Media release

Materials Science & Technology

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20 years of industrial computer tomography at Empa

The view inside

Empa is one of the leading institutions in the field of industrial computer tomography as a result of its many years of experience. And it is not only technical components such as cylinder heads and batteries which find their way into the tomograph, but also items such as fossils and food samples…

A good example of this occurred in 2007 when Empa experts were able to create a three-dimensional reconstruction of the petrified skull of an ancient rhinoceros with the help of x-ray computer tomography (CT). Because Empa's equipment is particularly good at penetrating samples it can be used to investigate large fossil finds. In the case of the rhinoceros skull the CT data helped the conservation specialists to differentiate between sediment and fossil. It also showed that the animal was in the process of losing its milk teeth, so the skull obviously originally belonged to a rhinoceros baby.

«Exotic samples like this one actually quite unusual, though," explains Alexander Flisch of Empa's Electronics, Metrology and Reliability Laboratory, adding "….ninety percent of our work is industrially related." This is because the CT system is excellent for nondestructively testing components, for example to uncover any material defects. It is also very useful when the construction drawings of an item are no longer at hand or cannot be obtained from the manufacturer, because the CT scan makes visible the internal structure of the part. The computer then creates a 3-D model which can be used to produce the item once again.

Why industry needs Empa

An industrial CT scan also clearly shows how different materials are distributed within a sample, for example the positions of fibers in concrete or the deposition of pollutants in a particle filter. The food industry also makes use of the technique: "We've even x-rayed a piece of Toblerone to investigate the distribution of air bubbles and pieces of nougat in the chocolate!" says Flisch. Another example: clients from the construction industry make CT scans of building materials to determine whether they are correctly mixed.

In contrast to medical CT scans, industrial computer tomography is much more accurate – which is exactly what customers from industry need. The technique is based on the principle of x-ray scans of an object being converted by the computer into a series of cross-sectional images. A medical CT scan takes only about 90 seconds and creates a series of cross-sectional images of the body which show details at a level suitable for

the doctor to make a diagnosis. The x-ray scans in an industrial tomograph, on the other hand, can take minutes or even hours to make, depending on the technical requirements. The level of detail is such that a 25 µm sized defect on a solder joint one millimeter in diameter is clearly identifiable. Empa's tomograph is one of the three largest such machines in Europe and is capable of scanning samples of up to two tonnes in weight, such as truck engine parts. The high penetrating power of the machine also makes it possible to successfully scan samples made of very dense materials.

In addition Empa also operates CT equipment with conical beam geometries for three-dimensional data sampling. Here, it is not just two-dimensional cross sections of the object which are made – the instrument takes several hundred projectional images of the sample as the latter is slowly rotated through 360 degrees. The projections are later combine to reconstruct our three-dimensional volume tomogram of the scanned part.

There's nothing that can't be scanned!

As part of the jubilee celebrations held at Empa in November 2011 entitled "The View Inside", Alexander Flisch and his team launched a competition among users to find most creative CT idea. The most interesting suggestion won a free CT scan as a prize. Among entries were the investigation of the internal workings of an automatic trumpet-playing instrument, an archaeological clump of stone (in which a pan was found) and – cheese. How many holes does a Swiss cheese contain and how are they distributed? The answers to these cheesy questions are clearly visible on the CT scan!

Another CT success story was the "reverse engineering" of a motorcycle engine. A manufacturer of engines for racing motorbikes possessed an example of an original engine but had no engineering drawings for it. Flisch and his team made a CT scan of the old engine and, using the computer model which resulted, the manufacturer was able to continue developing the motor. A 3-D mold made of a resin-clad sand mixture was built up layer by layer, based on the model. A laser was used to harden the mass and the excess sand was then shaken off, leaving behind a perfectly-shaped mold of the engine. Not a bad way of doing things, as it turned out – using the recreated engine the customer then went on to win several races at the world championships!

Further information

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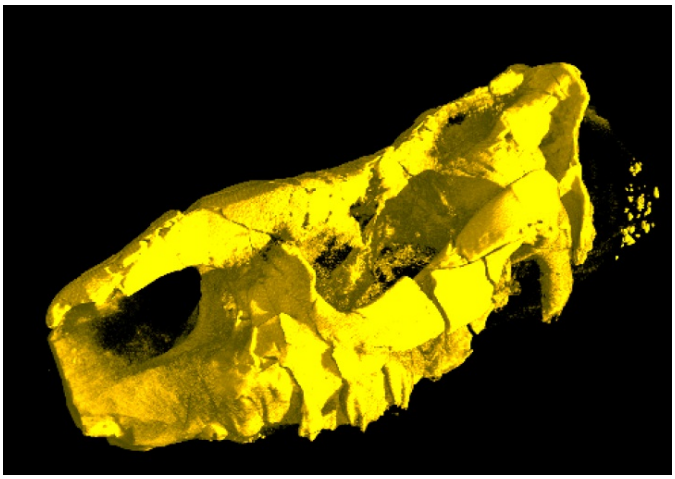
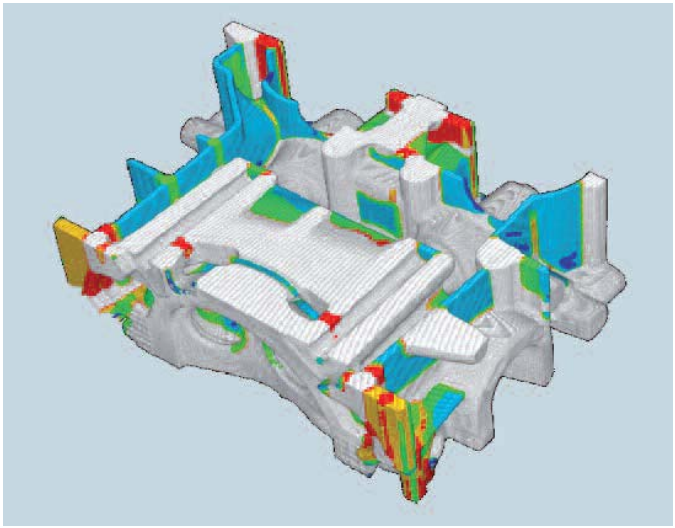
Empa specialist Alexander Flisch preparing the petrified rhinoceros skull for a computer tomography scan.



The computer tomograph "resurrected" the ancient pachyderm's skull, without having destroyed the fossil.



3D-computer tomogram of an engine.

Text and images are available electronic form at: redaktion@empa.ch