Visual Manufacturing

Improve collaboration and efficiency with better access to rich product data.

Manufacturing is a complex business with an increasing number of suppliers, contractors, partners and customers. And they all need to work together faster, more efficiently and in more innovation-friendly ways.

The specialisations that have developed in different parts of manufacturing companies – design, engineering, manufacturing, support, marketing – have inadvertently created silos that pass information on but don't always collaborate well.

Visual Manufacturing leverages 3D visualisations and graphics to optimise use of product data throughout an entire product value chain.

Implementing Visual Manufacturing provides a platform for sharing product data with everyone in a product's lifecycle from engineers to customer representatives to contractors. Data is shared in a highly accessible visual format, such as a 3D model in a web browser or ERP system; along with associated rich product metadata, such as order levels, component info, updates, documentation.

The end result is greater productivity and throughput – more products manufactured in the least time.

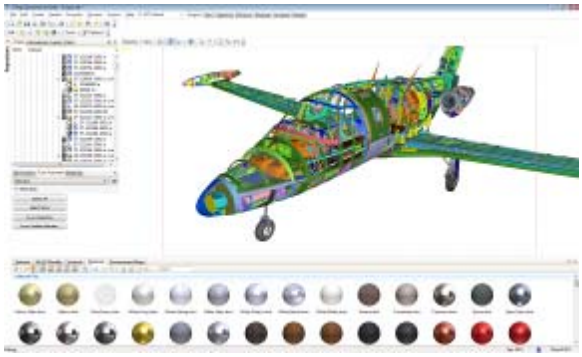
This whitepaper:

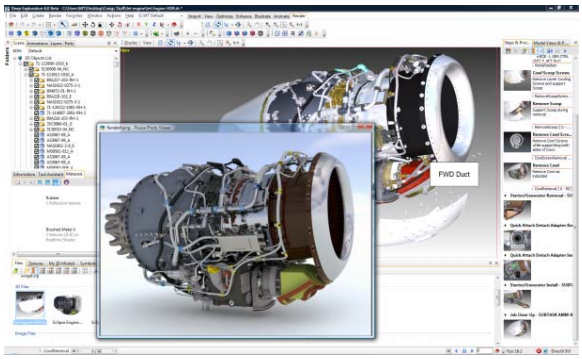
- defines what Visual Manufacturing is,
- identifies key business issues facing manufacturers, which are addressed by a Visual Manufacturing approach,
- outlines the key benefits of Visual Manufacturing, and
- cites specific results that established manufacturers have achieved by implementing Visual Manufacturing solutions.

Benefits Summary

The benefits of a Visual Manufacturing approach have been quantified by many leading manufacturers. They include:

- greater efficiency from improved access to quality information,
- faster response to customer needs and competitive pressures,
- lower costs,
- fewer errors and higher quality
- faster and greater throughput, and
- improved profits.





What is Visual Manufacturing?

"Visual Manufacturing" is a methodology, supported by software technology, that delivers visual product data to all stakeholders throughout a product's value chain – Improving everybody's ability to collaborate more efficiently.

Product data of all types becomes easily accessible to more people, who make faster decisions and accelerate their respective workflows. Business processes are streamlined, and 'islands of automation' are integrated.

By focusing on stakeholders outside of the engineering department, Visual Manufacturing yields significant cost and time savings throughout the company and supply chain.

Visual Manufacturing leverages product data

Product data is the core asset of any manufacturing business. Companies spend huge sums creating valuable product data such as CAD data, product specifications, technical documentation, maintenance and repair manuals, requests for quotation (RFQs) and bills of material.

Visual Manufacturing improves collaboration and communication by giving workers throughout the global value chain access to the right data at the right time, and in the right form.

Visual Manufacturing makes product information widely accessible

Visual Manufacturing uses software and technology that a variety of downstream users and stakeholders can access - not just designers and engineers with CAD software.

Colleagues, customers and suppliers are plugged directly into the product development and manufacturing processes, enabling companies to better respond to customer demand.

The user interfaces and technology employed makes 3D models accessible, simple and easy-to-use. 3D data can be taken from most manufacturing and CAD systems and made available on standard PCs using free software. 3D models can be viewed online, on handheld PDAs and smartphones, via web browsers integrated with online ordering or databases, and even integrated in common document formats like PDFs and Microsoft Word documents. The production of this 3D content can be automated and integrated with rich product data. When a change is made in engineering, all dependent 3D models in other departments or with customers and suppliers can be automatically revised.

Visual Manufacturing uses visual representations

3D visuals and accurate, interactive plans lead to much quicker understanding and faster response. Visual information helps people articulate complex product information and diagrams more clearly.

Visual Manufacturing integrates rich product data

As well as taking advantage of visuals, rich product data is also included within a 3D model. The model can act like an intuitive front-end interface that can be navigated easily and provide access to other documents and data.

This includes access to all the necessary documentation such as 2D drawings and 3D CAD data as well as rich annotations and product manufacturing information (PMI). Critical business workflows like requests for proposal (RFPs), RFQs, engineering change orders and configuration management, Bills of Materials can be included. Often-missed subtleties like sealants and coatings can be included, so documentation matches the product being built. The experience of people who actually made or first used the product can be captured.

Such information is rarely included in CAD systems.

Manufacturing Workflows

The lifecycle of a manufactured product can be viewed in four major stages:

- Engineering and Design
- Manufacturing
- Service and Support
- Sales and Marketing

At each stage product data must be shared in a form that each department can use for their own specialised and particular processes.

CAD product models are created in engineering, and are passed on to manufacturing who adapt them into work instructions, assembly diagrams, bills of materials and more. Service and support staff need to create and understand technical publications and training materials. Sales staff need the latest product information to sell to customers in advance and reduce time to market. Customer feedback goes to engineering for future product development.

Although each function has different skills and needs, they all rely on the same product information. However, CAD software has primarily been developed with engineering departments in mind, not the whole enterprise.

For example, one U.S. large heavy equipment manufacturer found that 50% of its production time for documentation was caused by non-CAD workers trying to manipulate CAD files to author product documentation.

Manufacturing trends

Many manufacturing approaches have developed which aim to streamline manufacturing workflows:

- **Product Lifecycle Management** is a strategic approach to managing products from concept through to retirement. By standardising approaches to creation, management and deployment of product-related information, PLM aims to help all stakeholders make more informed decisions, based on relevant, accurate information. PLM systems aim to create a single, centrally controlled product data "backbone" that helps streamline and automate processes.
- **Stakeholder-Centric Design** is a design-led approach that involves as many parties in the creation and design of products as early as practical. This aims to boost innovation, improve communication and prevent inefficient rework or change orders.
- **Model Based Definitions** are being adopted by more and more engineering departments. Designed to eliminate 2D drawings and embed rich product information as part of the 3D model, this makes engineering more productive.
- **Lean Manufacturing** places an emphasis on standardising processes in order to eliminate waste and create the foundation for continuous improvement. Tools include Lean, Toyota Production System, Six Sigma and Delphi's Lean Design Methodologies.

Some barriers to implementation

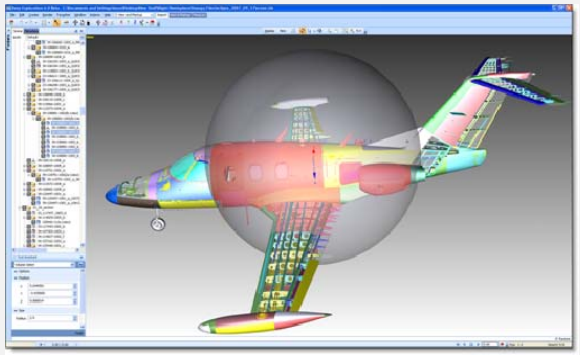
However, a number of practical limitations have prevented approaches such as PLM and lean manufacturing from delivering on their full potential.

To date, design automation software has focused on product development applications and operations. Even 'Product Lifecycle Management' software has largely been limited to automating cross-engineering disciplines such as Computer Aided Engineering and simulation.

- **Product data held in silos.** It is not uncommon for a single part in a global manufacturing operation to have two to three hundred documents associated with it. Often this critical data is held in different divisions or locations, each having developed their own processes over many years. These systems, built upon technology platforms available at the time, have become frozen in time and data is inaccessible to colleagues and wider stakeholders.
- **Specialist software tools restrict sharing.** While various software tools have been developed to automate different parts of manufacturing, compatibility and sharing of information is lacking. This has hindered a true PLM approach, as useful design or engineering data cannot easily flow to other users in the value chain. CAD tools were originally built for product designers, and so over the years software and processes have been molded to fit their specific needs. The product design team usually "runs the show" when it comes to designing and implementing cross-functional processes.
- **Complex software tools restrict use.** Most CAD software tools are difficult for non-technical users to learn and use. Yet many more people in an organisation could benefit from product data, if only they could access and manipulate it. For instance, hours are spent recreating data such as technical drawings that could otherwise be available from engineering.

The philosophy and technology employed by Visual Manufacturing builds on the strengths of PLM, lean and stakeholder-centric design while overcoming these practical shortcomings.

Case Study: Airplane Manufacturer



One large aeroplane manufacturer reduced the time spent searching for engineering data by 50%, thanks to ready-access to design data via a centralised graphics repository.

They also realised:

- a 84% reduction in person-hours spent creating next-generation illustrations for their manuals, due to enhanced graphics management, data search tools and animation creation tools,
- a 35% reduction in person-hours required to create animated maintenance manuals and interactive parts catalogues,
- a reduced animation creation time from two weeks to two hours,
- estimated savings of 112,000 person-hours over five years,
- a risk-adjusted ROI of 333% and an 11 month payback period. They estimated their monthly cost of doing nothing to be USD$88,262.

The Benefits of Visual Manufacturing

The efficiencies, cost savings and greater innovation delivered by a Visual Manufacturing solution are the result of many benefits:

- improved collaboration with all parties,
- better data and process interoperability,
- less waste and duplication,
- reduced errors and improved quality,
- faster and greater throughput, and
- encouragement of standardisation and continuous improvement.

Improve collaboration

Good collaboration is a competitive advantage, especially for New Zealand companies seeking to overcome the tyranny of distance.

A 'design anywhere, manufacture anywhere' mentality means companies now plan and optimise manufacturing capacity across multiple plants in distant geographies. This creates new issues like language barriers that must be overcome to enable global, multi-lingual manufacturing.

A survey of 650 manufacturing executives by Industry Week and IBM Consulting[1] found that 62% of purchasing executives listed supplier collaboration as the most effective contributor to increased profitability and reduced cost. More than 97% of product development executives selected collaboration with customers as the most effective strategy for meeting customer requirements and bringing innovative products to market. And, greater than 35% chose collaboration with customers as the key strategy to reducing product development time to market.

Aberdeen Research[2] found that best-in-class companies - those that meet time-to-market, cost reduction, revenue, and quality targets 80% to 100% of the time - engage in more forms of collaboration.

Collaboration is especially valuable in functions downstream from product design. Products increasingly require input from previously disconnected islands of automation and stakeholders such as customers, sales and marketing teams and suppliers. Cross-functional teams mean 3D product data needs to be shared with those without CAD software.

Product releases, sourcing, spare parts, service, marketing, maintenance and every other downstream process is improved in a Visual Manufacturing paradigm. For example:

- Parts catalogues become user friendly and intuitive, with simple search tools to find parts of interest, special packaging or past purchase histories.
- The shop floor becomes more efficient and productive. Assembly instructions contain visual diagrams and animated images of actual 3D products, which are always consistent with the latest release of the product.
- Assembly instructions are created from a single data source which is tied to the latest released CAD data, and deployed as highly interactive, full 3D, instruction manuals. Maintenance of these manuals is much easier, since the underlying software platform does all the work.
- Product updates, field service notes and language translations are always synchronised and correct since they're generated from a single source of original product data.
- Marketing materials use high-impact images of actual products without costly photo shoots.
- Quality standards worldwide are more easily maintained because visual product data is all derived from a single source.

[1] Industry Week Value Chain Survey (2005). www.industryweek.com/articles/iw_value-chain_survey_a_map_of_the_world_10629.aspx

[2] Product Lifecycle Collaboration Benchmark Report: The Product Profitability "X Factor"? (2006)

Where previously personal connections were sufficient to coordinate global manufacturing chains, as volumes and sophistication have increased these systems have been computerised. Computer-enabled design, ordering and Enterprise Resource Planning (ERP) systems are increasingly interconnected, and the Visual Manufacturing solution needs to integrate with these to maximise productivity.

Visual Manufacturing enables stakeholder-centric design processes that involve many parties in the creation and design of products to become possible. This boosts innovation, improves communication and prevents inefficient rework and change orders.

One U.S. heavy equipment maker completed an ROI study that yielded global savings of $6.15 million over three years in a single product line due to process automation in technical publications, marketing and training.

They realised a payback on their investment in nine months.

Improve data and process interoperability

Poor data interoperability remains the single largest source of waste in product development.

Studies[3] have suggested that the cost of poor CAD interoperability to the automobile industry alone could be more than USD$10 billion per year worldwide. Other estimates place the cost at approximately $1.2 billion per year for one large aerospace company, and about $1.3 billion per year for GM, Ford or Chrysler.

Two of the largest sources of waste in engineering are:

- time spent fixing CAD data, caused by poor interoperability, and
- time spent figuring out CAD data created by someone else, resulting from poor process standardisation.

These problems not only cripple efficiency and time to delivery, but also morale.

A large portion of the blame for poor interoperability goes to incompatible formats between CAD systems.

It has also been difficult to integrate CAD data with other critical product information. Poor integration between product design and process design have made it nearly impossible to create and maintain accurate associativity between CAD designs, process models and process documentation. This causes huge amounts of waste and cost. In addition, it is still quite difficult to share non-nominal product data such as dimensioning, tolerancing and annotations.

Cut waste and duplication

With a 3D Visual Manufacturing solution there is less duplication of work. Drawings and documents are easily and automatically generated from 3D models, saving huge amounts of time and preventing CAD models and drawings from getting out of synch.

For example, accurate technical service manuals are key to stakeholders and customers unlocking the value in a product. There is very little re-use of existing production graphics, mostly due to an inability to find previous files. Manuals produced in one territory are often different from others, leading to duplication of effort, high language translation costs and inconsistency.

Companies using Visual Manufacturing solutions have significantly reduced their technical manual and support costs. They have provided more accurate information to customers, and reduced document production costs by re-using data from components and previous models, reducing dependence on expensive CAD tools, eliminating expensive photo shots; and improving quality by capturing the knowledge of experienced users, and using the latest information.

Visual Manufacturing can also manage components that are used in multiple product lines, to prevent duplication and ensure one accurate master definition of each component is maintained.

[3] Interoperability Cost Analysis of the U.S. Automotive Supply Chain (1999). U.S. National Institute of Standards & Technology.

Reduce errors and improve quality

Visual Manufacturing's use of easily comprehensible visuals and inclusion of rich product data reduces errors and improves quality. This is especially true for complex products, shop floors handling multiple product lines or customising assemblies.

Visual instructions, including step-by-step instructions are superior to 2D blueprints and written manuals. Orientations, movement directions, dimensions, relative space and nearby obstacles are better understood in 3D.

A Harvard University study found that learning from animations and graphical story boards for one hour produced 10% better retention and 30% better understanding of information, compared to reading text books for two hours. The same subjects exhibited a 10% increase in their interest and engagement and spent half the time learning.

This approach is particularly useful for younger workers, shop-floor workers with lower reading literacy and for cross-cultural teams using multiple languages. It can also be a useful tool for companies seeking to capture and transfer knowledge from their 'old guard' to the new global workforce.

The Visual Manufacturing backend can automatically update all downstream 3D models if a change is made by designers to the master model-based definition. This reduces errors caused by stakeholders using out-of-date or obsolete product data, only to discover it later - requiring significant rework.

For instance, manuals and support materials can be developed at the same time as design alterations are being made, keeping rework to a minimum while speeding time to market.

Case Study: Medical Equipment Manufacturer

A medical equipment manufacturer benefitted by introducing Visual Manufacturing through:

- faster manufacturing launch times,
- faster shop floor training,
- a 50% reduction in time to create documentation,
- 8% reduction in time to create and revise the animated training curriculum,
- 30% reduction in time to update Service Manuals, Operator Manuals & Service Alerts,
- reduced language translation costs due to animated graphic procedures,
- 5% increase in territory coverage by field service people, representing USD$5,300,000 average savings per year,
- more accurate and faster spare parts orders,
- a risk-adjusted ROI of 1486% and a payback of their investment in ten months. They estimated their monthly cost of doing nothing at USD$452,040.

Speed up throughput

The fundamental business case for Visual Manufacturing is based on increased throughput - more products manufactured in the least time. Throughput depends on many things, but at the most basic level, it depends on having accurate, relevant information delivered immediately when it's needed at the right place in the right format.

This speeds time to market and capitalises on the trend towards more incremental product updates and fewer big-bang launches. According to AMR Research, twenty to thirty percent of all sales by industrial companies come from products that have been on the market for less than 5 years.

Encourage standardisation

Visual Manufacturing supports Lean Manufacturing initiatives by helping transform business and manufacturing processes, with higher efficiency and fewer errors. A large amount of the gain comes from standardisation and streamlining the processes of how people work together.

In a study of 165 global manufacturers, AMR Research[4] found that the main reason for failed projects and programmes is lack of formal processes around new product development and introduction/launch. The study also found that it is critical to standardise workflows and processes, so they can be improved and automated.

Visual Manufacturing helps standardise processes, for example, by reducing or eliminating interpretation on the shop floor. When everyone in an operation does business the same way, tremendous intangible benefits are added to top and bottom line business performance. Standardised processes don't need interpretation, improving speed and quality.

However, every business is different and Visual Manufacturing systems must be extremely flexible and configurable.

[4] The Innovation Imperative: More Than Better Product Design in Managing Automation (2006). David O'Brien.

Implementing Visual Manufacturing

In the past, technical limitations have prevented 3D and product data being shared fully. These included product data being held in silos, specialist software tools that cannot share and complex software tools that cannot be used by anyone outside engineering.

The technologies and approach used to create a Visual Manufacturing system are designed to overcome these barriers.

An effective Visual Manufacturing implementation will have:

- **Superior 3D data interoperability.** In a Visual Manufacturing solution, the most popular CAD formats will be available and accessible to all. Furthermore, most downstream stakeholders don't need the actual CAD files. They require an array of scalable, lightweight and ultra-light weight visual formats for a variety of users, including via a web browser or embedded in other documents. Rich product data will be able to be incorporated into and linked from these.
- **Integration with business systems.** Visual Manufacturing will integrate with the backend systems that supply rich product data. ERP systems like SAP® and Oracle® provide critical business and supplier information, such as part numbers, latest prices and inventory levels. MRP and MES systems provide accurate manufacturing information, resource plans, shop floor documentation and the latest mBOMs to make the products correctly. The Visual Manufacturing toolset is flexible enough to change as business requirements change.
- **Interfaces appropriate for non-technical users.** Most CAD software tools are difficult for non-technical users to learn and use. Yet many more people in an organisation could benefit from product data, if only they could access and manipulate it. Visual Manufacturing supports light-weight models accessible on a standard PC or even over a web browser. Ideally, custom interfaces and workflows for specific users should be developed.

Implementing a Visual Manufacturing system can be done in stages, with immediate benefits from reducing duplication and re-work, followed by projects to integrate and automate critical workflows and processes. This will require knowledge capture of business processes, which can then be modelled in the system. This standardisation is the foundation for ongoing continuous improvement, now that critical product data and processes are more readily available.

Taking the Next Step

To evaluate how Visual Manufacturing could help your business, and the solutions available contact:

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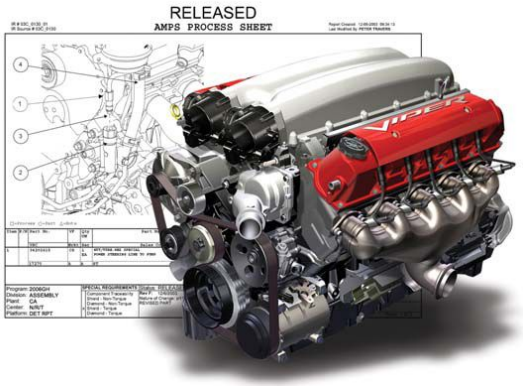

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