



Interoperability & Integration

in the Construction Industry

*Technology
or People Problem?*

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A CMAA Emerging Technologies Committee Article

The authors have worked to ensure that all information in this book is accurate at the time of publication and consistent with standards of good practice in the construction management industry. As research and practices advance, standards may change. For this reason, it is recommended that readers evaluate the applicability of recommendations in light of particular situations and changing standards.

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...promoting the profession of Construction Management and the use of qualified Construction Managers on capital projects and programs.

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Interoperability & Integration in the Construction Industry

Technology or People Problem?

Introduction

Systems integration and interoperability come up often as projects and teams launch new applications to make the delivery of capital projects more efficient, more collaborative, more predictable and most importantly, more successful. Systems integration was created because project team members needed a way to share reliable data and innovative solutions with one another, in order to help drive decisions and improve efficiency.

Modern software and cloud-based storage are incredibly powerful tools. There are many different programs for many different tasks. In theory, “selecting the right tools for the job” should be enough to produce optimal results. However, as the complexity of a system grows, so does the potential for data silos to occur within the system. The simple truth is that this technology, which is designed to make our lives easier, can actually do more harm than good if it isn’t properly managed; harm like raising project costs, causing inefficiencies, and draining resources.

Thankfully, interoperability is achievable, and there are tremendous benefits waiting to be reaped by those willing to invest in it. This white paper by the CMAA Emerging Technologies Committee will provide an in-depth look at the characteristics, benefits, challenges and effective techniques used to select the right programs for a project and then subsequently integrate them all into a one, highly efficient system in order to meet your project needs. It argues that the people using the technology present a bigger obstacle to achieving their goals than the technology itself.

Defining Interoperability

Let’s begin by defining interoperability. Our research team interviewed and surveyed CMAA’s members to gauge their understanding of the terms “systems integration” and “interoperability.” We first asked members to tell us what the term interoperability meant to them. We were happy to find that, while they did not provide a very detailed or technical

response, every interviewee was capable of accurately describing interoperability in lay terms, summarized as:

- The ability to have one piece of software exchange information with another.
- This definition closely matched one by Gartner, a leading industry technology research and consulting group:
- The ability for a device from one manufacturer to work with one from another.

However, those we spoke to who had a technical background or who were currently involved in the process of integrating systems, were able to elaborate a little bit more:

The ability of systems to exchange information seamlessly, thereby reducing the number of data entry points and enabling the format of data to be modified based on the needs of its recipient.

Interoperability in the Construction Industry

In 2007, McGraw Hill Construction published a document titled *Interoperability in the Construction Industry* that was sponsored in part by CMAA. This report provided several examples of the benefits, both measurable and perceived, that interoperability can provide. Our interview responses mirrored the report's findings.

Interoperability eliminates:

- Manual data re-entry
- Duplication of business functions
- Reliance on paper to duplicate and exchange data

Interoperability benefits include:

- Increased speed of overall project delivery
- Reduced infrastructure vulnerability
- Greater reliability of information throughout a project's lifecycle
- Decreased supply-chain communication costs
- Improved value to customers

Around the same time, the agcXML project was conducted by the Associated General Contractors of America (AGC) and the National Institute of Building Sciences (NIBS). Major software vendors were asked to come up with ways for building design and construction professionals to efficiently and reliably exchange digital construction project information.

Eight years later, this issue is still very relevant. Its continued relevance is the reason why the Emerging Technologies Committee has chosen to focus on it.

Different Levels of Integration

Each of the following system integration levels discussed below are currently in use. However, we found that most respondents' systems were at the partial integration level. Interestingly, several interviewees (particularly owners) indicated that full integration was not one of their goals, primarily due to the cost, security risks, or concerns about control associated with full integration.

Level 1 – Minimal/No Integration: This first level is when projects or enterprises rely on a third-party program(s) to manage data exchanges. Typically, a minimal/no integration level is only effective in a small, self-contained environment, such as a single department or a small office. However, unintegrated systems create problems when used for large projects. These problems are **inefficiency** (added costs, drained resources, and time delays caused by individuals needing to maintain separate systems or wait for information from others), **information silos** (lack of sharing) and **data availability** (data doesn't exist or is difficult to find).

Level 2 -- Partial Integration: This is when only certain systems are integrated with one another, in order to improve data exchange relevant to the specific needs of a project or enterprise. This most-common level of integration is used in both **internal** systems (data shared between members of the same organization) and **external** systems (data shared between multiple organizations working on the same).

Level 3 -- Full Integration: Finally, full integration is when all user systems are integrated with one another and are sharing information to their full capacity. Full integration allows all stakeholders and users to reliably upload information to and download it from a single source.

Which Systems Are Being Integrated?

For this research, it was important for us to identify the industry's most commonly used systems, regardless of roles, region or market sector. We asked CMs, PMs, owners, engineers, architects, IT Managers, professors, teachers, and industry experts working in the transportation, water/ wastewater, healthcare, civil, heavy construction, and academic industries which systems they used.

The most common responses were:

- PMIS – Project Management Information Systems (owner vs. GC centric)
- BIM – Building Information Management software

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- GIS – Geospatial Information Software
 - Asset management software
 - Reporting and dashboarding software
 - Financial software
 - Scheduling software
 - Space planning

Interoperability in the Building Information Management (BIM) Era

So what about Interoperability and BIM? Building Information Modeling (BIM) has different meanings to different people. Some scholars argue that Building Information Modeling (BIM) is an inappropriate title, because BIM is about more than just buildings or modeling. Some call BIM “Building Information Management” to place more of an emphasis on the information component than the 3D geometry component.

Whatever you call it, BIM has the potential to revolutionize the AEC industry by acting as a hub for data mapping information and integration. For example, 4D modeling (the intelligent linking of individual 3D CAD components to time-related or schedule-related information) is a product of scheduling and BIM integration. 5D modeling is essentially 4D modeling with the added layer of a cost estimation system. Examples of additional BIM system layers include model-based cost estimation, facilities management integration, and BIM-based PMIS workflows.

Fortunately, most of the software packages used in the BIM process include some sort of API (Application Programming Interface), which allows agencies with qualified staff to create these aforementioned extensions. APIs can perform a variety of the following tasks:

- Adding features to existing software to augment functionality or to customize the software for individual workflows
- Automating activities within the software package to increase productivity
- Extracting data to further analyze or to send to other systems
- Pushing data from other systems into the package

Leading AEC firms have found significant value in BIM. Many have established a BIM R&D team to develop more advanced BIM technologies, develop custom solutions, research ways to integrate additional systems, and to educate more people within their own organization.

As wonderful as this dedication to achieving BIM excellence is, it is only a starting point. Fully understanding all of BIM’s capabilities will take a long time and will require a lot of effort from a lot of people. Regardless of which systems are being used, it should be clear that our industry is

searching for a faster and more reliable way (pure stream) to share data with all project team members to improve decision-making, while reducing uncertainty and dissonance. Interoperability requirements must become a higher-priority topic for discussion as more and more new systems are adopted.

Benefits

There are obvious benefits to be realized by linking systems together and having them effectively communicate with one another. Most notably, **interoperability eliminates inefficiencies** caused by:

- Manual data re-entry
- Duplication of business functions
- Continued reliance on paper to duplicate and exchange data

Our study also indicates that greater efficiency and elimination of waste are two key benefits for CM industry professionals. In addition, any improvement-focused organization must have sufficient access to data in order to track performance.

The following are the benefits that interviewees and survey respondents most commonly mentioned:

Instant Access to Reliable Data and Improved Collaboration

Access to data provides a CM with the necessary information and insights into the status of a project, the performance of a business group, or the performance of a specific process, so it is not surprising that “instant access to reliable data” is one of the most commonly mentioned benefits. Most agencies rely on multiple systems to track different aspects of their project; one for estimating costs, one for planning, one for program management, one for construction management, and so on. Reports that require information to be gathered from that many different sources are more time-consuming and error-prone than they need to be. Respondents noted that having easier access to data improved team collaboration and cut down on response latencies to client needs.

Improved Efficiency and Time Savings by Eliminating Redundant Data Entry

Another frequently mentioned benefit of interoperability is that interoperability eliminates instances of duplicate data entry. Many agencies use redundant systems (systems that collect the same information into different locations). These systems require the same information to be entered two or more times.

Keith Tyson, of the Washington Suburban Sanitary Commission, was able to save his agency’s inspection team 20-40 hours per week by having data entered only once during their inspection

process. To put this into perspective, a \$10-20 million dollar project requires the entry of an estimated 200-300 RFIs. Imagine the time and money that could be saved by eliminating that many duplicate RFI entries (GC/architect/owner).

Secondary Beneficial Use of Data or Sharing Data on One System for the Benefit of Other Teams

In more extreme instances, agencies attempted to leverage information already stored in one system during their design and construction phase and turn that information over to the operations and maintenance group. One such example would be taking information from a BIM model and moving it to an asset management system.

Eliminate or Minimize Human Error

Another benefit of systems integration is that it reduces the number of required data entry points, which consequently, should eliminate the potential for human error. We frequently received anecdotes about someone taking information from one location (database, spreadsheet) and copying and pasting it into another system. Using APIs is one way that agencies we talked to are addressing this challenge.

Challenges to Achieving These Benefits

We asked respondents to tell us about the challenges they faced while trying to integrate different systems, and the strategies they used to overcome those challenges.

People Complicating a Simple Process

During one interview, we spoke with the leader of CannonDesign's construction services team, Gustavo Lima. Gustavo is responsible for developing and coordinating CannonDesign's construction quality improvement initiatives around the globe. He frequently lectures at AIA and other similar organizations. He also authored an article titled "Message to the Project Management Software Industry: You need to learn ESPERANTO."

http://www.aecbytes.com/viewpoint/2011/issue_59.html

"We put a man on the moon yet we can't fix this problem," Gustavo said, when asked about interoperability. One example AGC used to support its data exchange schema was an RFI exchange between a contractor and an owner's PMIS (Penta and e-Builder) at the 2006 AGC Conference. Gustavo commented on this, saying "Even though an RFI is nothing but a sophisticated email – to, from, date, body of text – contractor and owner systems are set up to collect the same information differently." This is not a software issue, it's a people issue.

One senior IT systems manager in Chicago noted that many problems start when a system's needs are not completely understood or aren't clearly conveyed to all of the system's stakeholders. This leads to frustration for users, who don't understand why data cannot be pushed or pulled in the format that they need.

Most interviewees agreed that the best way to combat this problem is through effective communication. Stakeholders must find a way to describe what they need from the system. Formal procedures (including roles, responsibilities, flowcharts and process maps) must also be established to improve the effectiveness of the system.

Territorialism (Loss of Control)

Another recurring challenge was the inability to integrate a PMIS with a company's financial system. In some instances, an engineering team would insist that the construction team's financial system not be allowed to integrate with their own (JD Edwards, PeopleSoft, Banner, others). The engineering team said that they were afraid the construction team's financial system might corrupt their own financial system if the two systems were integrated with one another. The likelihood of integration causing corruption is minimal. Nevertheless, the engineering team steadfastly denied the construction team's request. They even rejected a proposal from the construction team to integrate data through a batch process (in which data is dumped into an FTP site, where it is then picked up by a construction system). Groups have a tendency to associate control over data with control over entire processes. This can create serious friction.

Visibility

Several respondents expressed concern over their data being fully transparent. One agency recalled an instance where one of its teams continually stymied the launch of a new system that would create reports which offered full visibility of the team's entire program. It appears that what some groups consider to be common ownership can be seen as proprietary ownership to other groups. Transparency and visibility issues need to be addressed during the integration phase. Guidelines for what can and cannot be shared need to be formally agreed upon by all stakeholders to prevent problems from occurring later.

Wrong Tool for the Job

Some interviewees felt that problems could frequently be traced back to the wrong system being selected for a project. In order to make a sale, a vendor will frequently overstate a tool's capabilities and ease of use or understate the time and resources needed to implement and administer a tool. The aforementioned problems are exacerbated when the wrong program is integrated into an existing system.

"Wrong-sizing" is a similar, yet equally devastating factor to consider. Oftentimes, a vendor salesman will persuade an unwitting CM or agency IT department to purchase a more expensive product that is laden with unnecessary features and functions. In this scenario, the price for these premium programs is unjustifiable. The additional features provide no added benefits, yet they unnecessarily burden users with a steeper learning curve.

Over-Customization

Every project is like a snowflake, each one is unique and special, right? When projects adopt this mentality, and many do, they tend to over-customize their tools. This results in systems and integration processes becoming wildly overcomplicated. Applying industry best practices and standards can help avoid expensive, time consuming implementation, minimize deployment glitches and productivity issues, and prevent long-term system maintenance issues; all of which can waste valuable time and money.

Integration with Non-commercial, Custom/Owner Built Project Management Systems

Over the past five-to-ten years, agencies (especially owners) have shifted away from custom-developed systems. As highlighted earlier, Cloud-based, commercial off-the-shelf systems (COTS) will reduce interoperability's technical limitations. As one CM put it, "If you or your client are still holding on to an antiquated, custom built system to manage your financial or project data when there are so many good cloud-based tools available, you are needlessly subjecting yourself to slow data exchange, versioning challenges, slower response times and lower overall project management performance."

Time and again, the feedback we receive indicates that most challenges to systems integration are "people problems" instead of a technical issue, such as systems not being able to communicate with one another. As you will read in the "Integration Alternatives" section below, users have several options. Once the value of integration is established, the only real challenge is to overcome resistance from other teams.

If this argument is true, and technology is not the issue, why do people still interfere? Finding an answer to that question is the real challenge for CMs.

Applications Now Offer More Integration Alternatives

As previously stated, the shift to the Cloud has been one of the reasons that systems are now more integration friendly. True Cloud systems provide a multi-premise approach, whereby all users of the software work on the same version, as opposed to a single-premise approach, in which different versions of the same software are managed within the agency. Think of it in terms of how you use Outlook in the Cloud: As new features are released, all users are upgraded together, and consequently benefit from the synchronous upgrade. An example of the old model, would be one company using its preferred data storage program (i.e. Dropbox) and another company (or worse, another office within the same company), who is working on the same project, using an entirely different program (i.e. Google Drive).

Thankfully, organizations can select from at least three options to determine how integrated they want their system to be:

On Demand Import/Export – This method allows users to easily map their data to data fields in another system, as an import file. Data exports leverage query builders. Once the desired data fields and filter criteria are selected, the report output can be easily saved to a file that can be imported into another system.

This option is most appropriate when:

- You want to eliminate duplicate data entries
- Real-time updates are not required
- One system does not support automated integration
- Automated integration would be cost prohibitive

Scheduled Batch Import/Export – This method can be done through a job-processing engine that executes tasks at predefined intervals. Tasks can be scheduled for daily, weekly, monthly or one-time execution. On-demand imports and exports can be scheduled for unattended execution by the job processing engine. Import files are automatically retrieved from one system’s document library or from an external FTP site while the export files can be delivered to any combination of document folders, external FTP sites, or SMTP email addresses.

Web Service API – A web service API can allow secure programmatic access to a system’s data using industry-standard protocols such as SOAP, XML, HTTP and SSL. All project data, workflow, cost summary data and transaction detail can be retrieved or updated through the API. Integration with agcXML compliant systems requires no programming, and can be set up through configuration.

This option is most appropriate when:

- There is a need for real-time data exchange
- There are a high volume of transactions
- A user requires more granular control of the integration (For example, the API can be used to retrieve new invoices entered into a PMIS and record them in your accounting system without duplicate data entry.) Once invoices have been paid, the payment status and details are automatically updated through the API with no human interaction required.

Conclusion

There is still a lot of work that needs to be done in order to transform our industry into a model of efficiency. Analysis of our CMAA interview and survey data, which was still going on at this paper’s time of publication, reinforces the point that people are the biggest obstacle to interoperability. Software providers have done their part by releasing integration-friendly

applications. One interviewee, who represented one of ENR's top 10 construction management firms, made a great point that summarized part of the people challenge.

“We have a different view than owners in that the owner’s main concern is to get the project done, and they aren't overly interested in efficiencies if it costs them up-front money. It's more political than functional resistance. Overseas, our projects are more lump sum and cost sensitive for the life of the project. So there is a greater desire overseas, but fewer resources available to do it.”

Developing a better understanding of interoperability and its benefits is paramount to becoming a more integrated industry. CMAA continues to be an industry leader in sparking debate that leads to practical solutions. The next time you need data to help you execute your job more successfully, find the time to challenge other department’s leaders (IT, engineering, operations, others) to find more efficient ways to access the data. Do not accept “it can’t be done” as an answer. Instead, ask “how can we quantify the benefits to justify any effort involved?” The CMAA Emerging Technologies Committee will continue to push the envelope and find solutions for the Interoperability challenge.

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