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16th CIRP Conference on Computer Aided Tolerancing (CIRP CAT 2020)

Opportunities and Constraints in the Standardization of Geometrical Product Specification

Edward Morse *

UNC Charlotte, 9201 University City Blvd, Charlotte NC 28223, USA

* Corresponding author. Tel.: +1-704-687-8342; fax: +1-704-687-8345. E-mail address: emorse@uncc.edu

Abstract

A key focus of the CIRP CAT 2020 is the role of standardization in GPS specification, and the constraints and opportunities provided by standards throughout the design lifecycle, including in the verification of products. This focus is supported by two Keynote presentations from the chairmen of the ASME and ISO committees that develop standards for the specifications of geometric tolerances. The CIRP CAT conferences provide an opportunity for researchers and practitioners to exchange new ideas and discuss the implications of new and evolving research in the areas of geometrical tolerancing, assembly analysis, modeling of manufacturing processes, and standardization.

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Peer-review under responsibility of the scientific committee of the CIRP CAT 2020

Keywords: Tolerancing; Standardization; Dimensional Metrology

1. Introduction

Held every two years, the CIRP Conference on Computer-Aided Tolerancing allows researchers in the fields of tolerancing, variation, uncertainty, and metrology to gather and exchange their research findings. Although the novel coronavirus prevented an in-person meeting, the keynote presentations, research presentations, and question and answer sessions were all managed in an "e-conference" format.

The theme of the conference was "Opportunities and Constraints in the Standardization of Geometrical Product Specifications" and this theme was supported by having two keynote presentations on the first day. The speakers, Paul Drake and Iain Macleod, are the chairmen of the ASME Y14.5 committee and the ISO/TC 213 committee respectively. Their presentations intentionally had similar structure: giving the history of the committee, describing some of the current challenges at present, and describing a desired course forward as the demands for product specifications continue to evolve.

The titles of the keynote presentations are:

- Geometric Dimensioning and Tolerancing – the work of ASME Y14.5  Paul Drake
- Geometrical Product Specification – the work of ISO/TC213  Iain Macleod

Papers in the following focus areas were solicited:

- Standardization of GPS
- Specification
- Verification
- Tolerance Design / Synthesis
- Tolerance Analysis
- Variation Simulation
- Tolerancing for X
- Metrology Challenges
- Uncertainty in Tolerancing and Verification
- Needs driven by new technologies
- Education and Training tools & efforts
- Industrial applications and case studies

This is a resupply of March 2023 as the template used in the publication of the original article contained errors. The content of the article has remained unaffected.
Many of the papers in this special issue – and the presentations that accompanied them during the conference – made an effort to emphasize the links between the national and international tolerancing standards and the research work being pursued. It is clear that the synergy between research and standardization is particularly strong in the field of tolerancing. The concepts of invariance classes [1] and the duality principle [2] are but two examples of where research and standardization have supported each other. Papers from this conference made new recommendations regarding the use of mathematical tools for tolerance evaluation, filtration for datums, and the reconstruction operation.

2. A perspective on tolerancing

As evidenced by the broad participation in the CIRP CAT 2020 conference, the field of tolerancing research remains healthy. There are two primary drivers for the current evolution of the ASME and ISO tolerancing standards. The first driver is the growing number of fields of application for geometric tolerancing, where advanced manufacturing techniques are allowing more complex geometries to be specified. The second driver is the massive increase in the amount of data available to be analyzed in evaluating a given product. Compared to only ten years ago, orders of magnitude more points can now be measured on the surface of a part, which in turn are evaluated against the tolerance specification for conformance, or fed back to the manufacturing process. In addition, ancillary information about the part and its environment may be stored with the geometric information of the part, forming the digital twin.

The challenge to documentary standards, and the bodies that produce them, is to be sufficiently advanced so that designers have standardized tools with which to describe design requirements, but not be so avant-garde that standards are produced addressing technologies that are still rapidly evolving. Herein lies the role of research: to look for extensions to the structure of specification (and verification) that are based on current published standards, but provide important steps forward to support the growing needs of industry. These ideas can be tested in the laboratory and in other controlled settings to establish their efficacy in controlling the needed requirements, to determine that they can in fact be measured and evaluated, and to see that they have applicability across multiple product domains. This vetting of ideas, coupled with a close relationship between researchers and standards writers, is a fundamental connections that will insure that future standards retain their relevance and technical correctness in the future. It is hoped that the ideas exchanged and relationships established at this and other CIRP CAT conferences will continue to support tolerancing standards for many years to come.

Acknowledgements

The 16th CIRP Conference on Computer-Aided Tolerancing has been organized with the resources of the Department of Mechanical Engineering and Engineering Science at the University of North Carolina at Charlotte. Additional administrative support has been provided by the Center for Precision Metrology. The organizers also gratefully acknowledge the sponsorship of the University of Nebraska – Lincoln, the UNC Charlotte Center for Precision Metrology, and TDP360.

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