The Planetarium Environment

by Kevin Scott

The experience of a planetarium audience *and* staff is greatly affected by the basic physical infrastructure of a planetarium. Attention to detail in this realm is vital to a new planetarium construction project.

Electrical Power

Local building codes will provide a baseline for your particular power scheme and a licensed electrical engineer will handle much of the design work. Even so, it's probably a good idea to be involved with the design process and familiarize yourself with the electrical requirements of your theater. Your interpretation of the space and production philosophy will dictate many aspects of the electrical layout and capacity.

Every planetarium will have some form of star projector, and quite often there will be other unique equipment with special electrical requirements including laser systems, lighting instruments, projector lifts, and high concentrations of audio-visual equipment. Conduits and raceways for all of these devices will have to be mapped out. A spacious electrical room will make it easy to cleanly route power and control wiring throughout the planetarium. This master control area should be centrally located, perhaps beneath the theater to avoid any noise problems from equipment fans or lighting dimmers. A raised floor is an added luxury, but can make equipment installation and maintenance a breeze.

Your electrical contractor will probably provide raceways for any automation control wiring. These control signals are mostly low-voltage and will need to be housed in raceways and conduits separate from power delivery. Keep in mind that you'll want to have easy access to your low-voltage raceways for future equipment additions and upgrades. You might even consider open cable troughs as an alternative to closed raceways, especially in service areas and in and around any multimedia equipment racks that you may be installing.

The design stage is the best place to plan for power isolation and grounding issues. Sound systems are susceptible to hum from inadequate or improper grounding and laser systems are notoriously plagued by ground loops that cause wavering images on the dome. Ideally, every major projection system (and audio system) would have its own isolated ground and power. Ground lines are cheap and easy to install during construction, but can be quite impossible once foundations and substantial construction elements are complete. It's also probably a good idea to look into power conditioners – devices that "clean up" dirty power as it comes into the facility. By their very nature, AC lines over long distances suffer from problems of voltage fluctuations. Power conditioners help to maintain a consistent 60Hz, 115V line level, filtering out noise and other variations. Consider backup power systems. Battery backup may not make much sense for some projectors or audio equipment, but wherever computers are involved, they should be considered essential. Battery backup systems for

computers are relatively inexpensive and can significantly reduce problems associated with power outages, dips and spikes.

Location of the primary planetarium control center depends on the theater configuration (Chapter 15). In unidirectional and hypercentric seating arrangements, there is often a projection booth. The actual control console may be in or near the projection booth, or may be located in the front of the planetarium, especially if the vision calls for a live presenter to encourage audience interaction. In a concentric seating arrangement, control console is usually near the edge of the planetarium, but in very small domes, control console may be best in the center, near the star projector.

Whether you have a projection booth, cove space, or some combination thereof, you'll need an abundance of electrical circuits to handle all the slide and effects projectors. Some vendors recommend installing separate named circuits for each general type of projection system. For example, all-sky and panorama projectors would each have their own circuit with named and labeled outlets in the planetarium. This little bit of organization can help your design electrician evaluate power needs and also makes the layout of your circuit breaker panels quite intuitive. Planning for growth and expansion is always a good idea. Outlet distribution will most likely be a related to your seating arrangement. If you have unidirectional seating, you'll probably need more outlets in the "front" and "rear" of the theater to accommodate projectors and effects.

Finally, planetaria need to be cleaned on occasion, so don't forget convenient power outlets for your maintenance staff, as well as work lighting in the theater and cove areas.

Lighting—Cove Lights

Walk into twenty different planetariums and you'll probably find twenty different ways to install cove lighting. Today there are even more choices, including a wide variety of light sources and control systems. Some of the light source options include:

- Color coated incandescent lamps
- Multi-color LEDs
- Filtered Halogen or other high intensity lamps
- Neon
- Laser

Each has pros and cons when considering initial installation expense, maintenance, heat output, operating cost, color uniformity and intensity. When looking at an RGB or multicolor system, keep in mind that the eye is more responsive to various portions of the spectrum—most sensitive to green; least sensitive to blue/violet. You may need to select colored lamps of different wattages to achieve a balanced visual effect. High intensity lamps with dichroic filters can produce extraordinarily intense hues. LEDs are known for their long life and cool operation. Those facilities with laser systems like the Ominscan from Audio-Visual Imagineering have found that they can use various filter effects to create uniform sky glow and changing regions of color for spectacular sunrise/sunset effects.

Most cove lighting systems will accept some sort of automation control. Dimming is one of the key features of any cove lighting installation – especially long slow fades. Be sure to ask your automation system vendor about the types of dimming equipment you'll be getting and whether it will be able to handle smooth fades over durations of a minute or more. Some digital dimmers don't have enough control resolution to fade over such a long time making the cove lights change brightness in abrupt steps.

Lighting—Work Lights. When the theater is not occupied with visitors, it will probably be busy with staff members working on new shows, installing equipment, tuning, adjusting, and cleaning. Work lighting both in the planetarium chamber and staff accessible areas is essential. There could be three different types of lighting for behind-the-dome cove spaces. First, a system to fully light work spaces for cleaning and equipment installation. Second, a system to provide enough light for work, but shielded such that projectors can be focused without lights on the opposite side of the theater spilling onto the back of the dome. You want to be able to see where you're walking and what you're working on, but you don't want that light to spill into the theater where you're trying to make image adjustments on projectors and effects. Third, a low voltage under-the-cove system can facilitate projector adjustment during a presentation by allowing staff to move behind the dome and yet not interfere with the show.

Other spaces in the planetarium will require additional work lighting. The projection pit is a perfect example where extra lighting can be very helpful when it comes time to service the planetarium instrument and other equipment. Consoles can be equipped with dimmable "directors lights" such that operators can work with computers, find knobs and dials, or reference a script during a presentation – not that a planetarian would ever read from a script when describing the night sky. Another nice feature is to have mould lighting under your console desk so that you can work on computers and miscellaneous AV connections.

Cost considerations may necessitate some sort of portable work light system, e.g. clamp-on light that can be plugged in to strategically installed outlets, but even with this type of plan, thoughtful consideration to having a secure clamping bar or handle at every needed work location can make life easier. Of course the true planetarium tech geek will come equipped with a headlamp with flip-up red-filter.

Lighting—Theater, Decorative, and Dome Tour Lighting. If you plan to accommodate live actors in your programs, or if you'll regularly have special events with guest speakers it's probably a good idea to consider some theatrical lighting that can be used as spotlights and for general stage illumination. Moving head fixtures are a very flexible way to accommodate a variety of presentations. These devices often include a range of color filters and other effects. Most automation manufacturers can control these devices via the DMX protocol.

Your architect or interior designer may be able to recommend any number of special lighting instruments or decorative fixtures for your planetarium. These can also be functional devices. For example, a fiber optic strand around the

perimeter of the theater is not only an attractive accent but can also be used during shows as a special effect, such as providing interior spacecraft glows, klaxon flashes, or light for students to read by.

Dome Tour lighting can be an effective way to show off your theater and display the technology behind the wonder. These devices purposely illuminate speakers and other devices behind the dome screen to showcase how the planetarium works. In a similar vein, lighting can be used to show off the star projector and other features of the theater. If you've been to the new Hayden Planetarium in New York, NY you might have noticed a cloud of nitrogen fog that billows around the planetarium instrument as it rises up out of the floor. These and other effects may not fit into your philosophy, but may be worth exploring.

HVAC

Heating, Ventilation and Air Conditioning systems (HVAC) are an integral part of any construction project. As you might expect, planetaria have quite a number of special requirements to impose on HVAC system designers.

Probably the greatest question is how much control you need over the HVAC system, and how much control does it accurately provide. Temperature regulation is a trivial task. Add in humidity control, load balancing and fresh air intake and the complexity rises dramatically. By and large, you'll want the system to self regulate, within a given set of parameters. Local building code for occupation of public spaces will dictate some of those parameters, such as the amount of fresh air that must be infused into the system on a daily basis. Acceptable humidity levels will largely be determined by the operating requirements of your equipment. In any case, know where and whether you will have manual control, should adjustments be necessary.

Here are some other issues to watch out for. Any system that includes humidity control will most likely have a set of reheat coils. Humidity is controlled by first cooling air to remove moisture and then reheating it to the desired temperature. The order in which the reheat coils are installed is critical. Also note that you may need to have a chilled water source available year round to facilitate humidity control. In the interest of conserving energy, your chilled water system may shut during cold weather, affecting the overall performance of the HVAC system. The transition from cold/hot weather is difficult for automated systems to handle. You may find that the installation crew needs to come back to your facility six months after installation to make adjustments and tweak the control algorithms. Know where all the temperature and humidity sensors will be located. If they are in ductwork, are they easily accessible should they need replacing? Are they in public areas where they can be tampered with?

Like a movie theater, a planetarium is either empty with most of the lights and equipment turned off, or full of guests with nearly everything turned on. People and equipment obviously put a load on your HVAC system. It's appropriate to ask your engineer how quickly the system will be able to respond to such dramatic changes. Be cautious, however, because if the system is programmed to respond too quickly, it may overcorrect for the actual conditions.

In forced air heating and cooling systems, the volume of air moving through the space is the primary mediator of temperature and humidity. Moving this air through the planetarium chamber is a critical issue. First, if there are air ducts placed above the projection dome, diffusers should be utilized to avoid discoloring the dome with dust. Consider installing oversized air ducts with plenty of interior baffling to reduce noise and vibration. You'll also want to make sure all of the air handling equipment is located remotely such that it is acoustically isolated from the planetarium chamber. Finally, where will the return air ducts be located in the theater? It's probably best to keep them away from your visitors. The high volume of air moving across your audience can make them quite uncomfortable.

If your planetarium is part of a larger facility, the theater may be in operation after hours when the remainder of the facility is switching to an unoccupied mode. This has ramifications for the HVAC system as it tries to balance heating and cooling loads, and for your staff should they need to adjust the environmental controls during a late night production session or on weekends.

Acoustics

Acoustics are a dynamic part of the visitor experience. There is a whole separate chapter on Sound Systems, but planetarium acoustical treatments must be considered early in the design process. Proper sound dampening and active sound management greatly improves the planetarium environment by reducing the base noise level in a theater and enhancing the performance of sound reproduction equipment.

An acoustical consultant should be considered as part of the design team and present throughout construction. These professionals work alongside architects to implement acoustic features in the design of the theater. These features may include:

- Specific construction materials
- Surface treatments behind the projection dome and on interior walls and floors
- Doors and hallways that serve as sound locks as well as light locks
- Placement and materials for seating
- Equipment installation methods to avoid vibration and unwanted noise
- Recommendations for loudspeaker locations

Acoustic consultants should be familiar with local building codes and the various industry standards common in your area. For example, SMPTE has outlined several different standards for theaters, including room noise characteristics and equalization. Another popular guideline for theater sound is the THX standard. THX is not a specific sound format. Rather, it outlines how a theater responds to and complements sound reproduction equipment. Lucasfilm has engaged in some preliminary research on a THX specification for domed theaters.

Perhaps the key issue for sound in planetaria is making sure that every seat is a good seat. Audio engineers have known for years that sound makes or breaks a visual presentation. Today there is empirical research to back up those claims,

confirming that rich soundscapes are tightly linked to the human perception of visual quality and overall effectiveness. Spending extra time to consider acoustics in the design of your theater is well worth the effort.

Exit Signs & Emergency Considerations

Exit signs have always been a point of controversy in planetaria. Here are a few quotes on the subject from Dome-L discussion:

From Tom Callen: Before we opened Cosmonova in October 1992 we were getting pressure from the Stockholm Fire Marshall to leave not only our exit lights on during our Digistar planetarium shows, but also the stair running lights (we have a 23-meter dome that's tilted 30-degrees, so we have some pretty steep stairs). The only way we were able to get around this was to have the Fire Marshall and his staff come in, and then see the starfield with and without the exit/stair lights turned on. That was enough to convince him that we really did need to have these lights off for planetarium shows, and we were issued a waiver. ... We were also required to hook the theater emergency lighting system into the central alarm system so that in event of an emergency these lights come on automatically. ...Your best bet may be to invite those who need to approve such things to the theater and let them see for themselves how such extraneous lighting affects the show, but you also have to make clear to them what can be done in the event of an emergency, for example hooking the lighting to the emergency alarm system.

From Matthew Linke: ...place two layers of heavy red acetate between the bulb and the "EXIT" portion of the sign, using the same track that the sign part slips into. [The] plant people looked it over and approved it. It is deep red and very obvious, though not bright, during shows.

From: Gary J. Senn: We have a light switch to turn off our exit signs during shows. The exit signs are connected to our emergency system in such a way that if the fire alarm were pulled anywhere in the building, the exit lights in the planetarium would come on. This allows us to have bright exit lights when needed, to meet safety codes, and to avoid the Exit light floating in space during our shows.

From Dale Smith: We have our exit lights on a dimmer system. Using a photocell, they vary with ambient room light from full brightness to "dim but visible and not intrusive." There are automatic overrides that send them to full brightness and turn on emergency lighting if the building fire alarm sounds or the power fails. There is also a manual override the console operator can activate. The whole emergency system runs off a trickle-charged battery so it will work even if the power fails and the building's backup generator also fails. Best of all, this system is LEGAL! Our plan was approved by the Ohio state fire marshal's office in 1984 shortly after we opened and has worked reliably ever since. ...We know that the system works in practice. Several years ago at a rock concert, one the speakers the band had brought in caught fire. At the time, the room was dark except for the starfield, faint stand lights, and the exit lights. We had a full house -- 118 seated and many standing -- but we had been careful to enforce the aisle widths required by fire code. When the speaker caught fire, the system worked,

and the room was emptied in an orderly way in 45 seconds, less than the time required by fire code.

Perhaps the best advice you can get is to research your local building ordinances and develop a plan accordingly. Know what will be expected and be prepared to offer a reasoned solution. The building inspector or fire marshal may accept your proposal outright. If he or she objects, you have an understanding of where the inspector is coming from and can perhaps work out a mutually acceptable solution. In the United States, there are some cities where planetaria are allowed to have exit signs that illuminate only when a fire alarm is tripped or if the power goes out. Do your homework and find out what will be required. A clever architect may also be able to work with building inspectors in the definition of how a room is used, thereby changing the set of rules that apply. Political allies may also be able to help negotiate a suitable arrangement. In the event of a power outage, battery operated emergency lighting is a welcome feature, even if local laws don't explicitly require it. Try to find a vendor that offers emergency lights that automatically reset when power is restored. Be sure to install emergency lights in all of your light locks and entry/exit hallways.

Fire Suppression and Warning Systems

Along with exit signs, fire suppression systems are almost universally a headache for planetaria. We've all heard horror stories about sprinkler systems interfering with the projection dome. Again, the best advice may be to be prepared and familiar with local requirements during the design of your facility. If sprinkler systems are required in your theater, keep in mind that even if a sprinkler system has been pressure tested there may be residual oil in the system. When pipe fitters make threads on sprinkler pipe, they use oil to lubricate the threading machine. If that oil is not cleaned off and flushed from the water pipe it can drip down onto the projection dome.

Smoke detectors are often included as part of a fire warning and suppression system. There are several different types of smoke detectors and heat detectors available. You may want to decide which type is best for your facility or local law may specify one. If smoke or particle detectors are installed, can you disable them temporarily if you want to have theatrical fog for laser shows or as a special effect? Similarly, check to see if you can get away with a visual fire alarm in the planetarium installed at the operators console. Such a device would help the operator stop the show in the event of an emergency, directing visitors out of the area in a non-threatening way. In other words, we don't let people yell "fire" in a crowded theater, why should be we let machines do it?

During the design process you'll probably encounter discussions of fire ratings for walls and building separations. You may even be required to install special doors in your facility that automatically close when a fire alarm is tripped. It's remarkable how much effort goes into satisfying building inspectors.

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