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April 19, 1995

In Atlanta, Georgia

For Vendor use as a Handout at the CAD/CAM Conference

Idaho Falls, ID 83403-2528
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Charles V. Viegaen

By

Argonne National Laboratory-West
PHOTOGRAPHIC AS-BUILT FOR

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ABSTRACT

PHOTOGRAPHIC AS-BUILTS FOR
ARGONNE NATIONAL LABORATORY-WEST

by

Eugene K. Sherman
Charles V. Wiegand

Argonne National Laboratory-West
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Idaho Falls, ID 83403-2528

Located 35 miles West of Idaho Falls, Idaho, Argonne National Laboratory-West operates a number of nuclear facilities for the Department of Energy (DOE) through the University of Chicago. Part of the present mission of Argonne National Laboratory-West includes shutdown of the EBR-II Reactor. In order to accomplish this task the Engineering-Drafting Department is exploring cost effective methods of providing as-building services. A new technology of integrating photographic images and AUTOCAD drawing files is considered one of those methods that shows promise.
PHOTOGRAPHIC AS-BUILTS FOR ARGONNE NATIONAL LABORATORY-WEST

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I. INTRODUCTION

Argonne National Laboratory-West (AW) has undertaken the task of producing photographic as-builds in order to lower the costs of documenting facility, equipment and structural modifications.

It has been our observation that many projects run out of funding before proper as-building can be accomplished. Projects look at the funding required to complete the as-builds and if the costs are too high they may be delayed indefinitely. Up to date as-builds are important for a variety of reasons and by not doing them someone at a later date is usually affected by not having current information regarding a facility or equipment. Inexpensive photographic as-builds appear to prove that we can "have our cake and eat it too." We plan to create drawings for initial construction using our AUTOCAD Software and later use digital photographic as-builds for changes made during construction. If we can prove that our costs are substantially lower by using photographic images as opposed to AUTOCAD generated changes, we estimate we can save 80% or 90% of as-built costs.

This service will cost much less than regular as-building and contain the same information.
We recognize that digital as-builds can not be used for all as-building such as precision mechanical components, however, it fits well into facility modifications, piping installations and some electrical documentation. The demand for this new service is growing by the month as AW customers learn of our new capabilities. In addition, integrating photographs into AUTOCAD files gives us visual information that can be used in a future Graphic Information System (GIS).

Some DOE contractors are using photogrametery to obtain AUTOCAD vector files from photographs. Stereo camera as-building or photogrametery requires several cameras to obtain a 3-D image. Compared to digital photographic as-builts, photogrametery is expensive and requires a fair amount of labor intensive input from a CAD operator. The CAD operator must digitize points from the photograph in effect retracing the equipment to obtain vector shapes. Photogrametery's goal is to obtain a 3-D model which can be later manipulated or modified in AUTOCAD. Photogrametery is a worthwhile tool in many applications but for our need to provide additional documentation after modifications are complete photographic as-builts better suit our needs. DOE has indicated the need to use a graded approach to as-building. QA Level A requires extensive documentation and was not considered a candidate for this technology at this time. Argonne National Laboratory-West, therefore, has undertaken the task of research and development to produce photographic as-builts for QA Level "C" items.

At AW QA Level C is defined as follows:

"General facility support items or activities that are not critical to mission objectives and are not covered by QA Level A or B. Level C includes items or activities whose failure would not result in any significant health, environment or safety risk. The consequences of failure are negligible or acceptable and the probability of failure is insignificant." QA Level B may also be a candidate for this type of as-builts. QA Level B activities which include: "Engineered structures, systems or components whose failure has a significant potential for preventing mission objectives........," our focus for the initial test was QA Level C.
II. AS-BUILD REQUIREMENTS

It is Argonne National Laboratory-West’s plan to use these photographic as-builds in the following ways:

a. Combine existing AUTOCAD files with digital photographic information with AUTOCAD text/arrow overlays to achieve an as-built condition.

b. Use digital photographs to document construction or demolition activities.

c. Scan existing photographs and integrate them with existing AUTOCAD files for archival purposes.

d. Use digital photographs to obtain field measurements.

e. Use digital photographs to graphically depict proposed facility modifications to contractors.

Our goal is to obtain a flat 2-D raster image and integrate it with existing AUTOCAD vector files. COLOR VIEW Software from PEAK-GEO DESIGN, INC. maintains the vector and raster portions separately. AUTOCAD layers can be placed on top of the images to add vital information regarding the subject. Normally, the customer marks up the initial plots with sufficient information to make each image subject to one interpretation. If the as-built condition changes, we would simply re-photograph it and import it back into the file replacing the old photograph. We think this is an effective and fast way to show new as-built configurations. It is also our goal to make the use of this technology "cookbook" such that other drafters in our group can take on digital as-building tasks without massaging the images in Photoshop too much. We have been successful in that area by having controlled lighting situations prior to photography. In addition, we are producing a simple procedure for our drafters to eliminate "re-inventing the wheel."

The software we have found that accomplishes this task best is COLOR VIEW from PEAK GEO-DESIGN of New Philadelphia, Ohio. Their software can combine AUTOCAD vector files and raster images into one file. Neither the vector files or raster files are changed but rather live
together and can be manipulated separately later. These files can be "PK zipped" to reduce the file sizes for storage. In addition, COLOR VIEW has the ability to measure distances accurately from the photographic images.

III. DEVELOPMENT

Development of this new process took approximately five months. At this point in time, the first as-built images of an experimental apparatus designed to measure gases evolved from nuclear waste have been completed to document its construction. The experiment will support the Waste Isolation Pilot Project (WIPP) in New Mexico. These images are of the Gas Sampling System that did not have drawings associated with the installation. In addition, new photographs will be integrated with existing AUTOCAD files of experimental facilities.

A. DPI Settings

COLOR VIEW Software offers 100 to 400 DPI settings. These settings affect only the vector resolution output and not the digital images. We used 100 DPI settings for our initial finished product. Smooth lines were provided by 400 DPI but it also tended to thin the vector lines. This resolution is useful for drawings that are extremely complex, however, for normal AUTOCAD drawings we found that 100 DPI plotted quickly and was clear enough to provide a quality image. The processing time at 100 DPI was approximately 15 minutes while the 400 DPI took 30 minutes.

B. Gray Scale

COLOR VIEW has the ability to produce both color and black and white images. In as-building gray scale is used because the final output is black and white. The color images did enhance the equipment and they printed on a xerographic printer adequately. The trade off is that the file sizes for storage are approximately five times larger in color than gray scale.
C. **Blue Highlights**

Often photographs contained a blue cast caused by low light conditions. There is a way to adjust for this condition in Adobe Photoshop by turning the "Curve Blue Channel" command down by 1 grid mark. Optimum lighting eliminated this problem but some adjustments can be made if necessary.

D. **Video Capture Board**

We have captured images from video tapes taken in one of our hot cells. These images can then be treated the same as any other images with AUTOCAD overlays.

E. **Plotting**

The workhorse for plotting in our drafting department is an HP 7600 Electrostatic Plotter. We used this plotter with mixed results. The resolution was poor due to an incompatible driver. PEAK-GEO wrote a new driver for us. The Picel size was reduced and the image was considerably better, however, we eventually purchased a NOVAJET III Ink Jet Plotter which solved our quality problem.

F. **File Storage**

After the projects are completed we release them into our Document Control Center. In order to keep the file sizes to a minimum we make them an executable file using PK Ware. These files can be unzipped and manipulated later.

G. **Lighting**

Lighting was another variable that proved to be a problem. We had tried to use available lighting in the facility (fluorescent lights) but the additional light source provided by the camera module seemed incompatible with the fluorescent overhead lights. Fluorescent light has a yellow spectrum and incandescent lights have a red spectrum. The use of portable fluorescent track lights, which are soft in nature, seemed to eliminate the shadows. Two vertical bars each containing four 18 watt fluorescent lights and a horizontal bar with two 18 watt bulbs were used.
The camera is typically placed six feet from the subject giving us a coverage of six feet by five feet. All photographs are taken square to the wall. This positioning allows on-screen measurements. In order to get accurate on-screen measurements we put a small scale in each photograph so the computer scale has a standard from which to measure. Oblique photographs are avoided because they cannot be measured. Occasionally oblique photographs are requested for archival purposes.

The subject is lighted using soft, diffused fluorescent lighting to keep contrast ratios low. This type of lighting prevents shadows from "blocking up," making it easier to see information in shadow areas. The camera is carefully placed to avoid, or at least lessen any parallax (converging verticals), and a large scale is placed within the subject plane, if needed.

H. Digital Camera

The Digital camera did not initially come with a strobe so we were not able to try that variable. We have since received an SB-25 strobe and will experiment with it at a later date. Digital cameras do not function very well in low light conditions so our goal was to light the subject well but evenly with fluorescent lighting. We are continuing experimentation with the lighting to achieve the optimum conditions.

The camera that was used is a digital Kodak Model #DCS-420 with a Nikon body, 28-70mm lens. Digital cameras are not capable of producing the quality of prints that can be produced by a silver-based negative system but some of the trade-offs were worth investigation. Digital cameras produce no wet chemistry to dispose of and the images are directly importable to computers. The resolution is slightly over 90 DPI but still quite usable and we can get the images to the drafter very fast. The digital camera has a removable hard drive #PCMCII that is capable of 64 images. This hard drive is simply taken out of the camera and placed into Kodak's card reader that is attached to the computer. The images can then be off loaded to a printer for initial review by the customer or taken directly into COLOR VIEW for integration into AUTOCAD.
The Leafscan Scanner is another piece of equipment originally purchased for our GIS System. It gives us the capability of scanning existing negatives, 3 x 5 positives or microfilm cards for importation into COLOR VIEW.

IV. EQUIPMENT

The following equipment was purchased for this task but it should be noted that a standard 35mm camera, scanner and 486 computer are all that is required. The additional equipment was purchased for a Graphical Information System (GIS) but worked nicely in our research.

The equipment that was purchased to produce these images is as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Approximate Cost</th>
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<tbody>
<tr>
<td>a. Software - &quot;COLOR VIEW&quot;</td>
<td>$1,200</td>
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<tr>
<td>b. Computer - Pentium 90</td>
<td>$3,500</td>
</tr>
<tr>
<td>c. Video Capture Board</td>
<td>$400</td>
</tr>
<tr>
<td>d. Plotter - NOVAJET III w/32mb RAM</td>
<td>$8,200</td>
</tr>
<tr>
<td>*e. Digital Camera - Kodak Model #DCS-420</td>
<td>$12,000</td>
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<tr>
<td>f. Fluorescent Canister Lights</td>
<td></td>
</tr>
<tr>
<td>Philips #SL 18/R-40/27 120V Canister</td>
<td></td>
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<tr>
<td>*g. Kodak XLS 8600 Printer</td>
<td>$8,000</td>
</tr>
<tr>
<td>h. Relisys Scanner, 9600 DPI</td>
<td>$5,000</td>
</tr>
<tr>
<td>*i. Leafscan Scanner</td>
<td>$15,000</td>
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Our procedure for producing a finished product is as follows:

a. Take digital images of the facility or acquire existing silver based photographs that can be scanned.

b. Process images through Photoshop for proofs to determine which images best show the equipment.

c. Load selected images into AUTOCAD using COLOR VIEW Software.
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<th>VIEW LETTER</th>
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PROJECT MGR.

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ARGONNE NATIONAL LABORATORY

TITLE

GAS SAMPLING SYSTEM

PART NO.

NEXT ASSEMBLY

REQ'D

DRAWN BY

C. WIEGAND

DATE

95

SERVICE REQUEST NO.

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PROJECT MGR.

DATE

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C. WIEGAND
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RESP. ENGINEER

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PROJECT MGR.

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PART NO.

NEXT ASSEMBLY

REQ'D

THIS DRAWING IS THE PROPERTY OF
ARGONNE
NATIONAL LABORATORY

TITLE

GAS SAMPLING SYSTEM

SCALE SHEET DRAWING NUMBER

NONE 3 OF 3 W0095-0161-ED-00

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0161D002
d. Plot images for customer comment and input.

e. Add text, dimension and vendor information as required.

f. Plot a print to be submitted for checking.

g. Correct drawing as required for sign off.

h. All image and drawing files are condensed into a single file using PK Zip by PK Ware Software and are transferred to Document Control for storage.

i. Estimated time to produce one "D" size drawing is six to eight hours.

V. SUMMARY

In conclusion, AW Drafting is trying to provide the best value to our customers at the lowest price. We feel that digital as-builds are one of the best new technologies available in achieving that goal. All DOE contractor drafting organizations should have the most cost effective goals if they intend to stay in business in the ever-shrinking budget environment of DOE.