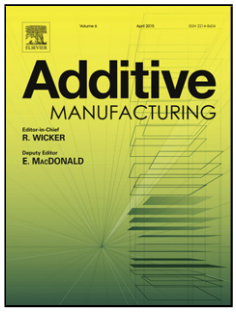

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Integration of FDM surface quality modeling with process design

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Abstract
Fused Deposition Modeling is one of the earliest types of Additive Manufacturing technologies. In this process a physical object is fabricated directly from a Computer-Aided Design model, using layer-by-layer extrusion of a feedstock plastic filament material through a nozzle. It was originally developed for design and functional prototype applications, but in the last decade gained considerable recognition and adoption in industry, due to the process simplicity, affordability and ability to make parts in a range of common engineering thermoplastics. Thus, Fused Deposition Modeling products must comply with tolerance and roughness requirements in order to satisfy a mechanical coupling or functionality. This work strives to develop an integrated methodology able to help the process design, with the aim of meeting the requirements of the product. This method enables prior knowledge of the surface quality of the Fused Deposition Modeling product at chosen process parameters, thereby making an ex ante product check possible. Moreover, the methodology can deliver a set of solutions when the requirements are prescribed for the product features, since it is possible to define the technology capability and analyze the proposed fabrication conditions. This methodology is highly useful in process management in conjunction with other operations, and can aid computer aided process planning since it can predict admissible scenarios.

Keywords
Additive Manufacturing, Fused Deposition Modeling, roughness prediction, accuracy prediction.

Nomenclature

r radius of the theoretical FDM profile peak
f spacing of the theoretical FDM profile
L layer thickness
$\hat{b}$ stratification direction
$\hat{n}$ surface normal
$\hat{n}_i$ normal of the generic *i-th* triangle
α deposition angle
α_i deposition angle of the generic *i-th* triangle
R_a average roughness
Δh dimensional deviation from the nominal value
ξ rotated *x* coordinate
η rotated *y* coordinate
ζ rotated *z* coordinate
φ_x rotation angle around the axis x
φ_y rotation angle around the axis y
$P_k^{(i)}$ vertex of the *i-th* triangle for *k = 1, 2, 3*