DISPLAY SOLUTIONS

Unique Solutions for Unique Problems

TO MARK OR NOT TO MARK

Multi-channel visual display systems in simulation & training theaters typically employ cylindrical, conical or spherical curved projection screen surfaces for display of the OTW graphics information. These curved screens provide wide fields of view up to 360 degrees to create visually realistic training environments. Older simulators have traditionally used CRT based video projectors, while new systems and upgrades today are typically using solid-state projectors with LCD/LCOS or DLP based light engines. Being analog devices, the CRT projectors have the ability to "warp" the shape of the projected image to correct for geometric distortions due to the curvature of the projection screen. This 'warping" feature is, to a degree, inherent in the design of the CRT projector. The newer solid-state projectors do not have this "inherent" warping capability and, therefore, typically use video pre-processors to re-map the image geometry prior to feeding the video signal to the projector(s). Some projector manufacturers integrate this pre-processor warping function circuitry into the projector housing, however Display Solutions does not recommend this configuration because it restricts the choice of available projectors and has higher life cycle cost implications.

With the CRT based projectors, it was necessary to "map" the projection screen to define the correct geometric shape of the resultant image. Once the screen was mapped, the system installer then made manual adjustments to the CRT projector to match a projected test pattern to the screen map. The end result was a projected image that was relatively distortion free on the curved screen surface. To achieve reasonable geometric accuracy over the entire image, higher end projectors typically had the ability to control geometry (and convergence) in 50 or more (almost) independent zones. While the results were generally acceptable, it was a time consuming procedure and required fairly regular maintenance adjustment due to "drift" of the analog circuits employed in the projector.

One of the advantages of the new solid-state projectors is that they are digital devices and essentially immune to the "drifts" encountered in analog devices. The video warping processors are also digital processors and equally immune to electrical drift. The better warping systems use "real-time" processors allowing WYSIWYG adjustment of the warping parameters while viewing the projected image. The geometry modifications can then be made in much the same fashion as is done with the CRT projectors i.e. mapping the screen and then making manual adjustments via the warping processor.

One of the problems with this method is, in fact, the mapping of the screen. This mapping is usually performed by using a laser theodolite located at the "eye point" or center of curvature of the theater. Radial points are then identified, usually corresponding to an available test image that is projected onto the screen. The screen is then “marked” at these points and the markers are used to correlate the test image to the proper locations on the screen. This, of course, assumes that all points on the screen are easily reachable. In domes or with screens with high height dimensions, this is not always the case. In order to avoid having the markers visibly interfere with the actual images during normal training sessions, an ultraviolet ink is generally used for marking the screen. The screen is illuminated with a UV light source during installation and/or maintenance, rendering the markers visible for adjustment purposes. The markers are not visible when the screen is illuminated with the projection light source only. Another method of “marking” the screen is to drill tiny holes thru the screen at the locations identified by the laser theodolite and inserting small LED’s into the screen. The LED’s are illuminated during the “set-up” process providing a visible marker pattern for alignment. When the LED’s are turned off, they are essentially invisible to the viewer during training.

These methods of mapping the screen are somewhat time consuming, but, again, they also depend on having “line-of-sight” access to all points on the screen from the “eye-point”. In marine simulators, this is often not the case due to the size of the ship bridge structure. Laser levels can also be used to create a geometric map on the screen surface and are often used in addition to other screen markings to facilitate the alignment process. However, once the alignment is complete and the lasers removed, there is no marker pattern remaining for future maintenance purposes (e.g. replacing failed projectors). Permanent laser diode arrays are sometimes employed (at substantial cost) to create a marker array that can be turned on as needed. It is an acceptable solution provided there are no “line-of-sight” issues between the theodolite and the eye-point preventing complete marking of the screen.

An alternate method used by Display Solutions in many of our installations utilizes an “automated” geometry alignment process. This feature is offered as part of the toolset in the 3D Perception CompactDesigner user interface (GUI) SW associated with their CompactUTM series of video warping processors. CompactDesigner includes a low level solid modeling CAD package for theater design. The CompactDesigner tool set is used to design the complete theater visual system layout, including obstructions (e.g. bridge house, beams, etc), projectors and screen(s). The CAD package includes capabilities to model specific projectors to account for projector size/location, lens characteristics, projector orientation and lens shift. Once the visual system is modeled in the CAD solids package, the SW calculates the geometry distortions required to correct for screen shape and projection angles and downloads the correction factors directly into the warping processor HW. Provision is made in the SW to input the image generator parameters such as resolution, VFOV, HFOV, etc directly into the CAD layout. These parameters are accounted for in calculating the distortion coefficients to be downloaded into the warper boards. The CAD model is developed as part of the initial design process and used to establish feasibility and guide the physical installation of the visual system components. After the installation is completed, the model is updated to “as-built” to reflect any deviations required by the physical environment. The resulting image pattern projected onto the screen surface contains the equivalent accuracy of a manual alignment using hundreds of "control points" in the warping pattern. Typically, a minimal amount of final touchup geometry adjustment is required for optimum registration between channels in the edge blend zone of the composite image. The need to do anything but basic screen marking (e.g. channel ctr positions which can be marked "off-screen") is essentially eliminated with this procedure. Both geometric accuracy and speed of setup are superior to manual alignment and screen mapping procedures.

Display Solutions, in close cooperation with 3-d Perception, has pioneered this method to improve installation quality, speed and ease of maintenance for theses systems. Display Solutions uses all of the methods discussed for various installations, depending on the demands of the specific design and customer preferences.