# Video Integration and Procedure Room Design Planning

Allie Paquette

The integration and management of multiple audio signals, video signals, and displays, particularly in an operating room (OR) environment is a challenge that clinicians and engineers are currently encountering. Traditionally, a hodge-podge of technologies has been used to deal with the signals in an OR, but the number of signals is increasing and the quality and standards of displays are being enhanced; hence, the traditional solutions are no longer sufficient. Clinicians and engineers alike are in search of a more advanced, more complete solution for the integration and display of signals in the operating room.

In the planning process for a new building with interventional procedure rooms and operating rooms, a video integration system is often considered. When considering the room layouts and the variety of monitors in these procedure rooms, different clinicians will require varying signals on varying displays for varying procedure types. The task can be assigned to the clinical engineering department to research the technological solutions that are available and to achieve these clinical goals in the most logical and cost-effective manner.

In addition to controlling and displaying a variety of video signals, which on the clinical side is likely the most important characteristic of a video integration system, an ideal video integration system will contain other features as well. These other features may include the ability to zoom in on an image from the display without a loss of resolution, the ability for the physician or a technician to easily change the signal on the displays, the ability to split a display to include multiple input signals, and the ability to video conference. The availability of these features varies across different solutions that currently exist.

The clinical application of a video integration system is primarily to aid clinicians in doing their work to the best possible skill level while utilizing the extensive data available to them through all possible technological means. This includes the ability to quickly reference a previous x-ray image of the area, for example, and compare it to a current image to identify any changes; this could then influence surgical decisions or other treatment options. Also, by making the data more readily available to the clinicians, they will be able to have their questions (i.e. "how's the blood pressure?") answered with a quick glance and hence experience less of a distraction from the surgical procedure they are highly focused on. Yet another clinical application of this technology is the ability to video conference. This has potential for teaching purposes such as increased exposure to procedures for medical students. More importantly, a physician working on a rare, difficult case could contact a specialist or pathologist at a different location and immediately present information and images of the case to that individual so they are better able to provide a consult.

From the perspective of a clinical engineer, with the goal of trying to achieve the clinicians' requested capabilities, there are many technological challenges involved with the management and integration of such a large variety of input signals. The input sources being considered include, but are not limited to, current physiological data being recorded during the procedure, current video streaming from overhead cameras, current fluoroscopic and reference images being collected from the c-arm in the procedure room, the patient's medical history from the EMR, and previous images from PACS. These signals vary in data type from patient monitoring/physiological data which would come from a network cable, PACS images which often require an exclusive workstation for access, EMR from the hospitals network, and a variety of video signals, web sources, and cables. The large number of video signals and cable types that exist create an integration challenge in and of itself; some of the cable types include VGA, SDI, RGB, DVI, HDMI, SVGA, fiber optic, and more. Depending on the technological solution, different formats are preferred and different conversions are required.

A multitude of vendors provide a wide range of solutions that all fit under the category of video management or more generally operating room integration. Some of these solutions focus more on central control of all things in an operating room such as control of lights, positioning of booms, etc. Vendors whose solutions seem more focused on this area than on the display of various video signals are Karl Storz OR1 and Stryker Sidne products. On another note, both the Storz product and another solution, the Olympus Alpha OR, are primarily focused on and hence somewhat limited to endoscopy procedures in regards to their video signals. Based on the clinical needs for our particular procedure room solution, there are three vendors that provide solutions with comprehensive video signal control and display. The vendors worth considering for this project are CompView DOCS, Skytron Skyvision, and Black Diamond Video. In addition to vendors that sell "all-in-one" solutions, there are vendors that serve as integrators and supply the various components to meet specifications.

Skytron is a company that sells lights, tables and booms and markets their product as a "medical imaging management system." Their digital integration is based on a fiber optic system, and they do remote video communications over IP. The CompView DOCS solution is sold in combination with a boom solution and is also marketed as a "medical imaging management system." They specifically market some of the capabilities that will meet our clinical needs including the ability to view information and route images with sources that include PACS, EMR, and the internet. Unlike the vendors for the other solutions available, Black Diamond Video (BDV) is a company that is exclusively focused on AV integration. They provide solutions for large venues, security operations, command and control centers, and medical environments.

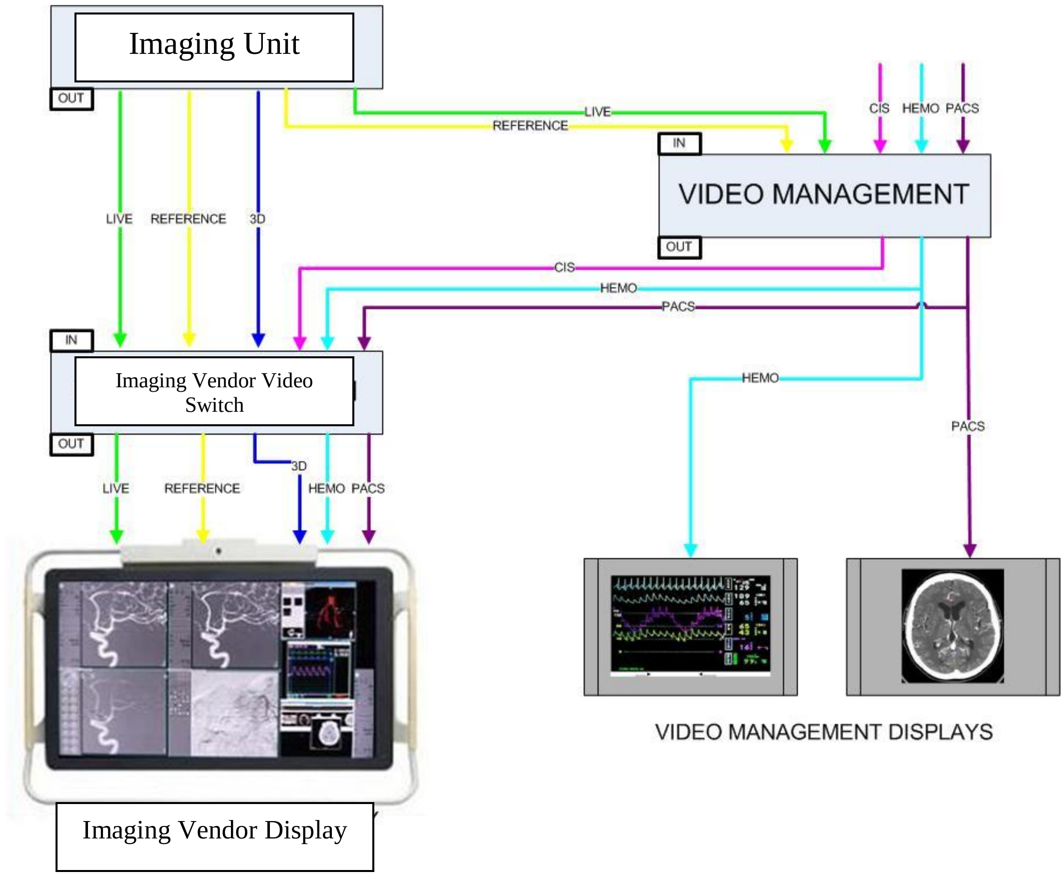
The BDV solution uses primarily copper cabling and has chosen the DVI format for all of its video signals. They sell conversion boxes that are built into the wall so that video wall units are universal and can receive and convert all other types of video signals to DVI before they are integrated. All of the inputs are routed to a single video switcher box which has the capability for up to thirty-six video inputs and outputs, as well as up to twelve USB ports. The USB ports are utilized to incorporate image sources from computers containing information, such as PACS workstations. The entire system including the video switcher, the necessary workstations, the controller PC, and UPS often requires a full rack for a system to control a large procedure room. The system utilizes a single, touch-panel control station, located in the control room, that allows for easy control of all the sources and the selection of which sources are displayed on which monitors. The control system has the capability for pre-sets, windowing (splitting a display to include multiple signals), and post-output scaling (zooming without loss of resolution). In addition, BDV provides means for in-house and remote teleconferencing.

Another potential option to consider is a video management solution that is offered by an imaging vendor. This would likely be the case when new imaging equipment acquisition is taking place simultaneous to the implementation of a video integration solution. Depending on the scenario, this option could either be beneficial or detrimental to your overall solution. If an imaging vendor has their own video management solution, it is likely that they are going to prefer, if not insist, that you use their solution. If their solution alone is not sufficient to meet the clinical engineering needs of your project and the requests of the clinicians, a solution for integrating an imaging vendor's system with a third party solution can be developed. In the current project at our institution, we are in this exact predicament. There is disconnect between the financial and strategic aspect of the imaging equipment acquisition and the clinical requests of the physicians (but these negotiations are a topic for another paper). It is important however to technologically evaluate our two options for a video management solution: the imaging vendor's proprietary solution alone, or a combined solution with the imaging vendor's product and a third party video management company.

One particular imaging vendor's proposed package includes everything from the c-arm to the displays. The solution includes an imaging system as well as a proprietary video switch. From the back-end perspective, the imaging system will send signals from the c-arm including two outputs each for live and reference images from the c-arm. It can also output a 3D rendering of the image. The idea is that these signals will be routed to the proprietary video switch to be available for display on the large monitor which is also provided by this vendor.

While this solution does provide all of the technological features we are looking for in a video management system, one of the primary concerns about the imaging vendor solution to video management is that there is only a single monitor for viewing. This limits the potential for clinicians at different areas around the table to have sufficient viewing of the displays and this does not seem to be an area in which clinicians are willing or able to compromise. There is potential to be able to move the large display around the table when mounted on a boom, but this doesn't address the problem of easy viewing from multiple areas at a time and can be a potential hazard for entering the sterile field above the operating room table. Also, a large monitor on a boom takes up a significant footprint in the operating room.

In the planning process, we have been investigating a possible way in which to incorporate the imaging vendor's solution with a third party solution. Hypothetically, we have designed the integration of the two systems (see the diagram below), but there are still factors that make it unclear if the solution will actually be feasible. Essentially, the c-arm would send one each of its live and reference signals to their switch, and the other two to a separate video management switch. All outside signals such as hemodynamic monitoring, PACS, EMR, etc. will enter the system by way of the video management switch. The outside signals could then be routed to the imaging vendor's switch to be available for display on the imaging vendor's display. The video management switch would allow for the display of both the imaging vendor's signals and the outside signals to additional video management displays that hypothetically will be present in the operating room.



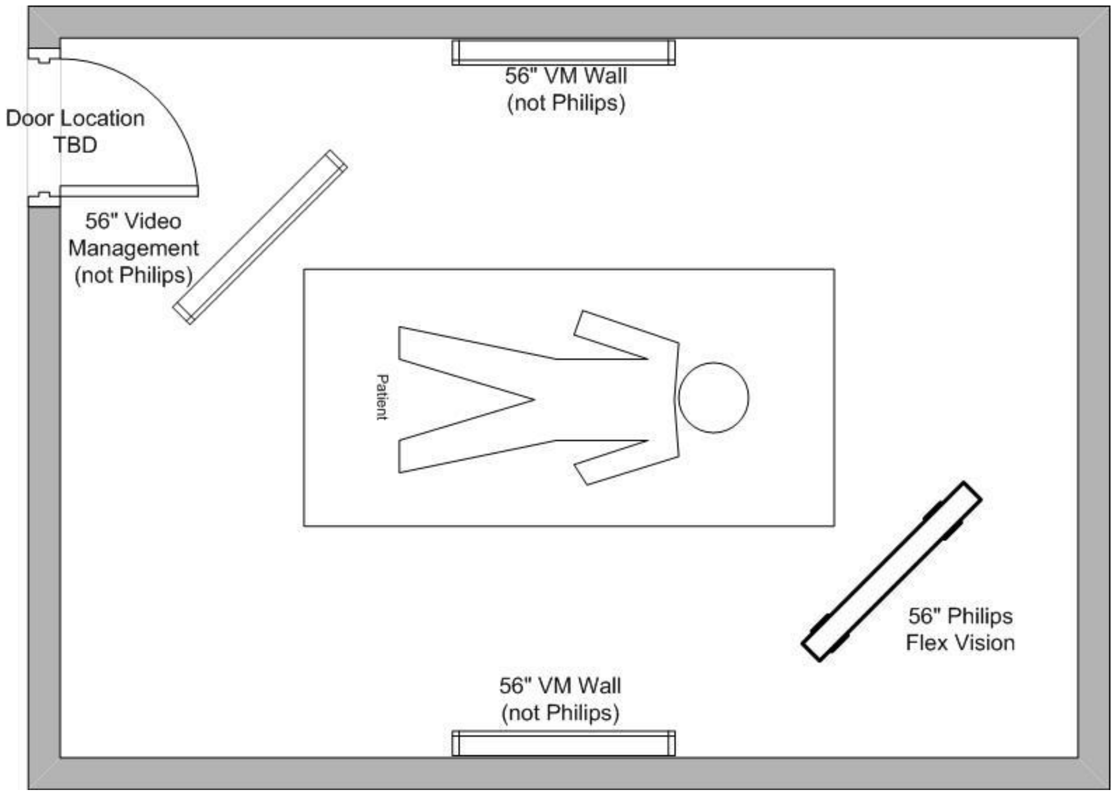

The presumed benefits of the combined solutions is that there would be additional displays in the OR room for improved viewing. There would be a potential for a greater number of sources to display, and hence more flexibility for variation across the different clinician groups for different procedures.

In addition to the potential benefits of a combined integration solution between the imaging vendor and a third party video management vendor, there are some concerns. One of these concerns is the difference in image presentation across different monitors in the operating room. Anyone who has walked into Best Buy and looked at all the different televisions, even those with the same specifications, differences in appearance can be easily identified. For physiological images being viewed by different physicians looking at different monitors in the OR, there is concern that their impressions could vary as a result of the differences in displays. There is also a technical support concern when two different vendors are involved, with the potential that each would blame the other for a problem. Another issue is that imaging vendor and the third party video management solutions will have different controls, tableside and in the control room for the respective options. It will be essential that the sources displayed on the Flex Vision monitor can be matched on a video management display and that any changes that are made must be consistent across the two systems again, so the clinicians' impressions are consistent and accurate.

Regardless of the chosen video management solution, whether it be exclusively the imaging vendor's solution or a combination of the imaging vendor's solution and a third party solution, there will be physical space that needs to be allocated for the video management system, as well as HVAC measures to take into account. Based on estimates, the procedure room equipment (not including any video management technology) will require 3 racks (~2'x2'x6') and 1 half rack (~2'x2'x3'). In addition, the imaging vendor solution will require 1 half rack, and a third party video solution will most likely require a full rack. The electrical needs and heat production of this equipment needs to be accounted for by facilities planning.

Yet another aspect of the video integration system that must be designed for is the number and size of displays, location of the displays, and mounting of the displays in the procedure room. There are both technical and clinical factors that influence this decision. The needs of the clinicians are understandably heavily weighted in the decisions, but there are technical challenges that can sometimes hinder the ideal clinical solution. For example, there are concerns about locating the displays too close or too far away from the surgical field. If the display is too close, there could be potential compromise of the sterile field (if the display can move), potential interference with the clinicians for different types of procedures, and potential interference with other equipment needed in the surgical field such as a c-arm. Although these concerns are not what you would think of as overly technical, they are "big-picture" type of scenarios that clinicians and administration tend to overlook.

For our particular project, there are at least three separate groups of physicians that will be utilizing the procedure rooms that are being designed. Along with the director of imaging, my supervisor and I created a presentation to demonstrate the pros and cons of four different options for display placement and sizes. Although a final decision has not yet been made, the most likely display layout is shown in the diagram below. This potential solution represents a combined system with the imaging vendor and a third-party vendor, and meets the clinicians need for two "in-field" (close to the surgical table) displays and two wall mounted displays. There are still some serious concerns about this potential layout including the large footprint of two 56" displays so close to the procedure table and hence smaller monitors may be considered for the video management displays. Also, the video management display at the patient right foot may interfere with the transport of a patient into the room due to its proximity to the door.




Another important consideration, although it spans more into the planning of the procedure room space rather than the specific technical aspects of a video integration system, is the placement of all of the booms in the room. For our procedure rooms, it has been decided that everything in the room is going to be mounted on the ceiling. This includes the c-arm, displays, perfusion equipment and monitors, and equipment cabinets. Depending on the number and location of the displays (which is of particular interest for video management) there is potential interference when moving the c-arm into or out of the parked position and even moving the patient into the room and on to the table. We were provided 4D presentations from our boom vendor that allowed us to test all of the booms' range of motion and potential cases of interference. Our clinical engineering group reviewed these documents and presented our concerns to the physicians. Final decisions have yet to be made on the overall layout, but due to construction timelines they will have to be made soon, whether or not an ideal compromise has been reached.

In conclusion, the technical considerations and design elements required to develop a high-tech, fully integrated video system for operating and procedure rooms are extensive. Whether designing the system for an existing room or a new room, there are the same technical concerns: integration and potential conversion of a variety of video and data signals from different sources. Determining available and functionally appropriate space for the displays in the operating room, the video system control in the control room, and the rack in the equipment room is another challenge that exists in either case. From the experience with this project, the clinical and administrative groups do not have a sufficient understanding of the breadth of the project to appropriately plan and budget for it. Also, it is important to make everyone aware that an interdisciplinary team is required to ensure that proper functionality of the systems are maintained while meeting the clinical needs. The extensive clinical benefits of a fully integrated operating room are difficult to quantify but most likely will include shortened procedure times, utilization of all clinical information on the patient to make the best surgical decisions, and ability to consult in real time with specialists all around the world. The idea is that these direct benefits of the video integration system will lead to improved patient outcomes for all procedures.