DEBUT

SUE

CHICAGO'S FIELD MUSEUM UNVEILS THE WORLD'S MOST FAMOUS T. REX

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PHOTOGRAPHS BY IRA BLOCK

In the next year almost two million people are expected to meet "Sue," one of Earth's largest ever land-dwelling carnivores, nose to nose.
HE T. REX IS BEGINNING TO RISE.
TOWERING 14 FEET OFF THE GROUND—Flashingly lit by a metalworker's sparks and the leaping light from a blacksmith's forge, the thing seems almost to breathe. A fine art foundry outside Trenton, New Jersey, is not a likely place to find what is probably the world's most famous dinosaur fossil. But here, in a building protected from the hustle of modern life by razor-wire fences and a state-of-the-art security system, is "Sue," the Tyrannosaurus rex fossil purchased at auction by Chicago's Field Museum in 1997. For the first time in some 67 million years, it is standing upright.

The building is home to Phil Fraley Productions Inc., among the world's premier creators of museum exhibits. In the midst of the hubbub, talking over the din of metalworkers creating an elegant and almost invisible armature to support the Sue skeleton, is Fraley himself. A solid man in his 40s, with the soul of an artist and the physique of the college football player he once was, Fraley is watching and considering every aspect of the armature's fabrication: fretting about the pitch and angle of Sue's hips ("We have to be so careful with the hips," he says, "since everything else on a T. rex relates to them."); wondering if some steeldwork will be unnecessarily visible, pondering the angle of Sue's enormous birdlike foot.

"The fossils are beautiful," says sculptor and metalsmith Leslie Ewing (below). "There's so much variation in color and texture." She fits a slender steel rod to the chevrons on the underside of Sue's bulky tail, while her colleague Paul Zawisha adjusts the armature that clasps hulking neck vertebrae. The Field Museum's challenge to the Phil Fraley Productions team assembling Sue: Every fossil must be totally secure and readily removable from the mount for study. Says Zawissha, "There's no room for error."

Sparks fly. The shriek of steeldworking tools fills the building. "This project has been a challenge but a fun one," Fraley says. "Our contract with the museum calls for us to make an armature that leaves every bone removable at any time for scientific study. So we're fitting them all in saddles; each bone's weight is what holds it in place."

Ahead of us, a young jewelry designer named Leslie Ewing is working on a saddle to hold one of Sue's cervical vertebrae. Made of carbon steel, the support resembles a pair of cupped hands bound together at the wrists. Its spreading array of fingers fits snugly around the contours of the bone's underside. Ewing feels for gaps between the steel and smooth bone, then removes the saddle and walks to a blowtorch nearby. Dipping one of the saddle's fingers into the flame, she brings the steel to glowing red-hotness and gently bends it to better clasps the fossilized bone.

After the steel cools, Ewing checks the fit. The saddle cradles the 20-pound bone tightly and almost invisibly, virtually disappearing into natural fissures in the vertebra. Eventually the bottom of this saddle will be bolted to the armature, which is supported by a narrow steel pole that emerges from the base of the Sue exhibit in Chicago. When the job is complete, after 15 months of solid work, more than 200 bones in Sue's body will be supported by variations on this theme.

"That's why I love this," Fraley says, watching and smiling. "It's part sculpture, part biology. Between the museum staff and ours, we've got all these skilled people taking an inanimate object—a pile of fossilized bone—and returning to it a semblance of life. We've thought about its posture. We've worked out how it would stand and move in life. We've thought..."
ABOUT

SUE

THE LIFE STORY OF ONE ANIMAL
RECORDED IN THESE BONES OFFERS
INSIGHTS INTO AN ENTIRE SPECIES.

"WE HAVE ALL THE IMPORTANT PIECES,"

says lead Sue researcher Chris Brochu. "Because they're from a single individual, we can begin to draw new conclusions about locomotion, growth, and the relationship of T. rex to other dinosaur species."

BUILT TO MOVE

Fossil preparator Paul Brinkman reassembles the fragments of Sue's right ribs—a 3-D jigsaw puzzle.

12 TO 14 FEET PER STRIDE

4 ft

14 ft
about how to best engage viewers in seeing Sue, having a relationship with it. And now we get to make these ideas reality. Who could ask for a more interesting job than that?"

When you consider that Sue's bones are among the most significant evolutionary gems discovered in decades, it makes sense that jewelry designers should be working alongside biologists and paleontologists on returning them to their former glory. But not only jewelers have brought their talents to the project. Before Sue is unveiled on May 17—in the museum's massive Stanley Field Hall—nearly two dozen museum preparators will have put in some 30,000 hours on the fossil skeleton.

Aside from the preparators—who for two years have painstakingly stripped off the rock, or matrix, surrounding the fossilized bones and re-created a number of missing bones—paleontologists have examined and scientifically described the specimen, a CT-scan team has used powerful x-rays instead of saws to dissect the bones, and a project manager has kept the efforts gliding toward completion.

No dinosaur has ever drawn so much attention. The Chicago Chamber Musicians have commissioned composer Bruce Adolphe to write Tyrannosaurus Sue: A Cretaceous Concerto. A seven-movement piece based on the life and times of Sue, the concerto evokes what life was like toward the end of the late Cretaceous period, when the dinosaur roamed what is now South Dakota. Scholastic books will publish several titles about Sue—both fiction and nonfiction. And two of the casts being made of the big T. rex will be included in a pair of traveling exhibits sponsored by McDonald’s and scheduled to make more than a dozen stops around the United States. Another of the casts will be on permanent display at Disney’s Animal Kingdom near Orlando, Florida.

That’s a lot of hype to live up to. But then, clamor has followed Sue since the specimen was discovered in 1990. That was when the eponymous Sue Hendrickson, a field collector created a mirror image of one of Sue’s right foot bones to stand in for a missing left one. "Originally these tools let moviemakers create imaginary dinosaurs," says Dave Bassett of California’s Scamizte 3D (left). "Now scientists use them to study real dinosaurs."

Field Museum preparators Jennifer Moerman and Matthew Groves (right) used old-fashioned muscle power to remove rock from Sue’s nearly complete set of bones. New technologies helped fill in gaps. A laser scanner and computer-guided lathe for the Black Hills Institute of Geological Research, took a "fossil prospecting" walk one morning and found three large vertebrae sticking out of the side of an eroded cliff outside Faith, South Dakota. "By their shape I knew the specimen had been a meat-eater," says Hendrickson, "and by their size I knew it could only be a T. rex." We will probably never know, however, whether Sue was male or female.

Unfortunately for the Black Hills Institute the specimen was found on the ranch of Maurice Williams, a Cheyenne River Sioux whose land is held in trust by the U.S. government. Though the institute paid Williams $5,000 for what it believed were the rights to Sue's bones, the U.S. government had not granted permission for the excavation, setting into motion a battle for Sue's ownership.

Three years later a U.S. district court ruled that the fossil belonged to Williams, after which the Bureau of Indian Affairs granted him permission to sell it. In 1996 Williams decided to auction the specimen at Sotheby's. The following year, after a frenzy of bidding, the Field Museum walked away with Sue for a price of 7.6 million dollars (8.36 million with Sotheby's commission), turning the sale into international news.

Around the Field Museum and across Chicago, a cheer went up. Chicago now owned the world's largest T. rex: an animal 41 feet long, standing more than 13 feet tall at the hip, and with an estimated live weight of some 7 tons. It was also the most complete T. rex ever discovered, with about 90 percent of the skeleton accounted for. The city had a new mascot, the museum a new focal point. But inside the museum's walls there was also apprehension. "Before we could show Sue off, we still had a lot of work to do," says John Flynn, chairman of the museum's department of geology, which oversees paleontology. "The specimen was only about a quarter prepared; the rest of it was still encased in rock. Before we could display it, we
had to address questions like what's the best way to study it, and where do we put it? We had to make these decisions quickly."

It has been a fevered two years. The museum has finished preparing Sue's bones. Chris Brochu, a museum paleontologist, will soon publish the first comprehensive study of a T. rex. The museum is developing a Sue-centered dinosaur exhibition hall that will open around 2003. Before then Sue will dominate the soaring marble space of Stanley Field Hall.

Once the location was fixed, Sue's posture had to be agreed on. "We wanted it to be dynamic," says Flynn, "to convey that this was a living animal." After several drawings—Sue in hunting posture, leaping, even sleeping—the museum's team came up with a winner.

"The specimen will be placed on a base that mimics shattered rock," says designer Phil Fraley. "It looks sort of like a fallen bridge. And the specimen itself will be crouched and turning slightly, like it was in the midst of eating when something—maybe the viewer—started it. The pose creates tension, a relationship between the viewer and Sue. We wanted that. 'What if?' sense. You get a real jolt standing there and addressing one of the largest meat-eaters to ever walk the planet."

Beyond these big pushes a welter of smaller decisions had to be made. Sixty-seven million years under the earth had distorted parts of Sue: Its skull was slightly flattened, some bones had been misshaped by the geologic pressure, other bones were shattered.

It was up to the museum's paleontology staff to decide whether to "undistort" parts of the dinosaur—making it look more lifelike but also more like a generic version of T. rex—or to keep its fossilized shape.

One of these decisions proved easy. Thanks to its hefty facial bones and long dagger teeth, Sue's fossil skull and jaws weigh nearly 750 pounds. Consequently, mounting them at the end of the skeleton's long neck could prove dangerous. "So we made a cast that weighs roughly 150 pounds," says John Flynn, as he walks me through Stanley Field Hall, "and we'll mount that on the actual skeleton. That way, we can also undistort the skull a little without damaging the real specimen."

Flynn points toward a broad, second-floor landing overlooking the hall. "The real skull will go up there," he says. "We're building another entire exhibit around it. A place for people to learn about Sue and look down on the skeleton, where they can touch casts of the bones and actually get close to the real skull."

Flynn leads me upstairs and through a maze of hallways, finally entering a fossil preparation lab on the third floor. Arranged on tables around the clean, brightly lit room are bones from Sue, each smooth and dark as richly aged hardwood. Spread across one table is the cast of Sue's skull—the one that will sit on the mounted skeleton—still in pieces and ready for gentle revisions.

"What we're going to do by undistorting this cast," says Bill Simpson, the museum's chief preparator of fossil vertebrates, "is make the more distorted side of the skull a little less flattened and crushed. We'll raise and straighten the midline of the snout, making it more symmetrical. We don't want to do too much, though, because then everything else changes. If you do too much to the palate, the orientation of the jaws and teeth changes."

Simpson and Flynn now take me to a sealed room off the back of the lab. There, the real Sue skull sits atop a custom-built crate. Just as the skull's frontal bones have been distorted on the left side, the left postorbital, parietal, and squamosal bones—from the top of the skull behind the eye—moved out of position during burial and fossilization.

"We still have the displaced bones, though," Simpson tells Flynn, grabbing the mahogany-colored bones from their resting places on white foam pads nearby. Simpson fits them in place and regards the fit, which remains rough.

The skull's right side is a smooth line, but the left bumps out strangely. "That's what I mean about trying to fix imperfections," Simpson says. "How much do we want it to imitate life as opposed to the way we found it?"

Ultimately, it's decided the bones will be epoxied back into place, despite their imperfect shape. "I think it fits better to life this way," Flynn says. "And casting them before fitting them back into the skull allows for better scientific study too. Those are advantages I like."

Flynn and Simpson want to show me one of Sue's imperfections. Across the hall, on a table in Simpson's sprawling office, are two tail vertebrae that fused together during Sue's lifetime. The bones are a big, knobby mass of calcified clumps, not at all like the other smoothly curved tail vertebrae being mounted in Fraley's New Jersey warehouse.

As we regard the freakish bones, Flynn is smiling. "I like these fused vertebrae so much,"
What was Sue's world like? Fossils of broad-leaved plants, conifers, and ferns (this page) recovered from the same arid and rocky South Dakota site where Sue was found indicate that some

Was Sue a hunter or a scavenger? Probably both, many scientists say. T. rex was well suited for hunting but could also have bullied other hunters to abandon their prey.

67 million years ago the environment was warmer and wetter than today, offering plenty of forage for the plant-eating dinosaurs that in turn became T. rex meals.
he says. "They show Sue was a living animal once. It had injuries or diseases or infections that left it damaged. It shows that Sue is not only an example of T. rex as a species but was an individual animal too—and one that spent its days with a backache."

Just up the tabletop from the vertebrae sits a short, flattened bone about the shape and length of a beef rib you might find on a backyard barbecue grill. "This is one of the gastralia," Flynn says. "It's one of the belly 'ribs,' from below the rib cage, closer to the pelvis. As we've prepared Sue, we've found about 70 percent of these—which is extremely high for T. rex. Until we found these, nobody could say much about this part of its anatomy."

Another intriguing find unearthed by the Sue preparation team is a stapes, a delicate six-inch, piston-like rod of bone connecting the outer ear's tympanic membrane to the inner ear's auditory canals. Finding one of these in a T. rex was a first. It may also help scientists locate T. rex's position in evolution—and give an idea of when T. rex heard the world around it.

Near the edge of the table sits a thick and strikingly blue bone about the size of a large ice-cream cone. "That's a replicated toe bone," Simpson says. "It's a mirror-image model, made from the same bone on Sue's opposite foot." The blue toe bone—made of plastic—will be sanded and painted a reddish brown before it's mounted into place. When Sue is finished, any bone that has been sculpted or cast will be painted this same reddish brown, to distinguish it from the deep brown of the true fossil bones.

"People get a thrill seeing the real thing," Simpson says. "All of us like being close to an object that's 67 million years old, especially when it was once a gigantic animal that walked the Earth. We love being able to show this isn't a replica or a fragmentary specimen. This is the real animal, right before your eyes."

And now, after 67 million years in obscurity, Sue the T. rex again towers above the Earth, commanding the attention of all below.

For an insightful look at Sue's skull see the CT scan at www.nationalgeographic.com/dinosaurus/sue.html.

Bone by bone, scientists and exhibit builders have worked for two years on the world's biggest Tyrannosaurus rex. Chicagoans eagerly followed each step as museum staff members prepared the fossils. "We've had people come in a dozen times in the past year just to see what's new with Sue," says project manager Amy Louis. "We call them Sue groupies." But Sue is much more than a celebrity, says John McCarter, the Field Museum's president. "This is a scientific treasure we've only begun to understand."