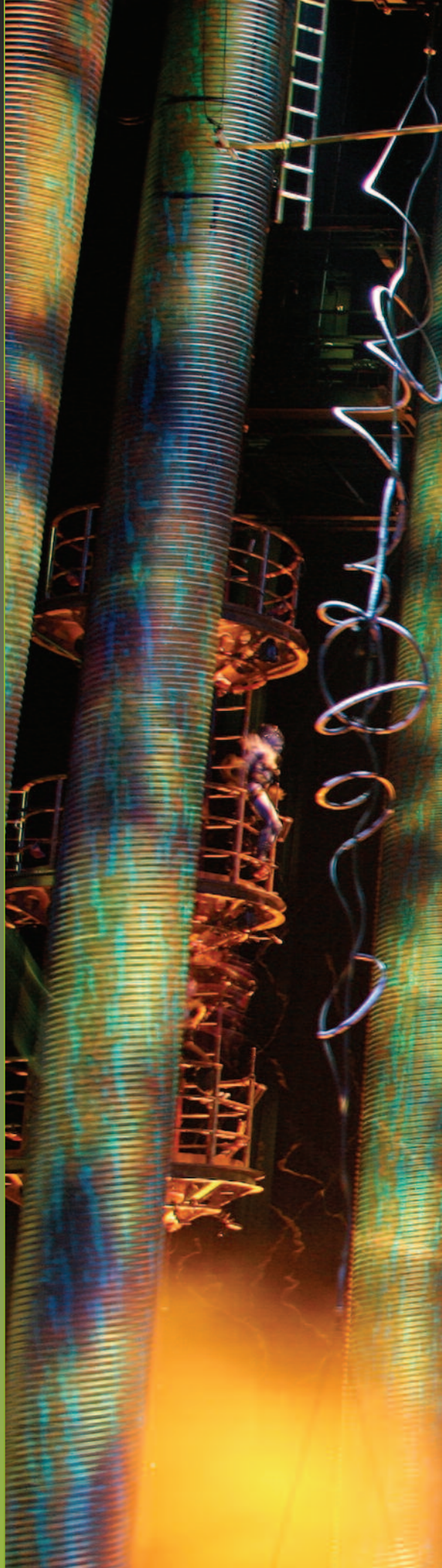
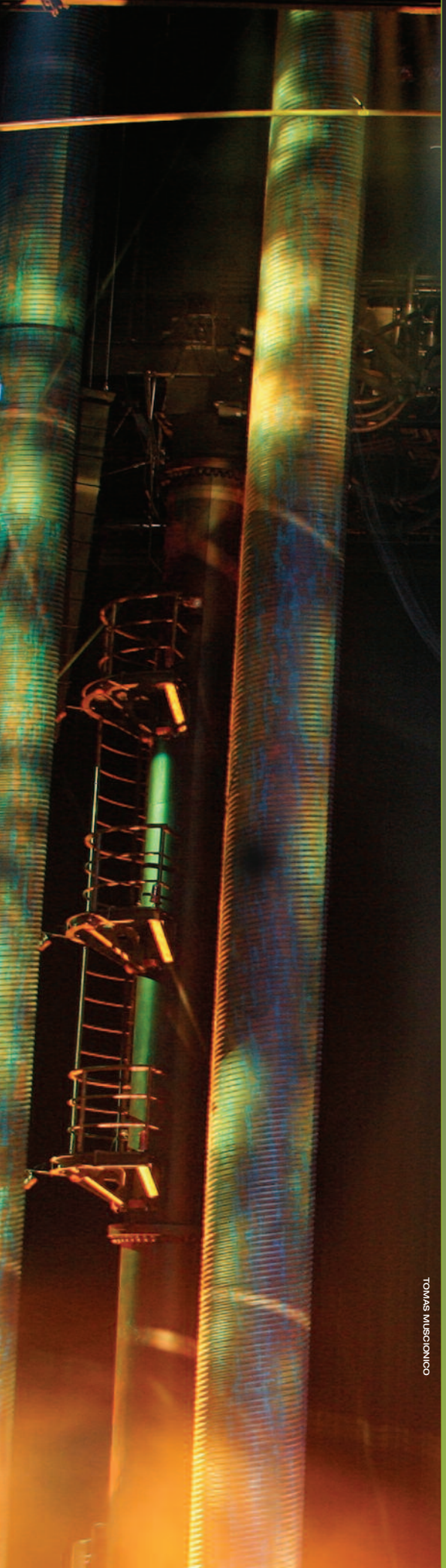


MAGIC IN A CATHEDRAL

The designers of *KÀ* discuss the concepts behind their work

By Mike Falconer





TOMAS MUSCIONICO

(Editor's note: Even by its extraordinary standards, the new Cirque du Soleil production in Las Vegas, KÀ*, represents a rarely seen fusion of design ideas and sophisticated technology. For that matter, it's often difficult to tell where the production's design ends and the theatre's design begins. For this reason, we are presenting a trio of stories, examining different aspects of KÀ.)*

Yes, it's another Cirque du Soleil show in Las Vegas. This time, the venue is the MGM Grand, in the space vacated by the extravaganza known as *EFX*. In case you haven't been counting, *KÀ* is the fourth Cirque entry to open along the Vegas strip; many have wondered how many Cirque productions this town can bear. This time, however, the French-Canadian troupe has redefined itself; it has also managed to bowl over this overly critical journalist—not an easy task!

All it took was $165 million…

One thing that instantly sets *KÀ* apart from other Cirque du Soleil shows is its linear storyline. Unlike many other Cirque attractions, this is no dreamscape with acrobats; the various feats are built into a story about a pair of Imperial Twins who undergo a series of wild adventures before their enemies are vanquished and peace comes to their kingdom. Another unique feature is a piece of stage machinery that many will consider to be the star attraction; the 25' x 50' Sand Cliff Deck (much more about this later) is simply awe-inspiring—from the moment it first appears in the guise of a canoe to its Catherine-wheel curtain call.

The Imperial Twins enlist of the help of the Forest People in their fight against the Archers.

Of course, if you take a risk, you're certain to be criticized. Some journalists have commented that *KÀ*'s emphasis on a story has caused it to sacrifice its soul. To quote the late Douglas Adams, this is "a load of fetid dingo's kidneys." Although it may be more difficult to read some kind of deep spiritual meaning into the assembled craziness of *KÀ*—compared to the assembled craziness of other Cirque productions such as *O* or *La Nouba*—it's only because the audience member has a general idea of what is going on and why.

The bottom line is that *KÀ* is sheer entertainment and spectacle, rather than entertainment and spectacle masquerading as something else. In KÀ, the story drives the acts and the technology. And what technology—the Sand Cliff Deck may not be the star of the show but it is certainly in line for a best-supporting role.

Then again, each aspect of *KÀ*'s staging, projections, lighting, and sound design features unique ideas and innovative technology, as a chat with each of the designers reveals.

Mark Fisher: Decompressing Las Vegans

Mark Fisher, who designed both *KÀ* and the theatre that contains it, first sat down in April 2002 with writer/director Robert Lepage to discuss a new show for Cirque du Soleil. Lepage is probably best known for his work with Peter Gabriel on the 1992 *Secret World* tour and the 2002 *Growing up Live* tour. He is also the creative force behind such avant-garde theatre pieces as *The Seven Streams of the River Ota, The Far Side of the Moon,* and *The Busker's Opera*. Fisher, of course, requires no introduction; he has created some of the most spectacular rock shows ever seen: *The Wall* and *Division* Bell for

Pink Floyd, *Steel Wheels* and *Bridges to Babylon* for the Rolling Stones and *Popmart* and *Elevation* for U2, to name a few.

"Robert had a neat diagram with a squiggly line," remarks Fisher, standing in the transformed and completely themed foyer of the *KÀ* Theatre. "It started in the sea, then on a beach, then up a mountain, then down the mountain, into a forest, a meadow, and finally ended up in a city. This squiggly line was to be a journey, and the journey a metaphor for the transition of a child—eventually a set of twins—from childhood to adulthood through a series of tests." Thus he was introduced to the first Cirque show with a true narrative.

Fisher's design has two main goals. First, to tell this story to an audience overstimulated by the frenetic pace of the Vegas Strip, Fisher decided he would need to "decompress" them. With martial arts and a Far-Eastern influence already in place as key components of Lepage's vision, the designer showed the director a picture of a 16th-century temple, in Kyoto, standing off the side of a cliff on a vast undercroft of tree trunks. "Imagine what it would be like if we carved our theatre out of this undercroft, so that we created a cathedral-like space?" says Fisher, remembering his conversation with Lepage. "You would recognize it instinctively as a cathedral, even through it wasn't one. It would have a rhythm, an uplifting sensation, height, openness, and spirituality. That is what the audience needs to feel in order to be in the right frame of mind for the show."

Second, with Hollywood churning out movies, typified by the *Matrix* trilogy, where the physical laws of nature and gravity do not apply, Fisher and Lepage were keen to create a live show that would challenge the special-effects expertise of film. In their vision, the traditional theatre experience, where the physical relationship between stage and audience member does not change, would be radically re-envisioned. "When you go to a movie, the director moves the camera everywhere and gives you different points of view," explains Fisher. "We had to defy gravity, and the performers had to defy gravity. My job was to provide the armature upon which Cirque could do all this."

The Post and Beam network of catwalks, highlighted by Color Kinetics LED units, connects the stage area and auditorium and is central to Fisher's immersive design.

The end result was a "stage" area that is, in fact, a void; its dimensions

are 120' wide, 120' deep, and 149' high. The distance from stage level to the high grid is 98', with the lowest floor level at 51' below that. Although the theatre has a proscenium arch—Fisher pointed it out to me—the designer has gone to great lengths to disguise it. The performers appear on an array of five stage lifts, the 30' x 30' Tatami Deck, and the enormous 25' x 50' Sand Cliff Deck.

Bridging, literally, the staging area and the auditorium is a network of columns and catwalks called the Post and Beam, which covers each side of the theatre. It is central to the immersive quality created by Fisher's design.


TOMAS MUSCIONICO

"I wouldn't have done it like this had we been starting from scratch," says Fisher; "I think we would have had a much more immersive experience. Not in-the-round, but something that is much more. We couldn't really change the structure of the building, because the casino was all around it." Nevertheless, the designer removed the false ceiling of the *EFX* theatre and increased the width of the auditorium, essentially leaving only the front and rear walls of the theatre intact. However, given the enormous amount of open space in the theatre—almost 2,000,000 cu. ft. when you include the stage area—the furthest any audience member is from the stage is 116'. This creates an incredibly intimate performance space for a 1,950-seat theatre aiming for a cathedral like ambiance.

> Fisher : "We had to defy gravity, and the performers had to defy gravity. My job was to provide the armature upon which Cirque could do all this."

Onstage, the various platforms are the key set elements. Of them, the Sand Cliff Deck arguably provides the most visually stunning moments in the show. It is supported and controlled by an inverted gantry crane—a mechanical arm attached to four 80' hydraulic cylinders that run along two plainly visible support columns. Controlled, like all of the show's automation, by a Stage Technologies Nomad system, the gantry crane can lift the Sand Cliff Deck up and down, rotate it by 360° and tilt from flat to 100° simultaneously. It first appears as a canoe, becomes a beach, then a cliff, and so on. The effect is an incredible suspension of disbelief. From the opening moments of the show, it is obvious how the Sand Cliff Deck works, yet it still astounds, even when performing the most obvious actions.

"Way before anyone else knew the project even existed, we were discussing the proposal that the beach would turn into a cliff," says Fisher, recalling an early meeting with Lepage. "I asked, 'What do you do with the sand?'" The reply: "We will tip the sand off, and in the process of the deck becoming a cliff, the audience will see the sand tip off." It's a truly magical moment, worthy of the applause it receives.

Nevertheless, says Fisher about the deck, "It is only the framework that the performers use to make their performances on. It is not the star of the show. It came about as a piece of equipment from the analysis of this storytelling proposition. It was not at all the kind of process where we said, 'Let's think up the most ridiculous machine we can and then build a show around it'. It was absolutely the reverse. Robert is a very technology-savvy director and I have obviously spent most of my life doing this kind of thing. Our conversations were very solution-driven and we just took it for granted that neither of us was going to sit around talking about things we did not know how to do."

Although at first Fisher may seem like a something of a left-field choice for a piece of acrobatic theatre, it does crown a growing trend in his career. Since 1997, he has been involved with circus and acrobatic shows. In addition to the Millennium Dome in London, which featured a

central Cirque-style show with music by Peter Gabriel, the designer has worked on two large circus shows in Japan with a Russian company. "It was a fantastic opportunity to go to another level with something I'd been very interested in," he says. "Otherwise, I never could have held my own against the other creative guys—it would just have been a complete nightmare. Although there have been a lot of other creative people involved, it is not that different, in the end, from working with a band like the Stones or U2, where they are really involved. By the time you are spending these amounts of money, it is always a highly interactive process."

Holger Förterer: Interactive Projections

If you have never heard of Holger Förterer, you are forgiven; neither had I. I suspect, however, we may be hearing a lot more about him in the future. Originally a computer-science student from the southwest of Germany, he has installed his interactive projection system in several museums in that country. However, the *KÀ* installation is five times larger than anything he has done before.

Förterer's interactive projection system uses infrared-sensitive cameras sensor tiles built into the Sand Cliff Deck to follow an artist's movements and turn the stage into what is essentially a huge touch-screen. The information that the cameras gather is used to influence the imagery projected onto the stage.

The most obvious example of this takes place during the extraordinary battle scene at the end of the show. The battlefield itself is the Sand Cliff Deck—standing vertically on end. Sixteen artists, suspended on wires perpendicular to the ground, move across the battlefield in this gravity-defying sequence. High-speed wireless remote-controlled winches are used by each artist to control their movements and complete the illusion of looking down on the field of battle from above. As each artist 'steps' onto the battlefield, the deck reacts like liquid, pooling around their feet and creating an effect not normally seen outside of a movie theatre.

"To get the audience into the landscape, we are showing them some basic elements and these elements reacting to people," remarks Förterer. "All the images are generated by the

The performers appear on an array of five stage lifts, the 30' x 30' Tatami Deck, and the enormous 25' x 50' Sand Cliff Deck.

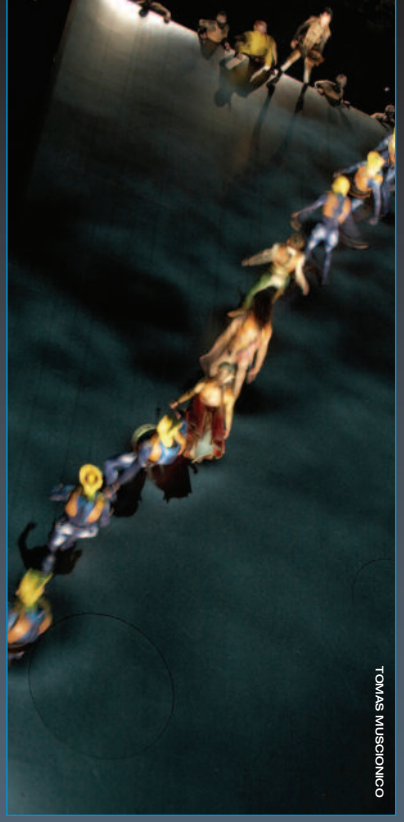
computer at the instant they are shown. No video has been taken and no pre-recorded material is used; it is all done live."

Förterer has been developing his handcrafted software since 1998 and customized it for *KÀ* with his team of four programmers. The software, which is written in C++ and runs on a conventional dual-processor, PC-compatible computer, outputs images at 1,280 x 1,024 to three 18,000 lumen Barco ELM R18 DLP projectors mounted at the rear of the theatre.

Fisher, in particular, is significantly impressed with what Förterer as been able to achieve. "If I didn't have the privilege of working with Holger, I'd be up to my eyes in trying to figure out how the Sand Cliff Deck could be a beach, a this, a that, and another without being able to change it," says Fisher. "In the end, all I have had to do is paint it grey. I think projection makes my job much easier. Particularly the interactive stuff that Holger is working with, you just couldn't do it any other way. The underwater scene is absolutely fantastic. You couldn't do it with lighting—it is so dynamic—it puts it on a different level."

The underwater scene Fisher is referring to is a moment when the female Twin and the Nursemaid, after being shipwrecked, are shown drowning. Förterer's interactive projection system allows for bubbles of air to escape from them as they descend underwater.

Förterer's work is remarkable—all the more so because it is so understated and subtle. It augments the scenic design, but unless you are looking for it, you will be hard pressed to find examples of its unique nature before the battle that is the climax of the whole show.


TOMAS MUSCIONICO

A view from above of the final battle, in which the audience's perspective is manipulated to emulate a cinematic point of view.

Luc Lafortune: Sourcing the Cinematic

Luc Lafortune is a constant in Cirque du Soleil shows. His keen sense of the theatrical has defined, in many ways, the look of Cirque over the years. It is, therefore, all the more astonishing to see what he has been able to achieve with *KÀ*.

Many designers look to films, such as Ridley Scott's futuristic thriller *Blade Runner*, for inspiration—but few of them come up with anything as successful as the originals. Lafortune has created a future-noir look on a live stage without relying on the sleight of hand that is available in film. As the saying goes, it is the quality, not the quantity. The designer has disproved this paradigm, however, by using 3,238 lighting fixtures, of which only 44 are automated. This is all the more astonishing when one realizes that, other than the walls, all the scenic elements, including the stage(s), can—and do—move.

"I'm always a little skeptical of automated lights," smiles Lafortune. "I like automation because it can get you out of a jam really quickly; you need light there, you move it there. But an automated system would not have been able to achieve what we have achieved with *KÀ.* This is why I went for the kind of lights you'd find in a parking lot. This is why I went and bought 48" neon tubes and beam projectors from Mole-Richardson."

Lafortune's eclectic choice of fixtures is plainly in evidence as you walk around both the backstage and front of house. The use of significant numbers of smaller fixtures is probably the single most important factor in creating the show's cinematic look and feel. The Post and Beam is lit, for the majority of the show, by 436 Color Kinetics' 6" ColorBlast fixtures. The walls backstage are dotted with 400W HTI floods, fitted with custom dousers from Wybron, plus fluorescent tubes and neon. Noting these choices, Jeanette Farmer, lighting director for *KÀ*, adds, "Luc does this very fun thing with unusual fixture types in that he enhances the stage setting not only with the light coming out of those fixtures, but also with the physical looks of the units."

"The number of fixtures is just an arbitrary number," remarks Lafortune. "In order to keep things three-dimensional, you need a lot of fixtures—but sometimes it can be a lot of very small fixtures. They define the space and create a sense of depth. We talked about cinematography a lot when creating this show, but you can't really use fixtures from the cinema, because there you are working in a 16 x 9 format and you don't care what happens out of the frame.

Lafortune: "An automated system would not have been able to achieve what we have achieved with KÀ. This is why I went for the kind of lights you'd find in a parking lot."

Another view of the Forest People: With no stage as such, each performer must be suspended on wires or standing on a moving stage element.

Theatre is very different. You care what happens everywhere because it is part of the environment."

Nowhere is the depth of the environment that Lafortune creates more in evidence than in the penultimate sequence: the Slave Cage. Two artists balance and control a "Wheel of Death" from their opposing cages on this spinning apparatus. The Wheel of Death is placed at center stage; Lafortune shows us the depth and space of the stage area by using the rear of the *KÀ* Theatre as a scenic element, with the shape being highlighted and accentuated by lighting.

"In a space such as this, you want fixtures that have character," comments Lafortune. "It helps define the space. A normal spotlight defeats that whole purpose. Despite the fact that there are over 3,200 fixtures, you look up and say, 'Where are they?' Well, they all over the place, they are in the basement, they are on the walls, they are on the Post and Beam. We contaminate the auditorium and, ultimately, the lobby with what is happening on-stage. The theatre is a major investment, so we have to make sure that it looks good." Farmer adds, "The single largest element that needed to be lit was the Post and Beam; it was decided early on that this element would be considered theatrical, rather than architectural, lighting, so Luc and the lighting team [including associate lighting designer Nol van Genuchten] took on this massive project.") In fact, continuing on the theme of the venue's size, Farmer says, "The stage area is so big that some of the cueing has to be taken off of video monitors."

With 3,238 fixtures requiring 22,528 control channels and 2,260 dimmers, lighting control is a major issue for Lafortune and his team. A Strand ShowNET fiber-optic network is used to distribute DMX throughout the theatre. The main conventional control is in the shape of two Strand 550i consoles, three Strand 520i consoles, and two Strand 510 consoles. According to Farmer, the use of the consoles breaks down this way: One Strand 550i is used to control dimmers, scrollers, and Color Kinetic's LED units. One Strand 520i is in charge of smoke, pyro, flame effects, and theatre air handling. An additional Strand 520i is used to handle 750 DMX-controlled relays used for non-dimming power for lighting, projection, and special effects. The Strand 510 controls dimming for architectural units, rehearsal looks, stage manager cuelights, and the front lobby lighting looks. Moving lighting and strobes are controlled via a Flying Pig Systems' Wholehog II console. A Dell Precision 650 workstation is used for projection image feed. Each control unit has a

tracking backup. A Le Maitre Surefire is in charge of pyro cues.

Lafortune's approach to *KÀ* is a response to the very different working method of the clasically trained Robert Lepage. "Robert works with words and is very literary," he says. "My approach is less literary because of my background, but I have learned to work like him. I started picking groups of characters and writing a small dictionary to define them."

Using these words and sharing them with the rest of the creative team, Lafortune hunted on the Internet for images that would visually convey the emotions of each group of characters. The protagonists, who ultimately become the Emperor's Court, were summed up by such words as "lightness of being," "warmth," "flow," "incandescent," and "a midsummer's night." The antagonists, who would ultimately become the Archers and Spearmen, were summed up by the terms "industrial," "oppressive," "immensity," "monolithic," "arc sources," "structural," and "architecture."

"Once I'd defined the space in terms of words, feelings, and emotion, it was easy to pick the types of fixtures I needed to make it happen," remarks Lafortune. "When you sit down with the director, you discard images—sometimes a lot are discarded. At some point, you say, 'Okay, this is it. This is the show; this is the character of the lighting. Now, how do I make this happen technically?' It goes way beyond illumination and way beyond the technology; you are having a conversation at a whole different level with the director before you start talking about fixtures and colors. I think it is a more intuitive aspect of lighting design."

Leafing through Lafortune's book of ideas, it is easy to see why he likes working like this. It provides him with a safety net of sorts with his director, a method of checking that they are both on the same page. "It is scary when you don't have this," he says. "The technology is not rocket science; it is not that intimidating. It is intimidating when you don't know what to do with it, when you don't do your homework, don't know the character of the space, or what it is going to look like, and you are then faced with purchasing fixtures."

Lafortune knows what he's talking about, because, typically with a Cirque production, he begins working in a vacuum. Since construction of the theatre commences before there is little, if any, idea of what the final show will look like, the designer has to do a certain amount of crystal-ball gazing and covering his bases. (As well as designing the show, Lafortune worked with Farmer, specifying the theatre infrastructure.) "It is always a bit of a challenge," he laughs. "Contractually, we have to make some decisions early on in the process. We want to be financially responsible, so we don't delay the decisions too much. However, there is an old expression: 'You can pay me now or you can pay me later—but if you pay me later, it is going to cost you a whole lot more.' We try to design a system that is fairly conventional. We knew with *KÀ* what the throws were going to be, so we knew that we were going to be using smaller apertures. We also have a great relationship with the various manufacturers when it comes to swapping out equipment."

In *KÀ*, Lafortune has designed a

TOMAS MUSCIONICO

Let battle commence! The Sand Cliff Deck is raised into place to become the battlefield for the production's finale.

cinematic experience for theatre. The irony, of course, is that he has done it at a time when more and more movies are creating theatrical effects using moving lights. Lafortune's use of fixed instruments—I hesitate to use the word conventional, considering the disparate sources—makes this achievement all the more remarkable. Perhaps the greatest compliment that I can pay him is to say that, for the most part, the lighting is not noticeable, even to those looking to review it. It blends in effortlessly with the rest of the production and is integrated to such an extent that it is difficult to know when the lighting design ends and the scenic design begins.

Jonathan Deans: Focused Sound Design

"As a sound designer, one thing that I have always wanted to do is put speakers in the seats," laughs Jonathan Deans.

And so he has done it. Each seat in the auditorium has a pair of drivers mounted into each headrest, which makes up the lion's share of the 2,296 loudspeaker cabinets, using over 4,700 drivers, employed in *KÀ*. In addition, the designer also has a Meyer MILO line-array system in place as the main PA, which is augmented by Nexo, EAW, Turbosound, and additional Meyer cabinets around the theatre and backstage.

"Ninety percent of the time, there is audio going into the seats," says Deans. "You are only aware of it 15% of the time; however, if you turn the seats off, everyone notices. I would go into all these meetings with people saying they could not hear the seat speakers. I would run the system for them without the main PA, and say, 'This is the level it is running at during the show.' They'd say, 'No, this can't be; we don't hear it during the show.' To which I'd reply, 'Do you have to?'"

At the heart of the audio in the *KÀ* Theatre is an LCS Variable Room Acoustics System (VRAS) which was specified by acousticians PMK (Pelton Marsh Kinsella) Consultants. Forty microphones placed in the auditorium and stage are used to capture the sounds of the room. These sounds are fed through a multitude of magic boxes and reverberation algorithms and are sent back through the loudspeaker system. Unusually for VRAS, Deans is using the *KÀ loud*speaker system rather than a separate loudspeakers and amplifiers.

"The cost savings are huge as opposed to other systems, where the speakers and amplifiers are separate," says Deans. "I worked closely with PMK to make sure that the speakers were compatible and what the intention of each speaker was. That way, we knew what I wanted to do, and what they needed. If I was missing an area that they needed, or I was doing something that they didn't need, we'd play around to see if we could balance the system while using the same speakers and amplifiers."

The *KÀ* Theatre is a dry room, as Deans demonstrates by clapping his hands in the auditorium. VRAS, however, allows him to change the room's acoustics and create an environment as the audience enters the auditorium. "Cirque wants to be able to have the infectiousness of audience members being aware of the person next to them when they applaud—while still having a dry room. That way, we can produce the levels that one needs without it sounding like we are in an aircraft hanger. VRAS is an acoustical tool that got put in because it allows us

TOMAS MUSCIONICO

Above: The Archers make plans on the Tatami Deck. Below, left: The Wheel of Death in motion.

to do that. We can basically tune the room to simulate any space of this size."

VRAS, however, is not just an environmental tool, as Deans continues to explain. "VRAS is cueable. We can tell it what kind of reverberation time we want it to be and we can also have early reflections. As a designer, I can choose to break VRAS; I can do something and it says 'No, you can't do that. You are going to have early reflections and echoes,' and I say, 'Oh yeah, cool.'"

By manipulating the time delay of the seat loudspeakers, Deans focuses the sound to provide an extra subliminal hint as to where the audience's attention should be, so as not to miss anything in the vast environment of the KÀ Theatre. The auditorium is split into 16 separate zones, each with a left and right output. Each zone is as short, front-to-back, as possible, normally four or five rows, depending on auditorium's curve. A zone is defined by the point where the time delay goes beyond what is controllable.

"We can be in the middle of a scene, enveloped by it, and then zoom out," remarks Deans. "It should be a subliminal addition to support the story. It is actually better than headphones, because we are able to move or pan the sound out of the seats overhead, into the rear, into another zone of seating, into the side walls or into the line arrays. With headphones, you are still trapped within them. It is as if we are using a zoom camera but in audio terms."

The sound for *KÀ* is superb. Listening for the seat loudspeakers, one can be aware of the subtle acoustic manipulation taking place. That said, for the majority of the show, I sat immersed in the world that Cirque du Soleil has created . Even being aware of what was going on technically does not detract from the overall experience—and in some ways it enhances it.

A world of special effects

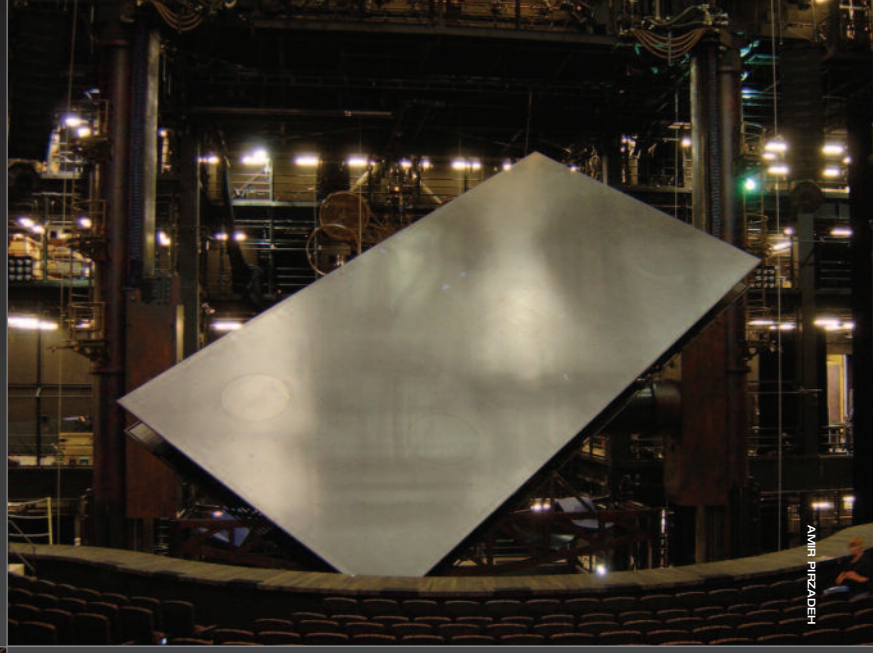
In addition, the story of *KÀ* is punctuated by an extensive lineup of special effects, including show, mist, wind, atmospheric haze, ground fog, smoke, propane gas, pyro, and showers of sparks. These were designed by special effects master Gregory Meeh, of Jauchem and Meeh, with engineering and installation handled by Advanced Entertainment Systems. Mat Dillingham of AES notes that six months were required to install the special effects into the theatre.

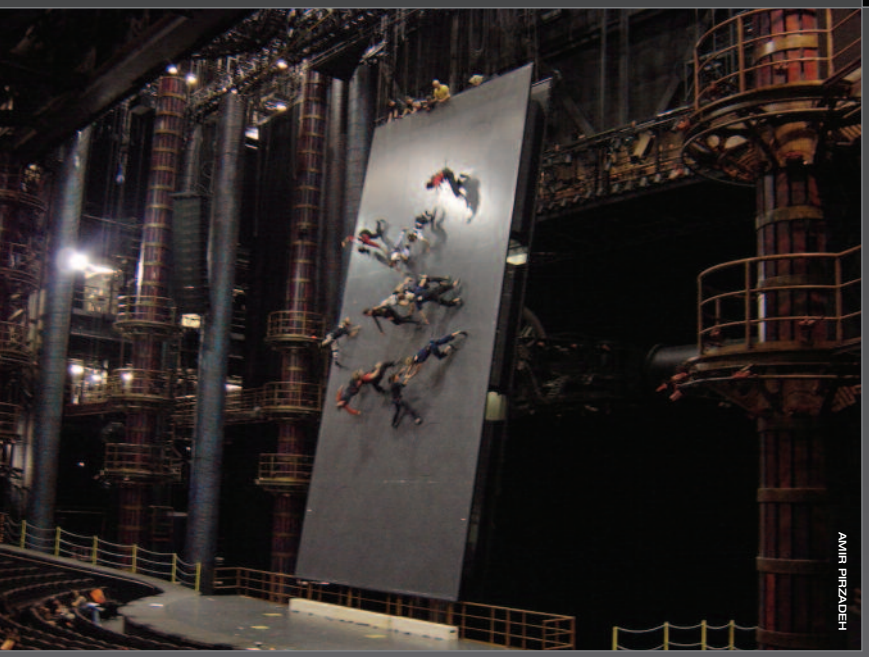
Several companies were involved in this aspect of production. Dillingham says that 60 MDG machines were installed to create all of the show's atmospheric effects. Sigma Services installed the propane gas equipment and the spark effects were created by Phil Cory Special Effects. DMX distribution is handled by the Strand Shownet system. Mist, he adds, "is created by atomized water vapor—a system built and installed by us."

The wind effects, adds Dillingham, consist of "approximately 40 fans placed in strategic places, mostly to distribute the fog and smoke effects." Perhaps the biggest challenge, here, he says, was getting fog effects into the elevators distributed around the set. "We needed a hose delivery system that could distribute fog up to 35'." The system, he notes, "is based on volume chambers placed under the elevators, equipped with fans. Injections of smoke are pumped up through hosing into these chambers, which contain machines to add supplemental smoke." Dillingham also notes that a six-man crew, headed by Jeff Schaen, is required to keep on top of all the show's effects.

KÀ is entertainment pure and simple; it is also live technical theatre at its very best—pushing the envelope of what is possible while never losing sight of its goal: to enhance, rather than detract or overshadow, the performances onstage.

KÀ is worth every extortionate penny the box office is asking. I'll see you there.


AMIR PIRZADEH


AMIR PIRZADEH

Above: performers rehearsing one of the vertical battle scenes under work light on the Sand Cliff deck. Above right: The Sand Cliff deck rotated to a different position.

HOW DID

A look at the scenic automation,

By John Huntington

After 20 years in the business, it's rare that I see a live show and say, "Wow—how did they do that?" But when I saw *KÀ*, I was so amazed that I felt compelled to write a behind-the-scenes detail piece, something I haven't done in many years.

Under the brilliant creative leadership of Robert Lepage and the Cirque team, the technology in *KÀ* is completely at the service of the art. While *KÀ* certainly could be called a spectacle, it certainly is not a case where the technology trumps the art, like one of those depressing high-concept special-effects action movies. In many ways, *KÀ* is an example of the kind of show I've been hoping would exist—and have been advocating for—for many years, because the performers are often in control of the technology, rather than the other way around, and the technology is integral to the performance, not a gimmick. In *KÀ*, the technology allows the show to connect with and reach the audience, extending the performance; it doesn't get in the way.

Scenic Automation

There is no stage in *KÀ*. There is simply a huge pit, from which enormous performance spaces rise, descend, track, tilt, and swivel. The scenic elements were conceptualized by Mark Fisher; the Tatami Deck and the Gantry were designed by the entertainment team at the McLaren Engineering Group in West Nyack, New York, starting in late 2002; McLaren also engineered the

Sand Cliff deck, which was designed by Tomcat. (The other scenic pieces were done in-house at Cirque du Soleil, with the company also handling the integration of the pieces.) "Mark is a very clever man," says McLaren Engineering president Malcolm McLaren. "He thinks motion through, and he has a very good understanding of the mechanics that it takes to drive these things. So when he gives us his thoughts on how something could be actuated, he respects the laws of physics."

THEY DO THAT?

projection, and show control systems in *KÀ*

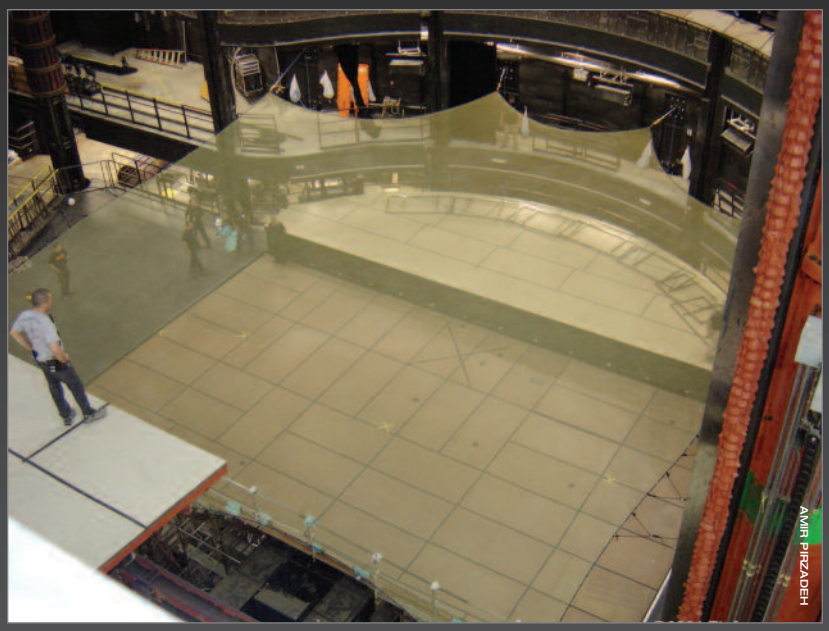
The Gantry Lift

The enormous 50'x25' Sand Cliff Deck is actuated by the Gantry Lift, the largest and most incredible element of the scenic automation system—a mechanism you'd be more likely to see in an aluminum smelting plant than a theatre. The Gantry Lift mechanism can rotate the Sand Cliff Deck 360° at 2RPM (which is 12° per second) tilt it from flat up 100° (beyond vertical), and track the whole thing up and down vertically nearly 70' at 2' per second. Determining the maximum speeds of the Gantry Lift mechanism was a critical part of the design process, since a faster move meant more horsepower was needed. To make these horsepower calculations, McLaren made extensive use of sophisticated MSC Nastran design simulation software. However, Nastran "was designed for mechanics and assembly lines and so forth," explains McLaren's Murphy Gigliotti, "so we actually had to write a cue automation front end for Nastran in Excel."

The smallest amount of power needed to make the gantry lift work as desired was "just less than a locomotive," says McLaren. After calculating all the trade-offs and determining the maximum move velocities, the resulting *KÀ* hydraulic power plant was designed for 1,250 HP continuous from electric pumps, and, according to McLaren, about 6,000HP stored as hydraulic pressure in giant accumulators for peak usage during high-power cues. "The hydraulic power plant," explains James Tomlinson, the head of automation for *KÀ*, "will fully pressurize the accumulators (approximately 1,700 gallons) in about five minutes. The accumulator bank is reminiscent of the missile tube scene from [the 1990 film] *The Hunt for Red October.*"

The Gantry Lift mechanism itself tracks on two enormous 4' diameter steel tubes that run from the lowest floor of the building to the roof, made, along with the rest of the "static" steel, by Fabriweld, of Salt Lake City, Utah, a company whose primary business is roller coasters and other enormous structures. McLaren Engineering was initially told that these tubes could be connected to the massive existing structure of the MGM's roof, but, partway through the design process, compliance with seismic regulations resulted in a new answer of no. Therefore, the team had to come up with an enormous bracing structure for the tubes, creating a sort of freestanding 75' tall "building within the building," according to Stephen Sywak of McLaren. Many details were considered; the enormous vertical tubes are even fitted with acoustical dampers to keep them from acting like "pipe organ tubes."

A massive 6' diameter cross tube, called the "torque tube, connects the two 'hammerheads,'" says Tomlinson, "which are guided by 75- and 150-ton capacity Hilman rollers traveling on steel wear plates on the columns." The rollers, made by the Hilman company of Marlboro, New Jersey, are generally used to move massive loads, like oil rigs components, entire buildings, and bridges. Perpendicularly attached to the center of the torque tube is an arm which goes out, towards the audience, to a pivot joint called the "wrist," which, according to Tomlinson, "includes a 10' diameter Rotek bearing typically used in tower cranes," and connects



A view into the pit at one of the safety nets.

to the Sand Cliff Deck itself. The moving parts of the Gantry Lift were made by Timberland Industries from Woodstock, Canada, a company whose primary business is offshore and timber harvesting equipment, giant winches and other huge mechanisms. The whole torque tube assembly and arm gets lifted, says McLaren, "by what we understand to be the longest cylinders ever produced in North America—a 70' stroke. When they are fully extended, the cylinders are 145' long." The cylinders are so massive that they must only ever be in tension—if put under a compressive load, they might buckle.The cylinders were made by Parker, of Cleveland, Ohio and supplied (with the rest of the hydraulic system) by Atlantic Industrial Technologies, of Islandia, New York, working in conjunction with GS-Hydro U.S. Inc., of League City, Texas. Even getting the cylinders to the site proved a challenge. "We had to get special trusses fabricated," says McLaren's integration project manager, Jay Reichgott, "just to support the 75' hydraulic cylinders during transit."

"No one wanted to be the one to flip the switch the first time. The system was so expensive and massive that there was no room for error."

The Sand Cliff Deck

The 80,000lb. Sand Cliff Deck was manufactured by Tomcat USA in Midland, Texas. Longue Vue Scenique of Montreal, according to Tomlinson, "supervised the artistic treatment of the playing surface by Tomcat staff." The deck is over 6' thick, and, according to William Gorlin, McLaren Engineering VP, consists of, "a steel primary truss structure that bolts to the slew ring. Mounted to that steel structure is an aluminum outer structure and deck system; it's configured so that you can have technicians inside to service all the pieces." During one part of the show, adds Tomlinson, "an 8 x 16' 'refuge' platform flies in from the grid and attaches to one end of the vertical Sand Cliff Deck, then moves with the Sand Cliff Deck as it rotates, tilts, and descends to the basement. It has a trap door for access to and from the Sand Cliff catwalk system."

In addition to lifts and other features of the deck, there are 80 pegs, each roughly 2' long, manufactured by Microtrol of Montreal, that can shoot out at 8' per second. At that velocity, the pegs appear to the audience in a quarter second, which is surprisingly fast since they are run by electric linear actuators. These pegs were designed so that performers can slide, swing between, and catch them when the Sand Cliff Deck is vertical. Many performers slide more than 60' from this platform to their "deaths," where they land on an enormous, hydraulically tensioned safety net in the pit, out of sight of the audience. Some falls are so extreme that air bags are placed on top of safety nets to break the performer's fall.

In one stunning scene, the Sand Cliff Deck is covered with "sand;" then the deck is raised before our eyes and the sand pours off. Real sand was originally considered but abandoned, due to weight and dust issues. The team considered walnut shells and Santoprene, but eventually chose cork. The material is contained on the edges of the deck by 3" "flippers," run by 18 electrical actuators, which are retracted when the material is dumped.

The Tatami Deck

The 30 x 30', 75,000lb. Tatami deck is

an amazing feat of engineering and construction, but it's actually the "small" piece on the show. The deck was named, according to Tomlinson, "because the opening scene with Tatami mats was to play there," but that scene was later moved to the Sand Cliff Deck. The Tatami deck is supported by a giant, 65' long, two-stage "drawer slide" mechanism, which is tilted at a 4° rake towards the audience from its anchorage upstage, with 45'-6" of cantilever. The Tatami deck and mechanism is actuated by 75 and 150 HP electric motors, and was built by Show-Canada in Montreal, with scenic treatment again by Longue Vue Scenique.

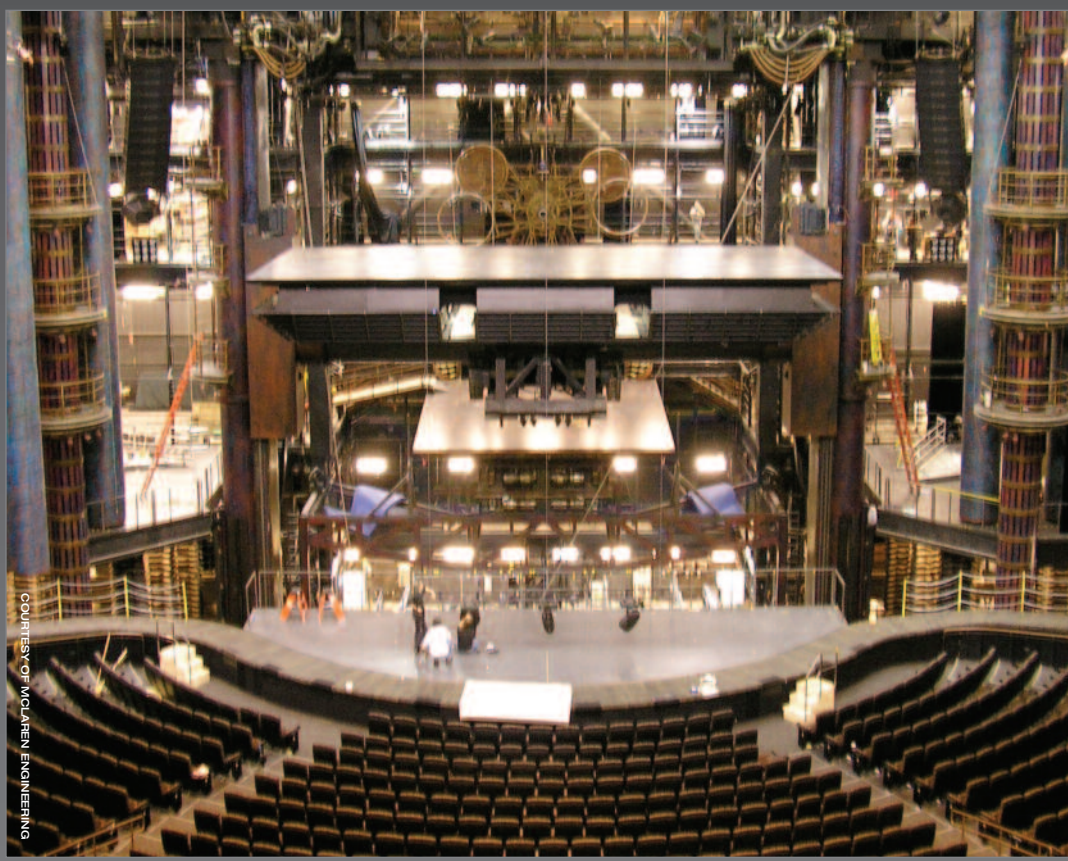
Scenic Automation Control

Controlling all this scenic automation equipment was the daunting challenge taken up by Stage Technologies, which has offices in London and Las Vegas. The company's Nomad system for *KÀ* controls over 40 arbor winches; 16 high-speed winches for the performers in the battle scenes, each axis with individual radio control; five lifts controlled by 26 motors; a giant bird flown over the audience, controlled via five 2,200lb winches with wings flapped by performers; the 80 pegs in the Sand Cliff deck; three small pod lifts [called "sand traps," according to Tomlinson]; 12 winches for the forest scene; 18 hydraulic safety net winches in the pit; and 16 actuators for the Sand Cliff deck's edges.

Control is highly distributed throughout the system. "We have 17 nodes in the theatre, each controlling up to 40 axes," explains Kevin Taylor, Stage Technologies' director of electrical engineering. "The desk sends commands to the nodes, and the nodes do the housekeeping, whilst the axes deal with actual position control. There are the Delta Tau [hydraulic control] nodes, 12 Siemens S7_400 PLCs, and the entire safety Estop [emergency stop] system is done using a Siemens safety PLC. In addition, we have two extra processors, one for the interlock system and the other to run the 3D flying of the bird. The consoles are connected over the primary command network, which is Ethernet, and the MaxisID internally positioning drives connect to the node PLCs over ProfiBus. A separate high-speed deterministic network is used for synchronization. The crew uses four desks during the show, with a fifth backup in the event of a failure, and, happily, we have had no desk failures to date. In addition, we provide a local backup network with a completely independent path for controlling axes via a hand held HMI in a crisis. In the worst case, during the climb scene using the pegs, we could be running 90 axes at once. The majority of the time, we are running 20-25 axes at once. In the event of a motor failure, we can continue to run the lifts right down until only two are left. The lifts are the show, so there is a huge amount of redundancy there."

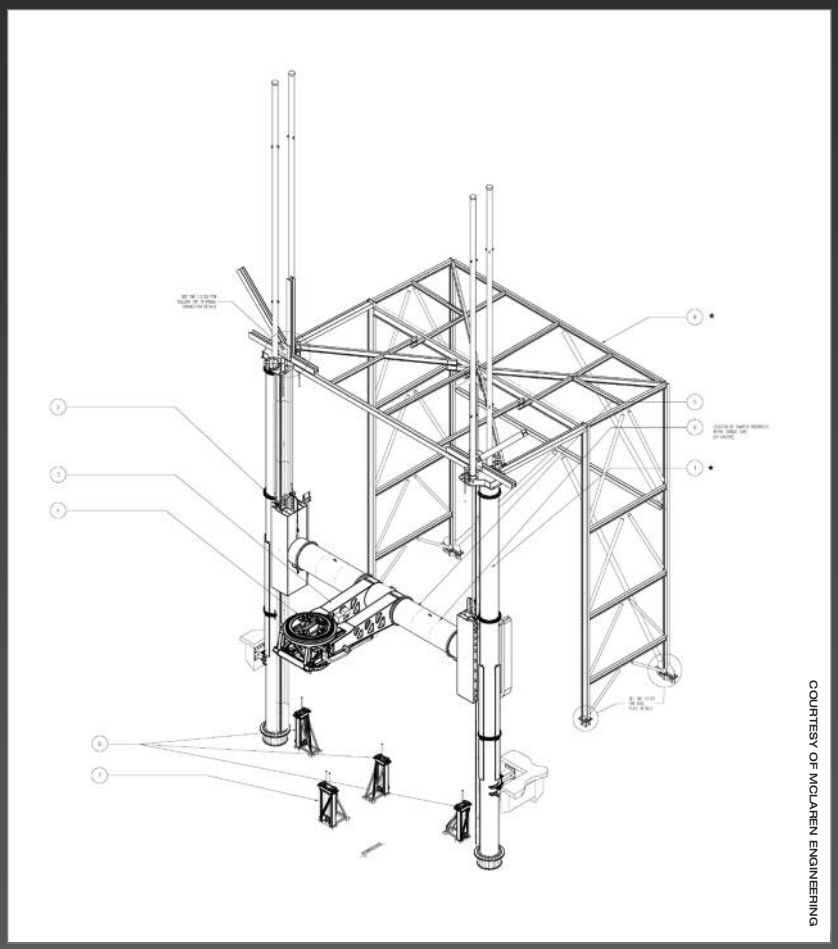
Hydraulic Control

While the Stage Technologies system provides overall control of the scenery, the hydraulics control is handled by Tisfoon Ulterior Systems, of Raleigh, North Carolina, using a Delta Tau motion-control system as a basis. "We provided Tisfoon with a spec at the beginning of the project," explains Taylor, "to enable us to make it mimic standard axes [in the Nomad control



COURTESY OF MCLAREN ENGINEERING

In this work light shot, the massive Sand Cliff deck is at about mid-height, with the Tatami deck retracted upstage.



COURTESY OF MCLAREN ENGINEERING

McLaren's schematic view of the Gantry Crane mechanism and bracing structure.

system]. The operator can instruct the axes to move to a different dead [target position] at a different speed for every cue as he so wishes." The Tisfoon system takes it from there, and also provides a local controller so that the hydraulic systems can be run independently of the Nomad. To protect the cylinders, the Tisfoon system provides "a closed loop 'charge-up' of the rod side of the cylinder before releasing the brakes," explains the company's president and chief software engineer Amir Pirzadeh. "This insures that the valves are operational and that there is oil in the rod side before the brakes are released. The load balancing is a closed-loop system on top of the regular positioning loop. This system uses the load cell information from the four cylinders to lead or lag an upstage axis (relative to downstage) for proper load balancing." The Tisfoon system incorporates a "VCR" feature, where all data related to the hydraulic systems is logged every 100ms continuously for 24 hours; if a problem develops, precise information is later available for troubleshooting. "No one wanted to be the one to flip the switch the first time," says Pirzadeh, only partly in jest. "The system was so expensive and massive that there was no room for error. I was not only the developer, but became the de-facto operator, as well."

Performer Winches

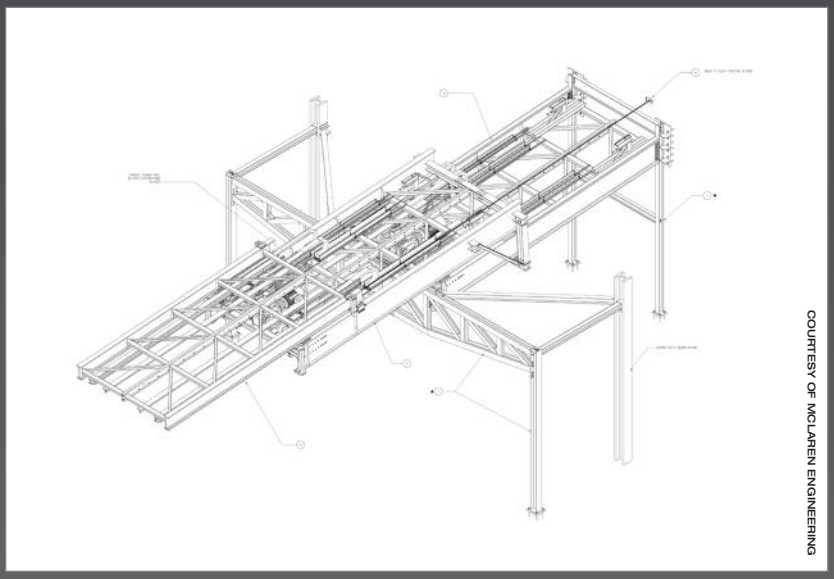
Some of the most incredible scenes in *KÀ* are the "vertical battles," where performers appear to defy gravity while battling on the Sand Cliff Deck in an almost vertical position. In fact, they are supported on high-speed winches supplied by Stage Technologies. Each of the 16 performers controls his own movement through a radio control, with the transmitter in his costume, using a handset controller. "The winches", explains Stage Technologies' Taylor, "are capable of running at up to 14' per second, and accelerating and decelerating in .75 seconds. The radio units are a standard component supplied from Germany, meet the very highest standards, and, in the event of [interference], shut down to prevent unauthorized movement."

Malcolm McLaren, summing up the team's experience on *KÀ*, says, "When the Ford Motor Company releases a new car, they design it, test it, crash it, run it around the track a few thousand times, tweak it, alter it, and value-engineer it. We have to build one prototype and it has to work, with time and budget constraints. It's not easy, and the tricks just keep getting bigger and bigger."

Projections

One of the most groundbreaking aspects of *KÀ* is Holger Förterer's interactive projection design. "I attempt to express poetry, emotion, and content in the language of mathematics and algorithms," he explains. "This is my artistic language, and the result on-stage is referred to 'augmented reality.' We do not use any real video footage in the imagery of the production—all images are generated on-the-fly by the projection computer in real time using physical or artificial simulation. Water, stone, clouds, air are all completely synthesized by the image computer—at the

McLaren: "When the Ford Motor Company releases a new car, they design it, test it, crash it, run it around the track a few thousand times, tweak it, alter it, and value-engineer it. We have to build one prototype and it has to work with time and budget constraints. It's not easy, and the tricks just keep getting bigger and bigger."



COURTESY OF MCLAREN ENGINEERING

McLaren's schematic view of the enormous Tatami Deck "drawer slide" mechanism.

same instant they are shown—and react to the action on stage." This is the hallmark of Förterer and his team's work on *KÀ*—the performers are actually controlling the imagery that surrounds them in a fully interactive and meaningful way. While, of course, there is a tight structure and some general predictability to the performers' motions for story and safety reasons, Förterer says, "We give the performers the freedom to improvise and follow the set wherever it moves."

Tracking the Performers

The freedom to which Förterer refers is quite apparent when you see the show. In one example, a scene called "The Deep"—a giant ship full of performers is raised, and performers fall off and "drown," descending almost the entire stage space, followed by a trail of bubbles. Förterer is tracking the performers, *creating the bubble images in real time and projecting them onto the scrim*. "Here, we are using camera tracking," explains Förterer. "We are lighting the actors with invisible infrared LED light. The IR camera acquires their movement through a scrim onto which we project the bubbles. The use of infrared light is necessary to avoid feedback of the projected image into the camera and be able to light the scene brightly without the audience noticing anything. My tracker picks up movement in the scene and generates bubbles based on the size and motion of the objects causing it. This is one of the scenes where projection helps in telling the story."

Scenic Interactions

In "The Climb", "The Blizzard," and—the most astonishing scene of the show—"The Battle," Förterer not only tracks the performers themselves, but can sense how they are interacting with the scenery. For example, under the Taraflex performance surface of the Sand Cliff Deck, are sensing tiles manufactured by Les Ateliers Numériques of Montreal, which turn the entire deck into (to overly simplify for the purposes of explanation) a giant touchscreen. Förterer uses this information to create graphical waves and other images that radiate out from where the performers' feet contact the deck, or to create interactive falling "rocks" that they must dodge. "The system of sensors in the deck was specifically created for this show by the interface designer and inventor Philippe Jean from Montreal," explains Förterer. "It works on a technology comparable to the musical instrument theremin, which allows musicians to control electronic instruments by moving their hands in

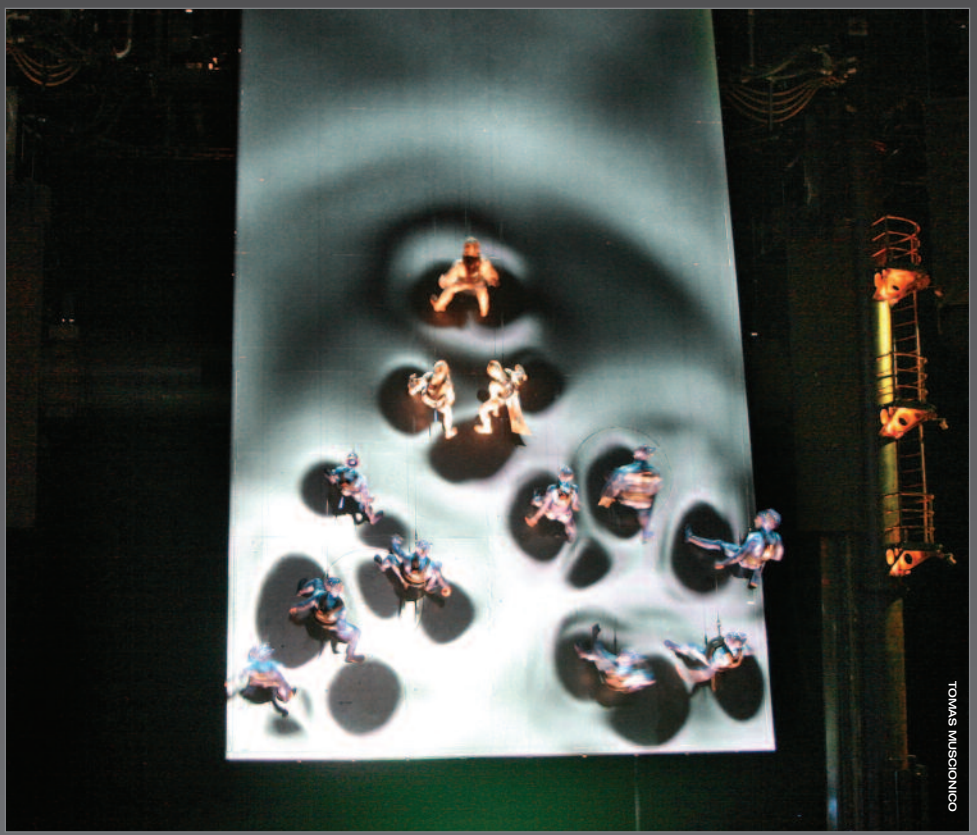
Förterer: "I attempt to express poetry, emotion, and content in the language of mathematics and algorithms. This is my artistic language, and the result on-stage is referred to 'augmented reality.'"

the air. The deck is literally able to 'sense' the proximity and presence of the artists to and on the surface. The maximum sensor depth is approximately 4". So it makes a difference if you are very close to the surface, tiptoeing, or sliding across it at a certain distance." JT Tomlinson, Cirque's head of automation, adds, "The sensing tiles system detects performer locations on a 6" grid pattern all across the deck and can simultaneously report every one of those coordinates, at 60Hz, via Ethernet."

With all that imagery created in real time, Förterer then projects it onto real, physical, three-dimensional, moving scenery, and the approach is so effective that many in the audience won't even realize they are looking at projections. To accomplish this, Förterer must track the movements of the scenery exactly. The projection system "listens to positions that multicast out through the Nomad system," explains Kevin Taylor, Stage Technologies director of electrical engineering. "The positions from this system are sent every 50msec, and because of the size of the pieces a lot of the data is sent in 1,000th or 10,000th of a degree resolution." To cope with the latency of the various systems, and potential encoder error, Förterer says, "We actually use an adaptive physical model that predicts the position of the stage into the future and smooths those values correctly to avoid both lag and jitter, so we're always on. I was surprised myself to see this work smoothly after punching in the maths for a month, but I think we mastered something you could never pre-cue or plan, since every show will not only be slightly different on the artistic, but also on the technical side."

Projecting it All

Three converged Barco Director R18 DLP projectors are used to give the required brightness and project from the back of the auditorium to create a canvas across a large part of the performance area. "Theoretically, we could project onto any moving surface within the show," explains Förterer. "We are using different convergence files [which call up different projector settings] to take care of the depth ranges. We are also using dousers in the drowning scene to avoid hard edges of video black resulting of the coupling, and to be able to kill all projection in an emergency." All projections on the main



Förterer's projections can be seen clearly in this photo, although to fully appreciate them you have to see them in motion.

moving stage use 3D modeling, "but we use a technique [similar to] the bubbles in the drowning scene to match the position of the actors one-by-one,"says Förterer. "A two-dimensional distort[ed] image would not have hit the main stage without causing warping on the close or far edge."

Infrastructure

Förterer needed a lot of computer horsepower and I/O for this project, and also had to ensure that the system can be maintained and updated over the projected 10-year run of the show. "We are using dual-processor PCs," he explains, "to ensure fast calculations and display of all virtual simulation and imagery. We kept away from most proprietary packages. Windows-dependency was reduced to a minimum; we are using OpenGL, and we skipped using the Intel Performance Libraries, since I strived for minimum dependency on the platform or processors used. Not too many portions of the code would have to be rewritten if the [IT] market went berserk for whatever reason."

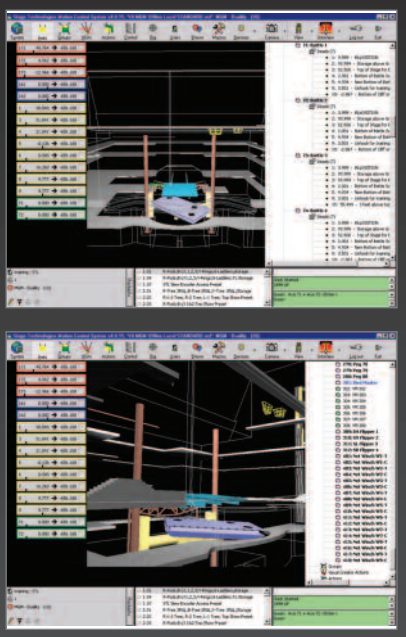
With projections so critical to the show, Förterer had to also ensure that there was sufficient redundancy in the system. "We have a backup PC for all vital systems," he explains. "Switching to backup systems is partly automated. On a crash of the main computer, the backup computer would automatically take over within a maximum of two seconds, causing the Barco projectors to smoothly fade into the new system's video output. This would be much faster than the operator could diagnose the problem and react by himself."

The front end for the system is actually a lighting desk, and, says Förterer, "we are not connected to the rest of lighting, to avoid both systems going down at the same time. Luc Lafortune prepared backup lighting if projections should fail—and if a certain part of lighting should, we are still ready to go."

Show Control

As a show control guy who has seen and enjoyed almost every Cirque production since 1991, it has always bothered me that some of the cue timings across and between departments were not as tight as they could have been. This is not the case on *KÀ*, and this is partly because of the use of show control for certain aspects of the show. A widely misused and misunderstood term, show control simply means interconnecting more than one production element control system (scenery, projections, sound, etc.), and on *KÀ*, says Förterer, "our system is networked to quite a few systems in the theatre." The projection system receives positional data from the scenic automation systems as detailed above, and then also communicates via Ethernet to sound. "We get data from projections," explains sound designer Jonathan Deans, "and then convert it (via MAX MSP [software]) to MIDI to trigger our effects." In some scenes, this structure allows performers to not only generate imagery interactively, but trigger sound effects as well. Cirque has recently been implementing show control systems on its cruise ship projects. However, for the more traditional shows, *KÀ* is "the first attempt for two departments to link," according to Deans, who has worked on many Cirque productions for more than 10 years.

Rigid, time-based control is what most people think of when they think of show control, and this approach has become routine in many shows today. However, the distributed and interactive interconnection seen on *KÀ* and other recent projects is an even more interesting and powerful way forward, and is one that I hope we will see more of in the future from Cirque and others.

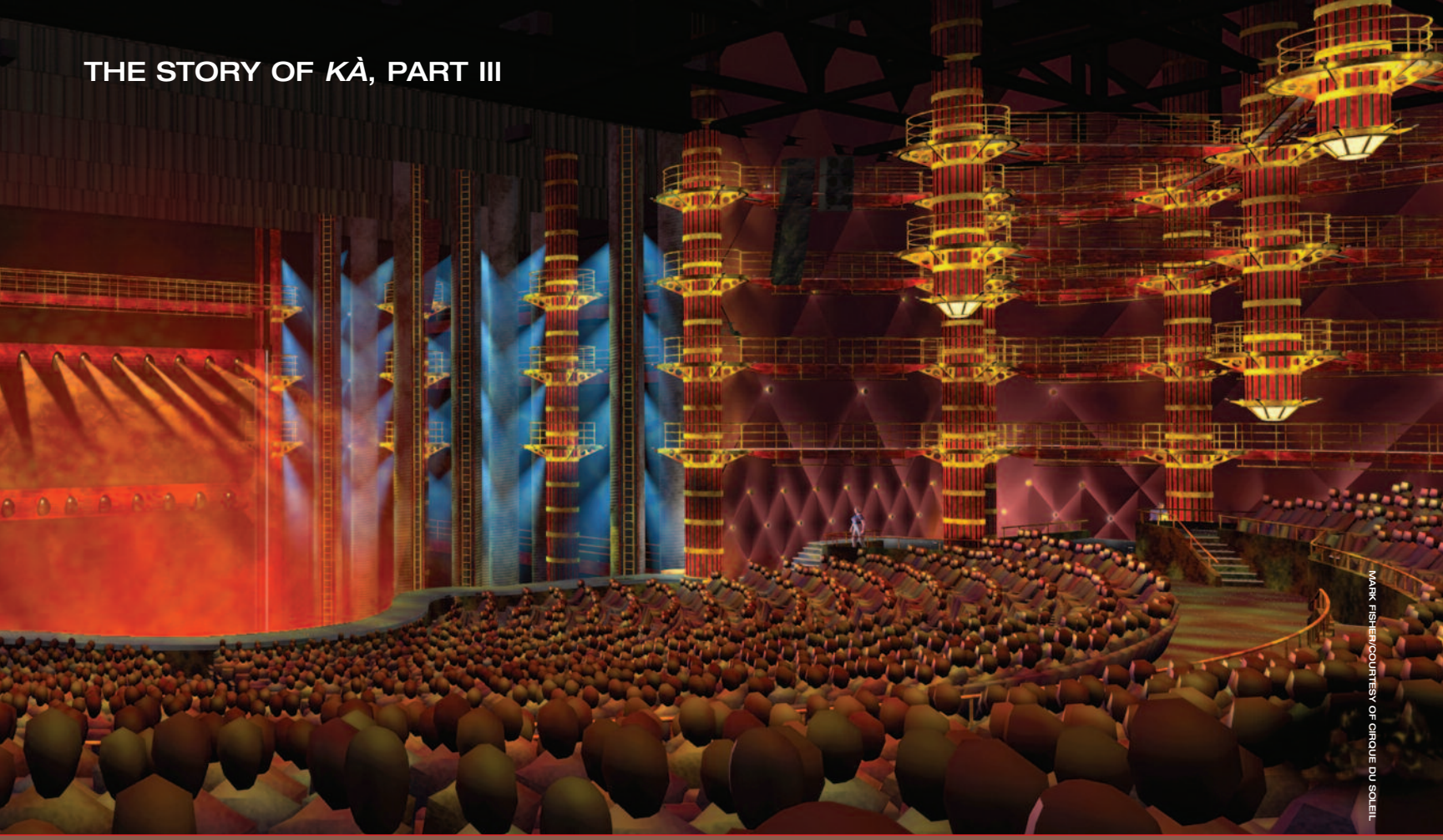


COURTESY OF STAGE TECHNOLOGIES

Two screen captures from the Stage Technologies Nomad scenic automation system showing some of the show's systems.

Everyone I know is tiring of me talking about this show, but I have to say that *KÀ* is now Mecca for anyone interested in the intersection of art and technology for live performance. You should make the pilgrimage yourself, and it's worth plopping down $150 for the ticket, as I did. *KÀ* sets a new standard in artistic use of technology, raising the bar so high I'm not sure who will have the imagination and resources to exceed it.

(John Huntington is an Associate Professor of Entertainment Technology at NYC College of Technology, and is author of the first book on entertainment and show control: Control Systems for Live Entertainment. *He can be reached through his consulting company at http://www.zircondesigns.com/.)*



MARK FISHER/COURTESY OF CIRQUE DU SOLEIL

INSIDE THE THEATRE

How a Vegas showroom was remade into the home of *KÀ*

By David Barbour

The theatre that houses *KÀ* has been described here as a unique space; its most extraordinary aspect may be that it was achieved within the confines of an existing building. The former home of *EFX* was reduced to a shell and a completely new theatre and lobby put in its place, accommodating the design and production requirements of Cirque du Soleil.

Although Mark Fisher is the designer of the theatre, its execution was an ensemble effort, involving architect Marnell Corrao Associates, theatre consultant Auerbach Pollock Friedlander, acousticians Pelton Marsh Kinsella, production manager Stéphane Mongeau, technical directors Paul Bates and Matthew Whelan, vice-president/production Luc Plamondon, assistant vice president, production Gabriel Pinkstone, and senior supervisor/theatre projects Don MacLean, among others. In addition, architectural lighting was designed and specified by Auerbach Glasow. The two Auerbach firms will be familiar to readers of this magazine—their many credits include the Judy and Arthur Zankel Hall at Carnegie Hall, the Borgata Hotel Casino and Spa in Atlantic City, and the theatre for *Zumanity,* another Cirque du Soleil show in Las Vegas. Pelton Marsh Kinsella has provided services for numerous theatres and performing arts centers across the country as well as venues such as the Golden Moon Hotel and Casino in Choctaw, Mississippi Marnell Corrao has worked for such hotel/casino players as Harrah's, MGM/Mirage, and Wynn Design and Development.

As has already been stated, perhaps the most unique aspect of the theatre is that it lacks a traditional stage. Instead, the show takes place within a 50' deep cavity filled with moving scenic elements. (According to Michael McMakin, project manager, a basement was already in place

from the building's previous life, but, he adds, "A fair bit of excavation was required for the gantry lifting columns.") Because the performance extends into the audience, the boundaries are blurred between show and spectators, a unity that could probably only be achieved in a situation where the theatre and set designers are the same person.

First, the floor area of the stage was removed, creating an abyss housing the five stage lifts, resulting in a total of 4,950 sq. ft. of flexible staging area. In addition, the theatre configuration was altered, from a cabaret space filled with booths, tables, and chairs, to a theatre that seats 1,951 audience members. In addition, a new set of catwalks and grid decking over the seating area was added for performer access and lighting and technical systems in the front-of-house area. The control booth was reconfigured to allow space for the production's extensive lighting, audio, projection, and automation controls. The control suite features 2,850 sq. ft. of booth space and 170 linear feet of glass; it offers a view of the entire performance area.

Meanwhile, the building's infrastructure had to be totally reworked to accommodate the production's extensive technical needs. All spaces, including rehearsals halls, technical offices, training rooms, dressing rooms, shoe and costume maintenance areas, green rooms, and a new annex (housing Cirque du Soleil offices, support facilities, and a rehearsal room with a full-span overhead gridiron) were interconnected with sound, video, and communications from the stage area. New structural supports were added for the extensive automated rigging system, including an 82' long hoist-support structure in the arbor pit, as well as a 37' long "battle-hoist" structure on the grid. A series of new company switches and equipment power were distributed throughout the theatre, for chain hoists, special effects, and specialty equipment. And a new multi-tiered rigging system was developed at the grid level to allow for sophisticated stage automation systems. (Jaque Paquin conceptualized and designed, with Pierre Mase the theatre's rigging and acrobatic systems; project manager Jeremy Hodgson, working with Tom Neville of Auerbach, developed the system).

Mark Fisher's stunning picture of the theatre reveals many key characteristics, including the Post and Beam structure.

Also, three high-speed data and communications networks were installed in the space. These independent systems are set up to ensure that the automation, lighting, and hydraulic systems can function separately and also be synchronized. Each system is provided with a minimum RAID-1 shared-drive array to help ensure system redundancy.

In order to achieve many of the staging effects discussed in the previous articles, Auerbach Pollock Friedlander developed an infrastructure for the stage machinery to Cirque's criteria. This included a number of elements, such as the five stage lifts previously referred to. Also, 40 individual counterweight-assist automated hoists were mounted in the newly configured arbor pit area. These hoists automate the operation of lighting pipes, special effects, curtains, and scenic elements. Five 1,000kg specialty hoists were designed for flying human scenery in a circular path over the audience and back into the stage area and six 1,000kg specialty hoists were designed for large scenic transitions.

An additional 16 high-speed hoists are used for flying human scenery for a dynamic encounter sequence involving several performers. Here is another instance in which the performers control the technology: each of them controls his or her own hoist via a wireless controller integrated into his or her costume. Using this system, one can travel up or down at a maximum of 4' per second. There are also 18 high-speed mooring hoists to enable the rapid deployment of the safety nets used in the battle sequence. These hydraulic hoists can deploy the safety nets in less than 10 seconds. Then there are the 80 high-speed scenic pegs, mentioned earlier, which are actuated from within the Sand Cliff Deck.

The implementation of the Gantry and Sand Cliff Deck was also a group effort. Jay Reichgott, the systems integrator of McLaren Engineering, coordinated the installation, tuning, and acceptance-test procedures of the Gantry. Jeremy Hodgson, Cirque's automation project manager kept an eye on the project. Project manager David Prior coordinated the fabrication, installation, and integration of the Sand Cliff Deck, working with Tomcat. During the acceptance test procedures, Tom Neville of Auerbach, served as facilitator. The Sand Cliff Deck system, the largest ever installed in a theatre, makes it possible to move a 280,000lb. scenic element at 2' per second.

There were extensive rigging and automation issues to be addressed, as well. The theatre's fly tower was re-rigged with manual and counterweight-assist linesets. The working areas over the stage and audience were equipped to support motorized spot winches.

Working together, the lighting staff at Cirque du Soleil, including lighting designer Luc Lafortune and lighting director Jeanette Farmer, and Auerbach Pollock Friedlander developed one of the largest and most complex theatrical lighting networks ever designed for a single venue. A

completely new dimmer system was installed, consisting of 24 Strand SLD series dimmer racks in three dimmer rooms. Two thousand twenty-six 20A dimmers and forty-five 50A dimmers are network-controlled. All dimmers are status-reporting, with local PCs running Reporter Pro for this purpose in each dimmer room. In addition to the main dimmer racks, two remote dimmer packs are located in the Sand/Cliff Deck and are controlled via wireless Ethernet.

There is extensive distribution of 20A and 50A dimmed circuits, utilizing custom-fabricated plug boxes. A wide-ranging system of cable trays was installed throughout to allow multi-cable distribution from these circuit boxes to virtually any light fixture hanging in the theatre. Emergency power transfer to selected architectural circuits is handled with six 24-circuit, UL 1008-compliant emergency transfer panels. All networked power circuits for consoles, PCs, and other sensitive computer-grade components are on dedicated centralized UPS circuits. A large system of switched loads of 120V single-phase and 280V single-phase are distributed throughout the theatre and are under network control.

Lighting control is provided by two Strand 550i 54-submaster consoles, each with 6,000 channels and quad video displays; four Strand 520i 24-submaster consoles with 6,000 channels and dual video displays; two Strand 510i rack-mount consoles with 6,000 channels, and two High End Systems Wholehog II consoles with Strand ShowNet network nodes. Forty universes of DMX can be mixed and matched to any of the 100 double-network taps distributed throughout the theatre. Sixty portable SN 110 nodes are available, all using power over Ethernet ports. There are five wireless data access points allowing use of handheld wireless remotes, and/or a remote wireless notebook for console video displays anywhere in the theatre. (Michael Lay was project manager for Strand).

All network equipment is housed in nine racks interconnected with three fully redundant fiber-optic backbones. All network switches/hubs are managed and patch bays are included for all taps and nodes. AMX-based card racks are also located in the racks for use of touch screens for network, house, and work light controls, and network video distribution electronics for touch screen feeds. In addition, the racks include space for system file servers and rack-mount consoles. Remote AMX-driven color touch screens, in both fixed and portable configurations, are located throughout the theatre for use by stage managers and lighting technicians to control cue lights, rehearsal lights (featuring digital virtual sliders) and to view remote stage video feeds.

Beyond lighting, extensive sound, video, and production communications systems were designed for the space in close cooperation with Cirque du Soleil's audio staff and Jonathan Deans. The Level Control Systems (LCS) computer-controlled audio matrix and processing system is in three sections: front-of-house, stage monitoring, and VRAS. The front of house system controls 144 sources in 184 matrix outputs. LCS is also used to control the stage monitoring system with a 112 x 80 matrix. Modular Cue Console control surfaces are used for sophisticated live mixing and routing control of microphones and other musical instruments and effects sources. The LCS Virtual Room Acoustics System (VRAS), as has been previously discussed, is used to enhance and augment room acoustics, providing real-time ability to alter reverberation time and delay characteristics as needed, using a 40 x 128 routing matrix and special DSP processors.

Much more gear was specified for the production. Eighty-eight channels of Aphex remote-controlled microphone preamplifiers are provided. More than 90 primary and surround loudspeaker systems by Meyer Sound (MILO, CQ, and UPA series) Nexo (PS series), and EAW are located throughout the stage and auditorium. Effect processors are by t.c. electronic, Presonus, dbx, Klark Teknik, and Aphex. Sennheiser provided 16 wireless mic channels.

In terms of communications systems, a 72-port Clear-Com Matrix-Plus-3 digital intercom system is interconnected with a Clear-Com 72x8 analog matrix and 24 channels

In Fisher's design, even though the theatre is quite large, it retains a notable sense of intimacy.

of Telex wireless intercom. More than 16 channels of in-ear monitors and 10 IFB monitor channels feed 100 receivers. Backstage monitoring is provided by a BSS Soundweb computer-controlled monitoring and paging system. The lobby playback systems use Tascam 2424 hard-drive players and BSS Soundweb computer control and routing systems, which feed Electro-Voice special effects loudspeakers. Custom theatre seating was supplied by Irwin Seating; as Leonard Auerbach himself notes, "The customized chairs were critical to the integration of a stereo pair of loudspeakers for each patron concealed in the back of each seat."

Also, more than 25 production fixed-focus and remote-controllable color video cameras are routed through a modulated video system for monitoring performers, musicians, and critical backstage systems. An FM assisted-listening system for the hearing-impaired is provided.

The theatre is designed to provide lighting that will begin transporting audience members to the magical world of KÀ as soon as they enter the theatre. Guests enter from the casino into a dark, low-ceiling space with lights the color of glowing embers. Large tree trunks, banded with light, marks the edge of the main lobby, where the ceiling soars to expose the full height of a wall, which appears to be an inverted ancient ship's hull. Colored light plays on the surface of the vessel wall. Before the performance, musicians located in the trees play the strings of a giant harp.

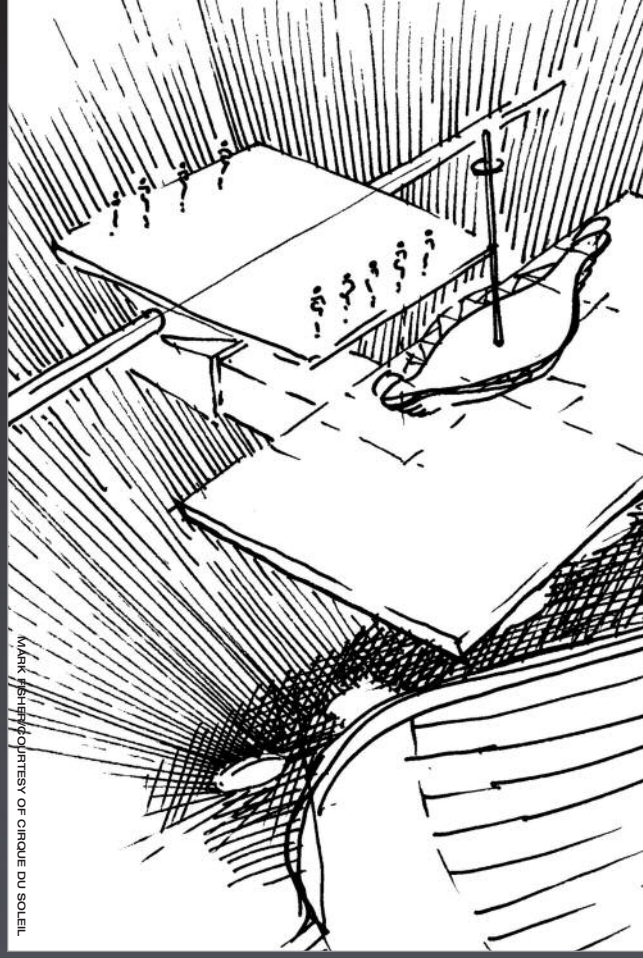
The main lobby theatrical lighting, designed and project-managed by Farmer (drawing inspiration from Fisher and Lafortune) is provided by ETC units, using color and pattern projectors to light the floors, metal mesh wall curtains, and stringed harp. ETC Source Four Zooms light the vessel wall. Other Source Four Zooms with gels light the lengths of the harp strings. Mole-Richardson Nooklites mounted to the exposed structural beams are inspired by the Post and Beam design. Surface-mounted MR16 monopoints, by BK Lighting, are recessed into the floor to reinforce the shape of the curved glass wall and uplight the glass fins.

Openings in the vessel wall led to the concession counters and public rest rooms. These spaces have an industrial feel, with metallic painted finishes and glow acrylic panels in the ceiling, walls, and the fronts of the counters. Fluorescent strips with dimming ballast and T8 lamps are mounted so as to be visible behind the acrylic panels. Prescolite recessed adjustable MR16 downlights with colored lenses light the counters. Compact Shaper Lighting fluorescent sconces with dimming ballast create a sense of glowing portholes leading to the rest rooms.

Entering the audience chamber from the lobby, one passes through a sheet of saturated blue light into a glowing blue entry vestibule. The blue light is created by a fiber-optic narrow beam wall-grazer by Glass Illuminations mounted in the ceiling behind the first set of doors. Mounted on the ceiling line at the side walls are Color Kinetics ColorBlaze fixtures with blue LEDs to fill the void with blue light. Recessed Prescolite adjustable MR16 units with blue glass filters provide pools of light at the entry doors.

In the audience chamber, the ramp is lit with Architectural Area Lighting Occulus fixtures above the entry doors. Architectural MR16 and PAR lamp fixtures are integrated into the Post and Beam structures. The house lighting system uses Kurt Versen fixtures mounted halogen downlights, each customized with a yoke and top relamping feature. The fixtures are mounted to the technical catwalks above the house and have narrow or medium distributions based on throw distances. ETC Source Four PARs mounted to the Post and Beam structure and Prescolite recessed adjustable downlights under the control booths supplement the catwalk fixtures to provide uniform lighting. Bega low-voltage halogen step lights are recessed into the walls for egress lighting. Tivoli warm white LED seat lighting, on dimmers, provides egress lighting during the performance. (Again, division of labor was key; Auerbach's house lighting system, with the exception of the Occulus fixtures and a few others, is mostly used as work light; Lafortune designed the preshow lighting).

All this happened in a very short 12-month schedule. It's another case of typical Cirque magic, with a little help from their friends.



MARK FISHER/COURTESY OF CIRQUE DU SOLEIL

An early Fisher sketch shows the absence of a stage with one of the deck's rising up, bearing performers and scenery.

Production Team
Founder/CEO: Guy Laliberté
Creator/Director: Robert Lepage
Composer/Musical Arranger: René Dupéré
Choreographer: Jacques Heim
Theatre/Set Designer: Mark Fisher
Costume Designer: Marie-Chantale Vaillancourt
Lighting Designer: Luc Lafortune
Sound Designer: Jonathan Deans
Interactive Projections Designer: Holger Förterer
Puppet Designer: Michael Curry
Props Designer: Patricia Ruel
Acrobatic Equipment and Rigging Designer: Jaque Paquin
Aerial Acrobatics Designer: André Simard
Makeup Designer: Nathalie Gagné

Assistant to the Director: Neilson Vignola
Assistant to the Set Designer: Ray Winkler
Assistant to the Costume Designer: Charline Boulerice
Associate Lighting designer: Nol Van Genuchten
Assistant to the Sound Designer: Leon Rothenberg
Assistant to the Interactive Projection Designer: Madeline Jean, Domink Rinnhofer
Assistant to the Acrobatic Equipment and Rigging Designer: Pierre Masse
Assistants to the Makeup Designer: Florence Cornet, Marie Regimbald
Flame/Special Effects Consultant/Supervisor: Gregory Meeh
Pyrotechnic Consultant: Christophe Berthonneau of Groupe F

Technical Department
Production Manager: Stéphane Mongeau
Assistant to the Production Manager: Anh-Dao Bui
Production Stage Manager: Neilson Vignola
Production Coordinator: Lucie Doyon
Technical Directors: Paul Bates, Matthew Whelan
Technical Coordinator: Nathalie Rail
Set Project Supervisors: Guy Lemire, David Prior, Jean Thibault
Automation Project Supervisor: Jeremy Hodgson
Rigging Project Supervisor: Joel Svoboda
Acrobatic Project Supervisor: François Laurion
Rigging Supervisor: Ewen Seagel
Costumes Project Supervisor: Johanne Allaire
Props Project Supervisor: Jasmine Catudal
Sound and RF Project Supervisor: Steven Dubuc
Head Draftsperson: Michel Hébert
Assistant to the Head Draftsperson: Simon Limeux
Draftspersons: Marcel Lamy, Nathalie Ouimet
Acrobatic Draftsperson: Philippe Rivrais

Projections Project Supervisor: Steve Montambault
Projections – Programmers: Mykel Brisson, Daniel Fournier, Peter Ibrahim, Alain Trépranier
SFX Project Supervisor: Markus Maurette
IT Project Supervisor: Brad Guilbault
Moving Light Operator: Hubert Tardif
Costumes Coordinator: Geneviève-Isabelle Caron
Videographer: Marie-Pierre Guay
Scenic Painter: Christine Giguère

Theatre Design
Senior Supervisor, Theatre Projects: Don Maclean
Supervisor, Theatre Projects: Eric Liston
Project Supervisor, Theatre Construction: Richard Dobbie
Project Supervisor, Lighting and Electrical: Jeanette Farmer
Interior Design Supervisors: Gabriel Pinkstone, Luc Plamondon
Sound, Video, and Communications: Jonathan Deans

Project Architect: Marell Corrao Associates
Structural: Bennett and Jimenez
Theatre Consultants: Auerbach Pollock Friedlander
Acoustics: Pelton Marsh Kinsella
Architectural Lighting Design: Auerbach Glasow

Infrastructure and Stage Machinery
Stage Lifts:
Gala Systems, Montréal, Quebec

Gantry Crane: McLaren Engineering Group, West Nyack, New York
Atlantic Industrial Technologies, Islandia, New York
Timberland Industries, Woodstock, Ontario
Hilliard Corporation, Elmira, New York
Fabriweld Corporation, Salt Lake City, Utah
Parker/Hannafin, Cleveland, Ohio
Sick Stegmann, Dayton, Ohio
GS Hydro US Inc., League City, Texas
Siemens
Delta Tao, Citrus Heights, California
Stage Technologies, London, England
Tisphoon Ulterior Systems, Raleigh, North Carolina

Tatami Deck Drawer Slide: McLaren Engineering Group
Show Canada, Montréal

Post and Beams in House: WW Steel, Las Vegas
PCI, Las Vegas

Masking: J.D. International, Montréal
Gerriets, Allentown, New Jersey

Seating: Irwin Seating, Grand Rapids, Michigan

Scenery
Sand Cliff Deck: Tomcat USA, Midland Texas
Longue Vue Scenic
Les Ateliers Numérique, Montréal
Microtrol, Montréal

Tatami Deck:
Show Canada
Cirque du Soleil
Longue Vue Scenic

Forest: Arcofab, St-Foy, Quebec
SM Hydraulic, Montréal
Cirque du Soleil

Pillars: Cirque du Soleil

Post and Beams Onstage: Service d'acier International, Montréal, Quebec
Cirque du Soleil

Lantern: Show Canada
Sigma, Orlando, Florida

Hydraulic Crane Arm: Cirque du Soleil
Show Canada

Scenic Hand Rails: Great Lakes Scenic, Burlington, Ontario

Lighting Pods:
Great Lake Scenic

Spinning Sun:
Copper Creek Studios, Las Vegas

Acrobatic
Harnesses: Cirque du Soleil
Climbing Sutra, Las Vegas

Nets: Magneto Hydraulique et Magnétique, Boucherville, Quebec
Banonetti, Milan, Italy
Cirque du Soleil

Air Bags/Stunt Devices: Precision Safety Stunt Specialties, Universal City

Bird: Cirque du Soleil
Curry Design, Scappoose, Oregon

Boat: Atlantix Innovations Marines, Montréal
Falko, Montréal
Cirque du Soleil

Wheel of Death: Cirque du Soleil
Show Canada

Forest: Cirque du Soleil
Microtrol

Acrobatic Pegs: Microtrol
Acrobatic Winches: Stage Technologies
Fisher Technical, Las Vegas

Acrobatic Mats/Padding: Qued (div. Seaway Plastics Ltd.). Montréal
Distribution Sports et Loisir, Montréal
Speith Anderson, Toronto, Ontario
Robes and Cables: Sécurité Landry, Montréal
Cordage Barry, Montréal
Samson, Ferndale, Washington
Chaines et Elingues St.-Pierre Ltd., Montréal

Theatrical Rigging: JR Clancy, Syracuse, Stage Technologies
AMC Fabrication, Las Vegas
Engineers/Consultants: McLaren Engineering Group
Martoni Cyr et Associé, Montréal
Seneca Expert Conceils, Montréal
SBSA, Montréal
Geiger Gossen Hamilton, LIAO, Suffern, New York
Bennett and Jimenez, Las Vegas
Sadec, Inc., Montréal
SRS Technologies, Montréal
Insta Design, Montréal
Steve Killing Yacht Design, Midland, Ontario

Special Effects
Pyrotechnics: Advance Entertainment Services, Millersville, Maryland

Flame Effects: Sigma Systems, Orlando

Products Used: Le Maitre, Port Huron, Michigan
RES Specialty Pyrotechnics, Belle Plaine, Minnesota

Smoke Effects: MDG, Montréal
Interesting Products, Chicago, Illinois
Look Systems, Ronnenberg, Germany

Various Effects: CITC, Lynnwood, Washington
Mee Industries, Monrovia, California
Reel EFX, North Hollywood, California

Automation
Control System: Stage Technologies

Lighting
Assistants to the Lighting Designer: Paul Copenhaver, Alexandre Tougas
Moving Light Programmer: Hubert Tardif
Lighting Consultants: Auerbach, Pollock, Friedlander
CDS Infrastructure Design: Luc Plamondon, Gabriel Pinkstone, Don Maclean, Eric Liston, Rick Dobbie, Jeanette Farmer

General Contractor: Marnell Carrao and Associates. General Foreman: Randy Kuiper
Electrical Engineering: JBA and Associates.
Project Lead: David Magdefrau
Electrical Contractor: Bombard Electric.
Foreman: Ron Hatte
Lighting Equipment: PRG Lighting. Project Manager: Maggie Bailey
Lighting Cable: TMB Associates

Operations Team
Lighting Director: Jeanette Farmer
Assistant Lighting Director: Nils Becker
Lighting Operations Crew: Larry Carrasco, Selina Davenport, Chris Escher, Cliff Guiterrez, Danny Grose, Gabriel Hernandez, Martin Isaac, Bernie Lehman, Curt McCormick, Jon Mytyk, Majid Khazal, Liz Koch, Chris Kortum, Jeff Kyrish, Alan Pilukas, Stuart Pitz, Jon Pullen, Doc Roth, Tony Saurini, Mike Wescoatt, Susan Wilson

Dimming and Control: Strand Lighting

Lighting Equipment: ETC, Selecon, Altman, James Thomas Engineering, Strand, McMaster, Mole-Richardson, Robert Juliat, Pani, LTM, Arri, Hubbell, Clay Paky, Vari*Lite, Martin Professional, Lightning Strikes, Rosco, Gamproducts, City Theatrical, Color Kinetics, Encapsulite, MGM, McAllister, Wybron

Projection Equipment: Barco, Dell, Wybron, Cisco

Sound
Assistant to the Sound Designer: Leon Rothenberg
Audio Consultants: Auerbach Consultants
Senior Audio Consultant: Paul Garrity
Audio Consultant: Matt Ezold
Sound Contractor: Solotech, Inc.
Project Manager: Bob Barbagallo
Sales Director: Mario Duchesne
Inside Sales Coordinator: Mathieu Tallion
Onsite Supervisors: Patrick Marleau, Mario Lamy
Electrical Contractor: Bombard Electric

Sound Equipment
FOH Cue Console Mixing/Processing System: Level Control Systems, Sierra Automation, Klark-Teknik, Aphex, Solotech

Monitor Control/Equipment: LCS, Apple

Monitor Console Position: LCS

Backup Switching: Sierra Automation, Klark-Teknik, Yamaha, t.c electronic, Akai, Tascam
Wireless Mic System: Sennheiser

Signal Processing/Recording Playback: Presonus, True Systems, Alesis, Avalon

FOH Console Position: LCS

FOH Sound Effects
Position: LCS, Lorg, MOTU, Apple, Aphex, Yamaha, Sierra Automation, Compaq

Console Processing: t.c. electronic, Helicon, Presonus, dbx, MIDI Solutions, Peavey, Denon, Henry Engineering, Littlite

Loudspeaker Control
Processing: EAW, Klark Teknik

Power Amps, Stage
Surround: Crown, Crest

Loudspeakers: Meyer Sound, Turbosound, NEXO, EAW

Paging System: BSS, 83, Solotech, QSC, Electro-Voice

Fiber-Optic/Cat 5 Cabling: Leviton, D-Link, Corning Cable, Black Box

Intercom System: Clear-Com

Digital Stations: Clear-Com

Wireless Intercom
Equipment:Telex, Sennheiser, Professional Wireless, David Clark

IFB Listen-Only
Equipment:Sennheiser

Analog Units: Clear-Com, Sennheiser

Wireless In-ear Monitor: Sennheiser, Shure

CCTV: Panasonic, Leitch, Marshall Electronics, American Dynamics, Blonder Tongue, Rane

Announcement Mic System: Symetrix

Control Room Monitors: Panasonic, Peerless

Dressing Room Monitors/
Receivers: Sony, Panasonic, Peerless

Microphones: Shure, Neumann, AKG, Whirlwind, Sennheiser, DPA, Audio-Technica, Ultimate Ears, Beyer.

VRAS Equipment: LCS, Apple, Marathon Computer, True Systems, Middle Atlantic, Whirlwind, Tannoy, Crown, Shure, Solotech, Audio-Technica, Crown

Left to right: Members of the design team include Holger Förterer (interactive projections), Luc Lafortune (lighting), Jonathan Deans (sound), Mark Fisher (scenery/theatre design), and the director Robert Lepage.

Show Staff

Company Manager: Jerry Nadal
Assistant Company Manager: Victoria Webb
Operation Production Manager: Ray Forton
Production Assistant: Christina Petras
Artistic Coordinator: Eric Heppel
General Stage Manager: Armand Thomas
Stage Managers: Julie Aucoin, Sylvain Collette, Stacey Myers
Assistant Stage Managers: Grace O'Brien, Mikhail Petrov
Administrative Assistant, Technical Department: Kirstine Palmer-Tveleneva
Technical Director: Dave Churchill
Assistant Technical Director: Martin Crawford
Technical Buyer: Rhonda Roueche
Production Runner: Andy Ray
Head of Audio: Mark Dennis
Assistant Head of Audio: Brian Hsieh
Audio Monitor Mixer: Kevin Owens
RF Technician: Gary Trenda
Audio Technicians: Michael Atwood, Jonny Lee Tempest
Head of Automation: Jem Hodgson
Assistant Head of Automation/Show Operations: Bonnie McDonald
Automation Technicians: David Ball, Jason Burges, David Geving, Kyle Howe, Joe McCunney, Lloyd Monteiro, Jason Potter, Rick Sylvester, Jay Withee
Head Carpenter: Scott Stevens
Assistant Head of Carpentry: Kenneth Ramsey
Carpenters/Technicians: Bill Allen, Byron Barker, Russell Bruce, Frank Coombs, Stephen Emmerson, Scott Fadale, Timothy Frankfort, Michael Garrett, James Hutcherson, Aaron Hutsch, Nicholas Kreway, Micharl Mansfield, Michael Mattox, Dale Medina, Josh Misegades, Raul Mullera, Mark Myatt, Michael Norris, Ronald Reed, Wayne Robinson, Joshua Russell, Scott Smith, Jack Stanford, Dallas Tankersley, David Turnbull, Christopher Velvin, Anthony Vergot, Catherine Walsh
Lead Electrician: Michael Wescoatt
Assistant Lead Electrician: Chris Kortum
Electrics Technicians: Lawrence Carrasco, Selina Davenport, Chris Escher, Cliff Gutierrez, Gabriel Hernandez, Majid Khazal, Jeffrey Kyrish, Bernie Leman, Curt McCormick, Alan Pilukas, Stuart Pitz, Jon Pullen, David "Doc" Roth, Tony Saurini, Susan Wilson
Moving Light Operator: Danny Grose
Projectionist: Jon Mytyk
Lead Spot Operator: Martin Mawalimu Kawakou Isaac
Lighting Console Operator: Elizabeth Koch-Lichter
Head of Rigging: Tony Galuppi
Assistant Heads of Rigging: Albert Gregor, Joel Svoboda
Riggers: Eric Anderson, Kevin Candiotty, Vincent Cavaretta, Jason Cavazos, Eric Davis, Reid Draper, Robert Fejer, Michael Ferraro, Charles Haga, Mike Harbin, John Hegyes, Andrei Kazantsev, Vladimir Lagrev, Tom Lapp, Curtis Legacie, Marcus Minguela, James Moran, Steve Oxford, Joseph Percelly, David Piccola, Alex Poline, Glenn Priestly, Sergio Ramos, Dan Rowland, Joseph Sabo, Vincent Schonbrodt, Frank Simpson, Scott Stanley, George Stingel, Jose Tejada, Vinicio Vazquez, Juan Vazquez Rodriguez, Joseph Voelkel, George Wilson, Brendan Yeager, Wilson Zamudio
Head of Wardrobe: Ruben Permel
Assistant Head of Wardrobe: Sandra Fox
Wardrobe Attendants: Ryan Chin, Paul Franklin, Marina Goubenok, Sarah Haman, Jennie Hollander, Paul Ludick, Jo Ann McKee, Bridge Savadge, Yelena Tokey, Margaret Uesugi-Oh
Wardrobe Costume Technicians: Jason S. Brass, Kelly Burton-Gilmore, Kelly Lance, Mary Ann Racheau, Liann Rawlings, Teresa Soto, Cathe Sowin-Puckett, Elisabeth Wilson, Eric Wood, Kathy Wusanack
Head of Props and Puppets: John Gallagher
Props and Puppets Technicians: Jason Armuo, Gracie Buckner, John Rager, Drew Reardon, Jannelle Rivers, Sam Souza, George Verbinski, Merrill Whittenberger, Gary Wong
Head of Special FX: Jeff Schaen
Assistant head of Special FX: Richard Friday
Special FX Technicians: Eric Johnson, Melvin Lovelace, Karl Seymour, Douglas Talley