

PhD. A. Calleja, UPV/EHU, Spain

Universidad del País Vasco Euskal Herriko Unibertsitatea

General methodology for manufacturing complex geometries in turbo-machinery components

H. González, MSc, UPV/EHU, Spain
A. Calleja, PhD, UPV/EHU, Spain
O. Pereira, PhD, UPV/EHU, Spain
E. Artetxe, MSc. IMH, Spain
A. Lamikiz, Professor, UPV/EHU, Spain
L.N. López de Lacalle, Professor, CFAA-UPV/EHU, Spain

Abstract (300 word limit)

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 [1].

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 superalloys and need to fulfill dimensional requirements.

In Figure 1 is shown the manufacturing process for complex geometries that require 5-axis simultaneously movements.

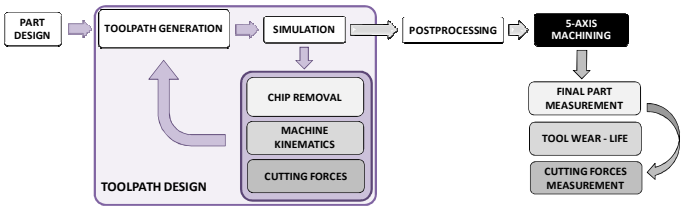


Figure 1. 5-axis machining process for complex geometries

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:

- 1st stage: Part design and definition, according to industry requirements.
- 2nd stage: Tool definition and tool path generation. CAM software is needed to define 5-axis simultaneous movements. A. Calleja et al. [2] developed a model for tool path programming of these components.
- 3rd stage: 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.
- 4th stage: Post-processing and 5-axis Machining.
- 5th stage: Final part measurements and results analysis.

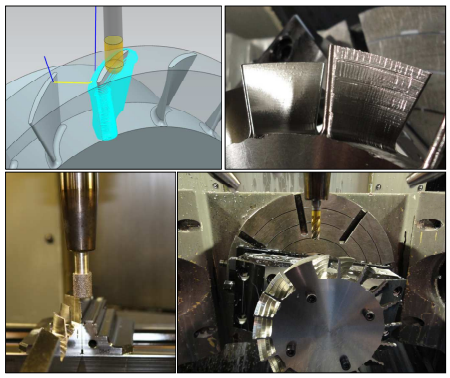


Figure 2. Case study: Blisk machining in a 5-axis multitasking machine

Notwithstanding, 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 [3,4]; and new ways of lubri-cooling technologies as CryoMQL [5].

Key words: turbomachinery components,Blisk, CAM, Digital twin

Recent Publications (minimum 5)

1. Artetxe E, González H, Calleja A, Polvorosa R, Lamikiz A, López de Lacalle L.N (2016) Optimised methodology for aircraft engine IBRs five-axis machining. Int. J. Mechatronics and Manufacturing Systems Vol.9, Nº4.
2. Calleja A, Alonso M.A, Fernández A, Tabernero I, Ayesta I, Lamikiz A, 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, 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, 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, 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

Haizea González: Mechanical and Manufacturing Engineer and PhD student at the Basque Country University since 2015. She has experience in industrial companies, such as Novalti S.A. (aerospace manufacturing company). She also has an I+D+i experience working as Mechanical Engineering Department Collaborator since 2013. She is specialised in hybrid manufacturing combining laser metal deposition and machining processes. He has a book chapter, 3 indexed articles, and 6 papers in industrial manufacturing magazines, 7 national and international conferences.

Amaia Calleja: University Teacher at the Mechanical Engineering Department in the University of the Basque Country and she received her PhD in 2015. She is an I+D+i Project Collaborator since 2010. Her research interests are related to machining processes and laser processed processes. She has 7 JCR international articles, more than 10 papers in international journals and 2 book chapters among others.

Octavio Pereira: Industrial engineering with master in cybernetics. Ph.D. from the University of Leon. Researcher in the Department of Mechanical Engineering at the University of the Basque Country since 2013. He is specialised in green cooling-refrigeration techniques, life cycle assessments in machining operations and hard turning processes. He has a book chapter, 9 JCR (>50% Q1) international article, 24 papers in industrial manufacturing magazines, 18 national and international conferences and 3 patents.

Egoitz Artetxe: Mechanical engineer with a Master's degree in Mechanical Engineering: Design and Manufacturing. PhD student at the Basque Country University since 2013. The research lines are related to optimization of 5-axis machining process for the aerospace sector. He has 4 papers in national and international conferences and 3 magazine articles related with the manufacturing and machine-tool sector.

Aitzol Lamikiz: , Professor of the Department of Mechanical Engineering at the University of the Basque Country. He is leading the laser material processing research line and is the author of 68 impact International Journal Publications, including laser material deposition process modeling, laser polishing and laser hardening research. He is the co-author of 3 books and more than 100 contributions in international conferences. Nowadays is member of the executive board in one of the three campus of the University of the Basque Country UPV/EHU.

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.

Presenting author details

Full name (As per the passport): Haizea González Barrio
University/Industry/Organization name: University of the Basque Country
Designation: (Director/Prof/Assistant or Associate prof/Researcher/Student): PhD. student
Country: Spain
Mobile number (*country code – number*): +34-946013932
Email: Haizea.gonzalez@ehu.eus
Category (Oral presentation/ Poster presentation/Young researcher forum/E-poster): Oral presentation
Research interest: Hybrid manufacturing, Super-abrasive machining, 5-axis advanced machining and multitasking, Laser Metal Deposition (LMD)

Your profile page URL in your department: http://www.ehu.eus/manufacturing/
Year of birth: 1964
Linked In/Facebook/twitter account: https://scholar.google.es/citations?view_op=list_works&hl=es&user=LHv1U9sAAAAJ

Note: Please fill up the Red mark fields so that it would be easier for us to cite your details in the conference particulars. (Please do not forget to fix your photo and Logo above the title)