

Look, Mom! No Tracks!

By: Paul Brunner

GPS-style positioning becomes a reality at Sight & Sound Theatres

The concept of wireless cueing and positioning for stage machinery has long been considered the holy grail of scenery automation. It's an extremely attractive idea—taking money away from heavy winch deck stages and giving it to nimble scenic units capable of rolling themselves into position, in any theatre, within a few minutes of installation. Sight & Sound Theatres' 2012 production of *Jonah* demanded just this sort of innovation. From a giant whale to a 30,000lb ship and dozens of live animals, the theatre has realized a unique application of technologies in a unfamiliar setting.

Based in Lancaster, Pennsylvania, Sight & Sound Theatres produces Christian-based plays that, in their production values, rival many shows found in New York City or Las Vegas. Founded by photographer Glenn Eshelman in 1976, the theatre began as a small traveling multimedia slide show but has since grown exponentially to earn the nickname "Christian Broadway." The theatre has earned a reputation for the stunning staging effects that support its Biblical narrative. The results are productions with an immersive cinematic quality that break the mold of what are commonly

understood to be "church plays."

Sight & Sound Theatres' productions are possible only because of meticulous attention to detail in a large and uncommonly organized operation. Its current production, *Jonah*, which runs 11 performances each week, is projected to attract nearly one million patrons over the course of a nine-month run. The 24 stage crew members and ten lighting crew members join with sound and wardrobe staff to support each production. When combined with the Branson, Missouri theatre, Sight & Sound Theatres employs approximately 600 staff including all part-time cast, and crew. There are 225 staff members in the Lancaster, Pennsylvania location, where shows are conceived, staged, built, and produced. Almost none of the staff possesses formal training in theatre arts, but they employ learned skills and talents.

Touring the theatre complex, it becomes clear this is no ordinary venue or production company. Housed in an expansive, state-of-the-art facility, Sight & Sound Theatres plays to a 2,000-seat auditorium from a 300' wraparound stage with more than 1,400 lighting instruments. A 12'-by-40' lift located center stage lowers scenery, cast, and animals 21' to the trap room below, where a vast network of generous hallways and corridors encircle the entire theatre and lead to dressing rooms and a stable. Directly adjacent to the stage are individual shops for machining, metalwork, and welding (Figure 1), carpentry, costumes, and crafts as well as storage and a separate shop for paints, properties, finishes, and decorations. There are also animators, graphic designers, construction supervisors, show engineers, and an in-house electronics and



Figure 1: The metalworking shop



Figure 2: A 3-D printed model piece

automation department. Including the theatre, shops, backstage areas, and vast warehouse space, the overall area under one complex is 313,317 sq. ft.

Creating *Jonah*

Development began on *Jonah*, based on the biblical account of Jonah and the whale, in the summer of 2009. Aware that the Jonah story was, for most, first encountered through picture books and spiritual lessons, director and associate producer Dan Deal says he sought to “bring the Sunday School story to life on stage.” In order to do so, he decided the visual impact should be inspired by a picture-book aesthetic. During the story, Jonah travels over land, by ship, and later by whale—or rather, inside a whale; Deal appreciated that the production’s most exciting potential feature was also among its most challenging. “With this story, we had to deal with the whale,” he sighs. “What are we going to do with the whale?” The solution came in the form of a 37’-long custom helium balloon made by the same contractor who fabricates the floats for Macy’s Thanksgiving Day Parade. After adding fins and paint, the whale was ready to

float throughout the audience under the guidance of trained performers.

More than anything else, Deal wanted *Jonah* to feel cinematic; fluid scenery movements were critical to him, and automation was the answer. Wayne Idecker, technical director, and Warren Keeney, principal designer for electronics and animatronics, set to work. The solutions were not clear-cut. A tracked winch deck was impractical for several reasons. First, the theatre’s stage floor was covered with GRT Genesis Stagelam, a costly and highly durable material perfectly suited to the rigors of a heavy production schedule and the issues that accompany live animals on stage. The tough floor was designed to support the immense weight of large animals and scenic units, and a tracked winch deck would cover the

Stagelam. Second, a traditional tracked winch deck would isolate scenic motion to a single axis of movement. The ship and other units needed more freedom to emulate the fluid choreography Deal envisioned. To remove the constraints of a knife-tracked floor and to ensure each performance was the same from day to day, wireless automation control with repeatable positioning was needed.

Well before any actors set foot in the theatre, Deal blocked all of the show’s scenes and scene changes using Flash animation. To accomplish this, representations of each of the 40 human performers, 45 live animals, 25 stagehands, and all scenic units and props were programmed using Flash, allowing the director to script every movement in the production. The result was a fluid visual ground plan with people, animals, and scenery synchronized to the sound track (recorded live). The animation greatly expedited staging and was also updated and refined during the run.

Like all shows at Sight & Sound Theatres, *Jonah*’s scenic elements



Figure 3: One of several omnidirectional axle kits made by Vehicle Technologies, Inc.

were designed by a team of graphic artists in collaboration with Deal and Idecker. From start to finish, the show took a little more than a year to build. The design process made extensive use of 3D Systems’ ZPrinter 450 to



Figure 4: Local positioning and tracking system, or LPTS

generate a detailed model of each unit, which was then carefully analyzed by the construction staff (Figure 2). The staff agreed on revisions, and a new model was generated and reevaluated. The cycle continued until

everyone agreed that construction could begin. The construction drawings are 3-D models made in SolidWorks, and craftspeople built the frames almost exclusively out of aluminum for durability and reduced

weight. In-house staff completed all finishing, painting, and décor in preparation for technical rehearsals.

Nine weeks were needed for programming and technical rehearsals. Audio, scenery automation, lighting, and media programming were combined with animal training and integration, properties, and dress rehearsals until all elements were unified into the show. Flash animation was used to train the deck crew. Four days alone were dedicated to “artistic work-throughs,” where the director refined the artistic feel of the deck moves.

LPTS tracking for scenery

Wireless positioning and cueing were accomplished by bringing together three particular products. Sight & Sound Theatres already had Niscon’s Raynok MK2 console with R2D software, which provides robust automation cueing for flown scenic elements, performer flying, and the wireless scenic units. Four scenic units were outfit-



Figure 5: The *Demon of the Sea* unit includes four linear actuators, two Vetex axle kits, and wireless lighting, sound, and fog.

ted with omnidirectional axle kits made by Vehicle Technologies, Inc. (Figure 3), including the ship unit, named *Demon of the Sea*, two tree units, and the Nineveh gate. These Vetex drive units came standard with Mecanum wheels, which permit forward and reverse movements as well as side-to-side, or "crabbing" motion with zero-turning radii. These units provide the fluid cinematic freedom the director and storyline demand.

A complete stand-alone position tracking system was needed. GPS does not provide the accuracy or reliability needed for live stage performance; instead, a newly developed local positioning and tracking system, or LPTS, was provided by iTrack Technologies (Figure 4). Developed by iTrack for the Department of Defense for use in conditions where GPS is either unreliable or unavailable, LPTS is ideal for theatre. iTrack's BM-400 beacons, placed in specific locations in the theatre, use RF-based range measurements and three-dimensional motion capture sensors to provide navigation and positioning information. Each scenic unit had installed one AVC-400 autonomous vehicle controller to process position information. The AVC-400 performs all calculations and processing and continuously communicates position data to onboard motor drive controls. The module requires communication with at least two beacons when traversing through the operating area.

Vetex uses a sensitive joystick to manually control speed and direction. iTrack installed an AVC-400 between the Vetex manual handheld controller and the vehicle master controller. This allowed a seamless transition from Niscon's automation control to manual joystick control and back again. The need for this sort of quick-access backup control was undeniable. The *Demon of the Sea* weighs 30,000lb, including at least 15 performers, gear, and batteries (Figure 5). It is also important to have backup in any scenery automation scenario.

iTrack says its system is not exclusive to Niscon and can interconnect with any automation control desk. The iTrack units have a rated accuracy of plus or minus 4"; Sight & Sound Theatres has experienced consistent positioning accuracy on its 300'-wide stage of 2" to 3". While this sort of accuracy is not always acceptable for live performances, the freedom it gives to the director and design team far outweigh the limitations of accuracy in this case. And if fine positioning accuracy is critical to a scenic unit, wireless technology may not be the best place to start.

The ship also features several more axes of motion. It is rocked 5° on either side of vertical by two large linear actuators, using one of Sight & Sound Theatres' own proprietary animatronics control boards to reproduce the motion profile. The ship's prow opens, again using two large linear actuators, to expose space below the deck. Add in wireless DMX for fog and onboard lighting, and the *Demon of the Sea* puts on a show of its own.



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How well does Sight & Sound Theatres like this new technology? Development and construction is already underway for the theatre's next full-scale production, scheduled to open in March 2014. The plan is to double the number of scenic units under automated wireless control from four to eight. Some scenic units in *Jonah* were built to accommodate the future addition of a Vetex axle kit. Scenic units in older productions are also being considered for retrofitting, upgrade to a Vetex axle kit, and wireless positioning. It is clear Sight & Sound Theatres is pleased with the system, as its investment into LPTS will double, and perhaps triple, in the next year.

For those who can afford it, the future of this system could be very bright. Sight & Sound Theatres' investment for each scenic unit is in the tens of thousands of dollars. With the combination of Vetex's omnidirectional platforms, Niscon automation controls, and wireless positioning and tracking by iTrack, *Jonah* has developed a first-of-its-kind wireless positioning system for live theatre.

Compared to more traditional scenic automation methods, wireless is always more expensive and susceptible to interference, but Keeney says the director and creative staff love the freedom the technology affords the show. The gear (Vetex and iTrack) is very tough and designed for environments far less civilized than a theatre stage. Apart from the up-front cost for gear, scenic units must be engineered to accommodate motors, drive wheels, batteries, and control cabinets. The forces motors place on scenery, and the added weight of control cabinets and batteries, all must be accounted for in construction. Altogether, these issues raise the price tag and further complicate fabrication.

As these systems are refined and competitors come into the market, costs will eventually come down. It seems likely that the system in development at Sight & Sound Theatres will eventually become a plug-and-play package, although it is currently far from being so. And while many problems of staging can be solved with this newfound wireless agility, technical problems still prevail. Advanced braking methods will be needed (because someone will want to do this on a rake), and lighter and smaller batteries will always be sought after. Then, tying the navigation system to automated lighting fixtures and lights could track scenery, and scenery could track lights. As with any technology, the only real limitations are imagination and, perhaps, also money. 

Paul Brunner is head of theatre technology at Indiana University. He is the exhibit project coordinator (TD) for the 2015 Prague Quadrennial, serves on a Broadway Green Alliance committee, and was recently elected to USITT's board of directors.