

A Study of Using Digital Photos to Document Construction Progress

David Deloach

McWorter School of Building Science, Auburn University

Junshan Liu

McWorter School of Building Science, Auburn University

liujuns@auburn.edu

Scott Kramer

McWorter School of Building Science, Auburn University

kramesw@auburn.edu

Abstract

The use of digital photos for documentation in the construction industry has vastly improved over the last several years. As technology has improved, so have the benefits of photo documentation on construction projects. This study purposes to investigate the benefits of the current photo documentation services available to contractors and owners, with an emphasis on owners. As part of this research, an interview was conducted with a representative of one of the leading companies that provides this service, a case study was reviewed on a construction project that the owner chose to add the photo documentation service, and questionnaires were sent to numerous contractor and owner representatives. This research provides that there are benefits to the owner and contractors in many areas of construction. The owners in this study agree that the photo documentation provides better as-built documentation, improves their involvement on the project by being able to view updated progress remotely, and reduces maintenance and upgrade costs over the life of the facility.

Keywords

Digital Photo, Construction Documentation, As-built Photos

1. Introduction

Documentation on construction projects has become more and more important. With the construction industry becoming a very lean industry, things need to fall precisely into place to ensure the overall process does not fall off course. One of the main forms of documentation today seems to be photo documentation; it has continually evolved and improved with technology. In the beginning, photos had to be taken with 35mm cameras and then the film sent off in order for the photos to be developed. This was a lengthy process, especially if you needed the photo to send to someone not on the project sight, such as the Architect. These photos did very little to increase the efficiency of the construction process, in fact they were labor intensive and time consuming. The only purpose these pictures served was documentation of the past; nothing was current or in progress. When you did have to refer back to the photos, you would most likely have to trudge through a very large filing system to retrieve the one photo you were looking for. This process was very cumbersome and not very user friendly.

As technology improved, the cameras used on construction projects became digital, allowing the photos to be taken, viewed, filed, and sent to other locations the very same day that they were taken. This was a breakthrough in the realm of photo documentation. The contractors could then send pictures with their requests for information to the Architects to provide more detail with their questions. Plus, all this information could be sent electronically through email. This allowed the process to go quicker than it had in the past. This also allowed the photos to be shared more easily with others involved with the project, such as the owner. With these new electronic photos came issues as well. The photos were taken more frequently because the process was much easier and caused a storage issue. Most of these pictures were being taken at a file size of 1 MB (or larger), which was taking up a lot of space on the companies servers. These storage requirements and other issues helped push the issue to be investigated further. We have now evolved into third party entities providing a photo documentation service to contractors and owners. Now that there are photo documentation services available to contractors and owners, it has helped to streamline the process, as well as, taken some of the load off of the contractors. This service provides a website where the project drawings can be accessed, and from the specific location on the drawings, a photo reference can be made for that location. These photos are even documented by date so that the progression of the project can be shown throughout the process. This has really provided the owner with benefits that they did not have in the past. Figure 1 shows a series of photos taken of the front entrance of a building project to document its construction progress.



April 9, 2010



May 6, 2010



July 23, 2010



December 6, 2010



February 14, 2011



May 13, 2011

Figure 1: Sequencing photos taken to document the construction of a building

Construction projects are being completed much faster and more efficiently than they were in the past, which means the owners need to stay up to date with status of their construction projects. If there is a change initiated by the owner, he/she needs to know what phase the project is in order to ensure that the overall sequence of the project is not affected. Owners can now do this as easily as a click of a mouse on their computer, if they are using photo documentation service, such as the one provided by Multivista System. There are several companies that offer this service, but Multivista Systems was the company selected because they are known as the worldwide leader in visual construction documentation (Balboa Capital, 2012).

According to Multivista Systems, the benefits of digital photo services to an owner are endless. The owner can remotely track the progress of the project, monitor the critical path, ensure accountability, review for pay requests, warranty issues, maintenance, future project planning, and facilities management.

1.1 Research Goals

It is the intent of this research to study the benefits of the current photo documentation services available to contractors and owners, with an emphasis on owners. As part of this research, an interview was conducted with a representative of one of the leading companies that provides this service, a case study was reviewed on a construction project that the owner chose to add the photo documentation service, and questionnaires sent to numerous contractor and owner representatives were reviewed.

1.2 Limitations of Study

This study was done only for building construction projects in the Southeastern United States. These projects were all multilevel vertical construction with associated site work. There were no roadway or infrastructure projects included in this study. The study was also limited to photos manually taken by a still frame camera. No analysis was done for continuous video of construction projects as part of this study.

2. Literature Review

The use of photo documentation on a construction project is not a new concept. However, its exponential growth over the past ten years shows that it is definitely a tool that is very beneficial to the construction process and will be around for many years to come. It was started in its early stages with simple still shots with cameras that required the film to be developed or possibly digital cameras if the contractors had access to them. However, as technology has grown so has the capabilities of photo documentation. Today's cellular and solar capabilities allow cameras to be positioned at virtually any site in the world and at any location on that site. Third-party networks, servers and support ensure they secure and redundant archival of virtually every moment of a construction project (Lamutt & McCormack, 2011).

As an owner, architect, engineer, contractor or surety, the most effective strategy for photographic documentation begins with pre-construction and runs through post-completion (Lamutt & McCormack, 2011). Construction companies are also starting to use this photo documentation from previous projects as a Marketing and Public Relations tool. It allows them to take the collected images during construction and use them in press releases, marketing documents, or proposals for future work (Kimos, 2012). Owners, designers, and contractors can all benefit from the high-quality, dynamic construction photographs. Owners use construction photographs to build public support. Designers use them to sell their services and contractors use them to document previous work experience (Bednarz, 2008).

Once you have taken numerous photographs of each project the marketing uses are limitless (www.cpdphotos.com). Where you normally would have had a few progress and finish photos in the past, now using photo documentation on projects you could have hundreds or even thousands to choose from. These photos are also from all different angles throughout each of the phases of work taken throughout the entire project. The photos can be used in presentations, posters, and billboards and as an added bonus if the progress photos were taken correctly, you will be able to create a time-lapse of your project. As a contractor, these photos can also show your next client how everyone on the project, including them, is kept informed and close to the project. The contractor also has the option of giving the owner a copy of the photo document leaving them with a complete photographic record of their finished building (www.cpdphotos.com).

The benefit to photo documentation has been further explained by Arbuckle (2011) when he answered the question of "How will construction documentation impact your next project?" First, "construction photo documentation will decrease costs." The photo documentation will help avoid costly change orders, and will reduce the costs of maintenance and renovations in the future. The second is the fact that it will

make you more efficient. Instead of having to drive across town, you will be able to monitor the progress from your office. The third way will help you run a lean project. It will help by reducing waste and overhead. Therefore, the General Contractor has assistance staying efficient and under budget. The fourth way is the fact that photo documentation gives you x-ray vision. Unlike in days past, once a wall was closed up there was no way to know exactly what was inside the wall without some type of demolition. With photo documentation, the interior of the wall can be inspected as easily as a click of a mouse. The fifth, and final, point made by Arbuckle (2011) was that it will keep you on schedule. This is because the General Contractor will have the up to date photos with them all the time and will allow them to keep their team on track. Furthermore, this will cut down on the time it normally takes for a decision to be made. All the decision makers can access the photos and make a decision without planning travel and coordinating everyone's schedules.

So many things can be documented by a camera, Shelton (2011) explains, manpower, equipment, access to the work, condition of the site, condition of work before its turned over to another contractor, interference, survey work, defective work, weather; the list goes on. But to make the photos useful, the proper documentation must be accompanied with them. Knowing when an event occurred is often as important as the event itself. The time/date stamp feature should be employed as a matter of course. It is also helpful to document the location of the item photographed. If the photo includes people, it is also helpful to know their name, their role, and their employer. Also, make a record of the person taking the photographs, because at a trial that person will have to testify that the photographs are an accurate depiction of the object or scene at the relevant time. Having the photographer on the stand makes this process much easier and more convincing (Shelton 2011).

Construction documentation technology has multiplied the advantages of the traditional as-built process, in which a red pen and the memory of the construction superintendent were the primary role (Kimos, 2012). Along with a set of marked-up drawings as a final contract deliverable, a more comprehensive construction journal is possible with the new construction documentation technology, which captures the as-built process and cross references electronic drawings to digital photographs. Building owners and facility managers have long known the value of accurate as built drawings indicating the final placement of building or utility systems that differ from the original design intentions. The ductwork or piping in a building's walls or overhead space may not have actually been installed in a straight line as shown on the construction drawings. When construction progress photos are indexed and dated, and the camera positions are cross referenced to construction drawings, a computer based platform that facilitates many advantages is created (Kimos, 2012).

This has brought forth construction photo documentation service providers that provide online documentation portals to host all project information for easy and immediate reference. Builders are implementing technology services like Multivista Systems for complete project photo documentation to better manage their documentation, which provides them a big benefit over the life of the facility. Balboa Capital even ranks Multivista Systems as the worldwide leader in visual construction documentation (www.balboacapital.com).

3. Methodology

In order to understand the current services available for photo documentation on construction projects, a qualitative method research study was completed, which includes (1) an interview with the managing partner of the U.S. south region for a worldwide photo documentation company, Multivista, (2) a study on an ongoing project that employed a third party photo documentation service, (3) a study on data collected through questionnaires completed by contractor and owner representatives that have used the third party photo documentation service.

3.1 Interview

An interview was conducted with a managing partner for the U.S. south region of Multivista. Multivista was chosen because they are a worldwide company known for providing first class photo documentation services, based on the information gained from the literature review. It is the expectation of this interview to gain the firsthand knowledge of what services are available, as well as, the benefits to those acquiring the service. The interview was conducted in person. The interview format was structured with a few lead in questions to start the discussion, which was used to learn as much as possible about their system and services that they provide. Due to the limitation of this paper, the data and analysis collected from this interview are not included in this paper.

3.2 Case Study

The case study was developed on an ongoing construction project. The owner decided to add the photo documentation service to the contract after construction had begun. The owner made this decision based on the service being able to provide better as-built documentation at the end of the project, rather than counting on the red lined drawings to show all the existing conditions of construction after the project was complete.

The construction project is a 65,000 square foot addition to an existing hospital. The project was a Design-Bid-Build project for just over \$23 million and had to be completed within two years. The project is located on the Winn Army Community Hospital Campus at Ft. Stewart, Georgia. The project is administered by the US Army Corps of Engineers (USACE), handling all the oversight of the project with respect to the contractor and architect. USACE also coordinates with the owner, in this instance, Health Facility Planning Agency (HFPA). HFPA oversees all Army Healthcare Construction to ensure that all projects meet the current standards of healthcare and are outfitted with the proper equipment to operate in the most efficient manner.

In the area of photo documentation on this project, the contract initially required the contractor to take photos on a weekly basis and submit them monthly with the pay requests, with the locations to be coordinated with the USACE prior to beginning construction. Upon further review of this requirement, HFPA made the decision that this was not enough documentation for this project. They had seen the benefits of a third party photo documentation service on other projects that they had constructed and believed that it should be added to this project as well. Therefore, HFPA advised to add the third party photo documentation service through a change order to the contractor. Then HFPA and USACE began developing the scope of work for the service, which was meant to supplement the original requirements and not to supersede them. Some of the items included in this scope of work included:

- The quality of photos and how they were to be indexed with the corresponding construction drawing
- Construction progress photos shall be taken not less than once every 30 days
- Take monthly exterior progressions
- Take weekly site progressions
- Take regular interior progressions of all walls of the entire project to begin at time of substantial framed
- All as-built documentation was to be documented (pre-slab utilities, exterior skin, and interior floors, ceilings, and walls)
- Detailed interior exact built overlapping photos of the entire building to include documentation of all mechanical, electrical and plumbing systems in every wall and ceiling, to be conducted after rough-ins are complete, just prior to insulation and or drywall
- Images shall be taken by a commercial photographer and must show distinctly, at as large a scale as possible, all parts of work embraced in the picture

- Upon completion of the project, final copies of the documentation (the "Permanent Record") with the indexing and navigation system embedded (and active) shall be provided in an electronic media format, typically a DVD or external hard-drive
- A minimum of four (4) images of each elevation shall be taken with a minimum 6 MP camera, by a professional photographer with different settings to allow the Resident Engineer to select the image to be printed

The scope of work was then sent to the contractor in a request for proposal, with a short suspense to have it returned, since construction was already underway. The project had been under construction for eleven months, with most all of the infrastructure work having been completed. The contractor chose to team with Multivista System to accomplish this service. Therefore, in November 2012, Multivista began acquiring photos and including them in their online web based program.

The first order of business for Multivista was to upload the construction drawings so that they could come up with the order of progression in which each photo would be taken each time they went to the construction site. Each photo would be taken as a number, and if one was missed or taken out of order, the entire day's worth of photos would not upload into the system. Therefore, it was critical for them to establish a sequence in the beginning that would work throughout the entire construction process.

3.3 Questionnaire

As part of this study, a separate questionnaire was developed specifically for owners and contractors to gain more useful insight into the recognized benefits of the services available for photo documentation. Questionnaires were sent by email to twelve contractors and eight owners that were known to have used the third party photo documentation service. Of these twenty individuals, a total of one contractor representative and six owner representatives participated in the questionnaires. Due to the limitation of this paper, the data and analysis collected from the questionnaire are not included in this paper.

4. Case Study Findings and Results

The intent of this research was to study the benefits of the current photo documentation services available to contractors and owners, with an emphasis on owners. The study has determined that photo documentation is not a new process in the building construction world but has evolved with technology (Lamutt & McCormack, 2011). The use of photo documentation is much more predominate now that it has been in the past. The days of having film developed and pictures filed in large files are gone, along with the low resolution digital photos that followed. This paper only present the data and its analysis that were obtained from the Case Study.

Because the photo documentation service was not established prior to the start of construction, the benefit of documenting preexisting conditions was lost, but was not the intent of the owner wanting the service added in the first place. They wanted the service to document the interior of walls and the conditions above the ceilings prior to closing them up. It was explained by the owner that the healthcare facilities are continually being upgraded and renovated to keep up with ever improving technology in the healthcare world. Therefore, they continually have to change the purpose of spaces and in some cases reconfigure spaces. This is where the benefit of having the photo documentation service comes into play for them. They had the photos documenting the conditions of the interior of every wall prior to installation of drywall, as well as, the conditions of all areas above the ceiling prior to installing the ceiling materials. These, combined with the as-built drawings for the entire building provided at the end of the project, gave the facility maintenance group what they needed for future changes. This would allow them to be able to plan and redesign the areas as needed years down the road. Below are some

photos, in Figures 2 and 3, of the actual construction on the project and how the in-wall conditions are shown in the Multivista program.

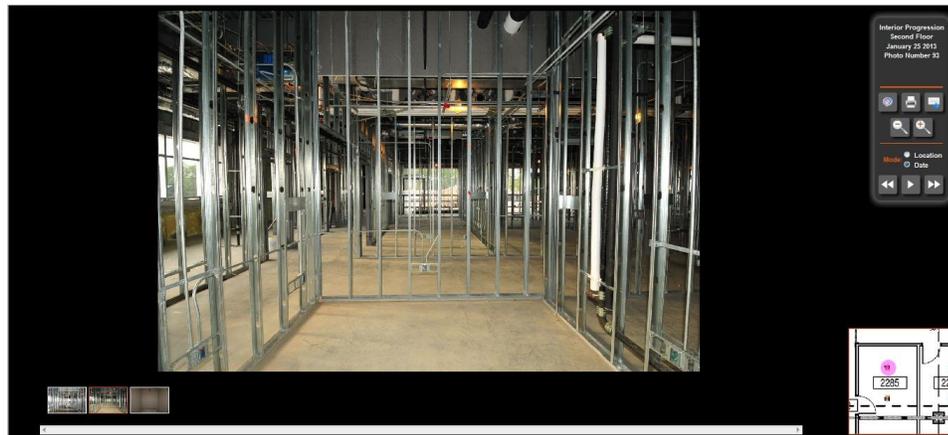


Figure 2: Room 2285 North Wall January 23, 2013 (Multivista.com)



Figure 3: Room 2285 North Wall February 11, 2013 (Multivista.com)

The owner wanted the service for the as-built conditions, but has seen other benefits as well. One example was one day the owner's representative went in the field and noticed that a wall had been shifted a few inches. When he asked the USACE and the contractor, neither could remember why the wall had been moved. He then went back to his office and looked at the photo documentation completed by Multivista in this area and found that a large roof drain was encapsulated in the wall which made the wall wider than called for in the drawings. He said that he never counted on the photos to answer these types of questions, but it is great knowing that it is there at your disposal to use as needed. He also advised that the owner would be making the service a requirement on all construction projects in the future, because they believe the benefits definitely outweigh the costs. The photo documentation services also allowed the owner to follow the progression of the project from remote locations by use of the photos posted on the Internet, therefore they would never lose touch with the status of the construction.

When the contractor representatives were asked about the service and how it has improved their efficiency, they felt that it was really too early to tell. They advised that it is not a service that they are accustomed to having and is not part of their standard operating procedures. They agreed that they do see the benefits but have not had a reason to tap into them on the project yet. The service has only been underway for a total of five months on this project at the time of this study. The assistant project manager did say that they would like to see this requirement included in the original contracts that go out for bid.

That way all contractors would be bidding the same requirement; otherwise, services such as this, that are considered extra, will not be included in these days of tight bidding.

5. Conclusions

This study reviewed literature based on digital photo documentation, an interview of a managing partner of a well-known company that provides the service, a case study in which the service is ongoing, and questionnaires that were sent to contractors and owners that have used the service. The research in this study has concluded that there are benefits to an owner with relation to a third party photo documentation service being included as part of the construction process.

The main benefit worth mentioning is the fact that everyone that participated in this study agrees that the photo documentation service is cost effective. The cost of the service is minimal when you take into account all that the service provides. It has been documented that the service makes the workers on the project more accountable and offers another layer of quality assurance on the project. The service allows those that are not on the project site to be involved with the construction process by accessing the current progression photos online. The service also assists with the payment process, as to verifying the construction complete.

Another benefit to mention is the ability to produce photo documentation of the existing conditions throughout the construction process. This is the main element that draws owners to use the service. The owners like the idea of using the photos to improve their ability to perform maintenance on the facilities, as well as, use the photos for upgrades or renovations to the facilities. It takes the guess work out of where and how to address the existing utilities, because they are all documented in the photos.

Even with some drawbacks, with the costs between \$0.25 and \$0.40 per square foot of the project and the amount of benefits it provides during construction through the life span of the facility, digital photo documentation is still considered cost effective. Though it has not become a standard practice in the industry because this type service has only been available for a few years, it has been documented in this study that this service will continue to evolve and become standard practice in building construction in the near future.

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