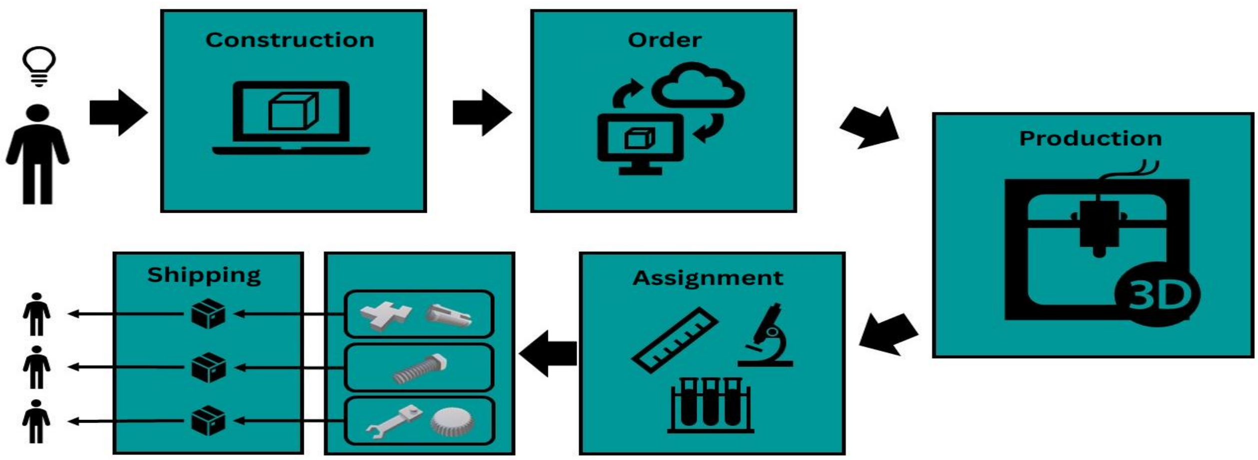
Automatic component recognition in additive manufacturing with the help of artificial intelligence

(A technical article from 2019, author: M.Sc. Tobias Nickchen, doctoral student at Protiq)

Industrial companies are in constant competition with their rivals. In order not to be left behind, it is necessary to continuously optimize internal processes. To do this, all areas of the process chain must be considered. As part of this, Protiq GmbH has examined the optimization potential in the sub-process of component order allocation.

In the field of industrial manufacturing processes, additive manufacturing is a comparatively young, up-and-coming production process. Additive manufacturing offers various advantages over conventional manufacturing processes.
The production costs of a component are largely independent of the number of units to be produced.

As no product-specific tools or molds are required for production, even individual pieces can be manufactured at low cost.
Furthermore, the low production technology restrictions result in a high degree of design freedom. The combination of these two positive aspects makes the process ideal for the production of custom-made products or prototypes. This offers both private and industrial users the opportunity to realize almost any creative idea.



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Optimization of the process chain

In order to minimize the time from the idea of a component to its delivery to the user, it is necessary to optimize the entire process. At Protiq GmbH, large parts of the process chain are already automated. This leads from the design and the actual production process through quality control to the finished component, which is delivered to the customer. The calculation of production costs based on the CAD model of the component, as well as further steps in digital pre-processing and mechanical post-processing of the components, have already been optimized at Protiq GmbH through automation. However, in order to further minimize the time from the idea to the actual component for the customer, it is necessary to consider and optimize the entire process chain. In this context, Protiq GmbH took a closer look at the process chain section of component allocation after the Selective Laser Sintering (SLS) process.

Selective laser sintering

Selective laser sintering (SLS) is the most widely used process for the additive manufacturing of plastic components in industrial production. This is a powder-based process. Plastic powder is applied layer by layer in a build chamber and melted with the help of a laser where the component or components are to be produced. The material hardens immediately after melting to form a solid plastic body. By applying the powder layer by layer, a three-dimensional body is created piece by piece. With SLS, it is possible to produce not just one component in an installation space, but any number of different components nested three-dimensionally in the space, thus making optimum use of the installation space. However, this means that the components produced together have to be separated and sorted again after production. As this requires a lot of manual time, it makes sense to use automation technology methods to simplify the process.

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Support through machine vision

The automation of production chains through the use of robotics with associated sensors and actuators has long been the standard in many industrial processes in the age of Industry 4.0. One example of the use of machine vision in series production is the conveying and sorting of goods on conveyor belts. The use of modern camera technology enables the automatic identification of objects, including their position and orientation on the conveyor belt. This means that objects can be picked and processed automatically by robots without human assistance.

Machine Learning

In order for machine vision systems to automatically distinguish between different objects, they need information on how they can recognize individual objects and how the different objects differ. These object properties are called features. In the case of series production, the objects to be gripped are always the same series parts. This offers the advantage that when setting up a new production line, the features for differentiating the individual objects can be generated manually using the objects. Although this manual feature engineering is relatively time-consuming and can take days to weeks, it only needs to be carried out once per production line. In addition, the machine vision system can be optimally adapted to the objects to be sorted.

However, the SLS process is not usually used for series production. Service providers such as Protiq GmbH produce hundreds of different components every day. The conventional procedure for commissioning a sorting system is therefore not practicable. Daily manual feature engineering to sort the current components is simply not possible. Machine learning (ML) approaches must therefore be used to enable automated sorting of the components produced despite this.

Deep Learning

The use of machine learning methods is widespread in image processing. One area of research in the field of ML is deep learning (DL). The name is derived from the use of deep learning systems such as deep neural networks (DNN). These systems are able to learn many non-linear problems independently using existing training data. The advantage is that manual feature engineering is no longer necessary. Instead, the system independently learns so-called deep features based on the training data. In the case of sorting, these are learned in such a way that the individual objects can be optimally differentiated by the features.