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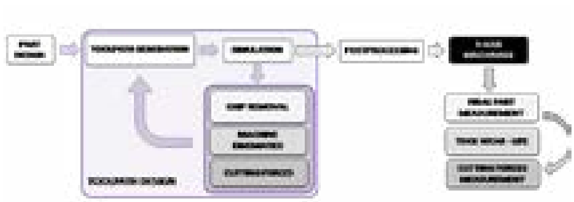
General methodology for manufacturing complex geometries in turbo-machinery components

Aeronautical industry is on the path to steady growth in the last decades. One of the major focuses for manufacturing is turbo-machinery rotary components, such as impellers or bladed disks. The fabrication of these elements presents many challenges to be faced from the designing conception to the arrival in the market. Among them, it is important to point that they are made of difficult-to-cut super alloys and need to fulfill dimensional requirements. In Figure 1, manufacturing process for complex geometries that require 5-axis simultaneously movements is shown. According to the defined process for complex geometries, an IBR was selected as case of study for applying different steps with the aim of establishing a full methodology to fabricate complex geometries. As workpiece material, Inconel 718 was selected, common material in these applications. The proposed process was divided in the following stages: part design and definition, according to industry requirements; tool definition and tool path generation. CAM software is needed to define 5-axis simultaneous movements. A Calleja, et al. developed a model for tool path programming of these components. Digital twin: Simulation of the full machining processes considering every machine component involved in the process. A digital twin of machining process is developed with the aim of predicting collisions or machine kinematics limitation; post-processing and 5-axis machining. Final part measurements and result analysis Not with-standing, improvement in this area of knowledge leads many research to analyze about alternatives to this traditional methodology with new manufacturing technologies, as electrochemical machining, linear friction welding, laser cladding or a new trend known as super abrasive machining and new ways of lubricooling technologies as CryoMQL.



Recent Publications

1. Artetxe E, González H, Calleja A, Polvorosa R, Lamikiz A and López de Lacalle L N (2016) Optimised methodology for aircraft engine IBRs five-axis machining. Int. J. Mechatronics and Manufacturing Systems 9:4.
2. Calleja A, Alonso M.A, Fernández A, Tabernero I, Ayesta I, Lamikiz A and López de Lacalle L N (2014) Flank milling model for tool path programming of turbine blisks and compressors. Int. J. of Production Research: 3354-3369.
3. Klocke F, Schmitt R, Zeis M, Heidemanns L, Kerkhoff J, Heinen D and Klink A (2015) Technological and economical assessment of alternative process chains for blisk manufacture. Procedia CIRP 35:67-72C.

4. González H, Calleja A, Pereira O, Ortega N, López de Lacalle LN and Barton M (2018) Super abrasive machining of integral rotary components using grinding flank tools. Metals 8:24
5. Pereira O, Martín-Alfonso JE, Rodríguez A, Calleja A, Fernández-Valdivielso A and López de Lacalle LN (2017) Sustainability analysis of lubricant oils for minimum quantity lubrication based on their tribo-rheological performance. Journal of Cleaner Production 164: 1419-1429.

Biography

L N López de Lacalle: University Professor of the Department of Mechanical Engineering at the University of the Basque Country (UPV/EHU) and director of the Aeronautics Advanced Manufacturing Center (CFAA). He is also head of the high-performance manufacturing line. He manages international I+D+i projects with several companies and research centers. Ph.D. for more than 20 years, nowadays his research lines are focused in machining processes for difficult-to-cut materials and green manufacturing. He has 3 books, more than 115 JCR international articles, 60 international conference papers and 5 patents among others. He has H-index of 42.

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