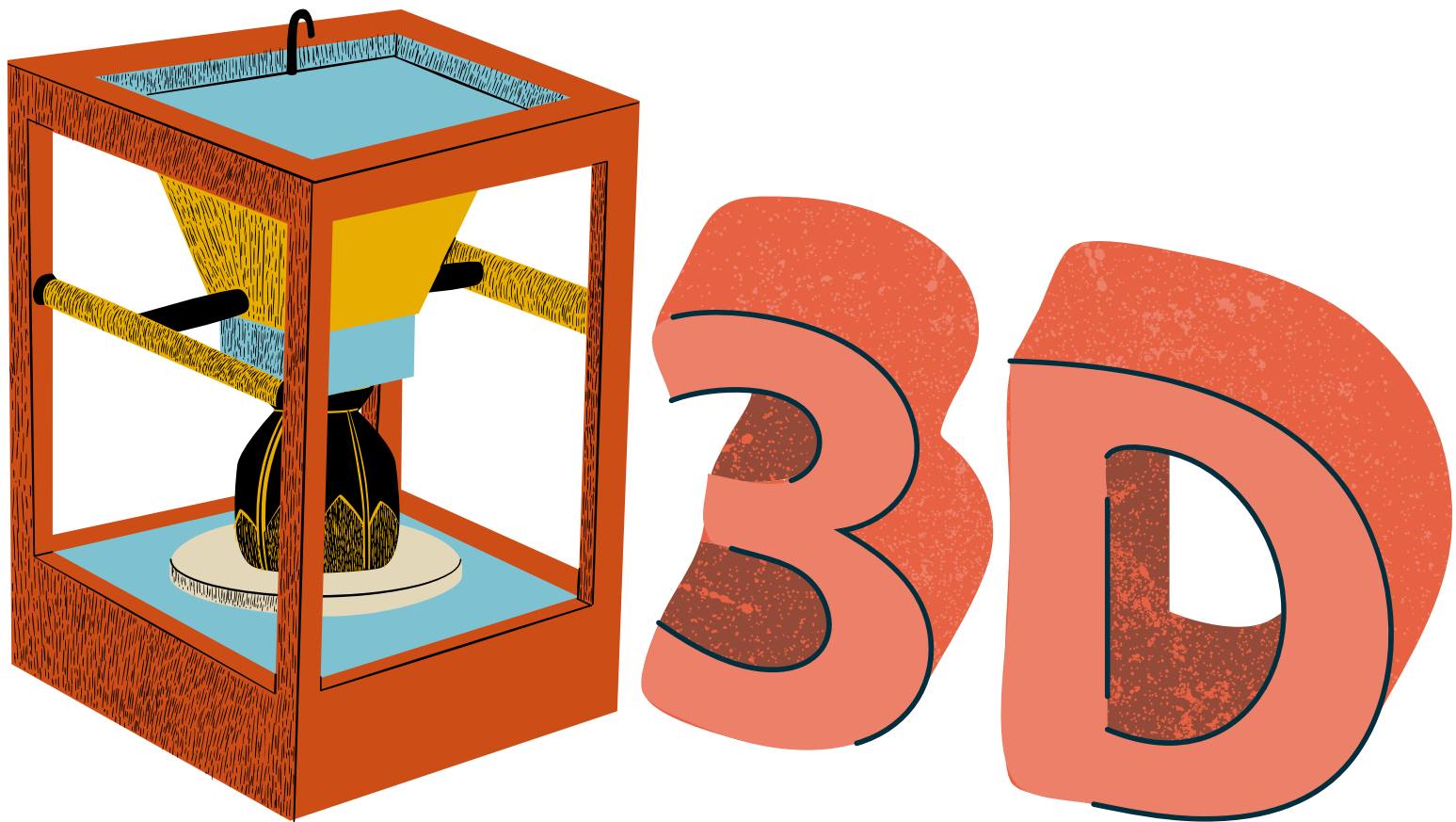
GTL Project

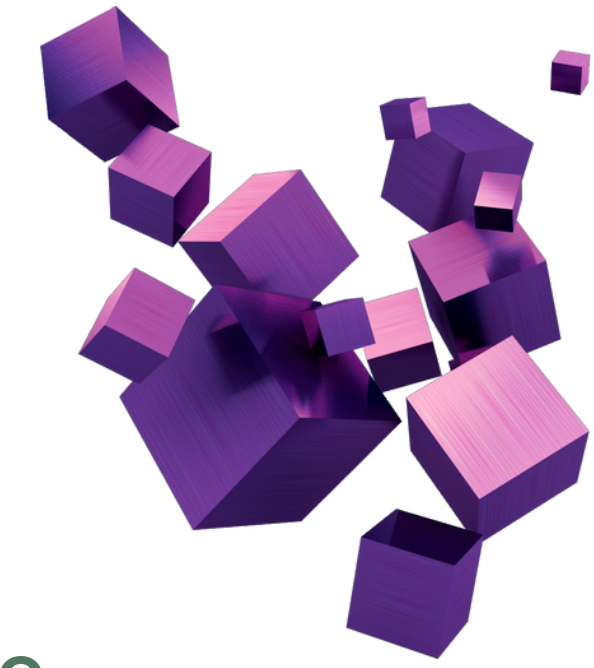
GreenTecLab

3D printing - Innovation Potential and Sustainability



3D printing - magic or useful technology?

Almost anything can be produced with a 3D printer, so it seems.



3D printing is conquering research, medicine, business, art and now even private households.

This informative overview is intended to raise awareness of the chances and challenges, also from the point of view of sustainability.

What is 3D printing?

3D printing is the umbrella term for manufacturing processes in which three-dimensional objects (3D), which have previously been designed and programmed using a computer-aided design system (CAD), are built up layer by layer using a technical device, the printer.

Depending on the manufacturing process, different materials can be used for the layer-by-layer construction, in liquid, solid or powder form. Physical or chemical curing or melting processes take place when the layers are built up.

Difference additive and subtractive method

Additive Method

When building up an object (workpiece) layer by layer and precisely, we speak of additive processes. Therefore, additive processes are in principle more resource-efficient.

Subtractive Method

Subtractive processes are when objects are carved out of a block of material (wood, metal, stone, plastic) by drilling, milling, sawing or grinding, which inevitably leads to high material losses.

Processes and Materials

There are different processes for 3D printing:

1. **PBF, Powder Bed Fusion Processes:** thin layers of powder are applied layer by layer to a carrier plate and fused or sintered together.
2. **EB, Extrusion Based Processes:**
    a. Liquid material is applied by nozzle layer by layer and chemically cured (chemical EB)
    b. Plastics in the form of continuous filaments are melted via heated nozzles and applied layer by layer to a carrier plate and hardened (physical EB, also Fused Deposition Modelling, FDM).

The materials used are plastics from petroleum, but also plastics from renewable raw materials or composites, synthetic resins, ceramics, clay, metals. These materials are used in powder form, in liquid form or in solid form, e.g. as filament.

Innovation potentials

Construction

The various processes offer new options in the production of objects. In particular, the possibilities of lightweight construction and the ability to apply the material more densely with pinpoint accuracy enable new mechanical material properties and offer innovations, e.g. in the field of aircraft construction.
Other innovative aspects are the development of "digital materials" and new alloys with specific properties as well as hybrid constructions with a combination of conventional construction and 3D printing.

Production

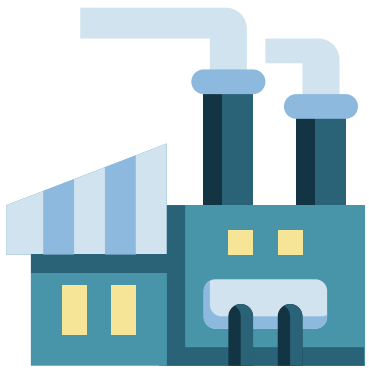
New design and production possibilities and an individualisation of manufacturing make 3D printing interesting in industrial production, both for individual and small batch production.

The higher local flexibility in 3D printing production can lead to the development of a new generation of producers.

Areas of application of 3D printing I

The innovation potential and new possibilities of 3D printing have led to its rapid use in various areas.

Research
In research, 3D printing is an important driver of innovation because it is a simple and cost-effective process. Errors can be identified quickly, models can be improved and tested more easily.

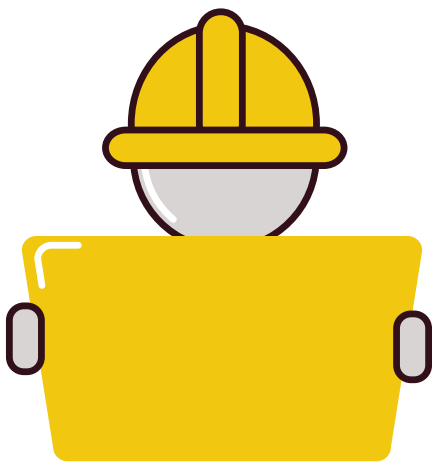


Industry and craft
Prototypes can be produced with less time, energy and material (rapid prototyping).
3D printing offers new design options and individualisation of manufacturing. Especially for the production of small series, 3D printing is often more cost-effective.

Medicine and dentistry
In medicine, 3D printing is used to create custom-fit models of prostheses and implants as well as the finished prostheses and implants.

Areas of application of 3D printing II

The innovation potential and new possibilities of 3D printing have led to its rapid use in various areas.



Construction/Building

In construction, there are now "traditional" prefabricated houses that are "printed" from clay mixtures, for example. In construction, 3D printing also offers completely new possibilities in design, e.g. transportable igloo houses as well as in insulation (termite houses). And all this with low labour input, low construction costs, fast production and the possibilities of self-building.

Arts

In art, 3D printing is increasingly used for the creation of sculptures and reliefs as prototypes, for the creation of own small artworks as well as replicas.

Chances and challenges for the environment, society and health I

Resource consumption

The great advantage of 3D printing is the resource-saving consumption, as it is an additive manufacturing process.
But unnecessary prototypes must be avoided.

Recycling

In certain processes (photopolymerisation), the materials are currently not recyclable. The processing of different materials in one object makes it difficult to separate them by type. Recycling concepts and possibilities are still lacking.

Energy consumption and pollutants in the manufacturing process

The energy consumption of 3D printers is still relatively high, especially if the printers are not in continuous use and have to be heated up often. Fine dusts, toxic vapours and fumes are produced. Occupational safety must develop protective concepts accordingly.

Chances and challenges for the environment, society and health I

Materials

The basis of most plastics used for filaments is petroleum. The alternatives, biodegradable plastics, are still expensive. Even biodegradable plastics (PCL and PLA) cause CO2 emissions through the cultivation of the crops and their processing. In addition, there is the consumption of agricultural land.

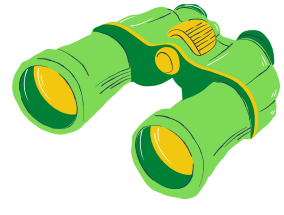
A promising idea seems to be the use of "waste products" for the production of the filaments, for example whey.

Social Aspects

The possibilities of local flexibility, the development of new production sites and new producer groups must not lead to environmental, social and consumer standards being bypassed.

3D printing as an alternative

From today's perspective, 3D printing will not completely replace traditional manufacturing processes in industry and trade.



It represents an addition to the existing manufacturing processes with innovative possibilities.
Therefore, it is always necessary to weigh up which type of manufacturing is chosen in each individual case for environmental reasons, for cost reasons, for reasons of better suitability: traditional process, 3D printing or hybrid process.

Visit our Website if you want to learn more about financing und funding opportunities

GreenTecLab

- https://www.ab3d.at/faktencheck-wie-umweltfreundlich-ist-3d-druck/
- https://www.3d-grenzenlos.de/magazin/thema/umweltschutz/
- https://www.umweltbundesamt.de/themen/umwelt-gesundheitswirkungen-des-3d-drucks