Center for Quantitative Imaging

General Description

The Center for Quantitative Imaging (CQI) is a unique organization, combining state-of-the-art X-ray Computed Tomography (CT) equipment with advanced computational facilities and data-mining expertise to provide three-dimensional internal maps of materials and processes. X-ray CT is a method for mapping x-ray absorption, which can be converted to maps of density, porosity, and component concentrations. In its simplest form, a computer combines images of an object taken from many directions. The result is a 2-D grid of numbers representing X-ray absorption of individual 'voxels' inside the sample. These slices can be stacked together to obtain 3-D images. Since X-ray absorption depends on density and atomic number, the data can be interpreted in terms of density, porosity, fluid saturation, or component ratios.

CQI can provide industrial and research clients with a state-of-the-art, non-destructive imaging service that advances scientific knowledge and/or improve industrial manufacturing processes. The Center has worked with a wide array of academic and industrial partners.

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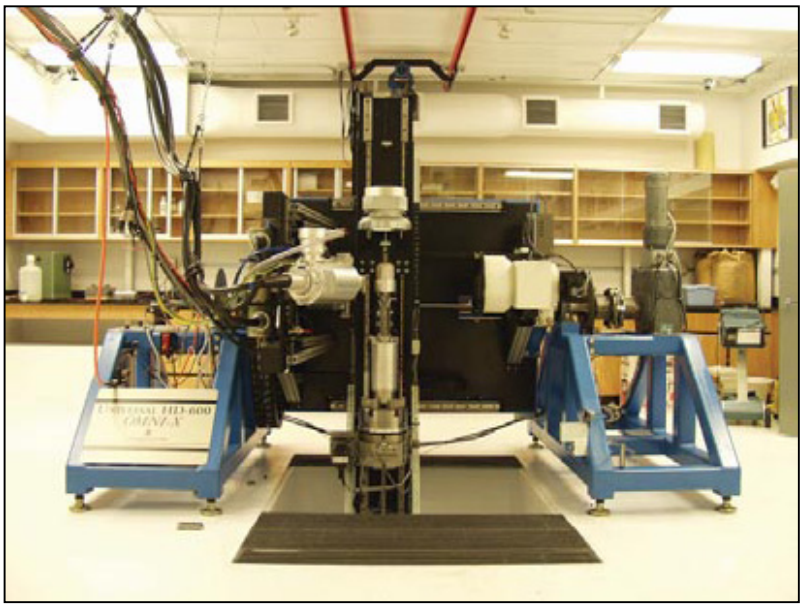
Key Equipment

The CQI maintains two state-of-the-art X-ray CT machines and a variety of ancillary equipment, including high-precision liquid pumps, transparent core holders, high-precision quartz pressure transducers, and specially designed pressure vessels. CQI is a highly collaborative global hub for those working on advanced imaging technologies.

OMNI-X Universal HD600 Industrial X-ray CT

The Omni-X HD600 scanner can collect image data with a resolution of about 1/1000 the diameter of the object down to a limit of about 5 microns. The emphasis is on interpretation of the data to map dimensions, density, porosity, and composition, rather than simply creating visual images. The facility also includes a 28-CPU parallel processing computer with one Terabyte of disk space for storage and analysis of large volumetric data sets. The OMNI-X unit was procured through funding provided by the National Science Foundation, the USX Foundation and The Pennsylvania State University.



OMNI-X Universal HD600 Industrial X-ray CT

HD-600 Medical X-Ray CT

The HD-600 medical CT scanner has resolution of 0.5 x 0.5 x 2mm with acquisition time of about 10 seconds/scan. The sample lies horizontal and does not rotate, allowing studies of loose materials.

Supporting Equipment

- A 28-CPU Sun Entropic mini supercomputer with 1 Terabyte of mirrored data storage. This facility is used to visualize and manipulate the large 3-D data sets produced by the scanner.
- High-precision pumps for multi-phase flow experiments.
- Transducers and data acquisition systems for monitoring pressure, differential pressure, temperature, and flow rates.

Equipment Capabilities

CQI has used x-ray CT as a non-destructive characterization tool for a wide array of applications. Some examples include:

Glass Communication Fibers subtitle

A good example of a quantitative industrial application is a recent study of density and composition of glass communications fibers. Recently, a fiber-optics company approached the CQI to image large silica billets from which glass fibers are made. It was determined that the technique could be used to profile both composition and density-distributions within the billets. Previously, the very expensive process of developing the thin fiber optic strands from the billet was used. The company now plans on adding a scaled down imaging machine at their manufacturing facility.

Examining the History of Baseball

When Babe Ruth hit his 60th home run in 1927, he established himself as baseball's single-season leader. His record remained untouched for 34 years, until Roger Maris hit his 61st homer and slid by him in 1961.

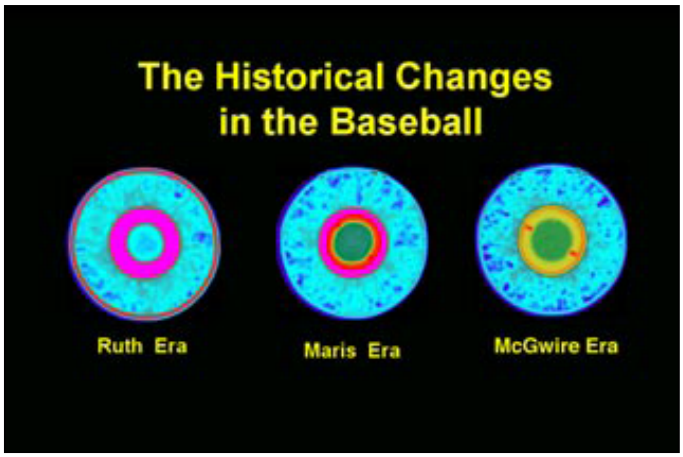
Maris' record stood for 37 years. Then, in 1998, Mark McGwire knocked it out of the park with a whopping 70 home runs in a single season.

In the past four years, both Ruth and Maris' records have been broken six times—pretty phenomenal considering it took a combined total of over 70 years to surpass Ruth's run record. An inevitable debate ensued: Are these guys really that good? Or has something in the game of baseball changed?

The CQI decided to use available technology in an attempt to answer that question. Using the CT scanner, the modern McGwire-era baseball and bat were compared to those used during the Ruth and Maris periods.

To the top right is a three-scan plate marking the changes in the baseball between the Ruth and Maris eras and the present. This plate, coupled with the quantitative graph, clearly illustrates the change in the density of the cork center of the ball.

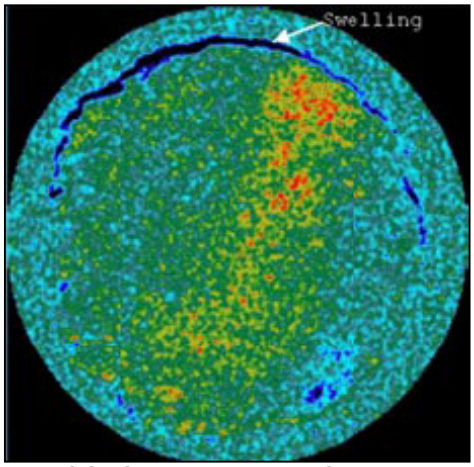
Variations in the density and grain structure of modern bats are also easily visible. The value of the CT for determining wood growth in general is also evident. Measuring the pattern of growth rings is a classic method of dating wood and speculating on the climate in which it grew. The advantages of CT scanning are: it is a noninvasive technique, eliminating the need to cut or bore holes into the wood to date it; and density graphs of each ring can be created, adding a new dimension to growth ring analysis.



Changes in the baseball.

CO2 Sequestration in Coal

The image below is an example of observing changes in a sample. The sample shown is being held in an x-ray transparent vessel under 1000 psi stress while being injected with carbon dioxide. The image shows two obvious differences between an injected and non-injected specimen. First, a yellow-red band appears in the area where CO2 is concentrated in the sample, showing that gas absorption is not uniform. Second, the black rim indicates that the sample swelled following CO2 absorption. The expanding coal displaced the higher density material surrounding it, decreasing the x-ray absorption in that region (dark colors are indicative of decreased absorption, while bright colors signify an absorption increase.) These phenomena could prove to be very important if we plan to store excess CO2 in deep coal seams.



CO_2 Sequestration in Coal.

Additional Information

- ***CQI Flyer***

Key Contacts

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