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ATTA, PALINDROME

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Abstract

The Atta project maps tunnels and chambers of a vast leafcutting ant colony. A Ground Penetrating Radar scan was translated into a 3D model and displayed on an immersive visualization system, scaling the viewer to ant size. The system developed by our team is nondestructive to the ants and is the first time GPR has been used to map a living ant colony. Due to this project, a few entomologists have begun to use GPR with encouraging results, and the translation process is being patented. An account of the Atta project prompts a case study of theoretical and collaborative conundrums.

Keywords: virtual reality, immersive, ground penetrating radar, Atta texana.

Atta tunnel mapping and display

One of Texas's smallest natives is also one of its largest: myrmecologists refer to ant colonies as superorganisms. *Atta texana*, indigenous to Texas and Louisiana, harvests tree leaves to farm a fungus in a network of underground cavities that can spread over more than an acre of land and reach to considerable depths, with over a million ants in residence [1]. Excavated leafcutting ant nests have proven large enough to contain a 3-story house [2].

Tunnel architecture is of importance to entomologists because each species of ant builds them in a different way, and clues about behavior and social organization can be discovered through studying nest structure.

Previous attempts to model ant colonies have been undertaken by myrmecologist Walter Tschinkel, whose technique involves pouring casting material into the nest, digging it up and piecing it back together. Tschinkel has stated, however, that an Atta colony is so large this technique would be quite a challenge. He described an attempt in the Amazon to cast a leafcutting ant colony using over 10 tons of concrete. The result was impressive, but could only be excavated in place [3]. Another means to map ant colonies involves using a backhoe to scrape away successive layers of soil and measuring the diameter of the holes. This results in a kind of abstract image composed of disconnected shapes. Tunnels collapse with this method and can't be tracked [4].

Ground Penetrating Radar (GPR) provided a means to map an Atta nest. Using GPR, high frequency radar pulses are sent from a surface antenna into the ground. Elapsed time between when the pulse is transmitted—reflected from buried materials or sediment and soil changes—and when it is received, is measured. The transmitter and receiver are moved along the surface, following transects of a grid [5]. Typical uses of GPR include mapping buried archaeological ruins, and locating unmarked graves, unknown caverns, earthquake faults, and lost pipes or power lines.

GPR scans contain noise that can affect the results. Soil composition, radio interference, and magnetic properties of substances can all contribute noise [6]. GPR software is constantly improving in the ability to filter out noise, but the resulting data is not an exact replica of the form. Yet, due to our project, a team from Louisiana State University conducted a side-by-side comparison of GPR scanning and backhoe digging in 2006, and found a 70-80% confidence in GPR chamber measurements [7].

A portion of an Atta colony was scanned with GPR for the first time in 2004. It was a small section of the entire nest, but it took three days to cover an 8-meter grid in 10-centimeter slices. After filtering and parsing the volumetric data, it was possible to identify underground voids by comparing the numerical signature of the speed of the radar signal in air above the nest with that of the signals underground [8]. Subsequent density layers were built around these voids, like layers of an onion. For the immersive system the "data cube" was color coded according to these layers, so that one could examine the tunnel shapes and fungus caches alone, or build up solids surrounding them. A photorealistic "tunnel fragment" model was also prepared: a small portion of the scan was smoothed, textured, lit, and inhabited with ants, fungus, larvae, and a queen [9].

The immersive system, designed by Fred Parke in the Visualization Laboratory at Texas A&M, consists of low-cost, off the shelf components. A faceted display of 5 rear-projected screens wraps around the viewer 180 degrees [10].

In the viewing zone, geometry is dynamically presented with correct perspective. Quite differently than simply tiling images, the system provides a viewer with a kinesthetic sense of immersion—one both sees, but also feels surrounded by the scene. This

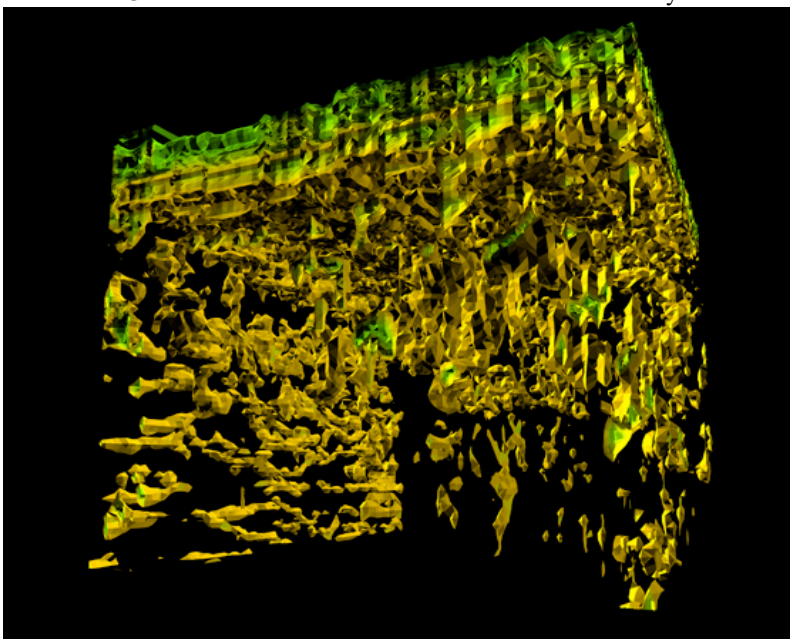

Fig. 1: Atta tunnel structure translated from GPR

allows the ant colony to seem truly enveloping—the viewer is scaled to ant-size.

The immersive system provides a near-infinite ability to zoom out of and into a 3D model. The tunnel fragment could appear like a tiny crumb floating in air, or one could move inside the nest to view details and tunnel architecture. The overall exterior and interior structure can thus be perceived in a seamless way.

The data cube (representing the entire scan) appeared like a block of Swiss cheese. One could set it spinning, advance to the interior of the model, and back out. One could also enable and disable layers surrounding the voids, or view only voids, which reversed figure and ground—air was represented as a solid object—the basis for the entire structure. The GPR translation process is being patented and may be applicable to other projects with similar parameters.

Calder-like in its coloration and form, the data cube seemed like a work of abstract art. Both cube and tunnel files were displayed using anaglyphic stereovision, augmenting a sense of immersion. Color corrections were needed to maintain enough red and cyan in each object, while retaining as much non-stereo color harmony as possible.

A Wii controller was used to interactively navigate the immersive scene. It provided a "home" state, a start and return point. Moving through the models with the Wii, one could enable and disable layers and stereovision, and control viewing orientation and location.

Symbol and index

The Atta project was the outcome of efforts by individuals from diverse disciplines: art, computer science, geophysics, entomology. What inspired us was an enjoyment of experimentation and collaboration. Yet there were always theoretical questions at work.

One artistic concern, broached with difficulty to team members, was a distrust of virtual reality as a means of delivery. It was important in a wider framework for the project to address the specific site and subject. The concreteness of *this* ant colony in *this* spot was significant. What connection could be maintained between a virtual representation and its referent?

The basis for my hesitation had to do with the metaphorical quality of mathematically derived images. Like painting and drawing, a work of art created algorithmically can sometimes seem to be more about the medium than the subject.

Like painting and drawing, algorithms are symbolic signs. They rely on generalization to address physical phenomena. Simulations of gravity, water, or terrain are freed from substance and geographic locale. At the same time, algorithms possess a fluid quality and can be repurposed from one form to another. For instance, an algorithm modeling a flock of birds in flight can be modified to simulate a swarm of bees. Berlinski describes the symbolic nature of algorithms:

"...[A] Turing machine may be realized in any medium in which symbols may be described....Whatever a computational system may be, it is in some sense a transcendental object, one that like the human mind itself conveys by some physical means an *im*material something, information, perhaps, the stuff that is stored, recorded, wired, faxed, communicated, exchanged, the impalpable fluid that seeps across international borders, and boundaries, the animating discharge that invigorates matter, the essential quality, speaking metaphysically, that gives form and content to the animate world, what is left when the medium of the message is

Fig. 2. Atta colony volumetric model on immersive system at SIGGRAPH New Tech Demos, 2008

withdrawn from the message itself, the message beyond the medium." [11]

Our team could develop a 3D *tromp l'oeil* version of an Atta colony (we created the photorealistic tunnel fragment, because it was the obvious thing to do) without going to all the trouble of field work, but the data cube issued from a radar scan. Though the data cube is not representational in a conventional way, one could argue it is realistic in a way that a symbolic representation is not—even if an artist's model from scratch might appear more lifelike.

GPR provides an indexical signal, formed by the action of radar pulses passing through substances over time and distance. In this way it can be compared to a photograph. Rosalind Krauss describes the index as a different type of signifier than a symbol:

"As distinct from symbols, indexes establish their meaning along the axis of a physical relationship to their referents. They are the marks or traces of a particular cause, and that cause is the thing to which they refer, the object they signify. Into the category of the index, we would place physical traces (like footprints)....Cast shadows could also serve as the indexical signs of objects." [12]

The impulse to mimeticism has long been discussed in art. In 1960, Bazin and Gray compared realism in painting and photography:

"The quarrel over realism in art stems from a misunderstanding, from a confusion between the aesthetic and the psychological; between *true realism*, the need that is to give significant expression to the world both *concretely and in its essence*, and the pseudorealism of a deception aimed at fooling they eye (or for that matter the mind); a pseudorealism content in other words with illusory appearances. [13, italics mine]

For Bazin and Gray, the pseudorealistic painting fools the eye and mind, but the photograph—true realism—delivers essence.

In his 1997 book *Return of the Real*, Foster hints that after artistic and theoretical inquiry had deconstructed belief in essential meanings and therefore any claim to recreate reality, the distinction between different types of signs might be coming undone. Whatever signifying system is in use, artists are never going to get at the real. Signifying systems are mediated by language at every step. For example, if a photographer collects an image, that image is first subject to the impulse to click the shutter, then to selection and placement in a different context, and subsequently to being interpreted and written about by others. The real is far away from the whole endeavor, giving rise to what Foster calls "a symbolic order in crisis."

By the late 90s, Foster observes, artists were grasping at ways to reclaim reality through mysticism, body art, the grotesque, and other methods. He interprets this as a return of the repressed, or the trauma of lost authority resurfacing in another form: the rebirth

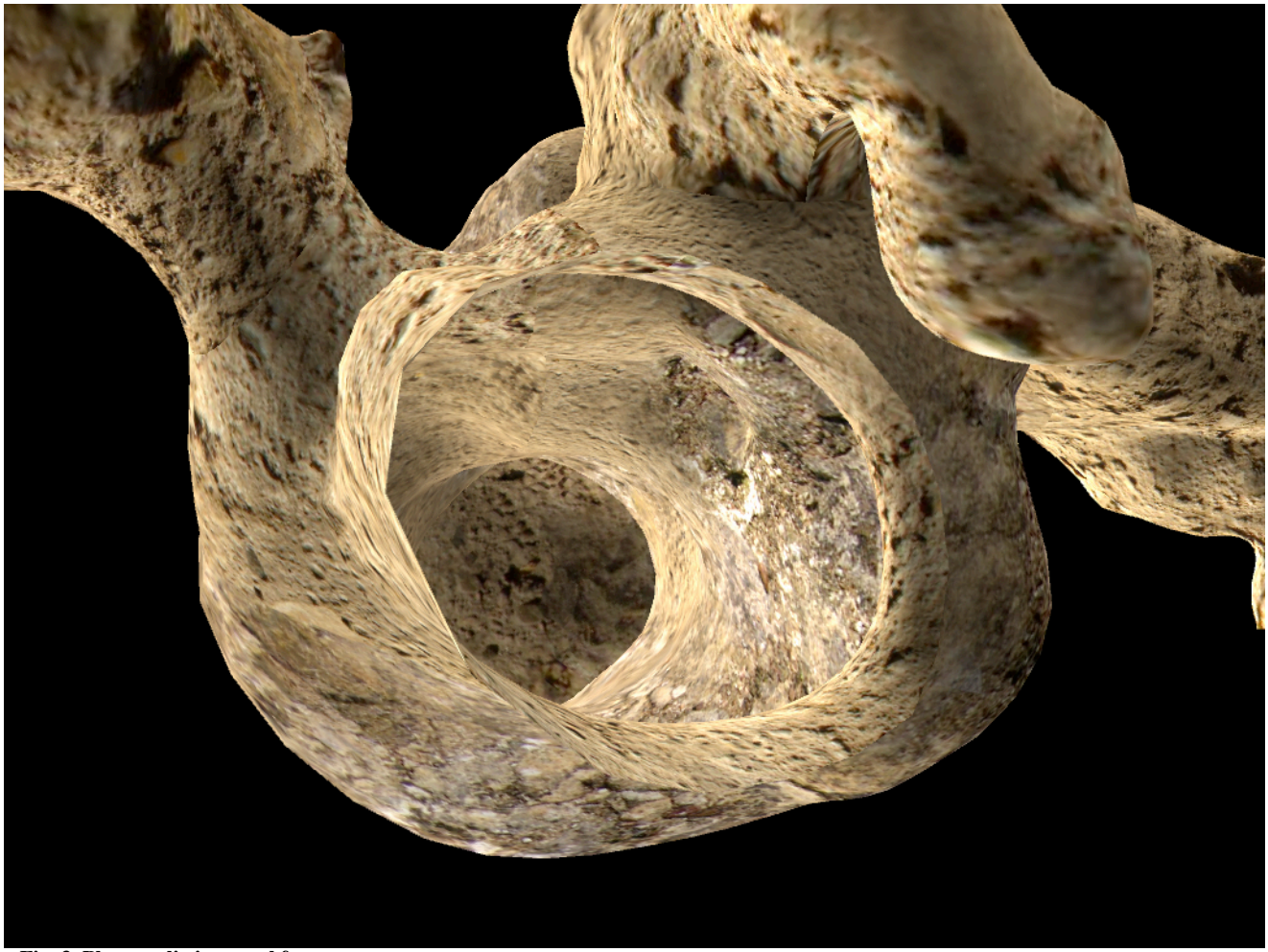

Fig. 3. Photorealistic tunnel fragment

of the author in a vain attempt to capture a shadow of the real. [14]

In scanning the ant colony, our team captured a form, shadows and all. There would be no absolute way to separate noise from signal unless we used a backhoe.

Unlike the colony cast in concrete, however, algorithms, like photographs, are fluid mediums. When one considers the difference between index and symbol, one can argue the GPR scan collected a trace of *this* colony, deep in the Texas soil. At the same time the 3D model, translated into a symbolic form, can travel, can be shared.

An indexical system can bring something foreign, and welcome, to the artistic process itself. Some artists use particular mediums and methods to reroute ways of making art that are self-recognized as both idiomatic and repetitious. The signature effect of the artist and the needs of the marketplace often obligate one to elaborate upon some forms endlessly. An artist might short-circuit this conscious or unconscious impulse by, for example, using indexical methods to generate forms impossible to imagine otherwise, or by collaborating with others who communicate with completely different, discipline-specific vocabularies. For example, the GPR radar signals were exhibiting strong "perturbations" indicating nest structure, our resulting dataset was at first a "point cloud." Ideas about the dynamics mentioned above were challenged as a simple illustration of "Schrödinger's cat." My interest in the spectacle of a gigantic ant tunnel as a combination of index and symbol could be communicated only tangentially.

Collaboration

Shared projects between artists and scientists can generate a tangle of unfamiliar verbiage rooted in concentration and close study. Participants confronting the opacity of processes not mutually understood listen at crucial times to keep the work on track. But it's certain that whatever each person gained from this project was something quite different and perhaps not entirely common. Far from utopian ideas of a shared team vision, we toiled, we created, we disagreed on what it meant.

Artists who collaborate with individuals from diverse disciplines must negotiate chasms of language. If the project is sufficiently time consuming (this one took 4 years to produce), there comes a point where one's identity as an artist is less important — at bay sooner — than the necessity to follow the direction the questions lead. Whether the result can be called art, science, or a hybrid is determined by its reception in a larger community. Like the species name and the pathway worn from tree to nest, the process of mapping the colony took the form of a palindrome: we pulled something out of the ground, passed it back and forth, and hoisted it back out into the real.

Author Bio

Carol LaFayette is building a digital nervous system for a rural landscape—or, earth art without the bulldozers—for sensing and responding, in the field and in the art space. LaFayette's artwork is in collections at the Museum of Modern Art, New Museum, and the J. Paul Getty Museum. Her 2003 award-winning video "Skateboarding in Sarajevo" screened at 10 international film festivals. Her video collection "'Texas' is an adjective" screened on citywide billboards in L.A. Freewaves Experimental Media Arts Festival 2005, and on stadium screens at Victory Media Arts Plaza, Dallas, 2007. "Atta," a collaborative immersive installation, was exhibited at SIGGRAPH 2008.

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