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## Statistical Modeling and Monitoring of Geometrical Deviations in Complex Shapes With Application to Additive Manufacturing

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The growing complexity of the shapes produced in modern manufacturing processes, Additive Manufacturing being the most striking example, constitutes an interesting and vastly unexplored challenge for Statistical Process Control: traditional quality control techniques, based on few numerical descriptors or parsimonious parametric models are not suitable for objects characterized by great topological richness. We tackle this issue proposing an approach based on Functional Data Analysis. We firstly derive functional descriptors for the differences between the manufactured object and the prototypical shape, on the basis of the definition of Hausdorff Distance, embedding then such descriptors in an Hilbert functional space, namely the Hilbert space  $B^2$  of probability density functions: such space is a suitable choice for the development of generalized SPC techniques, as functional control charts. The effectiveness of the proposed methods is tested on real data, which constitute a paradigmatic example of the complexity reachable by AM processes, and on several simulated scenarios.

### Keywords

Additive Manufacturing, Hausdorff distance, Functional Data Analysis, Industry 4.0

**Primary authors:** SCIMONE, Riccardo (Politecnico di Milano); Dr TAORMINA, Tommaso (Dipartimento di Meccanica, Politecnico di Milano); Prof. COLOSIMO, Bianca Maria (Department of Mechanical Engineering, Politecnico di Milano, Milan, Italy); Prof. GRASSO, Marco Luigi (Department of Mechanical Engineering, Politecnico di Milano, Milan, Italy); MENAFOGLIO, Alessandra (Politecnico di Milano - Department of Mathematics); SECCHI, Piercesare (Politecnico di Milano - Department of Mathematics)

**Presenter:** SCIMONE, Riccardo (Politecnico di Milano)

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