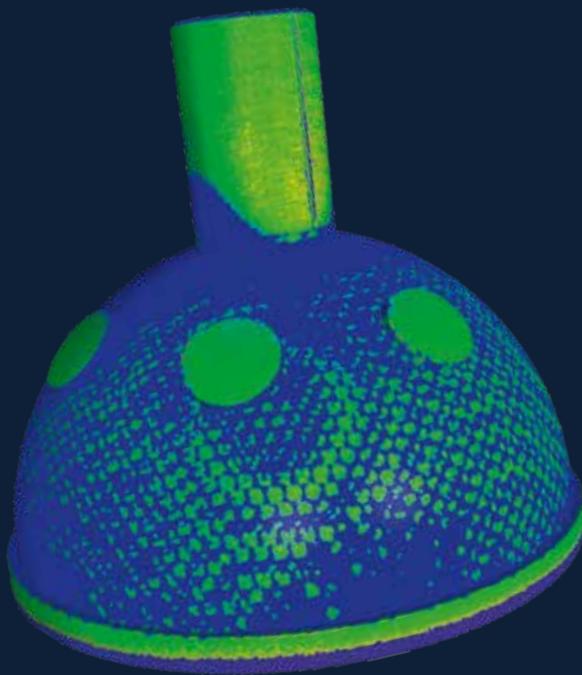


**CT and AM Working Together
to Serve Orthopedics**

Additive manufacturing (AM) is used successfully as an innovative production method in medicine, and especially in orthopedics. X-ray-based computed tomography (CT) is the only non-destructive testing technology that delivers complete and highly accurate data on scanned objects, including their internal structures, in the shortest possible time. However, even in the development and design phase, CT is the ideal tool for manufacturing high-quality, flawless, and perfect-fit products and for enabling manufacturers to satisfy the exacting demands placed on specialist orthopedic products, such as 3D-printed implants.

Additive manufacturing, also known as 3D printing, is becoming increasingly important in the orthopedic industry through the production of tailor-made implants, medical products, and orthotics made



3D printed acetabular cup implant of Ampower GmbH & Co. KG. Scanned with the high-resolution CT system YXLON FF35 CT

from a range of different materials. AM technology reduces surgery times, supports customized designs, helps to ensure better long-term stability of the implant, and improves the clinical outcomes of surgical interventions. It is primarily the design freedom that 3D printing offers for complex structures that has made this technology a valuable tool on the healthcare market. There are also various tasks that require different methods and materials.

3D metal printing is used to manufacture patient-specific implants. Micropore structures require better biocompatibility between metal and bone. Polymer printing technologies are used to produce surgical templates that improve precision during operations. Polymer implant models allow surgeons to practice and perfect complex surgical techniques on a realistic model ahead of the operation itself. To do this, the patient's medical MRI and CT data are used to create 3D CAD data, which are then used to print the anatomical model. The surgeon is able to ensure more precision, reduce risks and perform the operation faster.

Higher demands on implants also mean completely new challenges for design and manufacturing. Trends indicate that ever-younger patients are requiring a hip replacement. They want to continue pursuing their active lifestyles unrestricted, with cycling, swimming or jogging.

Orthopedic implants that have been developed especially for the patient can be very expensive and time-consuming to produce if they are manufactured using traditional production techniques such as casting or forging. AM, on the other hand, allows these individual implants to be produced quickly and, at the same time, with superb precision. Matrix or grid patterns can also be created on the component surfaces. These patterns support osseointegration and reduce the risk of rejection. The human skeleton is made up of over 200 bones and around 360 joints, which vary in terms of their characteristics from individual to individual. The sheer complexity of this becomes clear if you imagine having to manufacture and test an implant that needs to replace one of these important

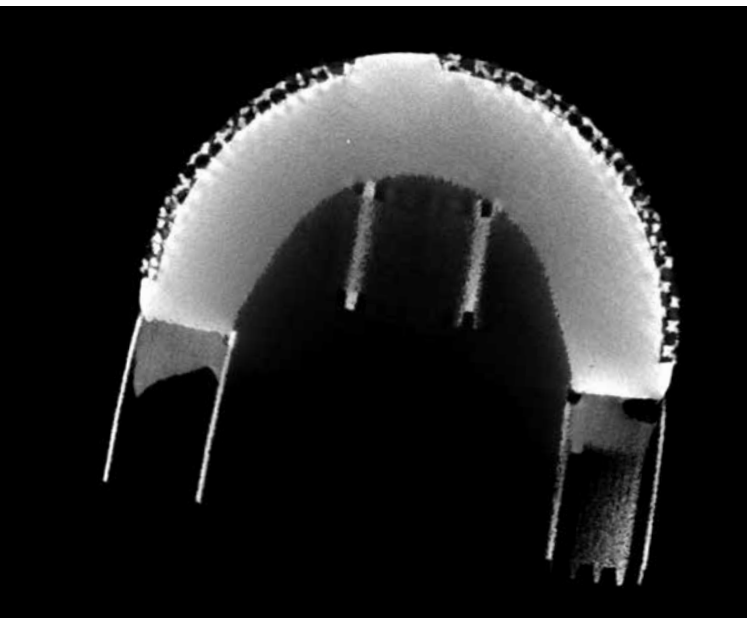
functional elements. The more complicated and complex the structure is, the harder it can be to work with. For production facilities, it can be a major challenge to remain productive. Computed tomography offers significant support to additive manufacturing.

As a non-destructive testing technology that makes the internal structures of objects clearly visible, computed tomography is usually the best and most reliable method for testing and measuring complex components. Implants need to fit the individual human body perfectly and be biocompatible so that they can improve the patient's quality of life in the long term. 3D printing facilitates the manufacture of such components, while CT ensures freedom from defects when conventional methods such as laser, light, or contact measurement technologies reach the limits of their capabilities.

Today, more than 100,000 acetabular cups are additively manufactured each year for use in hip replacements. They are produced in standard sizes

such as small, medium, and large, and then adapted to the patient's size and height. The careful testing of these components with CT technology even in the design and engineering phase, before they go into series production, helps to ensure that the acetabular cups meet all of the relevant specifications. This is crucial since the grid structure must fit perfectly for the bone to grow into the implant. Another important step in this strictly regulated medical industry is the certification of the production method. This includes identifying the best powder and the best parameter settings for the process in order to print the required design. It can normally take months until everything is aligned correctly. CT can significantly accelerate this process through the exact testing of powder quality and rapid identification of the correct parameters. Some of the typical defects caused by the powder bed melting process, such as porosity, lack of fusion, excessive surface roughness and trapped powder, can have fatal consequences for the patient. If powder remains in the sample, for example, it can be very dangerous for the patient receiving the implant since the human body can absorb the titanium powder into the bloodstream. With CT scan data, these problems are detected early, protecting the patient and at the same time increasing productivity.

According to a recent report by Frost & Sullivan, the orthopedic industry is set to expand further in the global medical technology sector. It is anticipated that the market will reach US\$ 43 billion by 2024. Key factors driving market growth include the continued rise in degenerative diseases, the growing geriatric population, increasing obesity and sedentary lifestyles, and early onset of musculoskeletal disorders. In the same way, additive manufacturing will play an increasingly important role in medical technology thanks to its numerous advantages. Industrial computed tomography (CT) is used from the design stage to ensure that critical products such as prostheses meet individual patient needs, are safe, and meet or even exceed legal standards.



The careful testing with CT technology already in the design and engineering phase helps to ensure that the implant meets all of the relevant specifications.



GERMANY – HEADQUARTERS

YXLON International GmbH
a company of the Comet Group

Essener Bogen 15
22419 Hamburg
Germany
T: +49 40 527 29-0
www.yxlon.com

Authors:

Jeff Urbanski and Nils Achilles, YXLON International GmbH

Images courtesy of Ampower GmbH & Co. KG