

Using Common Software Programs to Manage the Commissioning Process

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Synopsis

Building Commissioning is a process of gathering, evaluating, and communicating data. The most difficult part of the process (for some of us) is keeping track of that data. We use a myriad of low and high tech tools to gather information, but many of us still struggle with paper files and notebooks full of data that are eventually transcribed into the final Commissioning Report. Often, data is more useful in the field than in the office. This paper describes how one Commissioning organization uses three common pieces of software to organize, distribute and communicate Commissioning information.

Microsoft SharePoint is collaboration software that is used to create an interactive web site for each project. Each site contains an interactive issues list that allows the administrator to post issues and alert users by email that they have been assigned an issue. Users log on to the site, reply to the issues, and assign them to other users for further action, or send them back to the administrator for verification, if complete. This paper discusses one possible implementation of this software and the administrative, hardware and technical elements required to install and maintain the software. An alternative is to use a subscription service to serve SharePoint to your business.

Filemaker 7.0 is a relational database that we use to track the overall Commissioning process. The process of database development is discussed, as are the benefits and frustrations of bringing a database to fruition.

Adobe Acrobat is a program that is used by web developers to create universal documents that are accessible across computer platforms on the web. The presentation will discuss the process of using Acrobat to create electronic O&M manuals that are hot-linked to an index and also to building floor plans

About the Author

Felix Kersting, PE has 17 years of mechanical engineering experience in machine design, facilities engineering and Building Commissioning. Prior to his engineering career, he spent 11 years in the construction industry as a journeyman plumber and plumbing contractor. He is certified as a QCxP by the University of Wisconsin.

Introduction

Building Commissioning is a process of gathering, evaluating and communicating data. The most difficult part of the process for some of us is keeping track of that data. We use a myriad of low and high tech tools to gather information, but many of us still struggle with paper files and notebooks full of data that are eventually transcribed into the final Commissioning Report. Often, data is more useful in the field than in the office. This paper describes how one Commissioning organization uses three common pieces of software to organize, distribute and communicate Commissioning information.

My name is Felix Kersting and I'm the Building Commissioning Field Manager for the Construction Services Group, a program of Educational Service District 112 located in Vancouver, Washington. We're just across the Columbia River from Portland, Oregon. Washington State's nine ESDs were created in 1969 by the legislature. The mission of the ESDs is to:

- assist districts in providing quality, cost effective education,
- provide equal education opportunities for all students,
- provide cooperative and information services to districts,
- act as a liaison between local districts and the Office of the State Superintendent of Public Instruction,
- deliver programs mandated by the state.

The Construction Services Group is a fourteen person team that provides Construction Project Management, Constructability Reviews and Building Commissioning Services to the K-20 market on a fee-for-service basis. Through agreements with the eight other ESDs in the state, we provide services across the entire State of Washington. Often our small Commissioning staff is spread across the state making access to a central data repository essential. With the help of our IT staff, we have developed a set of tools to allow that communication and access. The three pieces of software that I am going to talk about today are Microsoft SharePoint, Filemaker 7.0 and Adobe Acrobat.

The Commissioning Issues List

The first automation task we tackled was the Commissioning Issues list. Our first Issues List was an Excel spreadsheet that was emailed to the contractor once a month for an update as issues were resolved. It was difficult to lock the document so that data could not be altered by anyone, but could still be updated. Occasionally, we found that issues just disappeared from the list. Next we tried a Word document to see if it improved upon the Excel spreadsheet; it was easier to edit, but still not secure and required a lot of management on our end. One night I was surfing the web at home and was inspired by a bulletin board. Why not set up a bulletin board for each job where we could post issues and let people respond? There were some great advantages to this approach – the users did the work – all the typing - and all we did was respond. It was Web accessible – so everyone could get to it from anywhere. There was lots of free software available, too. But there were some drawbacks as well; we needed someone who knew how to make it work. We needed a server; and security could become an issue. We needed to allow selective data access. The task looked daunting.

Throughout my engineering career, I have worked closely with IT departments on a variety of projects. Many of us who are familiar with DDC systems are fairly comfortable with networks and servers. ESD112 has an IT department that manages and maintains a large share of the IT infrastructure for the Office of the State Superintendent of Public Instruction – rooms full of computers and servers. I went to the IT guys for help. I asked if they could set up a bulletin board for us to use as an issues list. It turns out that the IT world has lots of issues – they’re known as “help desk issues”. There are hundreds of pieces of software used to track computer and network issues that are easily adaptable to the Commissioning field. A Google search for “help desk issue software” got 1.36 million hits. Four of the first ten listings were web based. Our IT director developed a list of software for us to try – some of it free. Another thing that experience taught me was that homegrown solutions are sometimes the best – especially if you don’t have a budget to continually hire a consultant every time you need to make a change. We were looking for a piece of software that our IT department could install and support for us.

The piece of software we settled on was Microsoft SharePoint, which is formally referred to as “collaboration software.”. It is a web based program designed to allow people to collaborate on projects. Since it is web based, all the information resides on a server, so the collaborators can reach it from anywhere in the world if they have access to the web. SharePoint allows users to share files, schedules, libraries, calendars, and on-line discussions. The software uses a canned, customizable web interface to build a site for each project. The administrator adds project members to the database and allows them access to specific sites. Each user that is added to the site is granted permissions to read, write, add or delete files or information to or from the site.

One built-in function of SharePoint is an Issues Log. Issues are individually numbered and posted. SharePoint allows issues to be assigned to one user at a time. When that person has finished their part, he or she can assign the issue to someone else. When a user is assigned an issue, SharePoint notifies that user by email. Users can also subscribe to an issue. This option notifies them by email each time an issue changes, even if it is modified by someone else.

SharePoint’s issues list keeps a running history that is visible whenever the issue is opened. The history log is permanent and cannot be altered by the users.

We have had great success using SharePoint to resolve Commissioning Issues. In many instances we have reduced the time resolve issues from weeks to hours. Here's how we make SharePoint work for us:

- Open communication to the whole team – we get buy-in from all the players on the project team. We explain what SharePoint is and demonstrate how we use it. We then collect the names of the key contacts on the project; owner, architect and consultants, project manager, contractors and subs.
- Assign Responsibility - all the issues go to the architect. The standard AIA contract states that the architect will direct the contractor to change or correct defective work. The architect assigns the issues to his consultants or to the contractor. We always encourage the contractor to let us sign up his subs so he can pass issues directly to them.

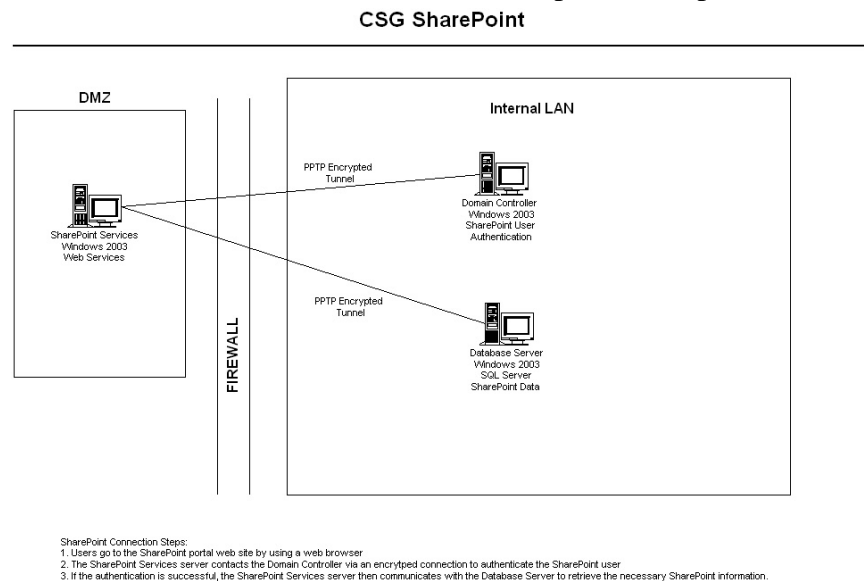
- Monitor progress. I am the SharePoint administrator for our organization. I subscribe to each Issue on each project. There are days when I receive hundreds of emails alerting me that the database has changed. When an Issue is ready for verification, it is assigned to me. I review each project on a bi-weekly basis to be sure that Issues are not going “stale”.
- Post project related information – we post progress reports, pictures and items to be reviewed by the project team on the site. This is a great place to drop copies of the Functional Performance Tests for review by the design team and contractor prior to testing.

We have received high praise from all team members on how easy and convenient SharePoint is to use. I'd also like to note here that SharePoint has some great project management uses as well, although we are just beginning to explore the possibilities.

DEMO TIME - Allow 2-3 minutes

Now all of you are saying, “Wow, sign me up!”

Let's talk about what it takes to run SharePoint for your business. SharePoint is server software. It runs on a web accessible server. The good news is that SharePoint comes with Windows Server 2003. If you own and maintain your own web servers, you will need to add a separate SharePoint server. SharePoint doesn't play nice – it doesn't like to share. SharePoint must run on its own server. You also need to run Microsoft SQL server since SharePoint is a SQL database application. If you don't already allow traffic through your firewall, you will need an authentication server as well. Here's a map of our implementation



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Figure 1 - SharePoint authentication and data access

The SharePoint server resides in our DMZ and talks to the authentication and SQL servers through encrypted tunnels. Now we're talking about real enterprise level internet security issues. You need to be an IT professional or have one on staff to make sure your business is safe from incoming internet traffic. Our IT staff maintains web servers for us – we just bring ideas and money and they make it work. By the way – it took our IT staff 8 months from concept to implementation for our SharePoint installation. Again – don't try this at home – unless SharePoint is installed on properly secured servers, your business data could be at risk.

One last note about IT staff: one of the engineering firms we work with has an IT guy who is developing a SharePoint-like application for their office under Linux. After all, "it's just a SQL database application". This reiterates the idea that some IT tasks are trivial for the real professionals.

If you don't have an IT staff or web servers of your own, take heart, another alternative is to use a subscription service that offers SharePoint or similar software access for a monthly service fee. I did a Google search for "Microsoft SharePoint" and found services starting at \$19.95 per month. Using these services is a simple way to get up and on-line with a great communication tool.

To summarize, using "collaboration software" can greatly enhance communication between the Commissioning team and lead to faster resolution of Commissioning issues.

Tracking Commissioning Project Data

With the Issues list out on the web and accessible from anywhere, we thought – what about the rest of our project data? Wouldn't it be great to be able to manage all aspects of a project from anywhere? We could do that with a web-enabled database. It would be a better way to keep track of the Commissioning process, too. We went back to the IT department for a recommendation of which database to use. Microsoft Access was the natural choice, since it comes in the Office Suite. I had some Access experience and my partner and I were pretty savvy computer users so we got some books from the local bookstore and were ready to start on our next homegrown solution.

A database is a means to keep track of data. In its simplest form, a database is like a spread sheet or a phone book – with each piece of data related to exactly one item. Databases with a one-to-one correspondence of data are called flat files. Categories of data are called fields, and entries in the database are called records. In the database shown in Figure 1, the fields are the columns such as Name, Company, Address, City, State, and Phone. The records are the information that goes into those fields – the information in the rows.

Many spreadsheets come with a limited set of data manipulation tools, because many simple databases work well as flat files. But, notice that there are three pairs of records that have duplicate entries in the Company field. This is fine in a spreadsheet, but as the database grows, there are thousands of duplicate entries. This is an inefficient use of memory and also creates a

headache if one of the companies in the database moves and someone needs to update all the associated records. We certainly needed a more sophisticated database than this.

Contacts

Name	Company	Address	City	State	Phone
Bob Stayton	ESCO	2118 SE Union	Portland	OR	503-788-6879
Bill Cobb	ESCO	21 SE Union	Portland	OR	503-788-6623
Sam McGill	U of O	223 E Main	Forks	WA	360-664-8977
Jim Brown	USGS	444 Cactus	Tucson	AZ	984-889-1239
Bill Stripe	USGS	444 Cactus	Tucson	AZ	984-889-1222
Rick Alexrod	UPS	25 Ward St	Forks	WA	360-907-8490
Buzz Sawyer	UPS	25 Ward St	Forks	WA	360-907-8491

Figure 2 - A flat file database

A relational database uses a series of flat files called tables that are linked in a manner that allows the user to glean the information he desires easily. The database developer creates relationships between the tables based on how the data will be used. Figure 3 shows the same data as Figure 2 in two tables that are related by the Biz ID column in each table.

EmpID	BizID	Name	Phone
1	1	Bob Stayton	503-788-6879
2	1	Bill Cobb	503-788-6623
3	2	Sam McGill	360-664-8977
4	3	Jim Brown	984-889-1239
5	3	Bill Stripe	984-889-1222
6	4	Rick Alexrod	360-907-8490
7	4	Buzz Sawyer	360-907-8491

BizID	Company Name	Address	City	State
1	ESCO	21 SE Union	Portland	OR
2	U of O	223 E Main	Forks	WA
3	USGS	444 Cactus	Tucson	AZ
4	UPS	2500 NE 65	Forks	WA

Figure 3 - Tables related by ID numbers

It was clear we needed a relational database and we were eager to get started and see results. But all of our references directed us to a formal database design methodology. The steps are:

- Overall System design – understanding the business model
- Output or Report design – a clear listing of what the output from the database will be
- Data design – listing the fields needed to get the output you want
- Table design – grouping fields into tables and creating relationships between data
- Field design validation – matching output to input
- Input or Form design – pages that logically cluster input data
- Automation – developing menus and report generation

Often databases are written to automate existing business processes. This was the case with our database. We already had a working Commissioning business. We had the paper forms we were already using for input and output. We went through the formal design process.

To understanding how the data will be used, it is necessary to have an overall understanding of the business process. The process is usually mapped on paper with the data in groups and the relationships between data sources are simply lines. The database is created within the software using the business map as a guide.

Overall System Design

During overall system design and development, we spent many hours mapping out how our business works. This was one of the most valuable results of developing the database - we forced ourselves to scrutinize every aspect of how our business worked. We streamlined our business model. I recommend this process for anyone – even if you aren't writing a database. We found out what data we gathered was never used and we discovered methods to extend the usefulness of the data we collected.

Report Design & Form Design

One of the most tedious tasks in developing a database is developing and editing forms. Building forms and reports in Access is painfully slow. The automated report generation provided in the software is a good place to start, but hours of editing are required for each page. Fortunately we have staff that is experienced with graphics programs to help us design forms and reports.

Data, Table and Field Design

We have fourteen tables in the non-testing portion of our database. As will be described later, our database is split in two for portability reasons.

In order for a relational database to work, the data tables are “related” to one another to allow data flow as needed. We evaluated several different data models, each using a different key element to link data. We came to realize that Project Scope was the key element to all the projects we do. Each project has enough variety that the Scope is what sets it apart from the other jobs. All the data tables relate to the Project Scope. The table names are generally recognizable to most in the commissioning business like “Specification” or “Ck1st_Submittal”. We can retrieve any data related to any project.

Creating relationships between tables is an art and a science unto itself. We struggled through much iteration of relationships to make all the components of the database work correctly. We are still modifying our database to add and remove features and streamline relationships. Not all portions of our database work as desired, but we are able to retrieve data as we need it.

Automation/Menus

Another unexpected time consumer was automation. Macros and built-in automation in Access has been replaced by VBA – Visual Basic for Applications. This is an additional programming language that is required for custom menus, sorting and calculations. VBA itself is no small undertaking, and it has extensions into Microsoft's web applications as well.

Once we had progressed quite a way in our development, we went to the IT department to begin the process of moving our database to the web – to be sure we could use the forms and reports we were developing. At this point they admitted that they had no experience getting Access databases to the Web, and we would need to hire a professional developer to get Active Server Pages built and in place. Recall that we were trying to develop home grown solutions that we could support internally. The new recommendation was to migrate to another product – Filemaker 7. This database was widely used at the ESD and this newly released version was fully relational. The ESD already had a Filemaker web server in place and it would be only a few months until everyone upgraded to version 7.

With no budget to hire an external developer, we made the switch to Filemaker. Immediately we made several observations;

- Forms and reports are better integrated into the product and are easier to use than Access
- Version 7 of Filemaker is the first time tables have appeared in Filemaker, so there are very limited facilities for editing, copying, etc.
- Data imports into and out of both databases well.
- The documentation that comes with Filemaker is woefully inadequate
- There were 50 books on the shelf about various releases of Access: there were 3 total for Filemaker. This is equally true for information on the web.
- Filemaker uses a scripting language for automation. It is much less flexible than VBA, but more than adequate for our purposes. I was writing scripts in a matter of hours.
- Menus are nothing more than script steps with a button assigned to them, so building basic menus is a simple task.

We reconstructed our database in Filemaker. We discovered that we had already learned a tremendous amount about databases and further refined our project as we progressed. We also had the experience that it took far less time to reconstruct the database than it did to create it originally.

Filemaker has a built-in function called instant web publisher. This allows one to publish a database to an intranet with a few clicks of the mouse. This is a great prototyping tool. We shared our database on our intranet to test it before we went to the web. This also allowed us to assign data entry tasks to clerical help.

It was time to go to the web. The database still had some rough edges, but was very close to complete. We needed it in the field. The data would be intact even if we changed or added some new forms or sorts. We went back to the IT department to have them load our database on their new Filemaker 7.0 server and get us out on the web. Unfortunately, the Filemaker 7 server had been delayed for about a year. The good news was that they were willing to put a server together just for us – bring \$5k and call us in about 2 months.

We got on the web and found a local company that would host our database for a \$50 set up fee and \$40 per month. We contacted them and asked them if they could put the finishing touches on our database and get it to the web and set us up with secure password access. The quote was

\$7200 and the password access was an additional service if we wanted that piece. So our database resides on the server at the ESD.

Where do we go from here? Here is our path forward on the database project:

- The database was split into two parts from the beginning. All the information regarding Functional Performance testing is on a laptop for field use. This data synchronizes with data on the server at the ESD every time it connects to the server from inside the building. It turns out that trying to run tests against a remote database may be a problem since so many projects don't have web access at the time we are doing functional testing.
- The FPT database is growing all the time and needs a way to synchronize Project data with the Administrative database at the ESD. The FPT database is also a set of flat files and needs to be turned into a relational database in the future.
- The Administrative database is very useful in the office. We use instant web publisher to allow our clerical staff to input project data. We are able to monitor project status at any time for all commissioned equipment based on the specification requirements including, submittals, O&M manual review, installation checklist status, training, owners spare parts and 11 month warranty review.
- A goal is to bring Installation Checklists for each project to the web. This may be possible using SharePoint and our IT staff is investigating that option. Conversely we may be able to eliminate SharePoint by using an Issues database that is built in to Filemaker when the IT department migrates to Filemaker 7.0

To summarize, our database has become a valuable tool in our Commissioning process. Development forced us to reevaluate how we do business and streamline our process. Information is quickly stored and retrieved regarding every aspect of a project. This is useful for billing purposes, too. As time goes on we find we already have much of the equipment on most projects already in the database – data entry is reduced over time. Final Commissioning Reports are easily generated from stored data in a preformatted report.

As with SharePoint, we must caution that database development and implementation is a time and expertise intensive enterprise. Get an estimate from a reputable developer and decide from there if you have the budget to move to a database. If you cannot afford a developer, chances are you will need to hire or develop the internal expertise to do the job. I was surprised to discover that we had folded several hundred man-hours into our development effort, but that included converting from Access to Filemaker. This can be a reasonable enterprise for slow periods or for using interns. Moving your database to the web requires another set of skills that you will likely need to purchase. Rather than – “don't try this at home” – we would say move ahead slowly and don't expect instant results.

Electronic O&M Manuals

An additional service we offer to our customers is electronic indexed O&M manuals. This is an O&M manual on CD. This manual can be web accessible on the owner's intranet.

We used Adobe Acrobat to build the manual and to create a linked index and linked images. Adobe Acrobat will combine any number of PDF files into one file and allow you to link any hot spot you create to another page in the document. This navigation allows the user to move from a site plan to a specific room in a building with a couple of clicks. The user can then select the equipment he would like to view manuals and service information about. We also offer an index of equipment by system (that comes from our commissioning database) to allow the user to go directly to equipment data.

The best thing about creating electronic O&Ms is that Adobe Acrobat is easy to use. No geeks are required for this task - it's a task that your clerical staff can accomplish after some initial guidance. It's a good thing too, because assembling O&Ms can be extremely tedious work. What is required is organization. Here's an overview of the process:

- Create an Index. Building the index first will give you an idea of what kind of information you will need to have to assemble the manual.
- Gather all the drawings and literature you will need. Most manufacturers have O&M information available as PDF files on their websites. We maintain a database of manufacturer's literature files. When we have to use hardcopies, we use a service to scan drawings and brochures and save those files for future use. An office copier/scanner will work just as well, but this is just too much volume for any scanner without self-feeding capabilities.
- Convert all your files to PDF files. PDF stands for Portable Document Format which is a format that Adobe developed. PDFs are compact files. They often appear as a photocopy of a document. Adobe distributes Acrobat Reader free on the internet to allow users of many different operating systems to read PDF files, hence the portability of documents. This document format offers a distinct advantage – for example the guys in the maintenance shop with the old Windows 98 box do not need a new computer and another license of Microsoft Office 2003 in order to read the manual. Or if a maintenance tech is in a classroom and the manual is available on the school's intranet, he can view it from the iMAC on the teacher's desk.
- Insert files and link as you go. Set bookmarks at the same time. A word of caution, keep a written list of the page numbers of sections you insert as you go. You need to tell Acrobat what page you want to link to from the index at the beginning of the document. It is time consuming to scroll through 2000 pages to find that cut sheet on a control valve you forgot to link. If you find yourself in this situation, you can always add the sheet again and link it. Always add new material behind the last page of your file – it's easy to find it there as you are building the links. Similarly, if you are short some material, don't worry. Links take you to a specific page, so that the order of the pages doesn't matter.
- Have several other people proof the finished product – just as you would with any presentation quality document.

One trick in putting together a digital O&M manual is to provide the developer with a strong computer. Manipulating a 2000 page document requires a lot of RAM and a fast processor. We use a 2.8GHz machine with a gigabyte of RAM.

In summary, an electronic indexed O&M manual is a great time saver for any maintenance department. Building a manual of this sort is time consuming, but requires only limited technical expertise. This is a product that you can sell to existing customers as well as to new customers. As your database of equipment information grows, the time required building the manuals decreases and it would be quite feasible to have templates for different systems or building types on file. We have had several contractors interested in the idea, as well.

Conclusion

I have presented three different ways to streamline the data management tasks associated with the Building Commissioning process:

A secure on-line Issues List using Microsoft SharePoint for faster Issues resolution:

- offers Open communication across the Commissioning team
- allows you to assign responsibility for issues and notifies assignee
- allows you to monitor progress by the contractor on outstanding issues
- offers a venue to post project related information such as FPTs

SharePoint requires a high level of IT expertise to implement, but subscription services allow any business affordable access to this great communication tool

An Access/Filemaker database for tracking overall commissioning project data:

- allows instant access to project status (useful for progress billing)
- results in less wasted time coming up to speed on long duration projects
- provides rapid report generation for interim and final reports
- facilitates data transfer into O&M manuals
- uses less paper – better data access for your office

An Adobe Acrobat for building electronic indexed O&M manuals:

- Uses a universal format for use on any computer
- Saves time for maintenance departments
- Assembles easily – non professional staff can assemble without problems
- Is compact, easily copied or easily available over company intranet
- Results in a product to sell to existing customers for completed buildings

All the software presented here is readily available. Microsoft SharePoint is available via subscription service. This is a great way to get up and running immediately with a great communication tool, or you can “try before you buy” this product if you have the IT capacity to support it. Microsoft Access comes with the Professional Office Suite found in most business offices today or Filemaker 7.0 is less than \$200. Adobe Acrobat 7.0 is \$275.

I hope this look at our experiences with these products will inspire you to investigate the potential benefits for your Commissioning business.