet ISO’s requirements, became ISO 32000-1 in 2008.

The process was smoothed by the fact that ISO standardization for PDF-based technology began almost 10 years earlier with PDF/X and then PDF/A.

Why do ISO standards matter?

An open, democratically-managed standard eliminates vendor control and lock-in, ensuring an equal playing-field and a healthy ecosystem of developers providing support to end users. ISO standardized technology is completely open and royalty-free; anyone can use the specification to develop PDF software.



The Experts for the automatic conversion of Files and Documents

Integration in SAP

Archive Formats

CAD into 3D PDF

Application Formats

Standardized Formats

Digital Signature

Security

Authenticity

Release Processes

Conversion Server for all Conversions

Contact us!
Our experts will be happy to advise you!

Dr. Uwe Wächter
uwe.waechter@sealsystems.de
+49 (0) 6154-637 372

www.sealsystems.de

f t y in x

JavaScript

Defined in: ISO 32000-2, 12.6.4.17 “ECMAScript Actions”

First added to PDF: PDF 1.3 (1998)

Description: JavaScript actions provides a wide range of programmable interactive features in the PDF context, including the ability to execute commands to change the PDF file’s contents, fill, process and submit forms data, and manipulate 3D models.

Suitability: The vast majority of PDF documents and drawings do not require JavaScript, but many interactive PDF forms and 100% of 3D PDF documents require not only JavaScript support, but support specifically for 3D PDF JavaScript.

Although a key technology for websites and applications in every sector, using JavaScript always requires attention to security; JavaScript in PDF is no exception. Most PDF viewers, if they support PDF JavaScript, ensure that questionable actions, such as external calls or attempts to access local files, should be approved by the end user.

Applications

- Manipulation and interchange of 3D models
- Operating interactive content (buttons, annotations and form controls)
- Executing business logic (e.g., show or hide an area of a form)
- Calculation and input validation

Optional content

Defined in: ISO 32000-2, 8.11 “Optional content”

When added to PDF: PDF 1.5 (2003)

Description: Authors can configure optional content groups (OCGs) to label and control the visibility of sections of content in a PDF document.

Suitability: The optional content feature is often identified as “layers” in the desktop applications that support this feature.

Applications

- CAD drawings (e.g., to separate structure, plumbing, electrical and other systems)
- Layered artwork
- Maps
- Multilingual content

Outlines

Defined in: ISO 32000-2, 12.3.3 “Document outline”

When added to PDF: PDF 1.0 (1993)

Description: Outlines allow the user to navigate interactively around the document as well as perform other actions. A hierarchy of outline items (commonly known as “bookmarks”) serve as a visual table of contents representing the document’s structure.

The user may interact with individual items to display or hide its immediate children in the hierarchy, or activate the item, causing the viewer to display the destination or trigger the action.

Suitability: Although outlines are well-supported on the desktop and mobile devices many web browsers continue to ignore this feature.

Applications

- Intra-document navigation
- Launching actions (show/hide annotations, launch URL, etc.)

PDF/A (archive)

Defined in: The ISO 19005 family of specifications

When published:

- ISO 19005-1, 2005
- ISO 19005-2, 2011
- ISO 19005-3, 2012
- ISO 19005-4, 2020 / 2021

Description: Archives of PDF documents must remain useable across multiple generations of technology. The inclusive, feature-rich nature of PDF implies that some constraints are necessary to ensure suitability for long-term preservation. Future use depends upon maintaining their visual appearance as

well as their higher-order properties, such as the logical organization of pages, sections, and paragraphs, a machine recoverable text stream in natural reading order, and a variety of administrative, preservation and descriptive metadata.

PDF/A defines constraints on PDF required to meet these objectives. The various parts of PDF/A provide distinctive functionality:

Table 3: PDF archival standards

Standard	Purpose
PDF/A-1	primarily intended for scanned documents, based on PDF 1.4
PDF/A-2	supports transparency effects, based on ISO 32000-1
PDF/A-3	adds the ability to embed arbitrary files
PDF/A-4	based on PDF 2.0 (ISO 32000-2), includes support for 3D content and JavaScript

Suitability: PDF/A-1, -2 or -3 are great choices for long-term preservation of 2D content. PDF/A-4 is ideal for engineering and manufacturing applications requiring an archival format.

Applications

- Highest degree of reliability
- Long-term preservation

PDF/E (engineering)

Defined in: ISO 24517-1

When published: 2008

Description: PDF/E is a subset of PDF based on Adobe's PDF 1.6, and is designed to be an open exchange format for engineering and technical documentation. It defines core features of a format for the creation of documents used in geospatial, construction and manufacturing workflows. The specification also supports interactive media, including animation and 3D.

Suitability: PDF/E-1's uptake was limited; the specification is made obsolete by PDF/A-4.

Applications

- Distribution of technical documents

PDF/UA

Defined in: ISO 14289-1

When published: 2014

Description: PDF/UA is a subset of ISO 32000 defining how to represent PDF documents in a manner that allows the file to be accessible to users with abilities. PDF/UA leverages tagged PDF (see below).

Suitability: PDF/UA is supported by a range of PDF creation and accessibility remediation software.

Applications

- Document accessibility and reuse

PDF/X

Defined in: The ISO 15030 family of specifications

When published: 2001 (PDF/X-1a) – 2008 (PDF/X-5)

Description: The oldest ISO-standardized PDF subset. PDF/X facilitates the exchange of graphics, including various requirements specific to high-end printing environments common to manufactured products.

The latest version, PDF/X-6, is due to be published in 2020 or early 2021.

Suitability: PDF/X is supported in the printing industry worldwide.

Applications

- High end printing applications

Product Representation Compact (PRC)

Defined in: ISO 14739-1

When published: 2014

Description: PRC is one of two 3D formats (the other is U3D) native to PDF 2.0 (ISO 32000-2). It is an accurate, highly compressible format optimized to support different representations of a 3D CAD model.

PRC was developed from inception as a file format capable of representing 3D model data from all of the popular CAD authoring applications. PRC data files contain product structure data and can optionally contain precise 3D geometry, visualization, metadata and Product Manufacturing Information (PMI). 3D models can be stored within PDF as accurate BREP geometry, tessellated data or both. Because of this, PRC models can be both visualized by people and exported from a PDF for use in CAD, CAM and CAE systems.

Suitability: PRC is the best format to use for representing three dimensional technical data in a PDF document. It offers the following advantages over U3D:

- Data structures for CAD data including assemblies, precise geometry, tessellation, PMI, text, annotations, etc. U3D is limited to mesh data.
- Better compression than U3D.
- International standard (ISO 14739)

Applications

PRC is well suited for communicating technical data for most general engineering processes including:

- Reporting
- Design review
- Quality planning and reports
- CAE reports
- Supply chain collaboration
- Training
- Archiving

STEP

Defined in: ISO 10303-21

When published: ISO 10303-242, 2014

Description: The ISO 10303 standards are collectively known as STEP. Shared definitions are defined in the lower numbered series (10303-21, 10303-27, etc.) and are collected and extended in functional groups known as “Application Protocols” (APs). For example, the STEP standard used in MBD, ISO 10303-242, “Managed model based 3D engineering”, is commonly referred to as STEP AP 242.

STEP provides a mechanism to describe product data throughout the product’s life cycle in a system-independent fashion, including a basis for sharing product databases. The STEP standards are under continuous review and development to ensure compatibility with modern technologies.

Usage is broadly distributed, as the model addresses most domains relevant to 3D applications in manufacturing, including mechanical and electrical design and analysis of geometry, dimensions and tolerances. STEP files can include domain-specific data types to support specific industries such as aerospace, automotive, heavy engineering, construction, energy, healthcare and more.

Suitability: Support for including STEP AP 242 in PDF 2.0 is currently under development as ISO TS 24064.

Applications

- Model Based Definition (MBD)
- Smart Manufacturing
- Supply Chain Integration
- Engineering Data Exchange
- Long Term Archiving (LTA)

Tagged PDF

Defined in: ISO 32000-2, 14.8 “Tagged PDF”

First added to PDF: PDF 1.4 (2000)

Description: Tagged PDF is a stylised use of PDF that uses a set of standard structure types and attributes to add semantic markup to page content

(text, graphics, images, annotations and form fields) for extraction and reuse for other purposes.

Suitability: Developed in part to support accessibility requirements for users with disabilities, tagged PDF is appropriate for workflows that require repurposing of PDF content.

Applications

Tagged PDF can be leveraged in manufacturing in the following ways:

- Indexing, search and data-mining systems
- Semantic grouping of distributed content
- Enabling document reflow for use on mobile devices
- Enabling accessible documentation for employees and end users

U3D

Defined in: ECMA-363

When published: 2006

Description: No longer in active development, the Universal 3D File Format, or U3D, is a compressed binary 3D file format that can be embedded in PDF documents beginning with PDF 1.7 (ISO 32000-1). U3D and PRC together represent the historical foundation of 3D interactive data in the PDF context. U3D was designed as a general-purpose visualization format with features such as key-frame animation. The format is optimized to store triangle meshes, lines and points with hierarchical structure, metadata, color and texture.

Suitability: Unlike PRC, U3D lacks the CAD specific data structures for geometry, topology, text and PMI. In PDF, U3D is best suited to animation in 3D PDF.

Applications

- Technical publications
- Marketing Materials

XMP (eXtensible Metadata Platform)

Defined in: ISO 32000-2, 14.3 “Metadata”

When added to PDF: PDF 1.4 (2000)

Description: PDF’s document information dictionaries provided the means of including metadata such as document title, author, and creation and modification dates in PDF files since the first days of the format. Starting with PDF 1.4 PDF files could include XML-based metadata streams at both the document and object levels using the eXtensible Metadata Platform, or XMP.

XMP provides a rich, machine-readable mechanism for metadata in the PDF document context. XMP allows a document’s title to be stored in more than one language, or allows a document’s authors to be represented as a list. XMP is also extensible, allowing for the use of

Suitability: XMP is commonly supported by both PDF writers and processors.

Applications

- Identification, categorization and association

Example 3D PDF files

This PDF includes a variety of 3D PDF examples provided by sponsors.

You'll need a PDF viewer capable of displaying the attachments panel in order to access these files.

- **Anark:** "NAVAIR Hydraulic Manifold Additive Manufacturing 3D PDF TDP.pdf"
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- **Tetra4D:** "TDP_Creo_2020.pdf"
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The 3D PDF Consortium is a non-profit, corporate membership organization comprised of end-user companies, independent software vendors (ISVs), and systems integrators (SIs) who are committed to driving the adoption of 3D PDF-enabled solutions for the communication of complex 3D data.

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