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Spare parts for selectively assembled linked parts in micro production

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Abstract

Production processes with small tolerances are still challenging the industry. The increasing competitive pressure raises the necessity of economically efficient processes. Assembling parts while considering part-specific clearance enables a widening of the tolerance field by considering trend specific clusters and matching. Two or more otherwise rejected parts are assembled to one functional assembly. Assembling parts under consideration of a trend-specific clearance affect the interchangeability of the assembled parts. In the case of small tolerances and a high widening of the tolerance field a systematic identification of the number of spare parts is required. An approach for considering spare parts and therefore, the interchangeability in the concept of tolerance field widening is presented.

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Keywords: maintenance; micro forming; tolerance field widening

1. Introduction

The production of micro parts in high quantities and quality still challenges the industry. These parts are characteristically smaller than 1 mm in at least two dimensions [1]. Size effects that could be categorized concerning the density, shape and micro structure affect the production of these parts [2] [3]. Regarding the handling of micro parts, especially the adhesion of parts with comparatively low weight in ratio to the surfaces´ dimension increases the complexity of these processes. An upscaling of micro parts through the production as linked parts enables a simplified handling as macro parts [4] [5]. Metallic linked parts are divided into three kinds as depicted in figure 1. The ladder type, where parts are left in belt material, a line type, where the parts are interconnected through wire as well as a comb type [5].

The production of linked micro parts enables a widening of the tolerance field by a trend based joining of micro parts. This approach could be used due to the defined sequence of the parts and the resulting defined position. This offers the opportunity to build trend based sections which could be matched under the consideration of the clearance. Moreover, the nominal value is adjusted within this approach. This enables a joining of parts while considering the clearance of one pair of parts [6]. The goal of the tolerance field widening is mass micro production with more than 300 pieces per minute. Micro parts could be produced in high quantities with high quality by linked parts and tolerance field widening.

The widening of the tolerance field increases the number of micro parts due to the consideration of one part-specific clearance. Therefore, the interchangeability of these parts decreases. The paper shows how the methodology of tolerance field widening must be extended for the consideration of interchangeable parts.

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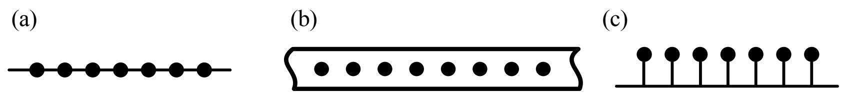

Fig. 1. (a) line type, spheres on wire; (b) line type, cups in belt material (c) comb type, spheres on wire.

Nomenclature

C_n	Cup Cluster n
S_n	Sphere Cluster n
P_{SnCn}	Number of joined parts

2. Tolerance field widening

During production processes, trends, which are for example caused by wearing, often occur as shown in [7] and [8]. As a result, the measurements of parts are not in tolerance range anymore. In micro mass production, where tolerances are in range of micrometers or nanometers these tolerances are smaller than in macro range [9]. The number of assembled parts could be enlarged through the consideration of piece-specific clearances [6]. In micro range, the consideration of bulk parts for assembly processes causes complex processes [5]. Therefore, the consideration of linked parts enables the production of higher quantities with less complex processes. The concept of tolerance field widening is based on linked parts. This provides parts in the production sequence and the present trends could be used for the maximization of the number of joinable parts. In order to accomplish this, three steps are required [6] as depicted in figure 2. The widening of the tolerance field is depicted, using the example of cups and spheres that are produced as linked parts. These parts should be assembled regarding the clearance of the parts.
For the consideration of trends, the first step is to measure the parts of both types and the diameter, which is significant for the join-ability, is observed. This is the basis for the building of clusters. The consideration of the variation of trends, while forming clusters is mandatory for enabling large sections. The size of the sections affect the performance of the process. Smaller sections result in a higher number of interruptions caused by handling. The second step of the methodology maximizes the outcome of the assembled parts. For this, the clusters are combined iterative and the combination with the maximal number of mountable parts could be chosen for assembling. Within the third step, the nominal value is shifted. This leads to an improved design parameter, while the adjusted nominal value enables that further batches are produced with a higher outcome. The shift of the nominal value results in a shift of all measured data using the same value. Following to this, the number of parts that can be assembled is iteratively proven by another matching for assuring that the number of assembled parts is improved [6].

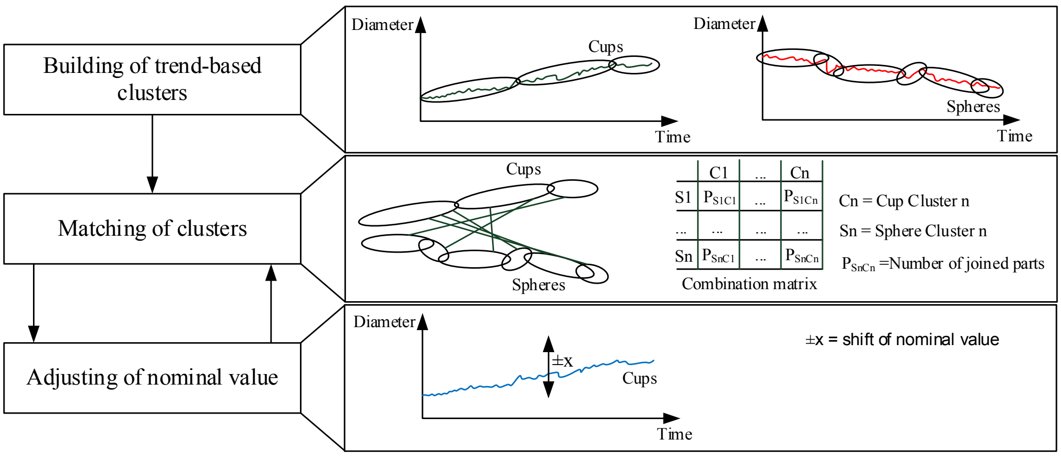

Fig. 2. Methodology of tolerance field widening.

The concept of producing linked parts enables high quantities in complex processes. Due to the tolerance field widening the cost-effectiveness could be increased. However, the widening of the tolerance field complicates repair and maintenance processes. The diversity of possible measurements of diameter, using the example of cups and spheres, makes these processes more difficult. Spare parts must be available, with the consideration of the size of parts. Therefore, the ejection of parts that are required for repair