

## CADD Risk Management

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The architectural and engineering professions have grown more complicated in recent years. Now, many of our clients have CADD systems, and they want professional design firms to deliver their designs in CADD format. Many clients are now requiring CADD as a contracted delivery item, stipulating specific CADD brands as a requirement to do business. And, because CADD is perceived as a productivity tool, our clients also expect the design fee to be less than before CADD. How does a contractual requirement to deliver CADD files impact the way a design professional should plan a project, estimate scope, schedule, and fees, and, most importantly of all, contract for professional services?

### The New Promise

When CADD was created, it was a tool to enhance productivity. CADD would do for drafting what word processing was doing for typing. We would be able to perform interactive drafting and design with easy and quick modifications and to reuse standard details. Because it enhanced productivity, optimists felt that CADD work would always be faster than hand drafting and would inevitably reduce costs. Experience has shown that a mix of drafting and design techniques can yield greater efficiency across different projects than either one used exclusively.

### The New Nightmare

Our productivity tool is quickly becoming a medium of exchange. Many clients now require delivery of electronic CADD files. This can hamper CADD's effectiveness as a productivity tool because it removes the flexibility to mix CADD with other drafting and design techniques.

When CADD is a delivery requirement, it is not solely a productivity tool. We are then required to use it for 100% of the project's deliverables. This raises serious questions about scope, work schedule, resource allocation, production cost estimates, compensation, and professional liability. They include the following:

- What is the professional liability risk to the design professional in delivering "instruments of professional service" in an electronic media form that allows the client to make quick and easy changes?
- What is the practical life of a CADD file? For how long are they readable? Should the professional seal be reproduced as part of the file? How do engineers and architects protect themselves from subsequent changes to the CADD file after formal delivery is made? Can these changes be tracked or proved years later should the need arise?
- Who owns the CADD files after they are delivered? Who has the right to edit or reuse the designs, either during the construction phase of a project, or afterwards on other projects?
- What is the impact on traditional plan production estimates when a complex CADD specification is required? What other scope, schedule, and compensation issues should be addressed in the contract for professional services when CADD is a delivery requirement?
- What liability, scope, schedule, and compensation issues should be addressed in the contract for professional services when the client insists that its CADD files be used to initiate a project (e.g., a

client's digital terrain model for use in the design of a highway or "as-built " drawings for use in a building remodeling project)?

## Why CADD Risk Management?

The purpose of CADD risk management is not to discourage the exchange of CADD files, but, rather, to encourage their exchange between parties knowledgeable as to what is being delivered, what is being received, and what potential consequences and risks are associated with the exchange. The exchange of CADD files, whether between an engineering subconsultant and an architectural prime or between the engineer/architect and the client/owner, has serious implications for scope, schedule, compensation, and professional liability. Our purpose here is to educate design professionals on the issues associated with the exchange of CADD files and help them manage the expectations of all parties involved.

Engineers and architects have no control over the client's quality control procedures for the CADD file once it has been delivered. What happens to the floppy? How many copies are made? Where are these floppies stored? Under whose control? Who controls whether or not changes are made to the contents of the file (and, therefore, to our design)? When are the floppies used by the client, and for what purpose? Are they given to other parties, such as the contractor or independent design consultants? Who controls their use once they are transferred to these other parties?

The potential risk, of course, is that the original design may somehow changed before or during the construction phase of the project, either intentionally or inadvertently, by someone on the client's or contractor's staff. If the change is responsible for a failure, or if it results in some construction phase claim, how does one prove that the changes were made and the errors introduced subsequent to the formal delivery of the CADD files? How does one establish that the change was not discovered and ignored or could not have been discovered in the exercise of reasonable care?

The crucial question, though, is whether any of these issues are addressed in the professional services agreement. Now that CADD is becoming another service we are required to perform, do our contracts adequately describe this new service and its associated delivery items? You need to evaluate these issues before you sign the next contract requiring CADD delivery.

## The Impact on Scope

A CADD delivery requirement often includes the demand that you adhere to your client's CADD specification. The CADD specification dictates what graphics must be placed in what layers, what line styles and lettering styles must be used, what special naming conventions must be used for graphics and special symbols, and how the files are to be organized. A complex CADD specification can add significant time and effort to the traditional estimates for plan production time. Reusable standard details may have to be modified to adhere to the client's specification. This can add significant cost to what was once a tremendous productivity savings. For you and for that job, CADD is less productive than its potential. Imagine your client's surprise when you suggest additional compensation!

Some clients have unrealistic expectations about what they will be able to do with CADD files once they are delivered. Some expect that they will be able automatically to calculate material takeoffs from architectural or engineering drawings; therefore, they require that special symbols and specific naming

conventions be used for individual bits of graphics. They may require, for example, a special symbol and name for "manhole cover, " "telephone pole, " or "rebar, " with the unrealistic expectation that by counting the number of occurrences of that symbol or name, they will be able accurately to determine material quantities.

Unfortunately, most architectural and engineering drawings do not show every occurrence of most items. Spread footings are shown in 2-D, and as "typical. " Accordingly, volumes of concrete or tons of rebar can not be calculated from the structural drawings. Even so, where the CADD specification dictates the use of special symbols and names and separate layers for concrete and steel, you are going to have to spend extra hours separating the graphics into the various layers and specifying the required symbols and names. Will the client get the expected material takeoff? Most likely not. But you will have spent the hours anyway.

Often, the CADD specification is written by the client's CADD operators. Are they familiar with the design process? Are they aware that architectural and engineering drawings in CADD form are not suitable for material takeoffs? Are they aware that material takeoffs are the responsibility of the contractor, not the design professional?

The client's project manager is often in the position of having to enforce a CADD policy he or she neither wrote, nor understands. It is assumed that those CADD folks knew what they were doing in demanding that a particular specification be met. Unless you point out just how much extra time and money it is going to cost, the requirement is likely to go unchallenged, and someone will pay the cost.

Your project manager and the client's project manager, together, must decipher the reasoning behind the CADD specification. Then, you must decide whether the requirements add value at reasonable cost. The client's CADD specification can make or break a design project with a CADD delivery requirement. A full understanding of the CADD specification is needed before plan production estimates can be finalized. Many federal agencies, a large number of state agencies, and many private sector clients already have complex CADD specifications to which you must adhere.

Whatever CADD specification is finally adopted, it should be clearly referenced in the contract. Changes by the client to the CADD specification once the project is underway should be subject to your review, and if the change is deemed to cause extra work, an additional fee may be necessary.

## Ten Key Contractual Issues

Ten key contracting issues need to be considered whenever an exchange of CADD files is required. Each points the way to questions that need to be answered before an agreement can reasonably be signed. Here are the issues and the questions they raise:

1. CADD deliveries from owner to engineer/architect.

The owner may wish to supply the engineer/architect with CADD files which contain important project information. Examples include survey data, existing building conditions, data from an earlier phase of the project, digital terrain data, or other potentially useful information. Where this is the case, there are questions to consider: Who created the files? Who should your firm contact if there are problems with the



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data? How old and how accurate are the files? What is the CADD specification for the file you are receiving? You must resolve these questions and many more and ensure that the terms and conditions needed to address them are incorporated into your agreement.

## **2. CADD deliveries from engineer/architect to owner.**

You and your staff need to understand fully the implications of the required CADD delivery. What is the CADD specification for the files to be delivered? What impact will it have on traditional plan production estimates? When are the CADD files to be delivered? Just once, or with all intermediate submittals? With the bid set, the construction set, or at the end of construction as "as-built " drawings? How many more production hours will it take to meet this CADD specification than it would to use your normal procedures? Is a CADD file translation required?

You must answer these and related questions before you can agree to scope, schedule, and fee. A complex CADD specification can add significant hours to plan production time and adversely affect your ability to deliver on time and within budget.

## **3. CADD deliveries between consultants and subconsultants.**

When you are on a project team which includes engineering and other specialty consultants, you must address all the above issues, as well as several more. Who is responsible to the owner for the accuracy of the electronic files created by each consultant? What if a subconsultant's CADD system is different from the prime consultant's system? Who is responsible for coordination and making required file translations? Will you receive CADD files from the owner's other consultants (or will you give yours)? If so, who is responsible, and who coordinates?

## **4. CADD file translations.**

File translations are probably the most misunderstood and frustrating aspect of CADD. Because most engineers/architects work for multiple owners, and because these owners do not all have the same CADD systems, the issue of CADD file translations will eventually arise.

CADD file translations are not as easy as simply running a DXF translation software package. You must plan and organize the project carefully, anticipating the limitations likely to be encountered in translating from one CADD system to the other. These limitations may include the number of layers, special naming conventions, line styles, lettering styles, and myriad other details. To be sure your proposal includes enough schedule time, payroll hours, and fee to perform the translation, seek the assistance of professionals with translation experience on real design projects. A service vendor who wants to charge you for simply running a "DXF translator " program is insufficient support.

## **5. Long term archives.**

Many people think electronic data files have an unlimited life span. They do not! Most owners and many engineers and architects archive floppy disks and magnetic tapes of drawings, specifications, and calculations. The information in these archives is slowly dying, fading to noise.

CADD files are not readable forever. Three factors contribute to **data death**:

- The first is the steady evolution of software and the gradual maturing of software products as new versions are released. Are sequential releases always totally compatible? Think about it. Can AutoCAD Release 12 software read an AutoCAD Release 2 file saved in 1986? There are also industry-wide shifts from one software product to another. Ten years ago it seemed as if everybody had Wang word processors. It was the apparent standard in word processing. Who still uses Wang word processors today? Can your current word processor read a floppy that was saved from a Wang system ten years ago? Will the file you save today under AutoCAD Release 12 be readable by AutoCAD Release 29 ten years from now? Will AutoCAD even be around ten years from now? Where is Wang? Who is LISA?
- The second factor is media life. Data on floppies are stored by a magnetic charge. This charge will dissipate naturally over time. The rate of dissipation will vary depending on the storage environment. Professionally run data storage facilities, where temperature and humidity are controlled 24 hours a day, every day, recommend that media be rewritten once a year just to renew the magnetic charge. Floppies stored in an office environment could lose the magnetic charge at a faster rate. Floppies stored for years may lose only small bits of data. But, in CADD files, where everything is stored in terms of delta x and y coordinates, just a single bit of lost data could cause the file to lose origin, and that file could become almost useless.
- The third factor is hardware changes. The media on which the data is stored are subject to change. The 5 1/4 " floppy is rapidly being replaced by the 3 1/2 " floppy. Whatever happened to that 8 " floppy disk you used to store your Wang data? Who still has 8 " floppy drives from just a few years ago? Today, if you needed to restore a WANG file from an 8 " floppy, how much trouble would it take to find someone who has a working 8 " drive.

Even the once reliable standard tape drives are questionable. Twenty years ago, the seven-track tape drive was the norm. Then came the 800 bits per inch (bpi) nine-track tape drive, then the 1,600 bpi nine-track drive, followed more recently by the 6,250 bpi nine-track tape drive. Now, there are several vendors offering low-cost, cassette tape drivers. Will the new laser drives render all of these devices obsolete? Who is going to maintain large, old, expensive, 1,600 bpi nine-track tape drives to run on low-cost micro work stations with either laser or 3-1/2 inch high-density drives? What will the standard media be 10 years from now?

Suppose the Owner takes delivery of your CADD files, stores them away for five years, and then finds they are not readable. Absent a clear contractual understanding, who will be blamed for the problem? Obviously, the one who made the files and delivered them in the first place! That could be you.

After five years, though, why is the CADD file unreadable? Was it incorrect when it was delivered? Has the charge on the media deteriorated? Have software revisions rendered the file incompatible? Has the owner changed hardware, leaving the five year old media unreadable? Has one of the owner's staff altered or deleted the files by accident? You can hardly afford the time and money to find out. Deal with these issues in your contract, and you may not have to.

In the early 1980's, a bridge collapsed on I-95 in Connecticut. The State of Connecticut sued the original bridge designer, despite the fact that the bridge had been in service nearly thirty years. The point is this: What if the failure had been due to a change in the design on a CADD file by either the owner or the contractor? How could it be proven thirty years later? The original designer, the owner, and the contractor

would not likely be able to read CADD files of thirty years ago, even if they still had the files in their archives. Are you willing to gamble on being able fully to read today's CADD files 30 years from now?

Archiving project data on electronic media is practical only for a **two to three year** time frame, assuming no major changes in technology. Electronic media must be stored in a controlled environment, clearly labeled, and correctly filed. Data on electronic media will eventually lose its readability as the electronic charge dissipates unless rewritten regularly (annually is recommended). Drawings and specifications may become only partially recoverable, as the media loses its charge and steadily degrades. Imagine the risks in using distorted data for additions and maintenance on a project built from complex design drawings. For long-term storage, hard copy or microfilm archiving is a safe and less risky alternative to electronic archiving. Should a renovation or addition need arise in the future, it would be far more economical to retrieve these hard copies. The data can then be scanned into a CADD system, merged with other design elements, and plotted as required.

## 6. Acceptance period.

Because of the problems inherent in long-term electronic archiving, you must be certain the owner understands that CADD files will not remain readable forever. The owner must understand the limitations, and this means you have to explain them. The owner must also understand that once you deliver your electronic files, you have no further control over them and that you can not be responsible for their contents, their compatibility with the owner's changing CADD system, or the length of life of the file. The agreement should define an acceptance period of a specific length.

## 7. Ownership of the files.

The professional services agreement generally specifies who will own the drawings at the end of the project. Engineers and architects typically seek to retain ownership, but in some cases a transfer of ownership is unavoidable. Ownership of the electronic files must be specified in the same manner. In most cases, ownership of the CADD files rests with the party who owns the drawings.

## 8. Right to use/edit the files.

You will want to limit the ways in which the owner is permitted to reuse electronic files after delivery, particularly where issues of professional liability remain unresolved. If the electronic files are defined to be included within your "instruments of service," along with hard copies of the plans and specifications, then the provisions of your agreement regarding reuse could also be applied to the CADD files.

## 9. Professional liability.

By accepting a CADD delivery requirement, you agree to deliver contract documents on a medium that can be modified quickly and without leaving a trace. Once the files are delivered, you lose control over what happens to their contents. What are the owner's quality control procedures for handling these files? Who will have access to them? How will they be stored and maintained? Once the files have been delivered to the owner, who will be responsible for their correctness, usability, and readability?



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Your agreement should define your instruments of service to include both the sealed drawings and the electronic files, and it should establish that in the event of a conflict between the sealed drawings and the electronic files, the sealed drawings will govern. It is also recommended that you remove your name and title block from all CADD files when ownership and control pass to your client.

## 10. Compensation.

Recovering your investment in your CADD system by increasing your overhead multiplier or by levying an hourly CADD charge is the *relatively easy* part of the compensation issue. The *hard part* is convincing the owner that your fee should include the extra effort required to meet the owner's CADD delivery requirements. This may include the additional plan production time required to follow an owner's complex CADD specification, or it may involve translating CADD files to another system. These and other factors can add substantially to the payroll hours and the length of time required to perform your services.

In the past, the engineers and architects delivered sealed drawings and specifications. Contemporary agreements now require delivery of all the traditional contract documents **plus** electronic files complete with special entity names and symbols, graphics separated into specified layers and special line/lettering styles. Additional services are being performed to provide the owner with an added value. Additional services which create added value should justify additional compensation, and your agreements should reflect this.

### A Step into Contracts

Contract language need not be complex, but it would be naive to conclude that a single provision will serve all architects and engineers and their clients in all circumstances. More important than having a ready-to wear clause readily at hand is educating yourself, in depth, on the risk you may encounter and need to address.

The author is not an attorney and does not offer legal advice. Nevertheless, it may be helpful to you in your efforts to begin thinking about contractual language to study an example of a rather broad CADD provision which one architect reports has been accepted by clients. In it, you can see how some, but not all of the risks and concerns raised in the ten points above have been addressed. Consider, subject to the advice of counsel, the following:

#### Architect's Drawings, Specifications, and Electronic Media

The Architect's instruments of service hereunder are the printed hard copy drawings and specifications issued for the Project, whereas electronic media, including CADD files, are tools for their preparation. As a convenience to the Owner, the Architect shall furnish to the Owner both printed hard copies and electronic media. In the event of a conflict in their content, however, the printed hard copies shall take precedence over the electronic media.

The Architect's electronic media are furnished without guarantee of compatibility with the Owner's software or hardware, and the Architect's sole responsibility for the electronic media is to furnish a replacement for defective disks within thirty (30) days after delivery to the Owner.



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The Architect retains ownership of the printed hard copy drawings and specifications and the electronic media. The Owner is granted a license for their use, but only in the operation and maintenance of the Project. Use of these materials for modification, extension, or expansion of this Project or on any other project, unless under the direction of the Architect, shall be without liability to the Architect and the Architect's consultants.

Because data stored in electronic media form can be altered, either intentionally or unintentionally, by transcription, machine error, environmental factors, or by operators, it is agreed that the Owner shall indemnify, defend, save harmless the Architect, the Architect's consultants, and the officers and employees of any of them from and against any and all claims, liabilities, damages, losses, and costs, including but not limited to costs of defense, arising out of changes or modifications to the data in electronic media form in the Owner's possession or released to others by the Owner and for any use of the electronic media and printed hard copy drawings and specifications outside the license granted by this provision.

## In Summary

CADD began life as a productivity tool. Now it is being used, both as a medium of exchange and for long-term archiving.

A complex CADD specification requirement can add time, scope, and, therefore, cost to the project. A project with a CADD delivery requirement and a complex specification can easily take longer and cost more to produce than a manual project.

An Owner's CADD delivery requirement means that you must deliver instruments of service in an electronic media form subject to deterioration and susceptible to tampering.

These new, technology driven developments demand a thoughtful review of our design services, and a legal review of how we contract with our clients. The engineer or architect who exchanges CADD files with another consultant or delivers them to an owner/client needs to address the potential consequences and risks in his or her agreement for professional services. That is an essential element of CADD risk management. The potential consequences of failing to do could be very serious, years from now, when it is too late to do anything about them. The time to act is now, before you hand over that next disk to your client.

Three steps are involved in implementing a CADD risk management program. First, you need to educate yourself as to exactly what CADD risk management is and how it affects your practice. Second, you need to educate your staff; not just your CADD staff, but your project managers and department heads, as well. Third, you need to educate your clients. They may not have thought about all of the issues presented here.

Finally, get expert help. Review the issues with your legal counsel and risk management advisor to determine how they apply in your own, unique situation, and work with both to develop appropriate contract language to meet the specific requirements of each project. You may also want to seek the advice and assistance of professionals who have experience with CADD production, the delivery of CADD files to



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clients, and CADD translations. Like everything else in professional practice, getting it right the first time can yield large dividends in the end.

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Mr. Ingardia also regularly conducts a seminar entitled, *CADD Risk Management: The New Nightmare*. The seminar focuses on the potential consequences and risks of exchanging CADD files and highlights the ten key contract points addressed here with suggested contract language and real life examples (both good and bad) from the author's many years of experience. The seminar was organized at the request of the American Consulting Engineers Council (ACEC), and it has been successfully presented at numerous professional society meetings in over 20 states over the past 3 years. Attendees need not be keyboard trained on CADD but, rather, should be experienced in project management, client relationships, and contract negotiations.

Before turning to management consulting, Mr. Ingardia was Vice President of Information Services at HNTB Corporation. At HNTB, he was responsible for all computer and CADD operations, installations, training, and systems implementation for more than ten years.