

The Advent of Visual Manufacturing



WHITE PAPER

Longview Advisors, Inc.

EXECUTIVE SUMMARY

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Product Lifecycle Management (PLM) is an intriguing vision. But its success has been limited to expanding the role of PDM systems to help automate cross-engineering disciplines such as CAE and simulation. Little has been accomplished to augment workflows and processes which extend beyond the four walls of engineering. Successful PLM implementation is hampered by poor flow of relevant and timely information out of engineering to other stakeholders in the global value chain. Efficiency and productivity require availability of product data at the right time in the right place and format. Without data, people can't collaborate, PLM remains only a vision, and business processes grind to a halt.

Countless software tools have emerged to help automate various aspects of manufacturing. Each deploys one or more proprietary data formats which are incompatible between applications. Thus, smooth workflow between and among "islands of automation" is further challenged, and efficiency is further compromised. Poor interoperability of data, caused by this proliferation of incompatible data formats, is a huge source of cost and waste throughout manufacturing. And it further limits the potential for successful PLM.

In addition, the majority of CAD tools are built for CAD people. They are generally quite complex and difficult to learn and use. Orders of magnitude more people in a typical global organization could benefit from product data assets, but aren't able to access it, or lack the skill or interest required to use. Thus countless hours are wasted recreating data that would otherwise be available from engineering. This adds to product cost and dramatically delays critical business processes.

A new vision is emerging, founded on leveraging visualization and graphics to mobilize product data outside engineering. "Visual Manufacturing" removes the barriers to effective collaboration and efficiency by delivering visual product data to stakeholders throughout the global value chain, through user interfaces uniquely packaged to suit the needs of specific user and functions. Product data of all types becomes accessible to thousands more people, to make faster decisions and accelerate their respective business workflows. Business processes are naturally streamlined, and Islands of Automation blend into are integrated into efficient drivers of customer value. Visual Manufacturing drives bottom line business growth in areas like MRO, training, marketing, with measurable ROI. This white paper describes how.

BUSINESS DRIVERS

Manufacturers face relentless pressure to develop new products and bring them to market faster than ever before. 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. Customers demand faster turnaround and more innovative solutions, in ever compressing time cycles. This drives higher and higher production rates, pushing the limits of manufacturing systems and people. It also drives higher re-use of existing product designs. More and more, manufacturers are trying to leverage design, assemblies and component parts across product lines. For example, more automobile lines are produced on fewer chassis, while many part and assemblies are shared across multiple product lines.

And competition doesn't rest. New product innovations appear constantly, driving the need for constant commitment and attention to customer retention and loyalty, and all the components of business that touch the customer.

It's not just about faster and cheaper. Customers continue to demand ever higher quality and reliability. In response, thought leaders in virtually every industry have turned to standardized work and "lean" initiatives. By eliminating waste and non-value-added activities, companies who implement lean processes realize greater efficiency, faster response to customer needs and competitive pressures, lower costs, higher quality, and improved profitability.

Numerous strategies and technologies have emerged to address these issues. And yet, the challenges not only still exist, but continue to magnify. What's needed is a new focus on the seamless integration of existing business workflows, supported by advanced software technology and well planned architecture, all targeted at enhancing the ability of everyone in the value chain to leverage the latest product data created anywhere in the global engineering factory. This is the quickest path to furthering the optimization, productivity and profitability of manufacturer processes.

REDUCE WASTE

In its simplest form, lean is about minimizing "waste" and creating value for the customer. Lean initiatives analyze various business processes using value-stream analysis, with the goal of identifying activities which add value in the eyes of the customer, and those that do not. Waste is identified and eliminated by setting goals for continuous improvement through standardized quality methodologies like Six Sigma. Anything that does not add customer value is considered waste.

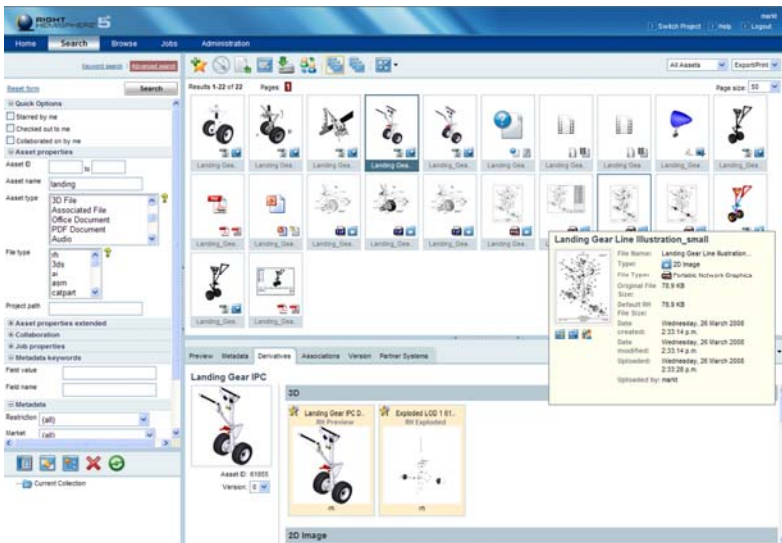
Much has been written about the intrinsic benefits of standardized work processes. Indeed, standardization provides the basis of Lean, Toyota Production System, Six Sigma, CM-II, Delphi's Lean Design Methodologies and all other proven methodologies, all of which have been recognized for their value impact throughout global manufacturing operations. The Toyota Production System

(TPS) is a cornerstone of Toyota's approach to building world-class quality into its products. By keeping lead times short and production lines flexible, manufacturers can increase productivity, reduce investment requirements, better utilize equipment and space, and improve quality. None of this would be possible without management's commitment to promote a culture of continuous improvement — a belief that along with operational efficiency you need to constantly improve your processes and offer innovative products to quickly respond to ever-changing customer requirements and stay ahead of your competition. Continuous improvement cannot take place unless and until the process being improved is standardized. Implementing PLM involves defining standardized workflows that can be encoded in software and process, and involving very complex people, process and technology issues – a daunting task.

PLM IS... (AND ISN'T...)

PLM is a strategic approach to implementing processes and technology to help companies manage products from concept through retirement. By standardizing approaches to creation, management and deployment of product-related information, PLM enables global stakeholders to make faster, more informed decisions, based on relevant, accurate information. PLM systems are designed to help companies centralize and institutionalize management of their product information. These implementations create a single, centrally controlled product data “backbone” that helps streamline and automate engineering processes. Implementing PLM involves standardizing processes and workflows and then encoding them in software. In fact, the process of standardizing workflows in itself enables continuous improvement of those same processes.

It is not uncommon for a single part in a global manufacturing operation to have two to three hundred documents associated with it. But all too often critical data is held captive in regional or divisional “silos”—inaccessible to partners and suppliers. Divisional operations have implemented business and product development processes over many years. These systems, built upon technology platforms available at the time, have become frozen in time. And the hurdles to change them have become formidable. CAD tools were originally built for product designers, so they were probably first to use 3D CAD in most companies, and they were therefore able to mold the software and processes over the years to fit their specific design needs. The product design team usually “runs the show” when it comes to designing and implementing cross-functional processes.



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Product data is the core asset of any manufacturing business. Companies spend huge sums creating valuable product data assets, such as product specifications, technical documentation, maintenance/repair manuals, CAD data, manufacturing process plans, RFQs, bills of material, annotations, macros and algorithms, configuration information and countless other forms of information. These data comprise a description – hopefully complete – of a product. More advanced companies also capture and archive designer notes to represent as accurately as possible the design intent of the product.

They developed, and now drive, the design processes that everyone else must use.

PLM is an intriguing vision indeed, but it’s a strategy, not a solution. However intriguing the vision, successful PLM has proven elusive. Global manufacturing processes are highly complex. They depend on synchronized information and work flows in a global context. And not only are the product development processes extremely complex, but successful PLM depends in large part on effective communication, collaboration, and flow of product data, all of which are proving fundamentally more difficult than technology. Most PLM implementations

amount to little more than PDM systems built around a few relatively simple common engineering workflows. And few, if any, implementations deliver on the promise of integrating globally distributed workers outside of engineering into everyday workflows and processes. The promise of PLM is not being realized.

The value of the PLM vision has yet to extend to other critical product lifecycle processes, such as maintenance, repair and supply chain. For PLM implementations to be

successful, they must extend their reach. Successful PLM implementation depends on the definition of common processes and workflows, and the standardization and implementation of these processes across the *entire* enterprise. Collaboration and communication can't work unless knowledge workers throughout the global value chain have access to the right data at the right time, and in the right form, so processes are improved and decisions are made on the fly. This is the real big win.

IMPROVE COLLABORATION & COMMUNICATION

The value of collaboration is well established. Numerous research reports have detailed many good reasons to collaborate, and the cost of not doing it well. A recent survey of 650 manufacturing executives by Industry Week (www.industryweek.com) highlights the mission-critical nature of collaboration. 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. Recently, an Aberdeen Research (www.aberdeen.com) study 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; work with more external partners; and use more specialized collaborative PLM tools -- across the product lifecycle.

Effective collaboration is indeed one of the keys to winning on the competitive front. Success depends on how well business partners share product knowledge and information, while reacting to changes in design and process, regardless of geographic location. Huge efficiency gains are being realized by implementing processes and tools that improve collaboration and communication throughout a manufacturing operation, especially in downstream applications and operations. Companies face similar pressure for improvement in most other downstream functions, such as customer service, training, spare parts sales and parts catalogs, sales and marketing and so on. Throughout downstream operations, huge efficiency gains are being realized by implementing processes and tools that leverage product data to improve

collaboration and communication processes. But these improvements can't happen until users get access to their product data.

For example, let's explore the production of technical service manuals. Typically this process is very informal, and highly dependent on CAD skills. Writers, who aren't trained (or interested) in using CAD, receive CAD data and create 2D illustrations in static text documents. In many cases, over 50% of their time is spent importing and manipulating the CAD data to get the right perspective in their document. There is very little re-use of existing production graphics, mostly due to an inability to find previous works. And manuals produced in one territory often look and perform differently than others, leading to multiple instances of the same work, duplication of effort, high language translation costs and inconsistency.

By improving the productivity and content for creating Technical Service manuals, winning companies are significantly reducing current project backlog, improving data re-use, saving people cost, reducing dependence on expensive CAD tools, saving update time and cost, capturing knowledge of experienced users, reducing production costs like expensive photo shoots, and enabling artists more time to deliver a better quality product, while enabling more projects to be completed with the same resource.

INCREASE OPERATIONAL EFFICIENCY & EFFECTIVENESS

Products are becoming increasingly complex. Powerful 3D CAD and engineering software tools are enabling users to create more advanced designs in less time. Powerful parametric, feature-based assembly modeling is allowing users to design extremely complex products, and digitally assess form, fit and function in completely virtual worlds. Products often require integrated design effort between previously disconnected “islands of automation”. Design and analysis/simulation, and design and manufacturing are forced closer together as companies push concurrency to extract every minute from design cycles. Similarly, disciplines like electrical and mechanical engineering are colliding as traditional boundaries blur. This is leading to new, cross-functional disciplines such as mechatronics, which require whole new advanced skill sets. It also proliferates the already overwhelming variety of incompatible data formats from even more engineering software tools, making any hope for integration all the more challenging.

Customers are also demanding a “personalized” product. Huge new markets have opened for high volume products that can be customized at higher and higher levels of granularity. Mass customization puts pressure on suppliers to be highly adaptable and ready to react instantly to change. It also drives the need for special attention to management of the countless different product configurations required to satisfy highly tuned product/market portfolios.

Highly customized product configurations require more sophisticated data management systems for the huge amounts of business and product configuration data that gets created. Comprehensive, powerful enterprise and manufacturing resource planning systems, such as SAP, have evolved to manage financial, customer, supplier, warehouse, and countless other types of business data. Similarly powerful PDM/PLM systems manage terabytes of product data, such as CAD models, drawings, manufacturing process plans, annotations, manufacturing information like tolerances and more. These ERP, MRP and PDM/PLM systems need interfaces to the operational community such that the right data is available at the right time in the right form. Success also requires the ultimate in flexibility in the tools that are implemented to support

fast changing business operations. Flexible tools help to minimize the number of tools required to run the business, but also enable the high level of adaptability that is required to respond to customer and business demands.

Data and business management is further complicated by increased consolidation across all manufacturing industries. As companies are acquired or merged, disparate data and business management systems and processes must converge into new platforms. IT departments are forced to plan for change like never before. Processes like maintenance, service, parts and warranty are often company specific, and always a core element of customer loyalty. These mission critical process are not immune to change and consolidation, and must converge into all new processes that suit the new, merged enterprise.

And all this must happen on a global basis. Customer and competitive pressures have led most companies to depend on global business partners for critical components.

Pressure to compress time to market and incredible demand for highly customized, configured products have pushed manufacturers to place critical operations at the customers’ doorstep, wherever they are in the world, in order to respond quickly.

Product design has become a globally distributed “engineering factory” consisting of in-house and outsourced engineers. Even highly specialized (and highly proprietary) products are being designed by third-party engineering service providers, who provide specialized, experienced engineering assets. A “design anywhere, manufacture anywhere” mentality forces companies to plan and optimize capacity utilization for a single product across multiple plants in distant geographies. In a similar fashion, Supply Chains in nearly every manufacturing enterprise have become globally distributed multi-site, multi-tiered and multi-national. This creates new issues like language barriers that must be overcome to enable global, multi-lingual manufacturing.

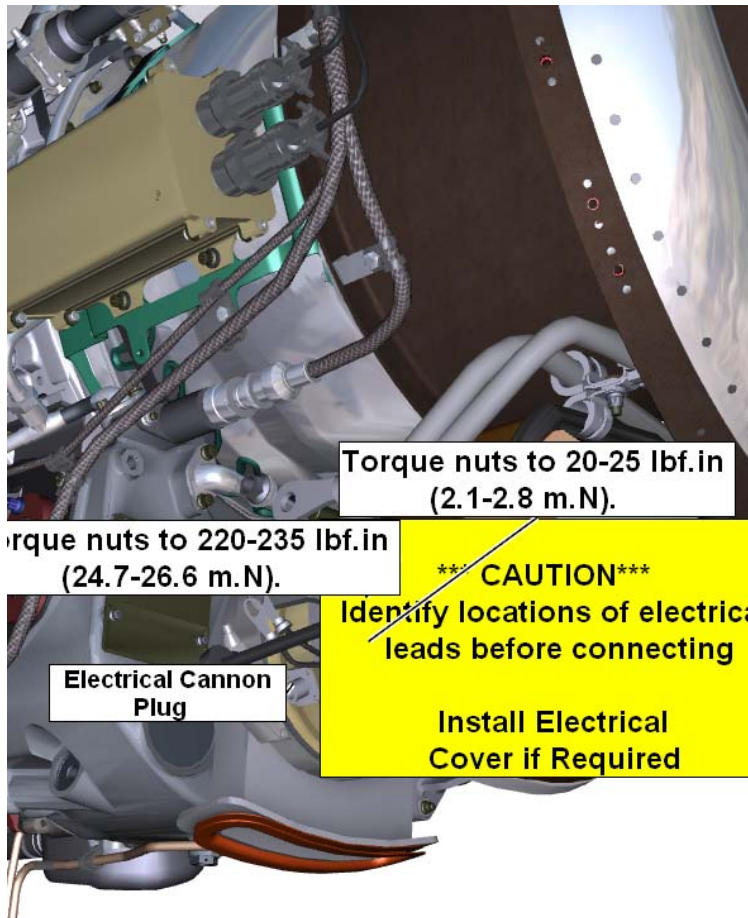
LEVERAGE PRODUCT DATA—ANYWHERE, EVERYWHERE

Data access problems plague productivity. A typical global manufacturing value chain could have as many as 1000 potential users who could benefit from their company's product data, but simply can't access it, or lack the tools or expertise to use it. The data is often available

in their PDM/PLM system, but the tools either aren't available or are too difficult to use by people who aren't trained in CAD. These numbers are likely much higher if one accounts for the extended enterprise, such as suppliers and customers. CAD software is too complex and too expensive for non-CAD professionals to use.

Manufacturers spend a lot of money creating valuable product data assets, but the clear advantages of business automation and collaboration can't be realized if the data isn't available to anyone who could benefit from it. Efficient manufacturing processes depend upon sharing product data throughout the globally extended enterprise. Simply put, people can't work together if they can't access and share their product data.

For example, manufacturing people need annotations, dimensions and tolerances to produce parts. They need configuration information and assembly information (ideally visual) to see how the parts fit together. And they



need manufacturing process information to see how the manufacturing process designers planned to manufacture the product. Technical document producers need 3D graphics that can easily be manipulated and inserted into interactive training and maintenance manuals. E-commerce managers need 3D parts in light-weight forms that can easily be packaged into interactive web-based parts catalogs. All this data must come from somewhere in the engineering factory. Without it, all these people can't add their full value, and every minute of time it takes for them to get the data they need is a minute wasted.

A new generation of computer users is entering the workforce, one that is visually driven; demands ease of use in applications and is intolerant of inefficiency. They have developed different skills requiring newer processes and tools, and a much more interactive, visually-oriented work environment. They also have much higher expectations from the tools they use. Learning curves are unacceptably long. The new generation of users simply doesn't have the patience, and quickly loses interest in adopting tools that are too difficult to learn and use. They multi-task technology in ways that boggle the minds of today's knowledge workers. These new generation users understand computers as a

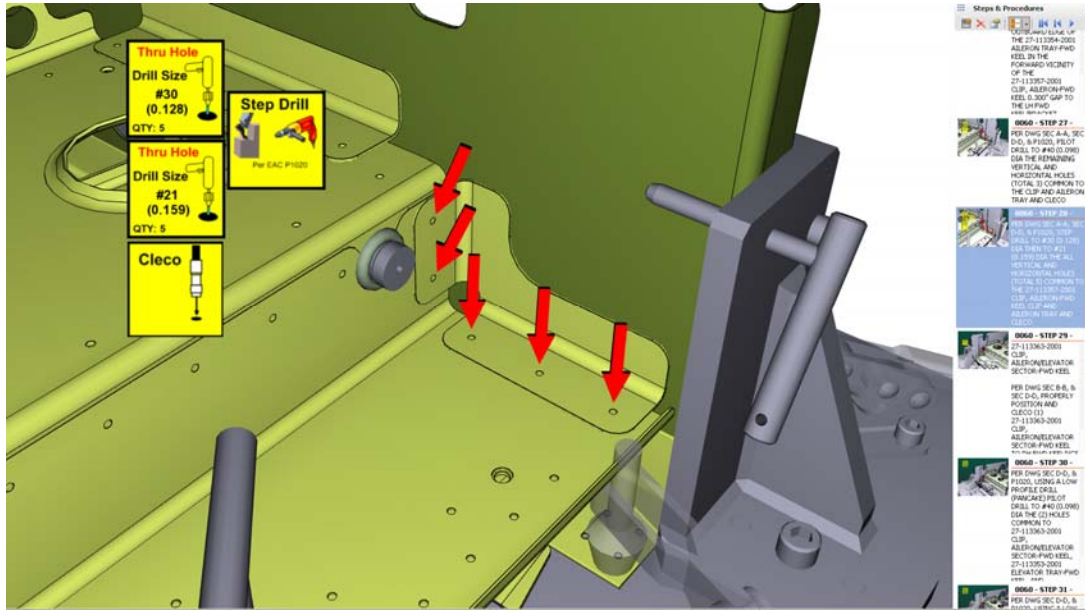
tool they've used for years and expect the computer and its user interface to be completely intuitive, with common functions and standardized interfaces. They expect tools to be just that – highly interactive, “visual” tools that can be used to get productive work done in a casual, part-time manner while the user focuses on other aspects of their job or work environment.

Software architectures are also outdated. Product development applications emerged over recent decades to

fill niches in the product lifecycle. CAD, FEA, CAM, process design, simulation – the list is endless – each satisfy, to varying extents, the needs of relatively narrow groups of knowledge workers. These myriad applications are very poorly integrated, if at all. They generally can't share data or other information, and each has its own user interface and usage paradigm.

prone. And intellectual property is at risk on a constant basis. PDM infrastructures are dated, often amounting to little more than file and transaction managers. They are very complex to use and worse to modify and update. Implementation and configuration projects are measured in years, at tremendous cost.

With growth and globalization comes a need for experienced workers. As the current workforce ages and



products become more complex, it has become more difficult to find educated, experienced professionals who are willing or able to step into critical roles, like shop floor assembly, in sites around the world. Much of the knowledge of the previous generation is still mostly unavailable to this new generation of knowledge workers, an issue managers everywhere are confronting daily. This has contributed to higher training costs of unskilled

Users of these disjoint applications, each in their own islands of automation, push information to each other as needed, often emailing huge data files which get lost or end up in the wrong destination. Communication processes are cumbersome, time consuming, and error

workers or outsourcing of production. Visual work instructions can help by improving training effectiveness, while mitigating language barriers.

IMPROVE DATA & PROCESS INTEROPERABILITY

Poor data interoperability remains the single largest source of waste in product development. These problems are well known and publicized. Few single issues present a more formidable impediment to accelerating product time-to-market. Studies have suggested that the cost of poor CAD interoperability to the automobile industry alone could be more than \$10 Billion per year worldwide. Other estimates place the cost to be approximately \$1.2 billion per year for one large aerospace company, and about \$1.3 billion per year for GM, Ford or Chrysler. As shown in the much-publicized problem suffered by Airbus a few years ago, the real cost is actually much higher, after accounting fully for direct and indirect costs of slower design cycles,

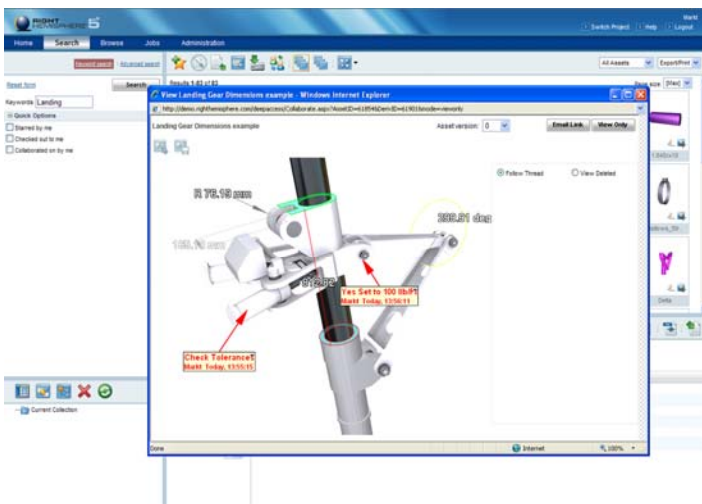
time to market and lost opportunity. The direct costs to Airbus were about \$6.1 billion in a single year, for a problem fundamentally caused by incompatibilities between CATIA V4 and V5. However, this only considers a portion of the total costs incurred by one company in a single incident. The 28% reduction in its share price alone represents an additional indirect cost of approximately \$9 billion. And lost orders due to delays caused by this event can be counted in dozens.

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

standardization. Non-standard methodology and poor CAD interoperability also prevent employees from collaborating, together and with their supply chains. These problems not only cripple efficiency and time to delivery, but also morale. Designers and engineers are happier when they are designing and engineering, not when they are cleaning up CAD data problems.

A large portion of the blame for poor interoperability goes to incompatible formats between CAD systems. Many new designs originate from re-purposing of existing CAD data. Each software tool has its own specialized format.

Interoperability problems plague downstream CAD data. For example, poor integration between product design and process design make 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 with manufacturing. The proliferation of file formats creates tremendous inefficiencies in all downstream operations. Lack of easy access to product structure and BOM information presents a huge challenge to training and



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Although most also import/export some or all of the common industry standards for most disciplines, the latest features, functions and new capabilities are usually introduced first in each vendor's proprietary format, and may never appear in any of the standards. The seemingly countless different formats and versions is overwhelming.

service document producers, as they struggle to present assembly and disassembly sequences and animations.

These problems sound formidable, and they are. But a new paradigm in communication and collaboration technology is emerging, and it's bringing together many powerful capabilities to squarely attack these challenges.

THE NEW VISUAL MANUFACTURING PARADIGM

Success depends on operational excellence and efficiency in business processes that integrate global customers, suppliers and partners directly into highly integrated, cooperative product development and manufacturing processes. Much off the focus of the design automation software industry has been on product development applications and operations. However, improving collaboration and access to product data by *downstream* stakeholders outside of engineering is yielding the most

significant cost savings and efficiency improvements.

In this section, we'll explore the potential business advantages of a new "Visual Manufacturing" paradigm, and how to tap the huge potential to be found in downstream business process improvement.

BETTER MANUFACTURING THROUGH VISUALIZATION

The quickest path to efficiency and fast response is through use of graphics, or visual data representations. Visual data representations, such as 3D graphics models, charts and control panels are quickly replacing complex tables filled with blurring numbers. Visuals lead to much quicker understanding and faster response. In a 2008 study, AMR Research found that 42% of respondents stated that when products fail, it's because they didn't meet specific customer needs, or that customer needs were not clearly articulated throughout the product development process. Visual information helps articulate more clearly. The executives in the AMR study also cited a lack of communication tools as another factor that frequently leads to product failures. In another recent study, researchers at Harvard University found that learning from animations and graphical story boards for one hour produced 10% better retention of information and 30% better understanding of information, compared to reading text books for two hours. They also found the same subjects exhibited a 10% increase in their interest and engagement in the information presented, and only half the time spent learning.

In the new visual manufacturing paradigm, computer-driven business processes and workflows are fed the right data at the right time, and in the right form, so decisions

can be made on the fly. And it's not just data, it's rich product knowledge. This includes access to all the necessary documentation – 2D drawings and 3D CAD data, and also the rich annotations and product manufacturing information (PMI), exposing and liberating the experience of the people who actually made the product in the past. Back-end business processes are computer-enabled – automated to model critical user-facing business workflows like RFP/RFQ, engineering change orders and configuration management. eBOMs are readily available, directly and transparently from a PDM backend somewhere in the world, to anyone who needs them. Manufacturing speeds ahead, based on the correct specifications, and the right products are built, quickly and efficiently. Colleagues, customers and suppliers are plugged directly into the product development and manufacturing processes as companies respond instantly to customer demand.

And consumption is free. Anyone who needs access to product data can receive and work with it without incurring software licensing fees. The usefulness and ubiquity of the Adobe® PDF Reader® has changed the software industry. Viewing and manipulating is free. Visual product data is just a download away for any user, anywhere in the world.

VISUAL PRODUCT DATA

A great amount of product data is graphical, and a significant and growing amount of that is 3D. 3D provides a lot of added value. The amount and type of information that can be shared in a 3D model is so much richer than in 2D. For engineering, simulation, supply chain, maintenance and training, sales and marketing, and countless other applications, 3D models offer unprecedented amounts of product information and potential for immediate feedback and collaboration, and faster decision making. Consider the difference between written directions and a colored, graphical map with your route boldly indicated in some bright color. Especially if you're concentrating on driving, the graphical map is far and away more effective at communicating the key information needed to reach your destination. Using visual product data leads to faster, better understanding and communication of information.

Numerous reports and case studies in recent years have consistently shown 70% to 100% user productivity improvements due to 3D product data. In a recent study, Harris Interactive, a leader in global market research, surveyed engineers and managers in manufacturing about their everyday communication and collaboration challenges. Among design respondents, 71% felt that collaboration reduced design errors or flaws, while 69% believed that it increased quality, and 63% said it increased productivity. While respondents clearly understood the many benefits of extending design information outside of engineering and sharing more product data with technical and non-technical stakeholders earlier in the development process, they were not all realizing these benefits.

With 3D data, there is less duplication of work. Drawings and documents are easily generated from 3D models,

saving huge amounts of time and preventing CAD models and drawings from getting out of synch. Designing holes, slots and other features in 3D product models becomes much easier than the tedious 2D techniques of the past. Creating backend connections that automatically update maintenance manuals with 3D images as design updates take place keeps rework to a minimum. In this way, 3D also reduces errors and improves quality.

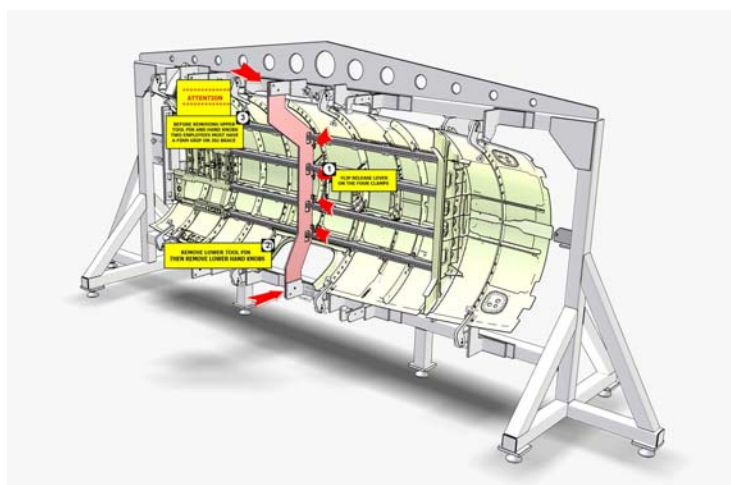
A recent report published by Aberdeen Research found that users of 3D CAD reported product profit margins that were 21% higher than user of 2D CAD. Furthermore, best in class performers in the report were 22% more likely than the industry average to meet product launch targets. They also reported shorter product development schedules due to their use of 3D CAD. Their designers experienced reductions in non-value added work that previously kept them from their design projects.

Visual representation of information also saves time in other ways. For example, work packages are assembled with most RFPs and RFQs. These work packages often include information that is best represented graphically, such as 2D or 3D CAD data, or PMI data. Huge amounts of time can be saved assembling these work packages because the parts referred to can be verified visually, in addition to the traditional tabular display of part numbers, vendor codes and the like. Assemblies of parts can be automatically grouped together by background computer programs into one or more associated work package(s), for example in RFX or change management processes, assuring all the parts are included and

minimizing errors. Consider how many RFPs and RFQs, or how many design changes take place in a large global organization daily, and the value of even a few minutes saved in each one.

Visual product data leads to faster, better communication, with fewer mistakes. Product releases, sourcing, spare parts, service, marketing, maintenance and every other downstream process is improved in a Visual Manufacturing paradigm. Part catalogs become user friendly and intuitive, with simple search tools to find parts of interest, special packaging or past purchase histories. Marketing materials use high-impact images of actual products without costly photo shoots. Web-based marketing content also has higher impact. And quality standards worldwide are more easily maintained because visual product data is all derived from a single source.

The shop floor becomes more efficient and productive. Assembly instructions contain visual diagrams and animated images of actual 3D products, which are always assured to be 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. And, because they're generated from a single source of original product data, product updates, field service notes and language translations are always consistent, synchronized and correct.



Users of 3D CAD reported product profit margins that were 21% higher than users of 2D CAD . . . They also reported shorter product development.

INTEGRATED, INTEROPERABLE WORKFLOWS

A new paradigm of integrated, interoperable workflows is emerging throughout the value chain, in manufacturing, supply chain, sales and marketing, and beyond. Where once users formed personal connections to communicate with colleagues, customers and suppliers, computer-enabled processes inter-connect workflows and data sources. Where once users extracted information manually from complex, hard to use backend systems and reassembled it in forms and tables to help make decisions, a whole new concept of visual communication is emerging. Users control their roles with interactive, visual interfaces which present the data that's important at the time, in the best format for the job at hand.

In the new visual manufacturing paradigm, backend systems are also significantly enhanced with visualization. ERP systems like SAP® and Oracle® provide critical business and supplier information, such as part numbers, latest suppliers and prices. They manage warehouse inventories, providing visibility to available spare parts and backorder status. MRP and MES systems provide the latest, accurate manufacturing information, resource plans, shop floor documentation and the latest mBOMs to make

Customer service systems are more efficient, with repairs happening faster and with higher first-time repair success rates, because visual representations of parts and assembly sequences assure correct and timely repairs. Quick-study procedures provide on-the-fly training for new or infrequent operations. Service center technicians can instantly pull up the currently installed view of the customer's products, parts and assembly. Service people are better trained, with guidance and knowledge provided through "visual" and animated instructions. Customer retention and customer loyalty increase – all as a result of visual communication and Visual Manufacturing.

When business processes and workflows require that data be shared outside the corporate firewall, next generation communications platforms enable a rich array of data security and digital rights management (DRM) capabilities. Some workflows require that access to data expires in a certain time, while others need to restrict the ability to print hardcopy output of a CAD model. Some collaborations require a workgroup to have access to the full CAD data, while others should be limited to specific users, with read-only rights to the data and no access to

The main reason for failed projects and programs is lack of formal processes around new product development and introduction.

the products correctly. Supply chain management systems manage and track RFPs and RFQs, with full knowledge of supplier status, preference and pricing history. All these processes and more are dramatically accelerated with graphical representations of product data. Customer Relationship Management systems provide up to the minute visual information about “as built” and “as installed” configurations, warranty and maintenance status, and past spare parts consumption histories.

the underlying CAD model. Modern collaboration and communication software platforms provide these and many more DRM capabilities in order to truly protect product data without preventing people from working together.

User interfaces are packaged to model underlying workflows, while being customizable to user preferences. For example, a purchasing agent's interface presents the information a procurement person needs, according to the policies of the company, along with the information to

support procurement decisions at the company. Information is presented in the “language” of the user. For example, PMI is the language of manufacturing, and CAD data and design methodology is the language of design engineering. Because user interfaces speak the language of the user, learning curves are short and users become productive very quickly.

And it all happens faster, with fewer errors, thanks to visual manufacturing. The new Visual Manufacturing paradigm enables lean initiatives by helping transform business and manufacturing processes, with higher efficiency and fewer errors. A good amount of the gain comes from standardization. As discussed earlier, process issues involve how people work together. In a recent survey of 165 global manufacturers, AMR Research found that the main reason for failed projects and programs is lack of formal processes around new product development and introduction/launch. It is also critical to standardize workflows and processes, so they can be improved and automated. Visual Manufacturing helps standardize processes, for example, by reducing or eliminating interpretation on the shop floor. This results in higher quality. We’ve discussed the huge business value of standardization. When everyone in an operation does business the same way, tremendous intangible benefits are added to top and bottom line business performance.

But there is no “one-way” – every business is different. Processes and policies vary widely, between companies and within a company. For this reason, visual manufacturing must be extremely flexible and configurable. The same toolset provides the many capabilities required to model and implement a similarly broad variety of common business processes. And it’s easy to implement and change as requirements, processes and policies change, with minimal repackaging.

And every business already has a dizzying array of computer software tools installed and keeping the corporate machine running. Software like PDM tools that support engineering, and corporate software systems like SAP that support financial, logistics, CRM and purchasing, to mention a few. An effective visual manufacturing platform leverages the capabilities of these existing tools and systems, complementing their strengths and negating their weaknesses rather than displacing or re-engineering the process. There must be minimal intrusion into the current workflows as this is the lifeblood process of these manufacturing companies) – making the whole greater than the sum of the parts, while minimizing the number of software tools required to run the business.

DATA INTEROPERABILITY

As discussed earlier, effective collaboration and communication is highly dependent on your ability to share product data. Although there has been much progress in recent years, poor CAD interoperability is still a huge barrier to effective collaboration, and remains the single largest impediment to most Lean initiatives.

The bulk of product data is CAD, comprising more and more 3D. Within the CAD department, a multitude of CAD and CAE applications have emerged, each with its own proprietary format. Users care little which format a design is in, only that they can work with it and complete the design/change as quickly as possible. In the new Visual Manufacturing paradigm, the most popular CAD formats are all available, transparently to the user. And

since most stakeholders outside of the engineering department don’t need or want CAD files, a wide array of scalable, light-weight and ultra-light weight visual formats enable any user in any application to view and manipulate product data to suit their needs. Single source, master data and MBD implementations would not be possible without access to a wide range of data formats. Users throughout the enterprise can visualize and manipulate simple, compact parts or massive 3D assemblies, including fully defined parts (metadata, MBD data, etc.) if necessary, along with ultra lightweight 3D geometry representing massive amounts of context or reference geometry.

FLEXIBLE SOFTWARE INFRASTRUCTURE

Each business is unique. Processes and policies vary widely, between companies and within a company. One company's (or even a division within a company) purchasing process differs from another, as does spare parts, service, warranty processing and so forth. For this reason, a technology that enables collaboration and communication must be extremely flexible and customizable. The same toolset must enable the huge array of capabilities required to model and implement a similarly broad variety of business processes. And requirements, processes and policies change, so the enabling technology must be able to change with it, quickly. So the software platform must be easy to implement, configurable and easily adapted to changing situations and processes.

Despite many years of technology and automation, most manufacturers continue to function as "islands of automation". Engineering has its design processes, approval processes, release controls, change processes and many other internal business processes. Manufacturing, another "island", receives drawings from engineering and develops process plans in accordance with its own processes and workflows. And production takes the resulting engineering and manufacturing designs and makes products according to its processes and available resources. Similarly, all the way down the value chain, supply chain, maintenance, and every other organization implements its own set of key business processes. In Visual Manufacturing, these islands of automation are transformed into globally integrated operations, with each functional operation tightly integrated with other stakeholders in the overall PLM strategy. And the glue connecting these users and processes together is visual product data.

In visual manufacturing, product design (and its product data) can be "connected" with process design such that manufacturing engineers can develop ideal manufacturing processes to produce the products at required quality and quantity levels with available resources. They can share visual representations of parts, or even huge assemblies, in non-CAD formats so they can optimize manufacturing processes. They can even visualize soft processes like painting and sealing, so complete high-quality production

processes are developed quickly. Design teams can also be tightly coupled with technical documentation, and with the maintenance and repair organization, so that updates and changes can percolate downstream to these respective organizations, automatically updating their respective documentation, in formats that are usable and interactive. One large heavy equipment manufacturer found that 50% of their production time for documentation was caused by non-CAD workers trying to manipulate CAD files to author product documentation. In the Visual Manufacturing paradigm, this inefficiency all but disappears.

And, product design can be tightly coupled with the shop floor so that the current released version of product data drives the actual production process, including critical but often missed subtleties like sealants and coatings, and so that manufacturing documentation is guaranteed to match the product being built. CAD systems don't model soft materials such as paints, coatings, glues and sealants well (if at all). Visual Manufacturing supports the complete and comprehensive manufacturing process. All the required data flows freely as needed between and among the people who need it (and who are authorized to see it), enabling fast decision making and standard, more efficient workflow.

Finally, visual manufacturing synchronizes engineering and other product development functions with the rest of the global organization. As changes occur in a released product design, updates should be triggered (managed by a change management process) downstream so that technical manuals, update notices, parts catalogs, and the countless other touch points in the organization are updated and synchronized to incorporate the change. Synchronicity enables concurrency and accuracy, which together increase efficiency.

One of the biggest assets of any business is the knowledge and experiences that are stored in the minds and computers of their people as they do their jobs. Yet, most companies lack a system for capturing this information. Excellent methods and technology exists to make this information available to other knowledge workers in your company, but first it must be captured. Good collaboration and communication tools should provide formalized approaches for capturing this critical asset, as processes are standardized and automated.

Significant value accrues through the process of implementation itself. Often the value of implementation is not the destination, but the path to getting there. The act of getting thought leaders in an organization to work together and agree on common processes and workflows is in itself a valuable exercise in capturing and documenting some of the knowledge otherwise trapped in the people who run the processes. This is a valuable exercise. Good collaboration and communication technology not only facilitates this process, but makes it a dynamic process that works within the context of everyday business. People must continue to do their jobs, while helping to define and refine common workflows and processes. Collaboration and communication tools should not disrupt or intrude on the process, but rather streamline and automate. They should enable implementation to be a dynamic process that automates subsets of the overall workflows while allowing people to continue to carry on the everyday business of delivering product and satisfying customers.

One equipment manufacturer found that 50% of its production time for documentation resulted from non-CAD workers trying to manipulate CAD files to author product documentation.

BUSINESS CASE

The fundamental business case for Visual Manufacturing is based on increased throughput. Quite simply, the more products that can be manufactured in the least time certainly equates directly to bottom line profitability. Throughput depends on many things, but at its most elemental level, it depends on having accurate, relevant information delivered immediately when it's needed at the right place in the right format.

Visual information delivery results in faster, better understanding. And faster, better understanding produces faster and better decisions and actions. Decision and action means faster design cycles, production turns, design changes, part orders, service calls, learning curves, and countless other beneficial results throughout global downstream operations. The value of time differs in different businesses. It could mean workers designing better products, or innovating, or more projects completed by the same level of resource (productivity), or procurement experts sourcing materials instead of looking for information. But whatever the benefit, these metrics are all measurable and form the basis of the business case for Visual Manufacturing.

They say a picture is worth a thousand words. Actually, it's worth much more than that. What is the cost of indecision or waste in your company? Consider the value of even a few moments saved in every decision or communication that goes on in a large, global company in a single hour. Or how about shaving 5 minutes off the time it takes for every person in a global supply base to understand and use the information they receive in every transaction. These are huge potential savings.

Standardization of workflows and processes has helped make many good companies great. Standardized work removes variability. Reducing variability increases value while enabling a continuous improvement process to work. Continuous improvement is proven to increase quality, speed turnaround and improve processes. Standardized processes don't need interpretation. For example, if production line workers were left to interpret

MEASURABLE BENEFITS FROM VISUAL MANUFACTURING CASE #1: HEAVY EQUIPMENT MAKER

One medium sized 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 realized a payback on their investment in nine months. Another medical equipment manufacturer found savings of

- 50% reduction in time to create documentation, faster shop floor training
- 8% reduction in time creating/revising animated training curriculum
- 30% reduction in time to produce/update Service Manuals, Operator Manuals & Service Alerts.
- 5% increase in territory coverage by field service people, representing \$5,300,000 average savings per year!

...resulting in a risk-adjusted ROI of 1486% and a payback of their investment in ten months. They estimate their monthly cost of doing nothing at \$452,040!

They experienced these intangible business benefits:

- Faster development of documentation
- Eliminated duplication of effort
- Reduced graphics search time
- Reduced language translation costs due to animated graphic procedures
- Insulate the organization from future CAD/PLM/ERP technology transitions
- Protect Intellectual Property (IP) from piracy
- Reduced training time
- Reduced risk of documentation delays
- Delivers “One-Face” to internal and external customers
- Competitive advantage
- Faster manufacturing launch time
- Rapid expansion of global footprint
- Spare parts’ orders are accurate and faster
- Collaborate remotely and in real-time with Engineering, Marketing, Manufacturing and Service to ensure designs are optimized and engineering changes are minimized.

manufacturing processes, the wrong parts and fasteners could be assembled, or they could be oriented incorrectly. Improper tools and fixtures could be used, and incorrect sealants applied. Standardization also increases quality by reducing non-conformance issues, which reduces scrap and rework. All this reduces non-value added work, saves time, cuts cost and improves product.

What is the value of experienced people? Visual Manufacturing platforms help capture tribal knowledge from the workforce and embed it into automated workflows that can be standardized and deployed so everyone can benefit. In this way, the valuable knowledge held captive in the minds and computer files of the best people becomes available to everyone and anyone in the global value chain.

MEASURABLE BENEFITS FROM VISUAL MANUFACTURING CASE #2: AIRPLANE MANUFACTURER

A large airplane manufacturer recently reduced their time spent searching for engineering data by 50%, thanks to ready-access to design data via centralized graphics repository. They also realized

- 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,
- and a 35% reduction in person-hours required to create animated maintenance manuals and interactive parts catalogs, ...thanks to their visual manufacturing implementation. And, they reduced animation creation time from 2 weeks to 2 hours. In all they estimate savings of 112,000 person-hours over five years, representing a risk adjusted ROI of 333% and an 11 month payback period. It’s interesting to note that they estimate their monthly cost of doing nothing to be \$88,262.

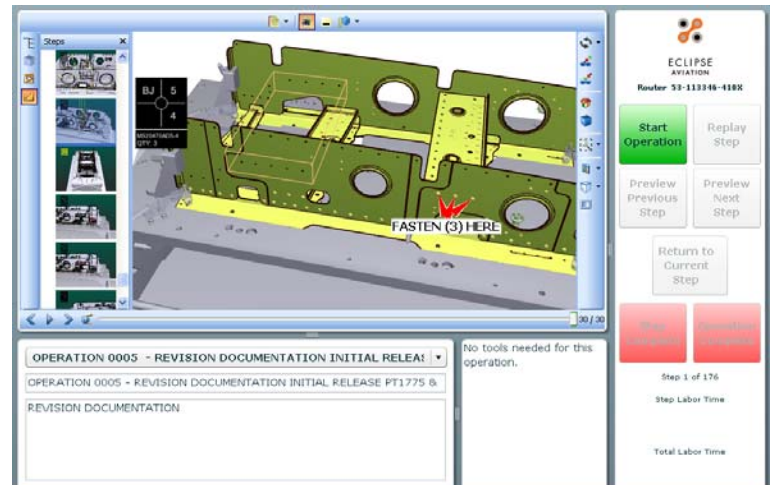
SUMMARY

The real win: visual manufacturing enables people. It enables people to work smarter, not just faster; to make better decisions and add value to the customer experience. It reduces tedium by removing mundane repetitive tasks, allowing people to do what they do best. It enables engineers to engineer, production staff to produce, sales people to sell and everyone to innovate. The people in a company are its most valuable asset. Visual manufacturing

helps extract the most value from its people – their experiences, knowledge and skills, to innovate more and produce higher quality products faster – by integrating people directly in the processes they drive and by providing the information they need, when they need it, in the form they need. Visual Manufacturing is about empowerment through the power of visual interpretation, to add value to the business and the customer.

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www.righthemisphere.com



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