Development of a Measurement System for Walking Excavator Outer Tubes

Graduate

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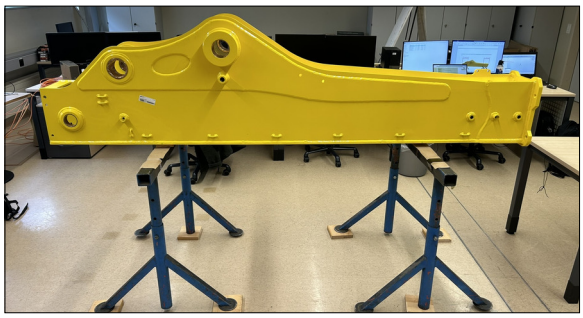
Initial Situation: The company Kaiser AG in Liechtenstein manufactures mobile walking excavators with a telescoping dipper arm. The telescoping mechanism consists of two square steel tubes that slide against each other and are guided by slide bearings. Due to welding-related manufacturing inaccuracies, these bearings must be individually adjusted with "shim plates" to minimize play and prevent jamming or excessive forces. Currently, this play is manually adjusted in the retracted position based on the experience of the assembler, making reproducibility only partially achievable.
A solution is needed to precisely measure the internal geometry of the approximately three-meter-long square tubes, with a focus on identifying the smallest and largest points in the width and height of the dipper arm. This would allow for more accurate adjustment of the components.

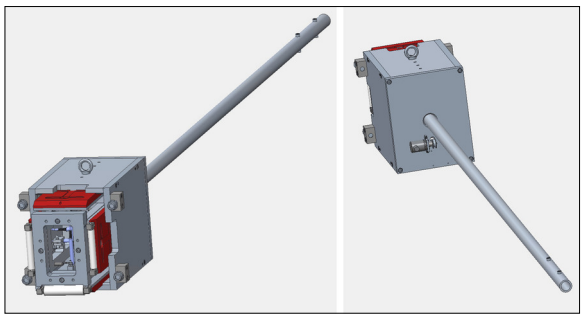
Approach: To achieve this goal, a comprehensive research on various measurement methods and potential solutions was conducted as part of the technical module. With this knowledge, four solution variants were compiled and evaluated using a rating system. The decision was made in favor of the concept "Hand-guided measuring head with guide plates and measuring carriage." This concept then entered the development phase and was designed using CAD software. The development status was regularly reviewed and improved with the responsible parties at Kaiser AG and the referees. Finally, all parts for a first prototype were ordered at the production facility at the Buchs campus. At the same time, all necessary reference measurements on the dipper arm were carried out using a laser tracker provided by the manufacturer Hexagon. Additionally, a calibration of the measuring carriage was performed using an articulated coordinate measuring device provided by the Competence Center for Production Metrology at the Buchs campus. The software for evaluating the required sensors was provided by Kaiser AG. During subsequent long-term tests, the measuring system was continuously optimized and the measurement uncertainty reduced.

Result: The prototype developed in the project can reliably determine the smallest and largest points in height and width, as well as their positions. The developed measuring system meets all required measurement uncertainties of less than 0.1 mm. Additionally, the evaluation can reliably convert the sensor values into the required actual values. However, compromises were made in determining the form and positional tolerances. These requirements would have exceeded the predetermined budget and made the design, software, and evaluation significantly more complex. The entire system, or the prototype for measuring the dipper arms, meets the basic requirements for use in the assembly of walking excavators. The measuring setup also provides a promising platform for further development and improvement of the measuring system, making it seem feasible to determine form and positional tolerances in a follow-up project, with the economic feasibility needing to be re-evaluated.

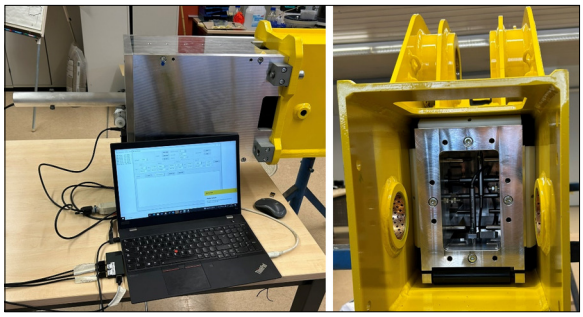
Dipper stick of the walking excavator
Own presentment



CAD model of the developed measuring system
Own presentment



Performing measurements with the developed measuring system
Own presentment



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