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Analyzing the Benefits of Utilizing 360° Panoramic Photo Survey Technology on a Shell Offshore Platform

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Abstract

Shell's Enchilada offshore platform has been surveyed in September 2012 with a specially built, fully automated 100 megapixel 360º HDR panoramic photography camera system with 3D measurement capability. Subsequently, a 360º PanoramicGuide web-based viewer was produced and made available to Shell users. The spherical photos were indexed to the facility's general arrangement drawings. Interactive descriptive menus and maps were made available to quickly locate and navigate to points of interest. Users can choose from multiple viewpoints of the Enchilada facility, view 360º in all directions around those viewpoints to virtually examine various areas/equipment in the platform, zoom in to view precise detail, and take 3D measurements between visually recognizable shapes and patterns from the viewpoints.

The paper will discuss a number of potential and tested applications, the latter where the technology has been used for the Enchilada platform:

a) Detailed visual assessments for engineering design, project planning, operations and safety reviews;
b) Visual reference during conference collaboration meetings with offsite subject matter experts and email communications to assure common understanding;
c) Visual assessments by subject matter experts, including consultants and sub-contractors that are not possible with video, standard photography or 3D models/images created from laser scans alone.

Experience using the viewer has demonstrated that users are able to improve quality and collaboration in planning work related to construction and modifications, potentially resulting in decreased cost and project recycle, improved HSE and reduced liability and risk, by minimizing or even eliminating offshore trips and time on site for vendors and other personnel.

Development of new advanced visualization and communication technologies will be a key success factor for future improvements in planning, asset management and Integrated Operations, among other remote operations activities.

Introduction

A 360º PanoramicGuide viewer has been produced for the Shell Enchilada offshore platform in the Gulf of Mexico. The background for this project is an agreement between Shell International E&P's Deepwater R&D group in Houston, Texas, USA and APIteq of Straume, Bergen, Norway, to conduct a cooperative technology project whereas Shell would evaluate recent developments in visualization and collaboration technologies developed by APIteq. The Enchilada platform was surveyed with the 360º panoramic photography camera system further described below. Next, from the survey pictures, APIteq technicians produced a 360º PanoramicGuide viewer, allowing multiple users within Shell to virtually visit the platform. The viewer has been in use since December 2012, and this paper describes how it is used, current and potential benefits, and observations made by Shell during this period of use.

The camera system used to capture the panoramas is an automated, specially built one, controlled by proprietary software. The calibrated system captures full spherical 360º panoramic photographs in less than one minute. The calibration involves measurement calibration, meaning that x, y, z locations of the relative pixel are calibrated to allow direct measurement. The system is also color calibrated in the workflow, meaning that all images have the same color representation. This is useful when comparing images from the same location captured at different times, as for instance changes in paint or color can indicate corrosion. The camera, built with a synchronous stepper motor, rotates in the horizontal plane and photographs six sectors separated by exactly 60º, thus completing 360º. The lens and camera module assembly provide for full 360º coverage. In each of the six sectors the camera records five photographs of different exposure times, totaling 30, pre-set to cover a large variety

of light conditions. After downloading the images, a preview processing is completed on site to ensure the panoramas are successfully captured. Later, the five photographs from each sector are blended in an automated process to provide a tone-mapped HDR (High Dynamic Range) image, before the individual images are stitched together, completing a 360º panorama. The complete 360º panorama images are as large as 14142 by 7071 pixels, e.g. 100 megapixel panoramas. Such high resolution allows the user to zoom in and see details such as tag text and other equipment minutia.

The camera system does not include a flash, to avoid accidental triggering of UV-alarms on the platform. If needed, the camera has built-in LED lights that do not trigger UV-alarms. However, due to tone-mapping technology and the very high dynamic range of the camera system, the LED lights are rarely used; they were not used on the Enchilada survey.

Additionally, a calibration verification procedure is performed before and after each project, as was done on Enchilada. This includes dual panoramas captured at a fixed calibration verification location, and performing the 3D measurement of a known dimension. This allows for 3D measurements, produced through triangulation from any pair of points in the panoramas, to be obtained by the user from the viewer. Two 360º panoramas with a known separation distance between them are taken in order to obtain 3D measurements. This is accomplished by taking a high and a low 360º panorama for each platform location, with a known height difference of precisely 600 mm (23.6”).

Figure 1: APIteq 360º camera system (left) and 3D measurement principle (right).

Before the actual offshore survey, the number and location of the panoramas are selected, based on the facility layout and specific customer requirements. Each panorama is located on customer-supplied general arrangement drawings, which are later shown as navigation maps, adjacent to the panoramas on the viewer screen.

After the offshore survey is performed, the panorama photographs are processed, and a 360º PanoramicGuide viewer instance is produced using the Visual Asset Management (or VAM) software, which has been developed by APIteq and Weiss AG in Kaiserslautern, Germany in a joint venture.

In addition to the ability to display 100 megapixel panoramas over a broadband Internet connection, the VAM software has a number navigation features that help users locate specific equipment or virtually visit the platform; it also has export/ capture features that allow users to share visual information found in the panoramas with others; and it has 3D measurement features that allow users to measure dimensions of equipment and distances in the platform. These features empower the user to perform from an office environment some tasks that would normally be carried out during visits to the facility.

The VAM viewer navigation features include a map, based on the general arrangement plan view drawings of each platform deck. Every panorama location is shown as a “hotspot”, or dot on the map, which also displays the user’s field of view from the current panorama. The user can access different panoramas simply by clicking on the corresponding “hotspot” with the mouse. Also available for navigation is an always visible integrated menu, organized at the highest level by platform deck, and at a lower level in terms of the major equipment in each deck; the user can select any major equipment from the menus to find which panoramas on the platform are pertinent to that equipment. A search box can also be used to type equipment names or designations and find pertinent panoramas.

The share/capture features of the viewer include a button that saves a screenshot capturing the panorama view and the map (including field of view) associated with it. The user can also generate a URL that can be shared with another user and uniquely

defines a specific panorama and pan, tilt and zoom values within the viewer. That other user can then use his or her own instance of the viewer to reproduce exactly the view from the first user. So, instead of exchanging pictures, users can save and share links, using fewer resources.

The viewer also features the ability to obtain 3D measurements by selecting a pair of points of interest in a panorama (actually, two views from the same location, a high and a low one), and obtain the distance (displayed in metric or imperial units) between these points. This feature can be used to measure dimensions or clearances in platform equipment when appropriate points are selected. The accuracy is linked to the user's ability to select the points accurately, but the viewer allows adjusting the points as needed to improve the accuracy of the measurement.

Another feature of the viewer allows select users to upload information, such as documents, still photographs, notes/messages, URLs and video that can be accessed directly from the viewer. Icons or "hotspots" visible from the panoramas can be clicked to access the associated information. For instance, a PDF file containing the maintenance procedure of a pump, or still photographs and notes from the interior of an electrical cabinet can be accessed by clicking on a "hotspot" near that pump or cabinet on the relevant panorama. This allows users to add more detailed and/or up-to-date information directly to the panoramas at any time.

The viewer can be operated with little training and accessed from any computer with a Flash Player-capable web browser, allowing users to virtually visually visit all surveyed areas. Access to the viewer itself is controlled by user logins and passwords, configured through a secure web platform solution. This structure enables a virtually unlimited number of personnel with different backgrounds, skill sets and expertise levels to obtain quick and easy access to the viewer.

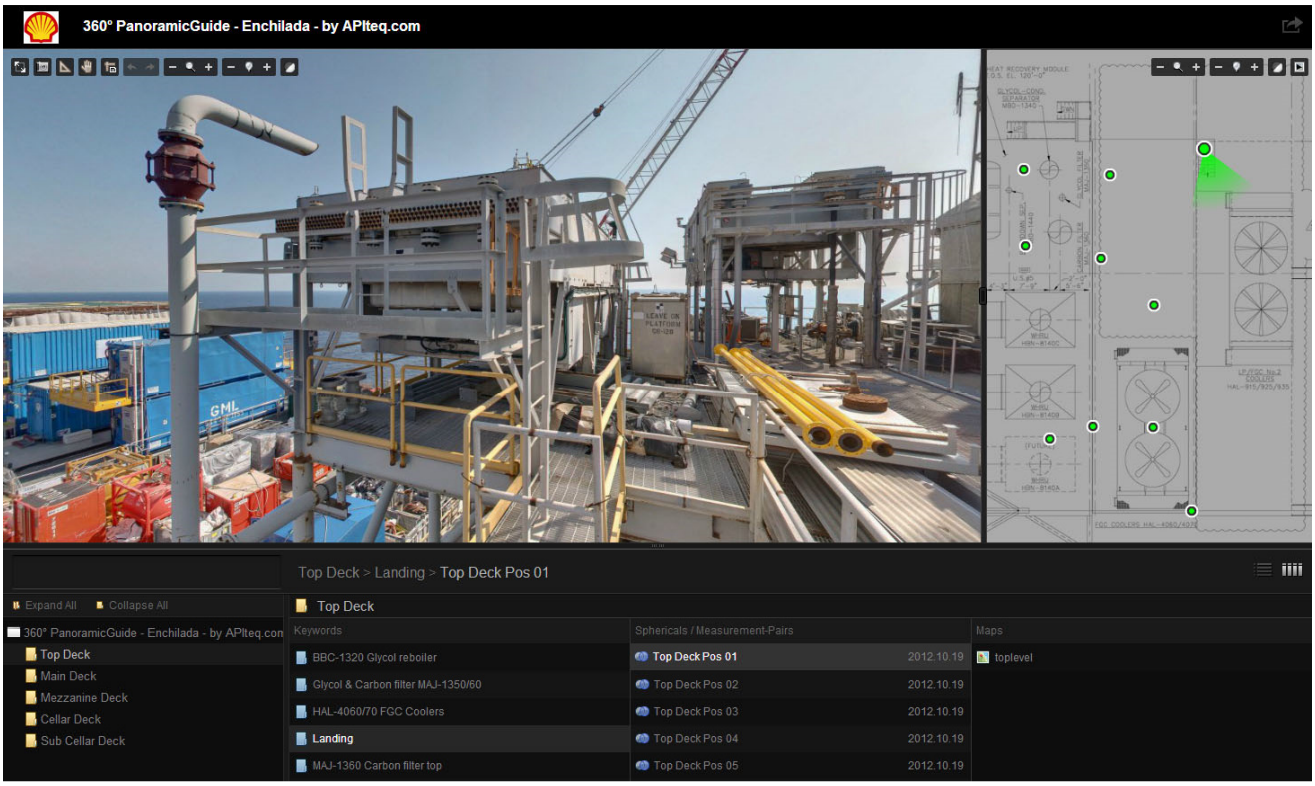

Figure 2: Screen capture of the Shell Enchilada 360º PanoramicGuide

Applications

In this chapter, some of the potential applications of the 360º PanoramicGuide are explored. The table at the end of the section summarizes and organizes the different capabilities or potential uses of the viewer in terms of specific areas of the oil and gas business.

General:

Familiarization with Facilities: The viewer's ease of use and the provision of good situational awareness make it an attractive tool to introduce new employees to the platform and facilities they will be working with. They can explore the platform at their own pace, and understand its layout and the disposition of the major equipment with a tool that is available at any time, from any computer that can connect to the Internet via a Flash-compatible web browser.

Asset Documentation: The viewer can be used to provide up-to-date screen captures (photos) with relevant views and maps of areas of interest in the platform, adding information and clarity to documentation that needs to describe the platform and its facilities. Such screen captures can then be pasted into reports, e-mails, proposals, etc. These screen captures usually do not

supersede traditional documents and drawings, but can be used to enhance the quality of the information being shared. An important aspect of this application is that the visual information needs to be up-to-date in order for it to be trusted and used as "as built" documentation. In order to accomplish that, a process to obtain up-to-date panoramas needs to be established.

Knowledge/Information Sharing and Learning: The viewer can also be used as a repository of asset information, for example displaying links to (or attachments such as) documents, drawings and other informational databases in relevant panoramas. Easy access to the viewer makes it a potentially powerful tool to share information that can be linked to the visual representation of their subject.

Multidisciplinary and Inter-Departmental Collaboration and Presentation: The ease of use of the viewer makes is a viable tool to quickly create and share views of the platform that can be used during meetings or teleconferences requiring an accurate visual representation of the platform facilities. The importance of participants seeing and referencing the same object or space is critical. Views can be shared by parties with different backgrounds (e.g. different technical disciplines such as electrical, mechanical, structural, etc.; or different companies such as the platform operator and a contractor or vendor about to perform work on it; or different teams from the platform operator such as the asset team operating from the platform and a Virtual Asset Team supporting it from shore), but creating a common understanding of the asset. The ease of use and high visual quality and fidelity of the 360º PanoramicGuide viewer makes it a useful tool to present visual information interactively to parties not usually familiar with the asset, such as partners, management and corporate. It is important to note that the viewer does not present real time information, but an interactive snapshot of the facilities at the time of the survey.

Engineering and Design:

Visualization and Planning: The viewer can be used to plan modifications or other construction work to be performed at the offshore platform. Planners can visualize the platform areas to be modified or worked on and have a better understanding of layout and access issues, and better information to produce more detailed plans. The visual information is usually of enough quality that plans can be generated directly from the tool, reducing the need to travel to the platform to survey it, with corresponding savings in time, cost and personal risk, besides the reduced demand on platform accommodations.

Visual Information for SMEs: Subject Matter Experts, who are usually not on the platform, can use the viewer to quickly access high definition views of the offshore platform facilities, and make decisions or assessments on the basis of that visual information. This is another application where the visual representation needs to be up-to-date to ensure adoption.

3D Measurements: Expanding on the visualization and planning capabilities described above, the viewer allows users to quickly take measurements by picking a pair of points of interest in the panoramas. The accuracy of the measurements depends on the ability of the user to accurately select the points in two views from the same "hotspot". Occasionally, objects of interest are obscured in one or more of the views, preventing 3D measurements to be taken. But generally, useful measurements can be obtained and used for more detailed planning activities.

Tender Submission: The same information provided to SMEs (mentioned above) can also be available to third party contractors or vendors to visualize the platform they are about to conduct work on. The vendor can be provided with screen captures generated by the engineering team or given direct interactive access to the tool via an URL and login/password information. Such data can be used by the third parties to prepare or refine project tenders for construction or modification work. The benefit again is an improved awareness and understanding of the facilities, and potentially eliminating the need to travel to the platform to survey it.

Operations and Maintenance:

Integrated Operations: The viewer can be used as a complement to videoconference capabilities the platform may have to display shared views of areas that may not be covered by real-time CCTV, or that are covered only with low quality video. Potential lag between onshore and offshore locations when connections are slow can be overcome by using a local version of the 360º PanoramicGuide database and viewer offshore, and synchronizing views by exchanging links (with pan, tilt and zoom data) on the fly between the onshore and offshore locations. This capability can be used during meetings with the asset (e.g. morning meetings), or continuously from the Operations Room.

Asset Integrity Management: The viewer can also be used for various asset integrity activities, such as planning of site inspections, collaboration with SMEs, and keeping track of visual information about the asset over time. The former can potentially reduce the time spent offshore doing inspections. The latter is accomplished by performing multiple camera surveys over time (maintaining the camera locations as unchanged as possible between surveys), and superposing the surveys obtained at different times over the same view (making use of a time slider to control which surveys are displayed).

Maintenance Planning: Similarly to planning for construction and site inspections, the viewer can be also be used to plan maintenance activities, since the panoramas are able to show relevant details, such as valve locations, tags, piping and cable trays, access panels, etc.

Training and Safety:

HAZID/HAZOP Planning: Another planning application for the viewer is during HAZID and HAZOP assessments. The visual information from the tool can give HSE focal points better understanding of operational issues and improved awareness to identify risks and hazards during planning.

Emergency Response Planning: The viewer can also provide emergency response teams with the ability to visualize the platform facilities before recovery operations. The improved understanding of the facilities by the emergency response team can lead to faster response times, improved awareness, and potentially reduced risk.

Incident Investigation: The viewer can also be used to give context to photos or other records taken during incident investigations. The tool can be used both before and after the investigations, to plan where to conduct them and where to focus, and also to complement the picture if records are incomplete. It has the potential to improve the quality of the incident investigation documentation.

Safety Training: Finally, the tool can be used to show platform personnel evacuation routes and muster areas and lifeboat locations, potential obstructions, etc. before they are sent to the platform.

Table 1: Specific capabilities of 360º PanoramicGuide, per area of application

General: a) Familiarization with Facilities b) Asset Documentation c) Knowledge/Information Sharing and Learning d) Multidisciplinary and Inter-Departmental Collaboration and Presentation (Onshore, Offshore, Vendors)		
Engineering and Design: a) Visualization and Planning b) Visual Information for SMEs c) 3D Measurements d) Tender Submission	**Operations and Maintenance:** a) Integrated Operations b) Asset Integrity Management c) Maintenance Planning	**Training and Safety:** a) HAZID/HAZOP Planning b) Incident Investigation c) Emergency Response Planning d) Safety Training

Results, Observations and Conclusions

In this chapter, the authors relate the experiences from surveying an offshore platform located in the Gulf of Mexico (Enchilada) and using the 360º PanoramicGuide viewer to access and visualize the photographic survey. The platform was physically surveyed over a week in September 2012, with the first version of the viewer delivered less than two weeks later. The viewer was updated with unit conversions and a revamped interface in December. This latter version has been used for about six months, and is the basis for this review.

Figure 3: Enchilada platform (left), and the automated 100 Megapixel 360º camera at low (middle) and high (right) positions

In general, the major opportunities to use the viewer have so far focused on the first two areas of application highlighted in the previous chapter, “General” use and “Engineering & Design”. This is mostly due to the fact that the team that deployed the tool supports engineering and construction activities offshore. The 360º PanoramicGuide viewer has been used during multi-disciplinary collaboration meetings, for example between electrical, mechanical and structural disciplines to get clarity on complex activities on the platform, such as shutdown coordination planning and modification work on the platform, which can be done more effectively and with a better sense of the platform layout the viewer provides. Work orders are issued with more

detailed information (such as screen captures of the relevant equipment on the platform), which improves the quality of the work scope description, and reduces the chances of rework and delays offshore. Also, the viewer provides a good, reliable documentation of the recent status of the platform facilities. The challenge then is to keep that documentation “evergreen”, and update the viewer with a reasonable frequency, to capture any major modification work done after the original survey.

Other potential uses for the viewer that require minimal effort for deployment, but have not yet been tested by Shell (because the opportunity has not yet presented itself) include tender submissions (no major work occurred involving third parties), HSSE investigations (no major incidents have occurred on the platform since the tool was deployed) , emergency response planning (no review of emergency response plans has taken place since the tool has been deployed), corporate/management briefings (no major engagements involving management have occurred), and visual aids for Integrated Operations and the Virtual Asset Team (VAT). However, the benefit and easiness of implementation is clear for the applications above, and it is probably only a matter of time until these uses are finally tested and deployed.

Other applications require a bigger effort for deployment, such as asset integrity and lifecycle management and maintenance planning. These require additional, separate information to be setup and integrated to the viewer, which could be a significant effort depending on the amount of information.

The viewer is very comparable in terms of capability to conventional 3D laser scanning. However, some of the main differentiators include the ability to view panoramas in color (though some modern laser scanners can also generate bubble previews in color), in very high resolution (the viewer can be zoomed to a higher level of detail without losing information than bubble views from conventional laser scans), and with better contrast (the High Dynamic Range capability of the 360º panoramic photography camera compares very favorably to photo surveys done without HDR, which is what laser scanners currently provide; however, black and white laser scans themselves are not affected by sunlight or very dark areas). On the other hand, measurements using the 360º PanoramicGuide viewer are slightly more complex, requiring defining measurement points twice in different views, instead of only once for conventional laser scans. The relative accuracy of the measurements between the 360º PanoramicGuide viewer and “bubble” viewers for conventional laser scans is currently being evaluated by Shell.

One of the major advantages of the tool is that it is Flash-based and readily accessible, especially for third party contractors and vendors, reducing the effort needed to access the information. While remote accessibility can be an issue for offshore platforms with slow connectivity, this can be overcome by keeping a local version of the photographic database on a machine on the offshore platform, allowing quick access to the information.