QuLS: QUALIFICATION OF LASER SINTERING SERIAL PRODUCTION

Reliable and repeatable part properties are indispensable to include polymer laser sintering in the industrial process portfolio of many companies. With the methodology presented here, not only the process flow from component to post-processing is considered, but also the machine performance is tested in an interlaboratory comparison and over a longer period of time. The backbone of the study is the DMAIC (Define - Measure - Analysis - Improve - Control) improvement cycle which originates from the Six Sigma approach. It was shown, that the proposed methodology is simple and flexible to use for the qualification of AM processes whereby the industrial level of the EOS P396 was evaluated.

PROJECT OVERVIEW

DURATION

01/2018 - 01/2019

PARTNER

Industrial Consortium of DMRC

FUNDED BY

Industrial Consortium of DMRC

RESEARCHER

Research leader
Prof. Hans-Joachim Schmid

Research assistent
Helge Klippstein, M.Sc.

WEBSITE

https://dmrc.uni-paderborn.de/content/research/internal-projects-2018/qualification-of-ls-serial-production/

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Qualification Methodology

Within this project the improvement cycle define - measure - analyze - improve - control (DMAIC) is applied for the qualification of the polymer laser sintering process with an EOS P396 system. This approach enables process qualification with a wide range of qualification objectives. It allows the process to be adapted flexible to the specific needs of different industries. The wor k packages for qualification are the following:

- **Definition** of a standardized workflow
- **Measureing** SLS parts based on quality criteria
- **Analyzing t**he measurements and potentials
- **Improve** the standardized workflow
- **Control** of improvements and overall process

The standardized workflow focuses on the process flows: design, pre-processing, powder material, machine process and finishing. In the end-to-end process, these sub-items are complemented by general headings such as query and order creation, human resources, environment, utilities, infrastructure, finishing, quality control, warehouse, storage and logistics.

For the methodology, quality indicators are defined first to measure the performance of the process. The mechanical properties are measured by the tensile test and Charpy impact test. For the length deviation, a component is measured with the aid of an outside micrometer. The surface properties for different construction angles are measured optically. In addition, the component density is determined using the Archimedean buoyancy method. Within the test plan, several further test specimens can be added and examined.

Quality Assessment and Test Layout

As shown in the diagram (Figure 1), the performance can be measured continuously for each build job of a series production. For this, test components must be placed in the job layout of series production which reduces the usable space. At the same time, the interpretation of the results is difficult because the measurements are often dependent on the position in the build room. Alternatively, quality assessment (QA) can be performed together with the maintenance period. This would correspond to a frequently inspection of the machine. However, it would not be possible to make a statement about the intermediate manufacturing jobs. Within the scope of this project, a QA-job is produced and measured six times on three different machines. The aim is to examine the serial capability of the machine and to record the performance limits of the various quality criteria. For industrial applications, a combination of the different measuring approaches is recommended.

Since the position within the construction contract is known to have an influence on the component properties, the test specimens must be positioned over the entire construction volume. These influences can be local defects as agglomerates or systematic deviations such as temperature fluctuations, laser spot shape and focus point etc. The test volume is set at ~300 mm height of the EOS P396 machine. The entire layout of the build job and the test parts are shown in Figure 2. The build room is divided into 27 test areas bounded by cubes. Inside these cubes are different specimens and test samples for the quality criteria measurements (Figure 3). The test specimens are positioned in such a way that they cover the weakest position and building orientation as far as possible.

Summary

The laser sintering process with polymers was investigated over a period of half a year and various powder batches and machines were used to assess the influences. The results of the analysis show high deviations which are due to the measuring method as well as the laser sintering process itself. A catalogue of measures was proposed for the Improve and Control work package. These include quality control card limits for mechanics, external dimensions, surface and density and thus a continuous quality measurement. This also enables the introduction of a statistical process control system.

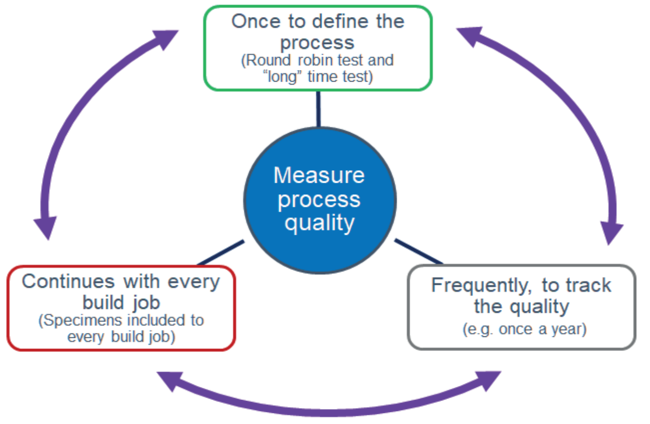

FIGURE 1 Quality assessment and assurence methodology

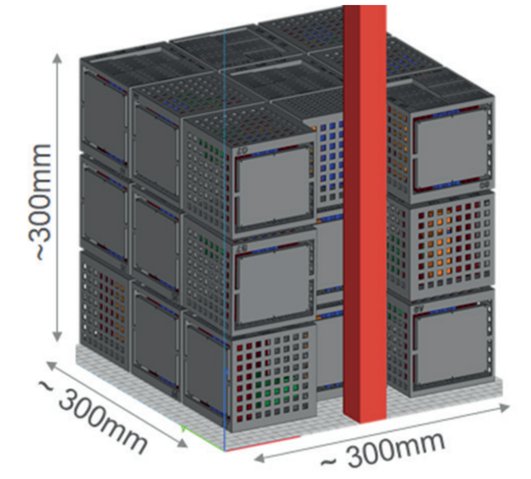

FIGURE 2 Quality assessment build job layout

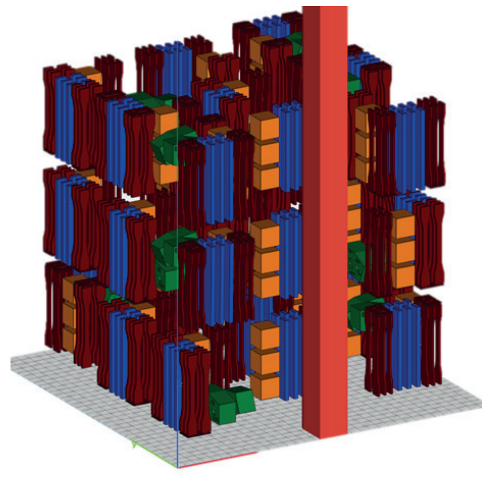

FIGURE 3 Quality assessment build job layout, without sector cubes