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## Digital X-Ray Technology Opens our Eyes to a Prehistoric Life

For many, NDT techniques have always been associated with applications involving safety inspection for quality driven industries such as: aerospace, automotive, energy and oil, electronics, and manufacturing. Now, thanks to the Leonardo Dinosaur Project, that scope has been expanded into a new scientific era of digital NDT research.

For paleontologists of the Judith River Dinosaur Institute (JRDI) NDT digital x-ray technology has played a major role in their ability to analyze, in non-invasive ways, a 77 million-year-old mummified dinosaur named Leonardo. With today's computed radiography (CR) techniques we can look into the past to a prehistoric world we once thought long gone. For Leonardo, NDT technology was a critical solution to help solve the mysteries surrounding his prehistoric existence.

### **Fast Facts:**

- The 3 year old male *Brachylophosaurus Canadensis* was discovered in the summer of 2000 in Malta, Montana. The discovery is extraordinary because Leonardo is by far the largest and best-preserved dinosaur fossil to be taken out of the earth.
- Leonardo's body is actually mummified and fully intact.
- Scientists believe environmental conditions played a role in Leonardo's preservation. During the fossilization process his skin was hermetically preserved and approximately 90% of his soft tissue including skin, muscle, nails, and beak remain intact. Even his last meal remains in his stomach.

## Using Kodak Industrex NDT Equipment in the Field

NDT field-testing of Leonardo was completed at JRDI in Montana by enlisting the help of Carestream Health's (formerly Kodak) NDT imaging experts. The team set up a digital mini-radiography lab in a remote field station. Using the Kodak Industrex ACR 2000i Digital System, they produced 40 radiographic images of Leonardo's head, portions of his skeleton, and abdomen.



“Scientists have been waiting for this moment for a long time,” says Joe Iacuzzo, Leonardo Project Manager. “The Kodak Industrex digital system was an integral part of this incredible discovery. If we didn’t have this type of technology we wouldn’t have been able to examine the confirmed organs inside of a dinosaur.”

With its power, speed, and latitude of the associated imaging plates, the ACR 2000i Digital System easily penetrated the dense fossil rock and captured spectacularly detailed x-ray images of Leonardo.

Steve Mango, Carestream Health’s Worldwide Technology Manager NDT Solutions, is the lead technical expert on the project.

“With NDT, we typically radiograph industrial materials and parts. As far as subject matter, there aren’t a lot of similarities with Leonardo so we discovered a lot, especially with exposure techniques. We really got a chance to demonstrate just how versatile our system is. The radiographic images we produced look as good as what you would see on a human x-ray in the medical field.”

Part of that clarity can be attributed to the systems specialized viewing software. Mango was able to fine-tune reader gain settings to optimize exposures and minimize the effects of scatter. By using the proper strengths and intensities of electromagnetic energy, a harmonious balance was created between image quality and penetration power.

The ACR 2000i Digital System, which relies exclusively on storage phosphor plate imaging, was also flexible enough to allow the team to shoot and rotate large imaging sections of the specimen. Now, the scientists are taking their examination to the next level and concentrating on x-raying Leonardo’s harder to reach, more fragile internal organ areas.

### **Creating the First Solid 3D Dinosaur Image with the Help of NASA**

In order to capture and create a 3D image of the fossil, the 1.5-ton Leonardo will move farther than he’s ever moved in 77 million years. His journey will take him approximately 1800 miles to NASA’s Ellington Field Facility in Houston, Texas to undergo further NDT testing with the Kodak Industrex ACR 2000i Digital System.

The NASA facility is a perfect choice for this phase of analysis. The large hangar is approximately 35 x 70 feet in length. Leonardo’s team of imaging scientists have already constructed a gantry system and platform to enable precise 3D imaging that will allow better access to specimen areas that were not accessible in the field.

“The NASA facility is ideal because it’s roomy and we can maintain a proper safety exclusion zone, especially when using the powerful radiation intensity of the Iridium 192 and Cobalt-60 gamma isotope sources,” says Mango. “The facility also enables us to conduct the imaging in one area, with a separate area to scan the imaging plates and do the analysis.”

Leonardo's remains will undergo a customized dinosaur proportion scan process to imitate a CT scan, using the flexible imaging capabilities of the Kodak Industrex digital system. The resulting 3D model will be the first of its kind that includes not just the skeleton, but also the actual organs and mummified skin.

"The 3D model will be significant to our research. Leonardo is so complete there has never been anything quite like it before. Most of our findings at NASA also confirmed

what we found in the field. If it wasn't for the NDT digital technology, we wouldn't have been able to be 100% certain about important elements that make up Leonardo. It's very rare in science to be able to say a finding is absolutely positive without any speculation."

### **The Digital Advantage**

The shooting technique used at NASA was based on a shoot-and-rotate operation. Radiographers produced several 10 – 12 minute images by positioning the x-ray tube at sequential 5° angles that will later be combined and stitched together to create the 3D model.

"We used a stereo radiography technique to gather about 55 x-ray images," says Mango. "With the stereo technique we took two radiographic images at two specific angles allowing scientists to reconstruct a full stereo image of Leonardo. Our digital system has enough user controls and preference options so we were able to employ a wide range of exposure techniques."

According to Mango, the Kodak Industrex digital system also allowed them to revitalize over-exposed images, and index images so scientists could clearly identify each specimen part.

"We would take a digital photo of the area we were shooting along with the x-ray image as a reference source with special annotations about the area," adds Mango "The system allowed us to file all of the images together to keep everything properly documented. We were even able to salvage shots by re-reading plates that had too much exposure or saturation. With film, or perhaps another system, we wouldn't have been able to do that."

### **Why is Leonardo so fascinating?**

With all of the new advancements we see today within the industrial applications of NDT there is still something about this unique paleontology application that draws us further into the technology. Leonardo is inspiring not only to the scientific community, but also to the future inventors of tomorrow.

"Dinosaurs draw us into science, especially kids," adds Iacuzzo. "Dinosaurs give kids their first real taste of natural science, which could very well start them down a scientific or engineering path."



## **Discover More about the Mysteries Surrounding Leonardo**

As a result of the work in the field and at NASA, a special one-hour documentary entitled, "Dinosaur Resurrection" will be broadcast in September 2008 on The Discovery Channel. Viewers can experience firsthand Leonardo's spectacular journey home including footage taken at NASA showing the use of the Kodak Industrex equipment.

Learn more about Leonardo's world and the mysteries surrounding his incredible discovery, as well as an unveiling of Leonardo's final 3-D image.

Leonardo's journey does not end here. Once the NASA analysis is complete, it's on to the Houston Museum of Natural Science for an exhibit that will run 9 months before his final journey back home to The Great Plains Dinosaur Museum in Montana.

"Thanks to Carestream Health's NDT technology, scientists will spend the next 100 years studying the paleoecology of the world in which Leonardo lived." said Martin Graen, worldwide General Manager, NDT Solutions Group, Carestream Health. "As they learn about the past, the Carestream NDT team will use our findings to improve the future. By trying new techniques and using this project as a learning tool, we can continue to develop the endless possibilities and applications of our technologies to improve our products and enhance the quality of all of our lives."

For additional information visit [www.mummydinosaur.com](http://www.mummydinosaur.com).

To learn more about Kodak Industrex Non Destructive Testing products go to [ndt.carestream.com](http://ndt.carestream.com)

## **About Carestream Health, Inc.**

Carestream Health, Inc., is a leading provider of dental and medical imaging systems and healthcare IT solutions; molecular imaging systems for the life science research and drug discovery/development market segments; and x-ray film and digital x-ray products for the non-destructive testing market. The company was formed in 2007 when Onex Corporation (TSX: OCX.TO) purchased Eastman Kodak Company's Health Group. For more information about Carestream Health, contact your Carestream Health representative or visit [www.carestreamhealth.com/](http://www.carestreamhealth.com/).