



ELECTRONIC DATA INTERCHANGE LIABILITY ISSUES

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WHEN COMPUTER AIDED DESIGN AND DRAFTING (CADD) was first introduced into the engineer's office it was looked upon as a productivity tool. The success of the CADD system was generally measured in terms of a ratio of the time to produce a conventionally drafted drawing to the time to produce a CADD drawing. Productivity ratios of 2:1, 3:1 or sometimes greater were often boasted by managers, in an effort to justify their decision to buy CADD in the first place, or by vendors, in their pitch to sell then very expensive CADD systems.

In truth, those high productivity ratios have only become reality in the last several years with the rapid advancement in computer hardware and improvements in software. As these improvements have developed, the use of CADD no longer represents a competitive edge to certain firms who choose to stay at the forefront of technology, but rather it is the price of admission to those who wish to stay in the business of engineering. Today, the success of the firm's CADD system depends as much on the Principal in charge of contract negotiation and risk management as it does on the CADD manager. As CADD has evolved into the primary method of production it has become more of a

medium of exchange of information and an archiving tool than an internal productivity tool. While the principal in the firm may delegate the technical aspects of the CADD system to the resident computer expert, it is essential that s/he, the principal, recognize the potential risks and liabilities associated with CADD deliverables. For example, while the high productivity

long way toward leveling the playing field among large and small firms. Drafting by hand today is equivalent to performing engineering calculations with a slide rule. Since this baseline has been redrawn, the success of today's engineering firm depends equally upon the technical manager of the CADD department, and how well the principal recognizes and manages the liability issues associated with electronic media.

For instance, the client may want to use CADD files for purposes which they were not intended or are ill-suited, such as quantity take-offs, delivery to other parties, facility management, use on other projects,

or project archiving. The compatibility of hardware and software of various parties to the transfer of electronic media poses additional liability concerns. Important CADD data may be lost in translation or in transmission. Files may be easily or inadvertently changed. Contractor's may use the CADD files to produce shop drawings thus circumventing certain quality control procedures.

This author is not a participant in the seeming hysteria of some who have written about liability issues associated with electronic media. In presenting the following overview of CADD liability issues, the author recog-

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ratios boasted in the 1980's may be achievable based on the development of in-house standards, onerous or unfamiliar CADD specifications by the client can totally negate productivity aspects of CADD. At the same time, fees may be lower, driven down ironically by the presumed efficiencies of CADD.

To discuss productivity ratios of CADD versus hand drafting today is passe, since CADD has become the standard of the industry. The reduction in cost of a CADD station from the \$500,000 range in the early 1980s to the \$50,000 range in the mid 1980s, and to the \$5,000 range in the 1990s has gone a



nizes that many of the same issues were equally present with conventionally drafted projects. For instance, it has always been possible to alter design drawings or duplicate a professional seal. However, CADD can make this process much easier to do and more difficult to detect. Also, the chance for accidental alteration or loss of vital information from an electronic file is greatly increased.

Also, since the author is a structural engineer, this overview is presented from the prospective of the Structural Engineer of Record (SER), and recognizes that most typically the SER acts as a sub-professional to the architect. The issues discussed are however pertinent to all parties of the design process.

The order of presentation of liability issues is arranged in the order that a typical project moves through the SER's office. Liability concerns are addressed at each of the key project phases; Scope Definition and Contract Negotiation Phase, Construction Documents Phase, Construction Administration Phase, and Post-Construction Phase.

SCOPE DEFINITION AND CONTRACT NEGOTIA- TION PHASE

Onerous CADD Specifica- tions

Anyone who works only in the private sector, and does work almost exclusively for repeat clients, may think that conforming to the owner's CADD System Details Specification is a non-issue. Most of those who work for government agencies recognize that this is not the case.

As an example, the author's firm has worked for a particular division of the Department of Defense (DOD) for 25 years, and has been delivering documents to that division in CADD format for about 12 years. The firm recently (actually about three years ago) had the honor of being

selected for a project by a different division of the same branch of the DOD, a feat which was considered a marketing breakthrough. The firm successfully negotiated a contract that contained brief language to the effect that the project would be delivered in accordance with the CADD Specification of the Division. Having done many DOD projects, and admittedly having suffered through a few requirements and changes in requirements that increased production costs on previous jobs, the principals felt they had a grasp on the risks associated with signing this contract. After all, could they say no to this new market opportunity, and how different could the specification be anyway, being simply another division of the same government agency?

The excitement about getting started on this project with a new client ended the day the CADD Specification arrived. It was delivered by UPS and totally filled a cardboard box, approximately 12x20x12 high. The total fee on this project was less than \$20,000, and the agency's maximum allowed profit margin is 10%. To break-even on the project, the cost of implementing this ridiculous specification had to be less than \$2000. It was not possible to even read the document for that amount of money.

Fortunately, the best of all imaginable outcomes happened. About a week after delivery of the CADD specification the project was shelved by the agency, and was never reactivated.

The scenario described above illustrates why the principals in the firm (or whoever negotiates fees and contract terms) be knowledgeable of the firm's CADD capabilities and standards, and recognize the impact on productivity of the onerous CADD specifications of some owners. This is possible, even if the principal is electronically impaired. Most firms have realized the high productivity ratios of CADD drafting versus manual

drafting of 3:1, 4:1 or more, only via the implementation of in-house standards; layering systems, line weights, menus, standard details, etc. Now that these productivity ratios have been achieved, the benefits have largely accrued to the owner in the form of lower fees. Consequently, a CADD specification that could nullify or even invert these ratios means economic disaster, at least for the given project.

In the final analysis, the SER should make sure that the contract states the specific CADD specification to be followed, whether it be the owner's specification or the SER's standard. Make sure that the manager of the CADD department as well as the principal reviews the CADD specification prior to contract negotiation. Defining and understanding the CADD specification up front will provide the basis for negotiation of increased fees in the case of onerous specifications, and will establish a basis for additional compensation should the CADD specification change at a later date.

Ownership of Documents

Most standard forms of agreement between the owner and designer have always addressed the ownership of the drawings at the end of the project. The ownership of the electronic files, like the hard copy, should be specified in the contract.

The owner may seek to own the electronic files for several reasons; to construct other projects without the involvement of the SER, to make future additions or renovations, to facilitate an operation and maintenance plan, to prevent others from using the design, etc. Some of these uses clearly represent a liability concern to the SER.

For obvious reasons, the SER should seek to retain ownership of printed documents and the electronic files. Also, due to the volatility of electronic files, the contract should establish that in

the event of a conflict between the sealed drawings and the electronic files, the sealed drawings will govern. The contract should also disavow any warranty of merchantability and fitness of the files for any particular purpose, and require an indemnity for any unauthorized changes and reuses.

The concept of instruments of service is also important in the consideration of ownership of the electronic files. Construction documents, plans, specifications, reports etc., represent a written or graphical depiction of the intellectual process of the designer. The agreement should define both hard copies of drawings as well as electronic files as instruments of service.

If the ownership of electronic files conveys to the client/owner, it is conceivable that they could legally be perceived as products, rather than instruments of service. As such, any use or reuse of the files could be interpreted by the court to be subject to strict liability or product liability. Under product liability, the professional would be held strictly liable for any defect, regardless of whether the professional standard of care was met.

CONTRACT DOCUMENTS PHASE

Project Coordination

In the earlier developmental phases of CADD technology, when CADD capabilities were limited to the more technologically advanced firms, the benefits of CADD to enhance quality control through better dimensional coordination was commonly used as a major sales pitch during the A/E selection/interview process. The pitch was that with all consultants working from the same electronic database, the coordination of dimensions would be automatic and virtually foolproof through electronic overlays.

The concept was, and still is, good. The reality is however

that CADD and fax machines coupled with the current axiom that every project is behind schedule the day it begins have made dimensional coordination very problematic. Architects often provide drawings for the structural consultants with no dimensions. In some cases dimensions may be on another layer that did not plot. In some areas of the country, dimensions are not provided, as a matter of policy on architectural drawings, even on the final contract set. The engineer must rely on the accuracy of the CADD database to obtain dimensions. If the database is wrong, or if the dimensions change (and they almost always do, sometimes at the last minute, and often without notification) then not only are the dimensions on the structural drawings not in agreement with the architectural drawings, but the structural design may be flawed. When the SER is the only one who shows column or beam centerline dimensions, or elevations, and those dimensions turn out to be wrong, where does the liability lie? The architect's position will likely be that his drawings are correct. After all, the dimensions cannot be wrong or in conflict with other elements if they are not shown. Complete sets of coordination drawings during the design process, as was the norm a few years ago in the manual drafting era, are now rarely provided. The architect can't afford to spend the time to stop production to plot progress prints. The best one can hope for is to receive progress drawings by disks or modem so that the SER can make its own coordination plots. Those plots are hopefully not corrupted by any of the errors that can occur in electronic transmission. Final contract drawings are often completed based on faxed details, often unnumbered and not keyed to the plans. The concept of exchanging completed drawings for two weeks or so of coordination is no longer standard practice.

Admittedly, this state of affairs is not totally unique to CADD technology, as schedule driven delivery techniques had already begun to take hold in the early and mid 1980's, before CADD was the primary production method. CADD technology has however driven delivery expectations to the ridiculous and the potential liability issues associated with the scenario described above must be properly managed.

Electronic Transmission of Data

The design process involves the electronic transmission of data among several parties, including the owner, the prime design professional, and the various consultants. In making or receiving these transmissions, whether by disk or by modem, there are a number of errors that can occur. The potential liability concerns, to name a few, include the following:

- Errors due to compatibility of hardware and/or software
- Hardware defects or software viruses on the transmitting or receiving end.
- Subjection of transmitted disk to physical or magnetic forces.
- Phone line problems.

Information may be deleted or lost from electronically transmitted files, or may be modified, either intentionally or inadvertently.

In order to minimize problems with errors in transmission, the SER should establish quality control procedures to ensure that the electronic equipment is fully operational and error free, and that users are well trained. All transmissions should include a hard copy as well as electronic files, and an identical hard copy retained, with a description, date, and size of the file transmitted. Also, all parties involved should use the best available virus protection software.



Definition of Deliverables

The A/E contract ties percentage of fee due to certain distinct phases of delivery of the construction documents. The classic phases include Schematic Design Drawings, Design Development Drawings, and Working Drawings. Any changes made after approval of any of these milestone submittals constitute "additional services" and entitle the A/E to additional compensation.

However, with the use of computers, the client may be receiving information continually throughout the design process. The distinction of the various design phases (i.e. Schematic Design, Design Development, Working Drawings) may become unclear, and consequently, the schedule for payment may become an issue of contention. Also, since the client receives information on a continual basis, there may be an added risk that the data will be used in an incomplete form. For example, the owner may seek subcontractor prices with incomplete information, and later hold the SER responsible for changes.

The contract should specifically define "deliverables", and tie payments to them. It should also restrict the use of CADD documents that are not finalized.

Upon delivery of each phase, it is good practice to write a letter of transmittal showing the date and size of all files transmitted, and to include a hard copy of the drawings as delivered. Also, retain an identical disk and hard copy on file, with proper dates, file sizes, and notations as to the purpose.

CONSTRUCTION PHASE

Electronic Seals and Signatures

The delivery of projects with electronic seals and/or signatures is a subject that is currently under consideration by a num-

ber of state professional licensing boards. The state of Florida has recently passed a law which allows the use of electronic seals and signatures. National Council of Examiners for Engineering and Surveying (NCEES) Model law was recently rewritten to allow electronic transmission of documents as long as "the licensee's seal and signature are transmitted in a secure way that prevents the seal and signature from being reproduced or modified." This implies that encryption technology is available which would provide absolute protection. This is in fact not the case.

The fact is, that even with mylar drawings, it was always possible to duplicate ones seal and signature. This is especially true since the advent of the plain paper copy machine and the "sticky-back" drafting system. It also was always possible to make unauthorized changes to mylar drawings after delivery from the SER. However, making unauthorized changes to electronic drawings with an electronic seal and signature, or lifting the seal and signature to use on another project is so easily done that it may encourage the practice.

The technology for absolute security of the seal and signature has not yet been developed. In the meantime, it is the opinion of this author that seals should be removed from any transmitted electronic copies of the drawings, and that hard copies of final drawings be provided with a seal (either wet seal or electronic) and an original signature. If delivery of documents with electronic seals is an absolute nonnegotiable requirement, the transmittal should include a statement that describes the files delivered and how they are to be used. Also, the delivery should be documented as described above under Definition of Deliverables.

Use by Fabricator

The question of whether to allow a contractor (primarily structural steel fabricators) to use reproductions of the SER's drawings for the preparation of shop drawings is a long-standing issue. With the advent of CADD, the potential savings in time and cost is even greater, and therefore the pressures for the SER to provide his CADD files to the contractor to facilitate shop drawing preparation have become even greater. The pressures may be brought to bear not only by the contractor, but by the owner, as project schedules have become increasingly demanding. The SER can be seen as uncooperative and not a team player by the client/owner by refusing to release the files.

The practice of using the SER's CADD files for shop drawing preparation raises concerns as previously raised in the conventionally drafted project delivery media, where the fabricator used reproducibles of Contract Drawings in the preparation of shop drawings. However, additional concerns associated with electronic data are raised as a result of this practice. Although the risk potential is undeniable, so is the advent of the electronic age. The maximum value of CADD will only be realized when tightly integrated into the construction process.

The SER should therefore identify the risks involved, and take the steps necessary to manage those risks. The goal should be to capitalize on the potential of CADD to minimize human errors in the transfer and interpretation of data, and thereby to reduce risk through the enhanced communication and reduced conflicts, errors, and omissions.

Most risks normally associated with transfer of electronic files among consultants, architect and owner apply, such as hardware and software compatibility and loss of data in transfer or translation. Some additional concerns include the following:

• **Clarity of Shop Drawing Presentation**

Contract documents contain a great deal of information which is extraneous to the information needed for the preparation of shop drawings. The presence of this data tends to obscure the information required on the fabrication drawing. This not only makes review of the shop drawing difficult, but it may be unclear as to which items on the drawings are or are not being supplied by the given fabricator.

In order to minimize this problem, the SER may require that all information on the disk supplied to the fabricator be plotted in a differing tone and text than the information added by the fabricator as required to meet detailing standards (such as AISC standards). The shop drawings should plot such that any linework or notes that are extraneous to the fabrication and/or erection drawings is plotted as a background (half tone). All information added by the fabricator should be in full tone. Also, all alphanumeric notations added by the fabricator should be in a text distinct from the contract drawings. Any information added by the fabricator that represents a deviation from the contract drawings should be clearly flagged and enclosed in a bubble.

• **Responsibility for Dimensions**

Under the conventional method of preparing erection and fabrication drawings, the process automatically results in an independent check of dimensions by the detailer, as the drawings are laid out. The use of the SER's CADD files for shop drawings can circumvent this second level of dimensional check. The result can be increased checking time on the part of the SER, the fabricator, or both.

There is no question that the use of the SER's drawings, whether they are on electronic media or hard copy, has the potential to increase the liability exposure of the SER. However if

used properly, CADD offers a tremendous potential to reduce the liability of all parties involved.

The errors involved in transferring member sizes from structural drawings to CADD drawings is eliminated. Also, the time involved on the part of the SER in checking for proper sizes is reduced. The potential liability incurred by inadvertently approving drawings with inaccurately transposed sizes is therefore reduced.

If CADD drawings are generated from an accurate database, the potential for dimensional errors or missing dimensions is minimized. The SER should establish procedures which train engineers and CADD operators on the importance of accurate databases. Databases received from architects and used to generate structural drawings should be checked for accuracy. The SER should take advantage of every opportunity to educate the architect or client/owner on the importance of accurate databases. In addition, last minute dimensional changes should be well documented on the record drawings. No drawing should be transmitted unless such notation that specific dimensions have been revised and are no longer to scale is attached. In any case, the SER should use contract language that would prevent risk-shifting from the fabricator to the SER. The use of the SER's CADD disks should in no way relieve the steel fabricator of his responsibilities for proper coordination of dimensions, showing correct sizes and gages of material, and anticipated fit-up as would be required under the conventional process.

Another pitfall is that the SER could become too lax in his/her review of shop drawings since s/he may assume the information is correct. A procedure for shop drawing review should be established to assure that this does not occur.

• **Drawing Revisions**

Drawings often undergo revisions

after the initial issue, and it may be difficult to determine whether the CADD files used by the fabricator represent the latest revision.

If CADD files have been supplied to the fabricator for his use, the SER should establish procedures that will require that revised disks are sent with each drawing revision. Each revised disk transmission should adhere to all the guidelines governing transmission of the original disk. The SER should also require that the shop drawings indicate the number and the date of the latest revision on each sheet.

The CADD files delivered to the contractor should be documented as defined under Definition of Deliverables. Also, the SER's title block should be removed. There should be no indication that the shop drawings are the product of the SER.

The Council of American Structural Engineers (CASE) has recognized that the efficiencies of production and communication through electronic data transfer is the current trend, and has responded by producing a brief contract between the Structural Engineer of Record and contractor for this purpose. In their introduction, CASE emphasizes that the publication of their standard form of agreement should not be interpreted to mean that CASE advocates the practice. This is a business decision that each firm should make for itself, preferably in consultation with its attorney and professional liability insurance agent. (For more information on CASE Document 11-1996, contact Ed Bajer, Executive Director, CASE/ACEC, 1015 15th St., NW, Washington, DC 20005; ph: 202/347-7474; fax: 202/898-0068).

Note that the CASE contract brings up the additional factor of compensation to the SER for the CADD files. It is the opinion of this author that the fee should cover the SER's cost in preparing and delivering the files, plus only a nominal profit. To charge



a large fee for the files may be interpreted by the courts to constitute a sale, resulting in loss of ownership of the content of the files, and possibly even resulting in raising the issue of "strict or product liability".

POST CONSTRUCTION PHASE

Delivery of CADD files to the Client

At the time of completion of the construction project, the conditions and limitations on use of the SER's CADD files should have already been covered with the client/owner as previously discussed during the negotiation of the design contract. If the contract requires that the CADD files be delivered to the Owner upon completion of the project, the owner should be informed in person and in writing of the limitations associated with the electronic file. Specifically, the following issues should be addressed:

Aging of Electronic Files

The owner should be made aware of the very limited shelf-life of electronic data and the importance of maintaining (rewriting) the electronic files on a periodic basis. Three factors cause rapid degeneration of electronic data, namely as follows:

- Changes in computer software: Most software programs become outdated about every 18 months. Data created on software several generations old may be unreadable. The operating system may become obsolete. As an example, Wang software and hardware was state-of-the art about 15 years ago.
- Changes in hardware: Hardware currently becomes outdated about every 2 years. For example, drawings generated just a few years ago may be stored on antiquated media, such as 8" floppy disks.
- Dissipation of the magnetic charge: The shelf-life of the

computer disk may be 2 to 3 years. Partial loss of data may go undetected, resulting in disaster if a project were shelved for a long period of time and then brought back to life. The improved technology of CD-ROM can increase this shelf life, but even then files should be restored periodically.

There is also an issue of how well the client may safeguard the file. The conditions of storage may not be ideal, or unauthorized changes may be made, or additional copies may be made. In other words, once delivered, the SER has no control of the content or use of the file, and s/he must rely on good contract language and owner education for liability protection.

Acceptance Period

Since the problems with long-term archiving of electronic drawings has been identified, it is important that it be established that the files were correct when delivered, and to relieve the SER of liability for later degradation of the file. The client must understand that once the SER delivers the files, the SER has no further control over them and cannot be responsible for their contents, their compatibility with the client's CADD system or the length of life of the file. The client should accept responsibility for proper maintenance of the files, once delivered in good condition. This includes indemnification against loss of data due to changes in the client's hardware or software.

If not already covered in the contract for services, the CADD files should be delivered with an agreement that defines an acceptance period for the client to review and accept the CADD files as delivered. The acceptance period should be specifically identified and of short duration, say 30 to 60 days. The agreement should further state that any defects the client discovers during this period will be reported to the SER and will be

corrected as part of the SER's Basic Services, and that correction of defects detected and reported after the acceptance period will be compensated as Additional Services. Delivered files should be documented as defined under Definition of Deliverables.

RECORD DRAWINGS

At the completion of the project, the SER may be required to provide record drawings (commonly referred to as "as-built" drawings) to incorporate changes made during construction. The liability associated with record drawings differs very little with respect to CADD drawings from that associated with conventionally drafted drawings. The actual process of preparing record drawings has been made much easier by CADD, as clarification sketches developed during construction can be electronically incorporated with minimal effort, and details may be shifted as needed to make room for changes and additions.

As with manually drafted projects, the agreement with the owner should avoid the term "as-builts" (which implies the structure was built identically as shown), and should clarify that the basis for the drawings is information supplied by the contractor, and has not been verified.

The important issue is to make certain that record drawings are converted to mylar, and to make the owner aware that the electronic version will deteriorate over time.

CONCLUSIONS

A number of issues have been addressed with regard to potential risks associated with the electronic interchange of data.

The American Consulting Engineers Council has recognized the increased liability exposure and the unique management challenges associated with CADD, and now includes Computer Systems Management

as one of seven major management issues in their Organizational Peer Review of design firms. The Council of American Structural Engineers (CASE) has also recognized these issues, and has prepared a contract for the Structural Engineer of Record (SER) to use when electing to allow the contractor (usually the structural steel fabricator) to use the SER's CADD files for the preparation of shop fabrication drawings.

Many of these liability issues were present prior to the introduction of CADD. The key to success is to recognize and properly manage the risks involved. This can be largely accomplished through good contract language, good documentation, and client education. The SER should use his or her professional liability insurance agent and attorney as a source for proper contract language.

The efficiencies of production and communication through electronic data transfer are undeniable. It is very likely that the project delivery method 10 or 15 years hence will not resemble today's methods as the entire project delivery process becomes electronically integrated. The successful firm of tomorrow will be the one that embraces the technology and manages the associated risks. To some degree, the rules of risk management must change to fit the technology. Those who think it works the other way around will be left in the dust.

This article is based on a paper for the 1998 National Steel Construction Conference by Roger G. Stroud, P.E. Stroud is president of Stroud, Pence & Associates, Ltd., a 25-person structural engineering firm with offices in Virginia Beach, VA, and Raleigh, NC. He currently serves as chairman of the CASE Contracts Committee.

