UNIT-5- ADDITIVE MANUFACTURING APPLICATIONS

Prosthetics and Orthoses

3D printed components also have many applications for prosthetics.

For a long time, 3D printing has been a useful manufacturing process for specially adapted prostheses and orthoses. Compared with other manufacturing processes, 3D printing allows you to produce individual parts that are specially tailored to an individual patient, inexpensively, quickly and easily.

Use of additive methods in prostheses and orthoses

Parts have to be specially adapted in the production of both orthoses and prostheses. However, whilst in prosthetics missing limbs or body parts are replaced, in orthoses the goal is usually more the support or immobilisation of individual limbs or joints. In both cases, additive manufacturing helps enormously in bringing innovative ideas to market faster and more cost-effectively. This way, people who urgently need the assistance of these medical aids can get assistance more quickly.

An example of this is the faster product development of exoskeletons - i.e. orthoses, that allow users a better functioning musculoskeletal system.

Manufacturing processes such as injection moulding often take a long time, while the waiting period for 3D printed parts is far less. 3D printing has similar advantages in the production of innovative prostheses, which need to be specially adapted to the respective wearer, or in prototypes of and entire new generations of prostheses which, like exoskeletons, have yet to go through a product development cycle.

2.4 Models for Planning, Research and Training

Modern imaging techniques such as CT and MRI give doctors much better insights into the human body than was the case a few years ago. These methods have played an essential role for doctors helping them diagnose diseases in their everyday work. These diagnostic imaging techniques also have a significant impact in their preparation for complicated procedures and operations.

This is another area where additive manufacturing processes can help. Modern imaging techniques are so accurate they can be used to create 3D printed life like models of the relevant organ on which a surgeon can trial the operation before the actual procedure. These models are also suitable for determining optimal approaches or trying out riskier procedures without risk to the patient. Because flexible materials can also be printed using additive manufacturing, the models can also have characteristics that you would expect from the biological material.

Replicas for research and training

Replicas of organs and skeletal parts made of a variety of materials using additive manufacturing also provide universities and colleges with the opportunity to gain a deeper insight into the human body.

While conventional replicas of anatomical parts have often been expensive and of poor resolution and quality, today's 3D printed replicas present a viable alternative to conventional modelling. Models made for surgical preparation can be used for training medical students, illustrating malfunctions of the human body and displaying disease in realistic examples.

The replicability of examples like these, is a major advantage of 3D printing. Particularly in cases involving a specific body part or organ, you can generate any number of models for medical faculties worldwide.

3. Looking to the Future - Applications of 3D Printing in the Medical Industry

Few new technologies have changed medical research as much in recent years and decades as additive manufacturing. At the moment, the development of additive processes and the possibilities created is still in its infancy. Work is currently in progress on a variety of new, modern applications that could change the medical world and our understanding of healing and care over the coming decades.

3.1 Current Research into Organic Materials

So far, the metals and plastics used for medicine are well-suited to 3D printing. These materials can help with patient care, but quickly reach their limits when it comes to living material. There are, for example, already the first 3D printed prototypes replicating entire organs, such as the heart; but since the material is not organic, not designed to remain permanently in the body and is not designed for the high stresses of everyday life, these are currently only being used for

individual prototypes. Developers and researchers are now focusing on innovating/ improving processes for printing organic materials for the future.

Current experiments mainly focus on applying additional tissue from cellulose and organic materials to existing structures, which are then suitable for implantation, leading to functional tissue. The benefits of such a technology, once fully developed and usable, will be enormous. Machines could produce vessels, organs or muscle tissue to be implanted into the human body. Research projects, such as an artificial heart produced via 3D printing, have proven that replicas of entire organs work and can potentially save lives. By extending and improving such systems, the lifespan of the implants could be extended from a few hours to medically useful time intervals.

In addition to this research, other experiments are taking place which may improve medical care in the future. For example, work is currently being carried out to produce human skin in so-called bio printing processes, to produce biological prostheses such as ears and to print organic material directly onto the patient. 3D printed tissue is also well-suited for trials and testing of new drugs and medical applications. In future, the best-case scenario would be that animal and human trials testing new, active substances would become redundant.

The innovative power of 3D printing in the medical field is almost unlimited. This is because of its flexibility, for example in the production of complex geometries. This is a major benefit, especially when considering the complexity of some medical applications, which typically involve working in difficult to access areas that allow little margin for error.

3.2 Optimization of Existing Processes

In the near term, applications of 3D printing in medicine will be towards processes that are already possible and how well everyday clinical practice can incorporate them.

Currently no other area produces as much innovation as additive manufacturing. This is due to the fact that constant development of processes and improvements to existing processes always generates new applications for 3D printing.

Techniques such as stereo lithography, direct metal laser sintering and polymer have gradually emerged and have been constantly evolving to print a wider variety of materials. In future there will be additional 3D printing processes to expand and optimize the range of possible applications. As new processes develop, the choice of materials will continue to expand and provide additional solutions. Subsequent advances in organic materials, new additive methods and results from future research, promise far-reaching innovations.

3.3 How will 3D Printing Work with Medical Facilities?

When it comes to additive manufacturing and medical applications, people have suggested that hospitals and research institutions might need their own machines and be able to use them, problem free. This is currently not the case, specialist companies are the primary manufacturers of implants, orthoses, prostheses etc. which are then sent to hospitals or end-users. Having 3D printers in hospital basements is unlikely to be common anytime soon.

One big reason for this is that the machines used for the production of bone implants made of titanium, for example, are very expensive to buy and use, and the additional post-processing of printed implants incurs additional expense. In addition, the use of additive manufacturing processes and machines requires a considerable amount of specialist knowledge and training. The fact that these procedures will be even more differentiated and that specialist companies have more extensive production options is another argument against its direct use in hospitals.

Instead the cooperation between hospitals and medical professionals and companies specializing in modern manufacturing processes for prototype production and additive manufacturing, will expand and become more interconnected. Since a wide variety of new applications are already emerging, the importance of additive manufacturing within medicine

will continue to increase. Doctors in generations to come will wonder how medicine ever managed without 3D printing.

B. Conclusion: 3D Printing in Medicine - A Technology of Today and Tomorrow

Whilst 3D printing has been with us for almost 40 years and has continued to evolve, the application of this manufacturing technology in medicine is still relatively new. Yet, the benefits of 3D printing have been quickly recognised by the medical community, and its applications are already very diverse.

With implants of any kind, specific designs for operations, medical instruments and the use of 3D printed parts for preparation, research and training - other technologies are increasingly fading out. And with the quality management system for medical devices – ISO 13485 – now recognised within the 3D printing supply chain, additive manufacturing is able to meet strict legislative requirements across the world.

In the future, new materials and processes will increase 3D printing's importance to medicine, and it will be hard to imagine the everyday life of patients and doctors without it. Science and

applied research have long been working on applications that will surpass the wildest expectations of many doctors. In fact, to speak of a boom in medicine thanks to additive manufacturing is, if anything, an understatement.

For the sick and injured, 3D printing promises improved chances of recovery, the alleviation of pain and a better quality of life, which is surely the most important goal of all.