A Facsimile Report

Reproduced by

UNITED STATES DEPARTMENT OF ENERGY

Office of Scientific and Technical Information

Post Office Box 62 Oak Ridge, Tennessee 37831

CONF-880719--6

UCRL--98333

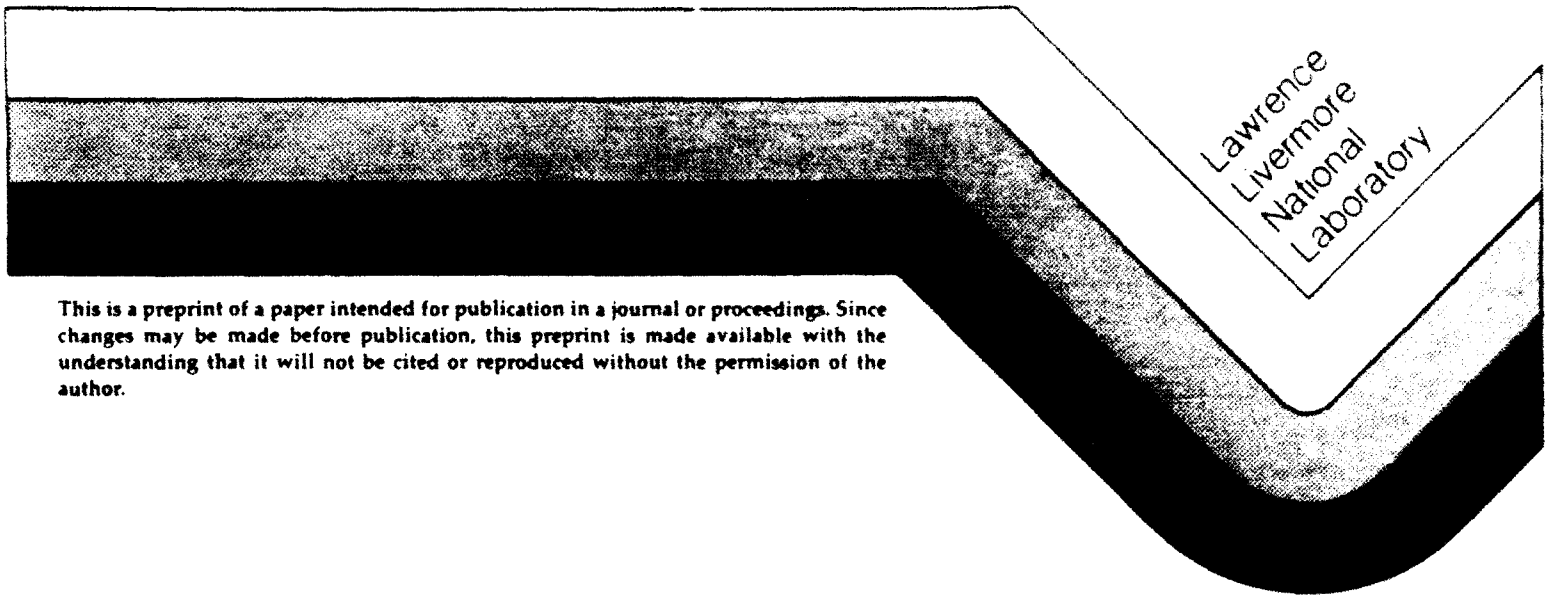
DE88 009050

Challenges in Product Definition Management

Stanley R. Trost

This paper was prepared for submittal to
ASME Computers in Engineering Conference
San Francisco, CA August 1-4, 1988
July 31 - Aug. 3, 1988

April 14, 1988



CHALLENGES IN PRODUCT DEFINITION MANAGEMENT*

Stanley R. Trost

Lawrence Livermore National Laboratory

ABSTRACT

Lawrence Livermore National Laboratory (LLNL), together with other DOE agencies, is participating in a multi-year program to provide full CIM capability across four design laboratories and seven manufacturing plants. We have gained substantial experience in computer aided design, secure electronic transmission using the IGES standard, and transferring designs to our manufacturing partners.

Two major shortcomings exist in current implementations: 1) IGES is insufficient to meet our needs and 2) database management and archival technologies require much more effort. We are addressing the first concern by active participation in development of the Product Definition Exchange Standard (PDES). We are also actively pursuing solutions to the second problem; we have learned that the ultimate development and application of PDES will effect data base management and archival.

New challenges emerge in an electronic environment. Among these are the merging of corporate and engineering databases, lack of industry standards, many new archival technologies including optical and magnetic media, and different data formats (raster, IGES, native CAD, plot). We must learn to manage 3 dimensional geometric data in addition to flat drawings. Producing new standards to help promote these technologies is vital.

We are approaching system design and implementation by application of a multi-layer model of the drafting and records environment. This logical model lets us break down requirements into easily understood and managed entities. Included are views of the drafter, drafting room, project, and entire laboratory. This paper discusses this model and implications for other organizations.

*This work was performed under the auspices of the U. S. DOE by Lawrence Livermore National Laboratory under contract No. W-7405-Eng-48.

INTRODUCTION

Lawrence Livermore National Laboratory (LLNL), together with other DOE agencies, is participating in a multi-year program to provide full CIM capability across four design laboratories and seven manufacturing plants [1]. Our goal is to design in an all CAD environment, transfer the design to manufacturing engineering and operate on the resulting data base. We have gained substantial experience in computer aided design, secure electronic transmission using the IGES standard, and transferring designs to our manufacturing partners.

We face many difficult technical challenges. In particular, the Initial Graphics Exchange Standard (IGES) standard, while showing the possibility of enabling CAD file exchange between dissimilar systems, has severe limitations. We have also found, that in many cases current technical capabilities are insufficient to meet new needs. For example, three dimensional data cannot be completely represented on two dimensional surfaces.

The second set of challenges, while not technically demanding, are proving harder to overcome. Namely, peoples resistance to change, lack of confidence in new techniques, and the inertia of several centuries of doing things the same way are severe obstacles to moving forward.

This paper outlines common issues faced by all industrial organizations, discusses many new challenges, and describes possible solutions. The Product Definition Exchange Specification (PDES) initiative promises to provide a rigorous foundation for future product definition. We touch on PDES and its implications.

We are approaching system design and implementation by application of a multi-layer model of the drafting and records environment. This logical model lets us break down requirements into easily understood and managed entities. Included are views of the drafter, drafting room, project, and entire laboratory. This paper discusses this model and implications for other organizations.

DESCRIBING THE PROBLEM

This paper describes our approach to making the transition from the paper world to the new electronic world. Many new user demands, new technical requirements, and peoples resistance to change complicate the problem. Consider the state of engineering documentation pre-CAD.

The paper world

Most engineering organizations manage drawings in a central print room or vault. The print room is responsible for archiving drawing masters, ensuring revision control, managing drawing distribution, preparing washoffs for new modifications, and similar functions (figure 1). In addition to engineering drawings, the print room assumes responsibility for specifications, procedures, material lists and similar documents.

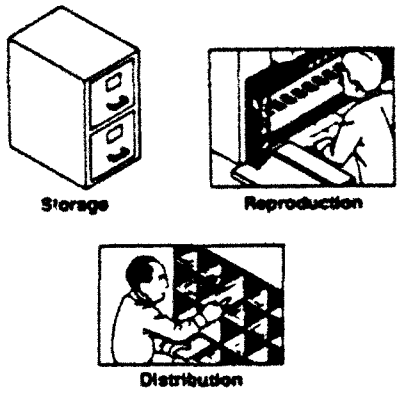


Figure 1. The print room is responsible for drawing storage, distribution, revision control, and other functions.

The metric in the paper world is the drawing. Drawings are usually thought of as sheets of paper of standard size. (Most organizations use A, B, C, D, and E size sheets, whose dimensions are well known and accepted.)

The archival medium for the paper world is usually film, prized for its longevity. Note that reduction to small film size and enlargement to original size are accomplished by using standard photographic equipment -- equipment in most cases that has not undergone physical changes in many years.

The electronic world

The electronic world is complicated by a plethora of CAD systems, none of which have native file compatibility. Often, different software revisions from the same CAD manufacturer are not guaranteed to maintain file compatibility. Further, many CAD systems use three dimensional geometry as the basic unit; this geometry can't be completely represented on paper.

We have noted that drawings are the metric in the paper world. A different metric applies to the electronic world; namely the basic unit is the file. Files can be drawings, but may also be electronic representations of specifications, standards, procedures and other engineering documents.

The new print room

CAD users, CAD managers, print room and engineering managers face a common problem - managing the transition from paper to an electronic world. New challenges emerge in an electronic environment [2]. Among these are the merging of corporate and engineering databases, lack of industry standards, many new archival technologies including optical and magnetic media, and different data formats (raster, IGES, native CAD, plot). We must learn to manage 3 dimensional geometric data in addition to flat drawings. Producing new standards to help promote these technologies is vital.

FACING THE ISSUES

Managing product definition means much more than automating the print room. A systems approach must be taken to define the problem, establish the requirements, and recommend a solution. LLNL's experience is similar to many organizations. We are moving toward automated product definition management in a careful and controlled way; we have identified a number of current issues as well as many new challenges that must be met.

Many different CAD vendors

Early on, we standardized on one CAD vendor. This simplified acquisition, training, and system support. However, capabilities of CAD vendors have increased and there are many new companies in the market. Futhermore, emergence and acceptance of PC based CAD systems has rapidly proliferated the number of systems in use. It is no longer reasonable to expect that a single vendor solution will suffice.

Because the native data formats of various CAD systems are different, any data management system must be capable of handling a wide variety of digital data description. At this time, there is no industry standard neutral data format that will suffice.

Paper and electronic systems must co-exist

Even though CAD system usage increases, there will always be the need to manage paper drawings as well. This includes established designs, as well as new ones. System requirements must recognize that paper and electronic systems will co-exist.

Maintaining security

All organizations, whether DOD contractors, or industrial firms needing to maintain trade secrets, must be conscious of computer system security.

system design must ensure that electronic archives are accessed by only authorized users. If electronic distribution is used, data outside the print room must be protected.

Cost tradeoffs

Modernizing a print room so that it can handle electronic data can involve considerable expense; traditional capital allocation methods must be applied in deciding how much and how fast to fund the new endeavor. It may be possible to defend a return on investment analysis through reduced labor costs. Our experience, however, is that improved productivity will not justify the required investment. The cost tradeoffs must be weighed with other engineering investments including new CAD equipment, computer aided engineering systems, and new research and development activities.

Resistance to change

Peoples resistance to change continues to plague conversion to modern electronic systems. Nevertheless, new electronic CAD systems cannot be adequately managed using traditional paper oriented print rooms. Management must face the cultural challenges and move forward.

THE MOUNTING CHALLENGES

As depicted in figure 2, CAD/CAM and electronic data management lead to a number of mounting challenges.

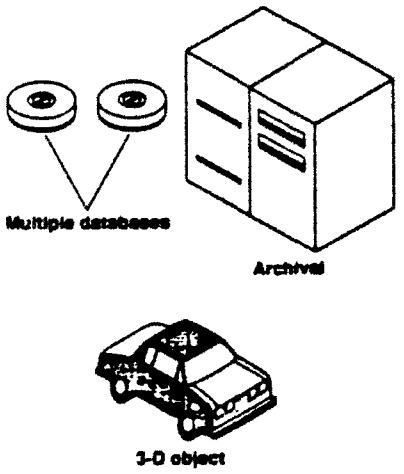


Figure 2. Electronic systems lead to a number of new challenges including multiple data bases, archival issues, and the need to handle geometric files.

Multiple data systems

Multiple data sources exist within the engineering organization; in addition to multi-vendor CAD systems we find materials property data bases, procurement data bases, and engineering standards. There may also be several departmental computers, with different databases and database management systems on each.

Merging corporate and engineering data bases

As the information content of engineering databases grow, there will be overlap and redundancy with the corporate data base. For example, material suppliers will show up in a bill of materials database, inventory database, and accounts payable database. Good database design requires consistency among all these; eventually, they should be merged as a single entity.

Finding an appropriate archival medium

Paper and film are the current archival media for engineering drawings. Print room managers assume that new optical disk technology will provide the appropriate future media. Magnetic media is also acceptable, provided it is periodically updated.

Note, however, that digital archival requires that equipment be available to reproduce the stored data. In the 1960's, digital tape density was 556 bits per inch; today it would be impossible to find a tape transport that would reproduce data recorded on a 556 bpi tape drive. People implementing archival technologies must keep future reproduction in mind - this may necessitate periodic updating to new standards.

Finding an appropriate archival format

Defining an appropriate archival format is a formidable problem. Native formats will not suffice for several reasons - vendors releases may not be compatible; companies may change vendors; vendors may disappear. Figure 3 illustrates issues related to electronic file archival.

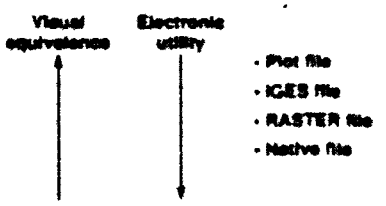


Figure 3. Many different file archival methods have been proposed. The drawing illustrates increased visual equivalence with decreased electronic utility.

Many companies are counting on the IGES data format as an archival means. However, current IGES technology is not sufficient to guarantee full reproduction in either a visual or machine readable format. Several other possibilities exist including HPGL or Calcomp formats (industry standard plotter formats), CCIT raster formats, and other common display formats. PDES may offer a future archival standard.

Managing geometric data

As previously stated, three dimensional geometric models cannot be managed with two dimensional methods (paper, flat files, etc.). This means that three dimensional storage methods must be available for complete data management. While plotter and

master formats will work for partial visual representation, complete digital descriptions will be necessary for product data.

INDUSTRY STANDARDS, PANACEA OR HOPE

We have touched on standards as offering industry wide solutions to common engineering problems. Well thought out standards, with wide industry support, can work. All too often, however, standards do not deliver on their promise. Below are some important standards you should consider as you develop your information architectures.

The Pandora's box (IGES)

The Initial Graphics Exchange Specification, (IGES), offered promise that different vendors CAD systems could interchange data. The IGES committee, working with the National Bureau of Standards (NBS), has raised its specifications to level 4.0. Inherent CAD system problems including different basic geometric entities, different usage by drafters, and varying engineering and drafting standards, have kept IGES from meeting its full potential. Most systems adequately exchange geometric information, but have difficulty with text fonts, certain drafting symbols, and similar items.

As mentioned above, the IGES data format has been tried as an engineering archival format. However, limitations noted in the previous paragraph preclude IGES as a serious contender.

PDES - Another Pandora's box ?

Individuals active in the IGES community have spawned a higher level activity - the Product Definition Exchange Standard. PDES is viewed as a standard to allow complete product definition description thus enabling design, transfer and archival. There is intense action at the national level attempting to define PDES. The Air Force CALS program is actively sponsoring PDES as a future standard.

LLNL is a participant in the PDES specification process. We hope that national activities will lead to a useful standard. Only time will tell how successful it will be.

Vector and raster formats

We touched on the possibility of using plotter formats for an archival technology. Many of these formats have existed for a long time; their stability offers promise of an effective archival specification. LLNL believes that appropriately chosen standard formats can be used as an interim specification for visual storage.

How you should approach standards

We believe that industry and national standards are very important components of engineering; in fact they are necessary for survival in a competitive world. PDES appears to be the most important emerging standard; we recommend active participation in developing and validating this new standard.

A NEW MANAGEMENT MODEL

The data management dilemma

Managing engineering information requires intensive thought, investigation, planning, and eventually commitment of resources. Proper balance between the needs of the drafter, engineer, print room, and corporation are needed to develop the new system.

Data management in the paper world

The traditional paper based print room serves as the drawing repository and distribution point. Print rooms are a production facility oriented around reproduction services. Archival technology is well known and understood. Careful thought shows that straightforward extension to an electronic world is not practical nor desirable.

A new model for the electronic world

We have developed a multi-layer model to describe requirements for the electronic world (figure 4). This model is based on individual and separate needs for data management.

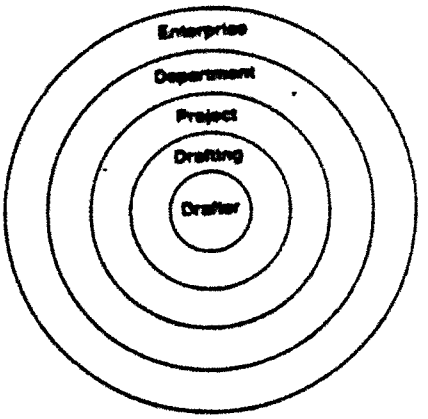


Figure 4. A layered model for electronic data management.

Model components are:

The drafters view. The drafter needs local control of his databases while they are in the preparation stage. He requires rapid storage and retrieval, system backup, plotting, and version control. He also needs the equivalent of an electronic washoff. Note that once a drawing version is released, the drafter should not be able to replace the drawing without formal revision control.

Drafting's view. The drafting room must have a means of controlling, storing, and retrieving drawings for the entire drafting room. Drafting rooms may have only one vendors equipment, or they may serve multiple vendors. Rapid access is necessary, with a feeling of local control. We believe that a central corporate database will not support the drafting view.

The projects view. The project serves personnel beyond the drafting room. This includes engineers, planners, and other support personnel. There must be capabilities for distribution, markup, and approval. Note that there is a lower time urgency as one moves away from the center of the shell.

The department view. The department is an engineering organization that spans several projects. There must be a measure of integration and compatibility between projects in one department. Depending on the department size, activities may span more than one drafting room and will certainly encompass multiple CAD systems. The management model must allow for these possibilities.

The enterprise view. The enterprise encompasses the entire organization's databases. We are a long way from being able to simultaneously handle engineering requirements and enterprise requirements.

CONCLUSION

We have shown that moving from the paper world into electronic management of electronic files is a difficult process. The transition can be eased by careful consideration of your requirements and industry trends. Requirements, trends, and potential technologies have been outlined by many authors [3], [4], [5].

New standards are arising and the PDES specification seems to be very important. Active participation in its development can help protect your organization's interests and will keep you current. A single vendor solution to CAD no longer seems possible or desirable; it's also likely that a single vendor data system will not suffice.

REFERENCES

1. Trost, S., "Engineering Information Management in a Distributed Environment", Fourth Chautauqua on Productivity in Engineering and Design, 1986, pp. 17 - 29.

2. Trost, S., "Product Definition Management", CAD/CAM Databases '87.

3. Gerdeen, J.W., "Honeywell Requirements for an Engineering Data Management System", CAD/CAM Databases '87.

4. Bray, O.H., "Engineering Database Management Requirements: The Next Generation", 1987 ASME International Computers in Engineering Conference, pp 27-32.

5. Rasdorf, W.D., "Engineering Data Management Needs", 1987 ASME International Computers in Engineering Conference, pp 41-47.