ARCHEOLOGY

Computers Bring Back a Long-Lost French Abbey

CLUNY, FRANCE—Visitors to the town of Cluny in the Burgundy region of France can once again look over what was once the largest church in Christendom, admire the vaulted ceilings, the rows of columns, and the marble inlaid stone floors. None of it, however, is real. The reconstructed abbey is a computer simulation: the fruit of a pioneering project in applying commercial computer technology to the services of archeology.

The abbey was wantonly destroyed after the French Revolution but it has been reconstructed with the help of archeological records built up over decades of work by a Harvard architecture professor earlier this century. Two graduate engineering students spent a year building up a computer model of the abbey in its heyday with the help of the computer company IBM.

Last month, Cluny honored Harvard's John Kenneth Conant, who died in 1984, by opening a permanent exhibit at the town's Ochier museum to display his notes and drawings. To bring the history alive, visitors can watch a filmed "tour" around the simulation of the abbey. French virtual reality researchers also used the simulation to make a "virtual abbey" that people can walk through by donning a headset fitted with video screens.

According to art historian Dominique Vingtain, until recently director of the museum, Conant "had the courage to undertake a gigantic enterprise." She says the virtual imaging of the abbey is an important experiment that has revived public and scientific interest in Cluny. "The Cluny computer reconstruction experiment will probably endure as an important milestone.... Archeologists, historians, and museum curators have been extremely interested in the approach."

"Virtual reconstruction is a fabulous tool for the archeologist," adds Jean-Pierre Mohen, associate director of the Musées de France. "With it we can reconstruct in volume buildings, towns, and even prehistoric camps, of which we have vestiges as small as a couple of centimeters thick. We can proceed by trial and error, verify hypotheses, study elevations, verify building technologies, make a selection among the most likely results and place objects, even food, where they probably belong. And there is, of course, the great pedagogic value of a spectacular reconstitution that brings to life vestiges of the past."

The Abbey of Cluny, founded in 909, was for several centuries the spiritual, artistic and cultural center of Europe. Answering only to the Pope, the Clunaic Order of Benedictine monks ruled more than 1000 smaller abbeys and monasteries in Europe. Its 187-meter-long church, with a stone vaulted nave rising 30 meters high, five radiating chapels, a double transept, and a portal flanked by two towers, was the largest in the world until St. Peter's Basilica was completed in Rome in 1615. Many Cluny abbots were wealthy aristocrats, who promoted arts and letters, assembled a large library of manuscripts and illuminated books, and gave refuge to scholars. Two abbots of Cluny became Popes.

IBM

Virtual reality. Computer reconstruction of Cluny Abbey based on records compiled by John Kenneth Conant from excavations begun in 1928. (Conant is the one on the left.)

By the time of the French Revolution, however, Cluny's power and wealth had declined. In 1790, the revolutionary government declared the abbey state property, and the last monks left. The abandoned abbey was vandalized and pilfered and in 1793 sold to a local merchant who blasted most of it with explosives to use the chiseled stone blocks as building materials. In 1801, a street was built through what was once the nave and the destruction continued until 1823. Little now remains of medieval Cluny except one transept with its tower. Houses were built over part of the nave, and the shape of the huge abbey is now indiscernible. Today, guests at the Hotel de Bourgogne actually sleep in the narthex, and fragments of the abbey's columns decorate the reception hall.

Enter Conant. In 1928, Conant, who was then a young professor of architecture at Harvard, started excavating the site with the support of the Medieval Academy of America and later the Guggenheim Foundation. By 1950, his workers had dug 90 pits and unearthed some 5000 stone fragments, many of them sculpted. Conant became a familiar and well-liked figure in Cluny (a street over the former main entrance to the abbey was named after him). He wrote a treatise on his work, backed by medieval documents, then donated his excavation registers, maps, drawings, and photographs to the town.

In 1990, Christian Père and Philippe Marécaux, students at the Ecole Nationale des Arts and Métiers, the national engineering school that has a branch in Cluny's former cloister, came up with the idea of transposing Conant's data into a computer model of the abbey. Supported by Vingtain, they approached IBM-France, which agreed to provide the technical and logistic support for the project. It took more than a year to record numerical data and the measurements from Conant's 600 pages of excavation registers and plans, to "raise" the abbey by constructing a computer wire-frame model, and to fill it in with solid volume structures, colors, and shades using an IBM RS6000 workstation and industrial software.

Besides providing material for the film now being shown at the Ochier museum, the simulation was used by a team of virtual reality researchers led by Luc Genevriez to make a virtual abbey. At the Imagina computer simulation conference in Monte Carlo earlier this year, delegates could walk around the nonexistent abbey wearing a helmet with a liquid-crystal screen in front of each eye. Sensors pick up their movements and the images change accordingly, giving the impression of being inside the abbey.

The simulation reflects Conant's theories on what the abbey looked like after its last enlargement, consecrated in 1130, and known as Cluny III. At that time, the abbey would have been full of tapestries and frescos and its capitals and columns would have been colorfully painted, conveying the "feast and all the magnificences of the world," in the words of historian Georges Duby. But few fragments of the decor have survived, so the interior of the electronic abbey is mostly bare and unadorned. A fresco of the Christ in Majesty, copied from a nearby chapel thought to be close in style to Cluny, was included, as was a depiction of the great rose window over the western main entrance, but they have been left deliberately fuzzy to reflect the lack of knowledge about their true appearance. More detail is known about the chancel screen (choir railing) because of the work of art historian David Walsh from Rochester University, who is currently sorting, assembling, and drawing stone fragments from the abbey. He is known to many locals as "the son of Conant."

The marriage of computer science and archeology at Cluny has drawn enthusiastic reviews from historians. Alain Erlande-Brandenburg, curator of the National Museum of the Middle Ages in Paris, says computer specialists ask very precise questions of archeologists, imposing scientifically exacting demands that they did not face before, such as the thickness of the walls, the nature of the soil and the building technology used at the time. "In exchange they give us something we don't have: A visualisation of the volumes, of the lighting, of the atmospheres of places that have disappeared. The images they produce add an important visual element to understanding the purpose and the use of the building." Adds Vingtain: "We are dealing here with concrete applications, rich in potential developments."

–Alexander Dorozynski

Alexander Dorozynski is a science writer based in Paris.

AZT PATENT

Court Favors Drug 'Concept' Over Proof

What kind of help must you give an inventor before you deserve to share in the patent? That thorny question has bedeviled U.S. patent courts for two centuries, and in 1991 it arose again when pharmaceutical giant Burroughs Wellcome launched a patent infringement suit against two rival drug manufacturers over the issue. The companies were trying to market their own generic versions of Burroughs' anti-HIV drug AZT, and they argued that Burroughs couldn't stop them because they had license rights. Those rights were granted to them by the National Institutes of Health (NIH), which was—the two companies claimed—a co-inventor of AZT.

Last week a North Carolina judge decided that even though NIH demonstrated the drug's anti-HIV activity, that wasn't quite inventive enough for patent law. The court ruled that Burroughs held the sole patent rights because the company had conceived of the drug, even before testing it on HIV, as an anti-HIV compound. But the inventorship question won't go away; the generic drugmakers—Barr Laboratories Inc. and Novopharm Inc.—have already announced their intention to ask the U.S. Court of Appeals to hear the case.

The issue here is whether conceiving of an invention is all that's needed for a patent, or whether proving that the invention works also deserves recognition. Barr and Novopharm claim that Burroughs' AZT patent should have included the names of two NIH scientists—National Cancer Institute director Samuel Broder and his colleague Hiroaka Mitsuya—who first screened AZT at Burroughs' request and proved that it worked against HIV. NIH has never pressed any claim on AZT, but officials at the institutes have not been happy with the high price that Burroughs charges for the drug—as much as $2,500 a year—and have been searching for ways to drive down the cost. In Barr NIH thought it had found a lever to do just that. It granted the drugmaker a nonexclusive license in 1991 to any patent rights the institutes might, in theory, have for AZT. The company, which had already been selling generic AZT in Canada at about half the Burroughs price, quickly moved to start U.S. sales. Almost as quickly, Burroughs brought suit against it (*Science*, 7 June 1991, p. 1369). Novopharm, which also sold the drug, was named in the suit as well.

As the case developed, through a pre-trial ordeal that included 541 pleadings, 88 written orders, and dozens of hearings, it boiled down to the issue of who did what when. This is what emerged: In mid-1984, when the scientific community learned that AIDS was caused by a retrovirus, Burroughs scientists began screening compounds for activity against two mouse retroviruses. AZT showed high activity against both of them, so the company's patent committee recommended in January 1985 that Burroughs prepare to file a patent for the drug as an antiretroviral that could be used against HIV. In early February Burroughs sent a number of compounds to Broder for screening against HIV, including a sample of AZT under the code name "Compound S." On 20 February, Broder phoned Burroughs to report that the NIH tests had shown that "Compound S" was effective against HIV. On 16 March, Burroughs filed its first patent application for AZT.

To Judge Malcolm Howard of the U.S. District Court in New Bern, North Carolina, this history clinched Burroughs' case. In his 22 July decision, Howard defined the law as requiring that the inventor merely have a "formulation in mind" of the invention's actual use. Burroughs, the judge said, had thought of AZT as an HIV drug after the mouse retrovirus tests, and before NIH became involved.

Barr had argued that activity against a mouse virus is not sufficiently predictive of activity against HIV to deserve credit as a discovery of a potential AIDS drug. But the judge disagreed. It was enough, he wrote in his decision, simply to have the idea that the drug might work: "For conception to be complete, the law does not require an idea to be proven to actually work." Indeed, the judge found that the creative input of Broder and Mitsuya was essentially nil, ruling that "a party who conducts tests wholly at the direction and instruction of another is merely a technician and not a conceiver."

A Barr official calls this reading of the law "unusual, to say the least" and predicts that the appeals court will reverse it. But independent patent experts don't agree. Stanford law professor John Barton says there is a good deal of precedent for the decision, and he suspects the appeals court will uphold it. "You are permitted to make 'prophetic claims,'" he says. "If you're right, you have a patent." Particularly in the biotech arena, he adds, such crystal ball reading is becoming standard practice. "A lot of patent drafting is how well you can guess what you can do."

While that's certainly true, says Kate Murashige, a patent attorney at the Washington law firm Morrison & Foerster, she also notes that the casebooks are sprinkled with exceptions where courts have awarded patents to those who have proved that an invention works. For example, in 1991 the biotech firm Xoma successfully defended its patent for a monoclonal antibody used to combat toxic shock by contending that while others had used it on animals, Xoma was the first to prove it worked on people. In this case "reducing the invention to practice"—proving that it actually worked in humans—was the real invention. The AZT ruling seems more in line with a traditional reading of the law, Murashige says, but "until there's a clear ruling about which inventions reduce to practice and which don't, this is never going to be resolved." In this murky area, an appeals court decision that makes the distinction clear would be a fine judicial invention indeed.

–Christopher Anderson