How to Modernize Your Paper Engineering Drawings

A White paper from the EDM Experts

To compete in today's world, a company has to survive in a fast-growing, technologically driven environment of producing goods and services. How does a company deliver the best product or service to market at a fair price in the shortest time?

To maintain a competitive edge, a company must leverage its information assets, which include a tremendous amount of engineering documents. Tools and processes to efficiently manage, distribute, and modify these assets are essential.

International Data Corp. and *Document Management* magazine estimate that there are more than 8 billion drawings worldwide, of which fewer than 15 percent are in a CAD format. This leaves an astonishing 85 percent of drawings maintained in non-electronic format, mainly paper-based engineering archives. Considering that each successive stage in a product cycle—design, production, support services—uses substantially more documentation than its predecessor, the benefits of integrating this information grows exponentially.

The need to capture, modify, and distribute existing paper designs within the environment of today's computing technology predates CAD technology itself. The intent of this paper is to provide an insight into the issues, benefits, and strategies for capturing paper-based assets into an open archive environment.

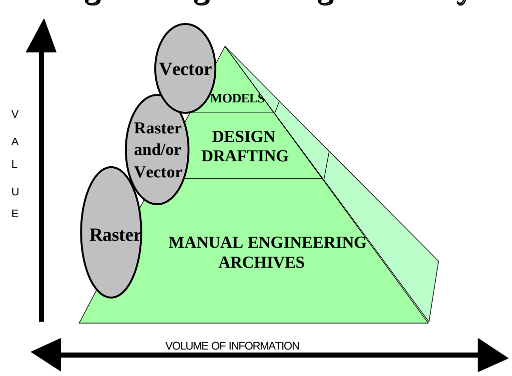
The Value of Engineering Drawings in Your Organization

The archive. A typical company has large quantities of designs which must be preserved throughout the life cycle of the product or service. Even though archived information may only be needed for reference or legislative purposes, it is highly valuable to the company that created it. Archived documentation also represents the largest quantity of information. At any time, a drawing can become active due to maintenance of an older design or because a new design resembles information created in the past.

Scanning these archives into a digital "raster" format has emerged as the most affordable and effective environment for maintaining vast quantities of drawings and related documents. Once captured, their value increases immediately as Engineering Document Management (EDM) and Product Data Management (PDM) systems can be used to manage these and other electronic files. Efficient revisions are also possible as they are now closer to CAD.

The revised drawing. Drawings within the revision cycle represent active changes or work in process. These are typically the result of an engineering change order or notice (ECO/ECN) or as-built designs. CAD provides the most productive environment in which to manage and modify engineering document. Newer designs are almost exclusively modified within the proven environment of CAD; however, a large portion of drawings are based on paper archives and are still modified manually due to the perceived costs associated with getting drawings into CAD.

Engineering Drawing Hierarchy



Integrating these older designs into CAD has created two potential environments: hybrid raster CAD and vector CAD, which is the conversion of raster to vector. The hybrid environment offers tremendous payback to the user as it leverages the past with raster imaging and the present with full CAD construction and editing.

Engineering models. Drawings with the highest corporate value are those used within the modeling and analysis environment found in CAE tools. These models require a vector database in order to perform analytical functions such as driving NC equipment, parametric modeling, automated mapping, and/or facilities planning. Integrating the paper-based archives into truly intelligent models requires the conversion from paper to raster to vector CAD or vectorization.

This process has brought about high expectations from users due to the promises of converting to an intelligent database.

Getting Started

It starts with a scan. Scanning is perhaps the most overlooked factor in the conversion process. Today's scanners provide more advanced image enhancement features, including adaptive thresholding and DSP technologies to produce better quality raster files. This is the single most valuable feature in starting the conversion process and is far more valuable than increased resolution. It is important to note that *eighty percent of all new designs are based on old drawings*.

Scanning these archives into compressed raster format allows them to be enabled for faster revisions and improved distribution. For instance, a typical "E" size drawing scanned at 200 DPI into a CALS or TIFF GP4 format will only be about 400K bytes - perhaps smaller than the original CAD native .DWG file. This process can be painless and cost-effective.

Good separation of text, quality line representation, and smooth raster geometry are also important aspects that should be considered in more detail when selecting your solution. Conversion to full vector CAD format is the most sensitive to a well-scanned image.

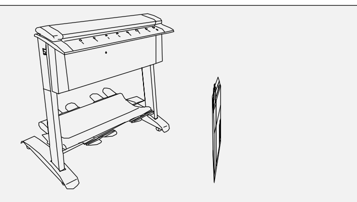
What is A Scanner? A scanner is a device that electronic images of documents. It is much like a photocopier, except that it produces electronic digital copies of your drawings, instead of paper ones.

How Does It Work? A scanner contains an electronic camera and a light source. The drawing is fed through the scanner. The details are seen by the camera which then creates an electronic file. This file is called a raster or bit-mapped file.

Much like a photocopier, a scanner has a threshold, or contrast setting. This is adjusted to produce the best electronic "copy". Usually a test scan is done to make sure that the threshold setting is good for the entire drawing, ie. the faint lines are visible and the strong lines and dark areas are not too dark.

Dynamic thresholding is a scanner feature where the scanner modifies the preset thresholding level in a given area of the drawing based on a darker or lighter background. This is a key feature for drawings with "uneven" backgrounds like faded blueprints and old sepias. Most vendors offer dynamic thresholding only on their top-of-the-line scanners. In order to have good quality and fast thresholding, the scanner should sense gray scale levels of at least 128 levels per pixel. All Océ scanners have Dynamic thresholding.

An advanced version of dynamic thresholding called "Océ Image Logic" is available on the Océ 9800, 9400 and 3000 scanners. Océ's Image Logic (a product of 40 man-years of research) is so "smart" that a pre-scan is not required. A special "photo" or continuos tone mode on the Océ 9800 takes Image Logic one step further for applications like scanning aerial photographs into a dithered monochrome image.



Typical paper and aperture card scanners

The accuracy of the scanner is measured in Dots Per Inch, or DPI. This is the number of pixels or dots that the scanner sees for every inch of paper. The higher the DPI, the more dots that are produced, *and the more accurate the scan is.* Typical resolutions are 200, 300, or 400 DPI. The higher the DPI setting, the larger the resulting electronic file will be.

Some scanners have the ability to interpolate or expand the scanned DPI to very high resolutions. Make sure that the true optical resolution of the scanner you wish to use is high enough for your needs. Most archival and raster applications are best served at 200 Dots per Inch.

High-density vectorization applications like contour mapping and GIS are best served at 400 to 800 DPI.

There are many types of scanners that are capable of scanning A to E size paper (and larger) or aperture cards. When choosing a scanner take a close look at the operating software for key features like viewing, despeckling, hole filling, batch naming and overall usability. Many vendors demonstrate scanners with CAD generated drawings - bring your own 4 to 5 typical drawings and one or two of your "killer" or worst case drawings. Request to bring back to your office the CALS/Tiff files created and a hardcopy print of each. Use the hardcopy to compare scan quality among various scanners and vendors.

Raster File Types. There are a wide range of standards and formats for raster files. File types are split into two broad types: compressed and uncompressed. Come common file formats are Group 3 (used in Faxes), Group 4, and Tiff Compressed. Common uncompressed formats include PCX, RLC, and Tiff Uncompressed. There are also several standards used by government and military organizations, such as the CALS standard created by the DOD and used throughout commercial industry. These standards are usually applied to existing formats, producing file types such as CALS Group 4. The most popular raster formats in the engineering field are the CALS and Tiff format, both utilizing the CCITT Group 4 compression method.

Compression Methods Data compression techniques have emerged in the market to allow raster based drawings to be stored is less storage space than a 3-D CAD file. This is due to the use of two-dimensional compression which can reduce and 8 MB uncompressed raster file to approximately 100 KB without any loss of information. Small file sizes also bring the added benefit of quick file retrieval over your network, thus significantly reducing the time to plot or view a raster file stored on a remote server.

A relatively new specialized IC chip set called DSP (Digital Signal Processing) has been designed to compress and uncompress raster data extremely fast. DSP chips are used in scanners to quickly compress the raster file created by the scanner. Plotters designed for "print-on-demand" EDM applications like the Océ 9800 and 9400 are also utilizing DSP technology to receive and uncompress Tiff/CALS Group 4 data for quick plotting/printing.

Viewing. A viewer is a software package that allows you to look at documents without having to use the original application that created them.

Viewing technologies offer a natural approach to integrating paper archives and CAD in a distribution function. In many cases, companies already maintain an active non-graphical database of drawing revisions. This database can be leveraged and “viewer enabled” to provide the graphical link between paper and CAD-based designs. As movement is made toward EDM/PDM, the viewer can be integrated at an API level (Microsoft standard for communication between software applications) for direct communications with EDM/PDM systems.

Introducing a viewer is a simple, inexpensive way to link scanning with the ongoing build of your total solution. A small investment in powerful viewing software package offers immediate benefits with little capital outlay and minimal training time. The right viewer can help you increase access to information, speed time to market, streamline workflow, comply with ISO 9000 and OSHA standards, and review and process change requests rapidly.

Look for speed, simplicity, and the ability to view multiple formats such as your CAD, spreadsheet and word processor's native file formats when selecting a viewer.

The ECO/ECN process can become involved by introducing users to the concept of redlining and integrating redline annotations on all drawings (raster and vector CAD-based) that are now contained on-line. More sophisticated editing systems can use the approved redlines as tools to facilitate accurate and timely revisions. As workflow is introduced, the process is enhanced further with a more controlled approval procedure.

Viewing and redlining software tools are available from Informative Graphics (Myriad), Expert Graphics (RxHighlite) and Spicer.

Printing/Plotting. With drawings now in an electronic format and the ability to view them comes the need to print/plot them out. There are basically two types of needs - individual user's print-on-demand for a few prints and requirements to print out numerous sets of drawings.

Many plotter and printer vendors now provide Windows 3.1, 95 and NT PrintManger Drivers. These drivers allow the user who is using the viewing software package to make a plot to the local or remote plotter. This type of print driver will also operate from within any Windows application. This works well when you want to print what you are viewing.

User's with more complex printing/plotting requirements such as a making 20 collated sets where the set has 50 drawings (1000 total prints) will need access to sophisticated printing software applications that print on a centralized high speed plotter like the Océ 9800. Typical print room application software allows the user to define a set of drawings at his workstation and make specific choices regarding the output. Choices such as which scale to print at (full or half-size), which media to print on (bond or vellum), leading or trailing media edge (for binding), folding method, or even notes telling the operator where to distribute the completed sets. EDM print room software applications are available from PageMasters (Apprentice), Intergraph (IPLOT Organizer), Groupware (PIM), TSA/Advet (Falcon), Formtek (QuickPlot) and performance plotter vendors.

Coming together, raster and CAD. With drawings now scanned, viewing and plotting processes in place, raster or hybrid-based drafting can be added allowing CAD systems to make revisions to existing paper drawings. The result is increased value from CAD even before a full EDM/PDM system is in place. As EDM/PDM is implemented, full management of the ECO/ECN process can be realized.

Re-engineering the Paper Trail

Considering that seven to 10 percent of companies' operating expenditures are spent on a manual document management process, re-engineering the flow of information, or paper trail, throughout an organization can have tremendous savings. Not only can designs be produced more efficiently, but also customer support expanded and rightsizing demands met through leverage of information assets and reinvestment strategies

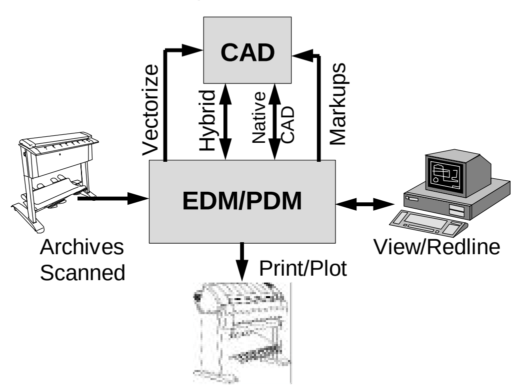
The archiving advantage. Through the implementation of a managed engineering digital archive, searching time as well as re-engineering time becomes past history. This translates into real dollar savings. Substantial savings can also be realized in a managed revision process. The reliance on manual drafting and control of drawing revision on older documentation can be put to rest.

The CAD advantage. CAD has already proven itself as a tool to design and maintain product and service documentation. Applying this tool to archived resources allows the CAD advantage to be applied completely. These electronic drawings can then be quickly revised, modified, plotted, or copied in a fraction of the time it takes to modify paper designs. The design process can become highly streamlined, providing substantial cost savings, improved product quality, and faster time to market.

The document management advantage. Once files are in electronic format, document management can be used to further increase and enhance productivity. Options range from a simple file storage system with limited revision tracking to a system that securely controls viewing, editing, and distribution of all engineering-related information.

Many organizations are required to comply with standards and regulations that virtually necessitate electronic document management. According to the British Standards Institute, 47 percent of ISO certification failure is due to poor documentation control. Cost and time justification can be realized by improving the ECN/ECO process and achieving ISO 9000 certification In addition, AEC firms are feeling regulatory pressures for process safety management, and OSHA 1910 regulations are demanding improved management of document control processes.

Paper Integrated CAD/EDM/PDM

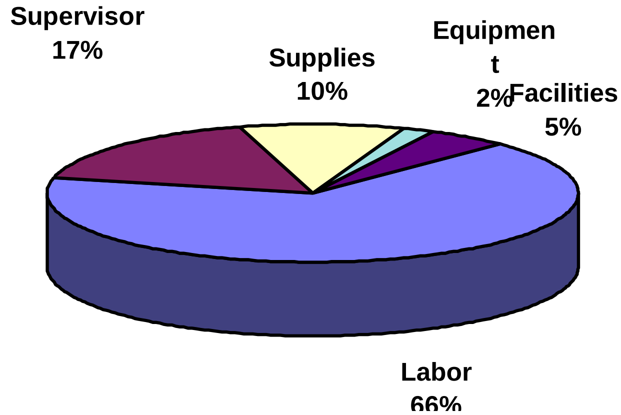


The workflow advantage. Workflow tools provide even greater value in meeting OSHA and ISO demands. Cost benefits of workflow products are far greater than those provided by document management tools alone. Workflow is the final enhancement to a paperless environment, enabling company-wide document management from scanning the document to viewing, redlining, tracking, and archiving.

The Hidden Costs of Paper

Manual methods of handling, storing, retrieving and maintaining paper drawings are difficult, time-consuming, and costly since most information is still in paper form. The following are some of the most obvious problems with maintaining paper archives:

- Paper drawings, vellum, bluelines, and other media are susceptible to aging and damage over time.
- Manual-based revisions are costly, particularly with drawings requiring frequent updates.
- Paper is slow to distribute. It takes longer to copy and distribute a single piece of paper than it takes to distribute or reproduce several documents electronically.
- You may be fully modernized, with a full suite of CAD software, but what about your contractors, subcontractors, and business partners? Many transactions between companies are inefficiently conducted with manual archives even when the originals may have been CAD files.
- Paper is cumbersome. It is often hard to find specific information in specific documents. Electronic searching is more efficient and faster.
- Paper is restricted in format. It is limited to graphics and text, while electronic documents can contain hyperlinks, audio, and video.
- Paper is static. It can be out of date even before it is distributed because of lengthy release cycles. The added concern of who has the most recent revision exacerbates this problem.



- Facilities costs for the storage and maintenance of paper archives can be substantial. Justifying a document management system can be based on significant reductions in facility costs alone.
- Paper gets lost. It is estimated that five to seven percent of technical assets are lost or misfiled using manual procedures for handling paper drawings.

Why Keep Paper?

Paper does still offer some advantages, the key is to use the proper method of communicating information based on the application. The following are some of the more obvious advantages of paper:

- Technology independent - can be viewed, copied and edited without computers. This is critical for some applications like field construction.
- Excellent for checking elements of information between drawings in a set. Checking large D/E drawings and paging between drawings is to difficult and cumbersome even on 19" monitors.
- Easy to mark up field as-built changes or reference material for field and manufacturing applications.
- Reality is that for heavy reviews people prefer to read/review paper vs. a monitor.
- Legal requirements of DOD and state governments may dictate long term archival on aperture cards or mylar film.

Integrating Paper with CAD

The earliest implementation of computer-aided design (CAD) was conducted in the 1950s to solve one simple problem: Modify existing drawings electronically. A flying spot scanner converted microfilm data into an electronic image. While scanning remained a cost-prohibitive option, interactive computer graphics and CAD evolved into an enormous tool for creating newer designs.

With the emergence of standards for storing drawings in raster format, and the emergence of cost-effective scanning hardware and services, the raster environment came of age in the early 1990s. Today there are a number of methods you can use to get your paper archives or "BC" (Before CAD) designs into the design and drafting environment of your CAD system.

Manual redraw. Manual redraw means exactly that: Just place your drawings on the desk by your CAD system and redraw them from scratch. A complete redraw of the original drawing is, and will always be, the most accurate method of conversion. It requires little capital outlay, as you have already bought your CAN system and can be useful to convert small numbers of simple designs. However, it is extremely time-consuming and a poor use of your CAD system. Your investment in CAD should not be to create designs that already exist.

Digitize. Digitizer tablets are a common CAD peripheral. Place your drawing on the tablet and u se the puck to trace over the original design with your CAD system. This method is faster than just redrawing the design, but it is prone to errors and still labor-intensive and slow.

Utilize a service bureau. Outsourcing to service bureaus is a common method for handling small jobs, pilot projects, or quick turnarounds. You save on resources and have little to no capital outlay for equipment. Bureaus typically use one or all of the methods listed here. These services, however, may not meet the security or design needs of your company. Be sure to choose your partner based on their experience and knowledge of your design practices and needs. Remember that the cost of conversion is directly related to the quality of the end result.

Scan it. Scanning paper drawings to work within the proven environment of CAD and the emerging environment of EDM or workflow offers the most control in the transition from paper. The scanning process can be customized to fit the individual drawing or its application. Scanning has been successfully implemented in both large and small companies to solve integration problems between paper and CAD.

Once the drawings have been scanned, their value increases because of the three principal ways to use the newly scanned design in a CAD system. The following section outlines three revision methods available.

Raster vs. Vector

CAD systems use vector files; scanners produce raster files. What is the difference? Raster files are fundamentally different from vector files.

If you draw a line within your CAD software, it is stored as a vector primitive. The software "knows" the starting and ending points and the line thickness. The line is "intelligent" because any part of the line "knows" that it is part of the line, and "knows" what the rest of the line looks like.

When a drawing is scanned, it is broken down into row after row of dots, or pixels. A scanned line is "dumb" because it is made of dots or pixels forming the shape of a line, and the dots do not "know that they are part of a line. For scanned data to be used and modified like CAD data, it has to be made intelligent.

The Revision Cycle

Raster drafting. Raster editing or drafting is the simplest and most productive way to modify scanned paper drawings. It is the lowest cost method to enable the drawings into a format where changes can be made. This is supported by the availability of many scanning service bureaus and the recent price breakthroughs of large-format scanners. Raster drafting works best when simple updates are required in non-dimensioned or analysis-oriented drawings.

Raster editing tools are also used as a "clean-up" station after scanning. The raster editing application is used to clean and edit dark areas, clip or edit out unwanted information, run a specific algorithm to despeckle or hole fill data. Some products can even smooth scanned line art. A number of raster editing products are available on the market including such as Expert

Graphic's (RxSpotLite), Intergraph's (PixelPro) and Spicer.

There is significant differentiation within the software products found in today's market in terms of features, functionality, and positioning. The more advanced products are capable of snapping to or selecting and manipulating raster "entities" just like vector CAD entities. Some packages are specifically positioned for niche applications, such as mapping, which requires distortion correction to update drawings for world-coordinated systems.

Conversion to vector. Drawings with the highest degree of corporate value are those used within Analysis and Modeling systems. These need to be in a fully vectorized format. Some examples: a company may need to develop a 3-D model from an old drawing and run FEM or interference checks within the model; or a city planner is looking at developing a new building and needs to use 3-D terrain models from old paper drawings. Both environments require vector CAD models in their purest form and consequently require full conversion to vector.

The process of automatically converting the scanned image into a CAD drawing is called raster-to-vector conversion, or vectorization. Tools are available to perform this function in an unattended batch manner, or operator-assisted with line following or selective conversion processes. Conversion software will not produce an unattended 100 percent conversion. It is best used as a component of the conversion process rather than a total solution.

The tools used to vectorize are:

Overlay tracing. This is often referred to as heads-up digitizing. A scanned image is loaded into the CAD system as a backdrop and the image is "traced" over with CAD entities. This is very similar to the idea of digitizing but a digitizer table is not needed.

Overlay tracing is quicker than a complete redraw, but is still labor-intensive, tedious, and time-consuming. It is a good option when working with poor-quality drawings. Raster snapping and heads-up digitizing improve throughput and accuracy over traditional hand-digitizing methods which are still widely used.

Batch conversion. Batch tools work with a set of predefined rules to recognize unique settings such as text classification, width separations, and geometrics. This works best when drawing quality is very good, drawings are consistent, and the desired result is basic primitives. Results of batch systems will often require clean-up to ensure the converted drawing meets the needs of the user. The best application is for contour lines on maps. Batch vectorization products are available from VP MAX NT and Expert Graphics.

Selective or interactive conversion. This is the most promising of the CAD conversion techniques. It combines the intuitive knowledge of the user with an interactive line-following or selective conversion process. These tools allow an operator to isolate selected geometry and text, then work within the limiting factors of the technology.

As an example, a topographical map is converted by selecting a raster contour, then the software vector traces it to an intersecting or gap position. This process is repeated for the entire trace. Then an elevation is assigned to make it a 3-D model for the GIS system to take over.

Hybrid process. A fully hybrid approach is one where scanned archives and CAD systems are maintained for a drawing. The term hybrid in this case means a combination of both raster (scanned) and vector (CAD) drawings. Hybrid editing means using both raster data and vector data simultaneously. Changes can be made within either environment. Information can be exchanged back and forth between two distinctive formats, thus offering the most efficient method for modifying the old within the new.

Calibration between the raster database and vector drawing model is typically provided with a reference or resource file. This file contains scaling and coordinate transforms to provide a real-world coordinate system on an otherwise unintelligent raster database.

Deteriorated drawings can be scanned, cleaned up, and stored in raster. Modifications can be made to the drawing in raster or areas of the drawing can be converted into CAD vectors as it becomes necessary. This combination of raster and vector can also be plotted and stored within more advanced EDM/PDM systems.

Working in a hybrid environment allows use of the scanned drawings immediately. Decisions to modify, plot, or vectorize can be made as needed. Investing time and money to convert existing drawings can be done on a “just in time” basis.

With reduced labor costs and improved usage of CAD, the benefits of revising drawings electronically are clear. What may not be clear is the trade-off of investing in the upfront conversion to full CAD vs. taking advantage of lower cost hybrid and raster CAD systems. Commercial hybrid editing systems include GTX (RasterCad) and SoftDesk (CadOverlay) for AutoCad users and Intergraph's I/RAS B for MicroStation users.

Integrating Paper with EDM and PDM

The promise of capturing, managing, digitally reproducing, and distributing documentation has long been a goal of organizations such as manufacturers, utilities, and AEC firms. EDM (Engineering Drawing Management) and PDM (Product Data Management) have reached a point of necessity for companies to remain competitive, improve product quality, and meet rightsizing requirements. More efficient operation of an organization’s greatest asset, information, is a primary benefit of instituting an EDM and/or PDM system.

Re-engineer the Paper Process. While companies have focused on improving the individual productivity gain by implementing task-oriented tools like CAD or word processing, scanning a company’s paper assets and implementing EDM/PDM can enhance the business process. Reduced product cycle times and lower cost goods represent the kind of business process issues affected by implementing an EDM/PDM system.

Reduce drawing life cycle costs. Creating an open environment for drawing archives requires an organization to incur a one-time cost of scanning paper archives into an electronic environment. However, once implemented, savings are realized throughout all phases of the produce life cycle. Considering that the amount of technical information grows exponentially more throughout each successive phase of the product life cycle, the savings can easily accumulate to provide a substantial return for the maintenance, archiving, and revision of paper assets.

Cost-Benefit Analysis

Scanning drawings to digital raster form is essential to realize benefits from the methods provided in this analysis. The justification for scanning to a raster image can be easily made when looking at the value of managing the documents, savings in facilities costs, and improved document accessibility throughout the organization.

Cost justification of the various technologies described in this paper is most measurable when based on labor savings in the revision process and improved information access and management.

Revision costs savings. The costs associated with revising drawings are dependent on the method and solution used. The four methods presented here include manual, CAD digitize, hybrid raster/CAD, and full vectorization to CAD.

Costs are incurred with each individual revision and include the cost associated with capturing the document to a digital form unless the manual method was used. Therefore, the true cost is calculated by combining labor rate and time spent on each revision plus the digital transformation expense.

In an article first appearing in Document Management magazine, the inherent costs to recreate and revise a complex drawing, using each of the methods we have discussed, were compared. The comparison considered both the initial capture time, various labor rates, and the time associated with making revisions to the drawing once it had been captured. The hybrid raster/CAD approach, which eliminates the redraw, cleanup, and verification processes, offers the greatest immediate cost benefit for the first revision and beyond. Drawings required in a vector CAD environment are best served by full conversion methods.

A simple cost-benefit example in which a company has 100 drawings with 20 ECO's to perform each month can be used to give an example of the benefits of the raster-enabled approach presented in this paper. Various labor rates are used for each discipline. Actual numbers should be determined for individual organizations.

Cost benefit comparison of raster enabled ECO process.

Action	Times Per Month	Manual minutes	Raster Enabled	Burdened Rate	Savings
Find a Drawing	100	1	.05	$50	$4,750
Find related ECO	20	1	.05	$50	$950
Approve ECO	20	4	.5	$50	$3,500
Update to Rev B	20	3	.1	$50	$2,900
Confirm Changes	20	1	.1	$50	$900
Distribute Latest Revision	20	3	.1	$25	$1,450
				Monthly Savings	$14,450 month

Intangible benefits. The direct benefits of integrating paper within EDM/PDM and CAD are based on labor savings in the revision cycle. However, there are many intangible benefits:

•An increase in the value of CAD by eliminating its use for tedious redraw. CAD can now be used for productive design and analysis functions.

•A common electronic database.

•Reduced retrieval and print times for documents with a document management solution.

•Improved information flow with workflow and E-mail tools.

•Improved conformance to the ISO 9000 or OSHA regulations by instituting better document control procedures.

•Increased value of paper drawings through integration with CAD and EDM/PDM tools.

•Fewer lost, damaged, and misfiled documents.

•Immediate availability of accurate information.

•Streamlining of the change process.

•Improvement in the time to market.

•Increased quality.

ADD Value to Drawings. The overall benefit to organizations of scanning paper drawings is to increase the value of the company's most valued asset, information. Once captured into electronic form, drawings can be used for many functions, such as maintenance and material control, project management, quality assurance, and purchasing.

Making It Work

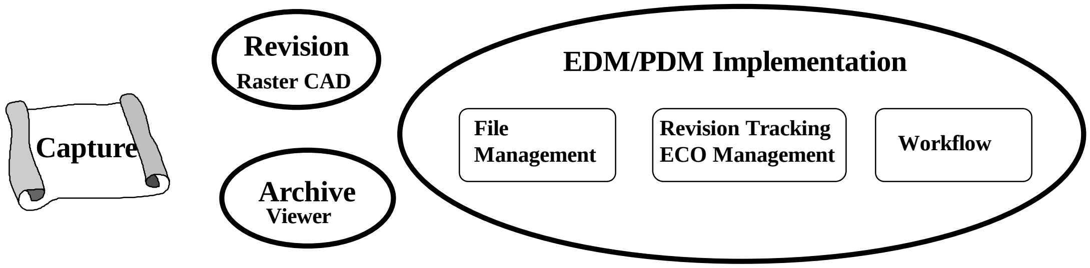
Once you've made an implementation decision, how do you ensure the success of enabling your paper drawing archives or EDM/PDM system?

With long implementation cycles for an enterprise-wide EDM/PDM system, payback and user acceptance can drag and stall throughout the initial stages of a full-scale implementation. The integration of manual paper-based archives as a first step can help companies to successfully implement such a system. An incremental approach can produce a more immediate payback and faster end user buy-in.

Plan Globally, Invest Incrementally. This simply means to look at the broader business issues related to the life cycle of paper drawings. Select the most critical business issues and implement the appropriate technology while planning for the bigger issues of document management and workflow systems.

A paper-enabled approach incorporates elements of EDM/PDM before deploying a full-blown system. This step-by-step process allows payback benefits to be realized while addressing the integration of the vast amounts of paper designs within CAD and introducing an electronic distribution environment. The value of the drawings increases along with existing drafting systems by implementing hybrid or raster CAD systems. This allows scanned archives to be manipulated within the same tool set used for newer design work.

Many organizations initially look at implementing a digital printroom. This approach sets



achievable short term goals of improving the productivity of the print room and the methodology of making print requests. It also necessitates the implementation of a digital archive and the basic search, view and print functions of the EDM system. Transitioning from labor intensive ammonia diazo copiers to high speed on-line plotters will provide the printroom or records manager with quick deliverables in the form of higher productivity and better response to his user community.

A more critical evaluation of the EDM/PDM backbone can be accomplished while enabling the initial conversion process. Users have more time to model workflows, design ECO/ECN processes, define security requirements, and determine other control issues best handled by EDM/PDM.

Paper-Enabling PDM. Companies with more progressive implementation strategies may have already taken the approach to implement PDM to help manage the existing CAD/CAE environment. Most PDM systems can be expanded by adding raster-literate viewers and hybrid raster editing systems to allow the vast amounts of paper archives to be managed by the same system in place to manage CAD.

Use a Consultant. Consultants can offer your company a broad range of expertise that comes from working with other, similar companies. A consultant can help with needs analysis, training, selection process, and implementation. Ask for reference accounts with needs similar to yours.

Include the User. Include your user community through the various phases of implementing this technology. Your users can provide extremely valuable insight as to where to put your resources and which steps to implement first. This will improve the acceptance of the technology and the overall payback to your company.

About the Author

David J. Wilson is principle of Open Archive Systems, specializing in paper-enabling consulting services and proven solutions for implementing document management and raster/CAD systems. Open Archive clients include reseller partners, manufacturing firms, utilities, state and local governments, and architectural firms that require raster enabled solutions.

Currently, Mr. Wilson works with major accounts including NYNEX, General Dynamics, Cummins Engine, Southern New England Telephone, Dresser Rand, Motorola, and AEG/Modicon, providing consulting and technological services. He frequently lectures and writes on integrating paper within the CAD and EDM/PDM environment.

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