

A close-up, slightly blurred photograph of a computer workstation. In the upper right, a portion of a CRT monitor is visible, displaying a bright blue screen. Below the monitor, a black computer mouse sits on a light-colored wooden desk. In the foreground, a large portion of a computer keyboard is visible, with its keys slightly out of focus. The lighting is warm, coming from the left, casting soft shadows. The overall image has a halftone or dithered texture.

SOFT FILES HARD PROBLEMS

Today's engineers use electronic file sharing to enhance the collaborative design process.

With the benefits of technology have come difficult problems.

An old joke says that the design of a military aircraft is not complete until the weight of its paperwork exceeds the weight of its structure. This statement is truer than most engineers want to admit. Every single part in the design of a bridge, for example, usually is documented by hundreds of pieces of paper.

But design is changing. By some estimates, more than 80 percent of all new designs flow through computer-generated programs. For years, the norm in many engineering offices had been "computer-assisted, paper-released." But as a result of state-of-the-art information systems, almost every firm now stores, communicates, and exchanges vast amounts of electronic data with clients and other collaborative partners. Without the ability to use electronic data, most organizations would founder.

"As engineering extends its reach, we need new ways of communicating and visualizing engineering data," says Mike McMeekin, chair of ACEC's IT Subcommittee and president of Lamp, Rynearson, & Associates, Inc., a civil engineering firm in Omaha, Neb. In the past, weak hardware performance, the complexity of the engineering data, or the lack of consumer tools

restricted clients and other team members from significant contributions. Today, these barriers are falling, and team members can access document information easily.

Advances in graphics performance, raw computing power, and networking provide the infrastructure to realize the vision of collaboration. The engineering profession has adopted the use of computers in generating, revising, plotting, and transmitting its work.

Of course this flow of electronic documentation comes with a price. While electronic documentation has streamlined the design process, issues such as software compatibility, cost, and electronic seals are first in the minds of design professionals and clients alike.

Collaboration and compatibility

For design professionals, location doesn't matter much anymore. It's now possible for clients to be online throughout the design process, from anywhere, and to have available to them all interim

design data. Delivery of the design product is made on a continuous basis. As a result, the clear lines between schematic, design development, and working drawings are easily muddled, especially when clients are technically competent and desire to work alongside the engineer or architect.

This was not the case a decade ago. Back then, paperless design and concurrent engineering were the norm in only a few isolated firms. The reason: Most computer systems didn't possess the memory and processing capabilities to handle large assemblies involving thousands of components. Software, too, was more primitive. Engineers often found that they needed to break designs up into hundreds or thousands of digital pieces, which were usually defined by the computer's memory capacity. Assembling all those pieces was a Herculean task that called for exceptional management skills.

"In all industries, engineers

consulting engineering firm headquartered in Columbia, S.C., "as long as there are no significant compatibility issues."

In theory, documents and drawings are best viewed in their native formats. This works as long as everyone in the chain has the native application installed—an unlikely scenario. While giant leaps have been made in software capabilities, there are ongoing compatibility issues facing firms and their clients.

To counter this, larger firms adopt the software programs required by their client. And some firms have found that designating one or two computer stations equipped with a client's software program is a cost-effective way of dealing with incompatibility issues. Unfortunately, due to cost constraints, this may not be an option for everyone.

"We continually work to meet the necessary software and program requirements of our clients," McMeekin says. While Lamp, Rynearson & Associates primarily uses AutoCAD—a multiple computer-aided design system, which typically creates proprietary data not easily shared—several of the firm's clients use Bentley's MicroStation or other software programs. When necessary, Lamp, Rynearson & Associates invests in the required software used by a client.

"This can be very expensive because the software technology changes so rapidly. So we find ourselves repeatedly having to outfit our organization with the latest and greatest," McMeekin says.



Increasingly paperless: By some estimates, more than 80 percent of all new designs flow through computer-generated programs.

have discovered that concurrent engineering is a natural extension of electronic documentation," says Michael Krannitz, a consulting engineer at Wilbur Smith Associates, an international

BY MAURA KELLER

Software manufacturers are continuing to tackle the compatibility issue by introducing updated versions of their software. As Tom Anderson, vice president of product marketing at Bentley Systems, explains:

"As most engineering projects involve multiple companies of different disciplines coming together, the sharing of electronic files is inherent in the process," Anderson says. "But for years the industry has had two different software companies, providing two different software solutions in two different formats. That's the part of the equation that software users feel they shouldn't have to put up with. It is a software industry-imposed compatibility problem."

Although Bentley has provided translators for the DWG file format over the years, the company recently released MicroStation 8.0, which now fully supports both CAD formats.

"It simply made sense for us to accommodate the industry's growing needs," Anderson says. "A few years ago, the technology to do what we are doing now virtually didn't exist at all. The newest software programs

help the industry take major step toward our ultimate aim of getting the right data, to the right people, at the right time."

Transmitting data

In the transmission of electronic documents to the client, a host of possible errors can occur. This is true whether the transfer is by disk or by FTP protocol. For example, the electronically transferred design data can be altered and damaged by the recipient's software or manually during review, or the recipient may use the software improperly.

tion "as transmitted," are critical. In addition, the engineer and client must partner to ensure that any individuals viewing the documentation do not manipulate the data themselves.

"Our reputation and licensure depends on our ability to have complete ownership of the design until final signoff," McMeekin says.

The design professional must also be concerned about additional transmission of the document from the client to others. For example, the client may transmit the design data to

the electronic transfer of design data cannot be completely avoided. But who bears these risks? The engineer or architect typically bears the risks of internal operations—employees' errors in conceptualization, documentation, and transmission. But risks in the electronic transfer of information may be borne by others.

Clients should bear the risks associated with their provision of information, modification of design data, reuse, reformatting, retransmission, and premature use of information. In addition, clients should also take responsibility for those they employ—consultants and contractors—to the extent that the information they provide is erroneous, whether in original conception, creation, formatting, or transmission.

However, even the clients' acceptance of their fair share of responsibility leaves fuzzy areas. For instance, the incompatibility of software or hardware that results in failed transmissions between the client and the engineer or architect is a shared responsibility unless risk of such incompatibility is clearly accepted by one of the parties. A contract can appropriately allocate the risks of the electronic creation and transmission of design data.

Signed, sealed, and delivered

While electronic documents continue to be transferred from design professionals to clients, state licensure boards are adopting regulations for the electronic transfer of stamps, seals, and signatures. Other state licensure boards continue to prohibit such transactions until adequate encryption security is available.

To help establish legal standards for electronic commerce, states adopt the Uniform Electronic

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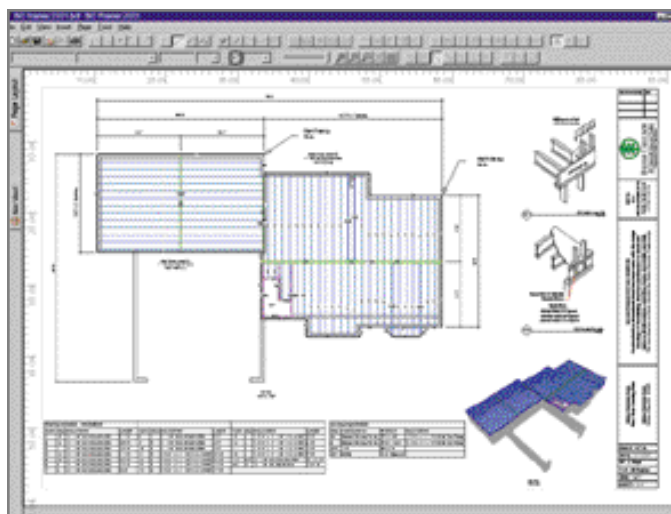
"To reduce these problems, the engineer and the client or consultant should institute procedures that address the various risks involved," McMeekin says. Procedures to document the receipt of information electronically, as well as a means of retaining a copy of the informa-

other offices, contractors, and consultants. Although standard operating procedures prior to computers may have required the maintenance of a correspondence log or the retention of transmittal sheets, the electronic transfer of data, particularly by way of modem or network, is not likely to be documented through these procedures.

"As with input errors, identification of the source of information and changes becomes increasingly important as the network of individuals sharing the electronic documents widens," Krannitz says. For this reason, many design firms use a system that allows clients to participate from the beginning of the project while gaining full access to the right documents whenever they need them, with an audit trail of the project's history available on command.

Risk taking

Some errors or omissions inherent in the design process and in



Unsecure designs: Files like the one pictured above can be susceptible to alterations from anyone who is able to open them.

Transactions Act (UETA), which gives legal effect to electronic signatures and records. More than 20 states have passed UETA

thereby eliminating the need for time consuming and costly couriers, while the Internet enables partners to get the soft-

documents issued in electronic format in much the same way they apply to paper documents. The respective rules for the engi-

measures for electronically transferred documents is imperative, especially since electronic documentation is here to stay."

However, McMeekin says there are a few areas of concern with the use of electronic data. First, there are tremendous risks associated with only archiving electronic copies of documents. For example, the potential deterioration of the media on which the data is archived, or changes in software over the years, could result in the inability to open a document. In addition, electronic documents do not provide ample evidence in the event of a lawsuit.

"Given the current technology, ACEC doesn't feel comfortable advocating a totally paperless environment," McMeekin says. "With all of the potential pitfalls, it is wise to keep paper copies as the 'official' copy of the documents engineers deal with."

**"Many engineering professionals use wet signatures due to potential legal risks and liabilities, even if their states allow electronic formats."
— Mike McMeekin, chair of ACEC's IT Subcommittee**



neering, architectural, and construction industries require the affixation of a seal, signature, and date of signature to all documents prepared and issued under the authorship or under the supervision and control of the design professional. For documents

issued in electronic format, however, the image of the seal, an electronic signature, and the date of affixing the signature must appear on each document issued in electronic format.

"Adopting electronic seal and signature software moves state governments toward paperless transactions," Krannitz says. "Determining the best security

and others are considering the measure this year.

A key component to electronic seals is electronic signature software, which leverages existing technology investments to enable partners to quickly collaborate in a secure and legally binding electronic process. E-mail becomes the new means of exchanging signed agreements,

ware plug-in needed to electronically sign, verify, and seal print-signed documents.

"While electronic seals save time in the project process, many engineering professionals use wet signatures due to potential legal risks and liabilities, even if their states allow electronic formats," McMeekin says.

Sealing rules apply to design