Plan Overview

A Data Management Plan created using DMP Tool

Title: Design for Residual Stress (DRS) on Gears Manufacturing: Industry 4.0 Approach

Creator: ANDRÉ LUIZ ROCHA D' OLIVEIRA

Affiliation: Instituto Tecnológico de Aeronáutica (ita.br)

Principal Investigator: Alfredo Rocha de Faria, Ronnie Rodrigo Rego

Data Manager: André Luiz Rocha D' Oliveira, Guilherme Fernandes Guimarães, Caio Felipe Siqueira Gomes

Project Administrator: André Luiz Rocha D' Oliveira, Guilherme Fernandes Guimarães

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Project abstract:

Gears are one of the mechanical components mostly influenced by residual stresses (RS) that come from the combination of a complex load stress state generated by the involute profile and a manufacturing chain with a wide range of processes. Incipient qualitative studies were conducted with the main goal of optimizing the manufacturing chain to achieve an ideal RS state at the end of the production. To expand the state-of-the-art towards a quantitative result, the objective of this project is to develop a predictive numerical method for the phenomenon of residual stress state interaction along with the gears manufacturing chain. This oriented development of the manufacturing chain for a specific residual stress state consolidates the basis of the concept of Design of Residual Stress (DRS). The design method searches for an optimal residual stress state, considering the desired failure mode to be avoided and undesirable outcomes from previous manufacturing processes. This project proposes to approach the manufacturing chain by means of the interaction between shot peening and grinding processes. In order to quantify the RS interaction effect, the grinding process will be modeled through the hybrid FE method that replaces the tool-workpiece contact by the input of machining loads (mechanical and thermal). This project is an important step towards the development of the Industry 4.0 philosophy, providing a smart decision-making capability on real-time adjustment of manufacturing parameters. Moreover, the scope of this project was proven to represent an actual demand from the national industry, contributing to place Brazil in a global leadership position on this topic.

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Copyright information:

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Data Collection

What data will you collect or create?

The project generates a huge database of residual stress fields by a Finite Element Software (Abaqus). The manufacturing processes of shot peening and grinding were modeled individually and after their interaction in a gear application.
The shot peening was approached in a simplified case, being compared to the indentation case. The database of indentation was done considering one, two, three, and four indentations, with indentation superposition. The material used in this experimental assessment was SAE 4120. The 3D cloud points are also available.
The grinding case was compared directly after the gear manufacturing.
The process' interaction initialized in a simplified case. These simplified cases combined the indentation process (representing the shot peening) and a thermal load (representing the grinding). A reference value for both processes was selected and fluctuations were done. No experimental verification was done.

Available dataset:

- Shot Peening Process:
    a. Simplified case (Indentation):
        i. Powerpoint file (.ppt) with an experimental layout
        ii. XYZ files (.XYZ) of 3D cloud point of indentations in the following conditions - It is possible to open with Excel:
            1. Isolated indentations: Four combinations of indentation, with the variation of two parameters (indentation force and indenter diameter) in two levels (high and low)
            2. Superposition of indentations: 2 indentations approaching (3 different distances); 3 indentations approaching (3 different distances in an equilateral triangle configuration) and 4 indentations (without approaching, 3 repetitions)
        iii. Output database file (.odb) of simplified cases - Native software: Abaqus
            1. The load profile used was identical to the hardness test.
    b. Shot peening process:
        i. Powerpoint file (.ppt) with process parameters
        ii. CAD file (.stl) of FZG tooth 3D geometry used
        iii. Output database files (.odb) of shot peening process - Native software: Abaqus
            1. 200 impacts; 600 impacts; 1200 impacts.
- Grinding Process (without the initial influence of shot peening)
    a. Powerpoint file (.ppt) with process parameters
    b. Output database file (.odb) of the grinding process (without shot peening) - Native software: Abaqus
- Interaction between manufacturing processes:
    a. Simplified case (Indentation + Grinding):
        i. Powerpoint file (.ppt) with simulated conditions
        ii. Output database files (.odb) of simplified cases - Native software: Abaqus
            1. 25 files, being the indentation load varying from 1800 to 2200 N and the grinding loads varying from 100 to 500 kW. The reference level was considered as 2000 N for the indentation load and 300 kW for the grinding.
    b. Gear case (Shot peening + Grinding):
        i. Powerpoint file (.ppt) with process parameters from both processes
        ii. Output database file (.odb) of the grinding process (without shot peening) - Native software: Abaqus

How will the data be collected or created?

The database was almost fully generated by the finite element software Abaqus, version 2019. The experimental database was generated by surface scanning made in the equipment Alicona Infinite Focus SL.

Documentation and Metadata

What documentation and metadata will accompany the data?

The documentation with experimental parameters as well as manufacturing process' parameters will accompany the available data. These data will be consolidated in a ppt file, with images to be easily readable.

Ethics and Legal Compliance

How will you manage any ethical issues?

There are not any ethical issues to be managed considering the database generated. All the researches are developed during master and doctorate period.

How will you manage copyright and Intellectual Property Rights (IP/IPR) issues?

The database and the method developed to assess the manufacturing chain belong to the research group related to the project. The sharing of data will be managed with the participation of Aeronautics Institute of Technology (ITA). The open access to the database will start 6 (six) months after the end of project duration, except in case of possible patents, where the database will be restricted until its use.

Storage and Backup

How will the data be stored and backed up during the research?

The data will be stored in an internal online database, where only the members of the research group will have the access.

How will you manage access and security?

The storage service and protection offered by Google is the technical service to guarantee access and security. None of supplemental services was used.

Selection and Preservation

Which data are of long-term value and should be retained, shared, and/or preserved?

The data will be available in a long-term period, without any restriction of consultation and use.

What is the long-term preservation plan for the dataset?

The data will be stored in a cloud file and the link will be available for future download.

Data Sharing

How will you share the data?

During the research and up to the end of the first year after the research period, the data will be shared on-demand. An e-mail must be sent to any member of the research team requesting the available data.

Are any restrictions on data sharing required?

The restriction on data sharing is related to the citation. Any outcome that will be linked to the dataset produced during the research must be well cited.

Responsibilities and Resources

Who will be responsible for data management?

The responsible for data management are: André Oliveira and Guilherme Guimarães.

What resources will you require to deliver your plan?

The resource needed to open most part of the data is the Abaqus software. To open the cloud points, excel could work, but it will not perform well. Therefore, a software to open a large spreadsheet will help the experimental visualization.

Planned Research Outputs

Image - "0101_Shot peening - Simplified case - Experimental layout"

Experimental layout of indentation experiments done to compare the initial finite element models.

Dataset - "0101_Shot peening - Simplified case - Surface indentations 3D cloud points "

3D coordinates of the indentations done to compare to the finite element analysis. The following conditions will be included:

1. Isolated indentations: Four combinations of indentation, with the variation of two parameters (indentation force and indenter diameter) in two levels (high and low)
2. Superposition of indentations: 2 indentations approaching (3 different distances); 3 indentations approaching (3 different distances in an equilateral triangle configuration) and 4 indentations (without approaching, 3 repetitions)

Dataset - "0101_Shot peening - Simplied case - ODB"

Output database file with the conditions experimentally assessed.

Image - "0102_Shot peening - Process parameters"

Process parameters of shot peening simulated in the FZG-C gear geometry.

Dataset - "00_Geometry - FZG-C gear"

FZG-C gear geometry used as a part of the finite element modeling.

Dataset - "0102_Shot peening - Process - ODB"

Output database of shot peening process, varying the number of impacts: 200 impacts, 600 impacts, 1200 impacts.

Image - "02_Grinding - Process parameters"

Parameters of grinding process simulated in the FZG-C gear geometry.

Dataset - "02_Grinding - ODB"

Output database generated with the grinding loads applied to the FZG-C gear geometry, without the influence of previous processes.

Image - "0301_Interaction - Simplified case - Simulated layout"

Simulated conditions in the simplified models.

Dataset - "0301_Interaction - Simplified case - ODB"

Output database with all the simplified conditions of manufacturing interactions.

Image - "0302_Interaction - Manufacturing process - Manufacturing parameters"

Manufacturing processes of the shot peening and grinding processes.

Dataset - "0302_Interaction - Manufacturing process - ODB"

Output database of the interaction between processes applied to the FZG-C gear geometry.

Planned research output details

Title	Type	Anticipated release date	Initial access level	Intended repository(ies)	Anticipated file size	License	Metadata standard(s)	May contain sensitive data?	May contain PII?
0101_Shot peening - Simplified case - Experimental ...	Image	Unspecified	Open	None specified		None specified	None specified	No	No
0101_Shot peening - Simplified case - Surface inde ...	Dataset	Unspecified	Open	None specified		None specified	None specified	No	No
0101_Shot peening - Simplied case - ODB	Dataset	Unspecified	Open	None specified		None specified	None specified	No	No
0102_Shot peening - Process parameters	Image	Unspecified	Open	None specified		None specified	None specified	No	No
00_Geometry - FZG-C gear	Dataset	Unspecified	Open	None specified		None specified	None specified	No	No
0102_Shot peening - Process - ODB	Dataset	Unspecified	Open	None specified		None specified	None specified	No	No
02_Grinding - Process parameters	Image	Unspecified	Open	None specified		None specified	None specified	No	No
02_Grinding - ODB	Dataset	Unspecified	Open	None specified		None specified	None specified	No	No
0301_Interaction - Simplified case - Simulated lay ...	Image	Unspecified	Open	None specified		None specified	None specified	No	No
0301_Interaction - Simplified case - ODB	Dataset	Unspecified	Open	None specified		None specified	None specified	No	No
0302_Interaction - Manufacturing process - Manufac ...	Image	Unspecified	Open	None specified		None specified	None specified	No	No
0302_Interaction - Manufacturing process - ODB	Dataset	Unspecified	Open	None specified		None specified	None specified	No	No