NEWTECH 2022 BOOKLET

The 7th International Conference on *Advanced Manufacturing Engineering and Technologies*

September 08-10, 2022
Rennes, FRANCE

Content

PREFACE

The 7th International Scientific Conference: NEWTECH 2022 – Advanced Manufacturing Engineering and Technologies was organized by National Institute of Applied Sciences of Rennes – INSA Rennes, France. It was held between 8th-10th of September 2022 in Rennes, France and was supported by the French Mechanical Association, Manufacturing'21 and ITCM Center of UDGJ Galati, Romania.

The situation with COVID-19 imposed restrictions on holding mass events and travelling. The health of the participants is key and so, the organizing committee, encouraged by the eagerness of the participants to share their scientific work despite the circumstances, decided to hold the conference both in life and online version.

The 7th International Scientific Conference: NEWTECH 2022 – Advanced Manufacturing Engineering and Technologies provides a forum where recent advances and future directions in the manufacturing processes and forming are discussed by scientists and engineers from academia and industry worldwide. The topics covered are of great interest for academics and for professionals (engineers and researchers) from industry involved in traditional and novel forming and manufacturing technologies for conventional and emerging materials.

The 7th International Scientific Conference: NEWTECH 2022 – Advanced Manufacturing Engineering and Technologies takes place in the year in which the France celebrates Mechanics Year during 2021-2022 academic period.

A total of 20 oral and 6 online presentations and from 10 worldwide countries, Cech Republic, France, Greece, Portugal, Serbia, Spain, Bulgaria, Romania… are registered including:

• 4 plenary lectures given by renowned experts from academia;

• 30 submitted abstracts and 20 oral presentations organized in 8 general sessions.

The all oral and online presentations are composed around of 20 peer-reviewed full papers (between 6 and 14 pages each one).

All the papers have been reviewed by two expert referees in their relevant fields. The papers selected for the volume depended on their quality and relevancy to the conference.

Free access to all the conference papers will be granted to all the registered attendees. However, the peer-reviewed full papers and a part of the plenary lectures will be published after the conference, in the open access proceedings by EDP Sciences on MATEC Web of Conferences ISI Conf. Journal Series.

In the proceedings, the first section contains a part of the plenary lectures papers delivered by the renowned scientists. These experts were invited to highlight various topics of the conference so as to provide a perspective on the future of scientific and industrial challenges within the scope of the conference. The second section consists of oral presentations which cover Cutting, Milling, Metrology, Bulk Forming, Hydroforming, Mechanical behaviour, Process Control, Welding... The authors report advances in aspects such as numerical techniques, including artificial intelligence.

The main goal of NEWTECH 2022, under the given conditions, was successfully achieved - to bring together researchers from academia and industry, scientists and experts in engineering and technology to address new challenges, share solutions and discuss future research directions.

We would like to thank all those researchers who have trusted the conference and who recognized NEWTECH 2022 as an appropriate forum to share their recent developments and learn about the new trends in the field of technical sciences and engineering.

We thank all the authors for their contribution to this valuable volume. We must also thank all the reviewers for their effort, which ensured not only excellent feedbacks for the authors but also a high-quality scientific research.

Last but not least, we sincerely thank the whole team involved in organizing the NEWTECH 2020 conference.

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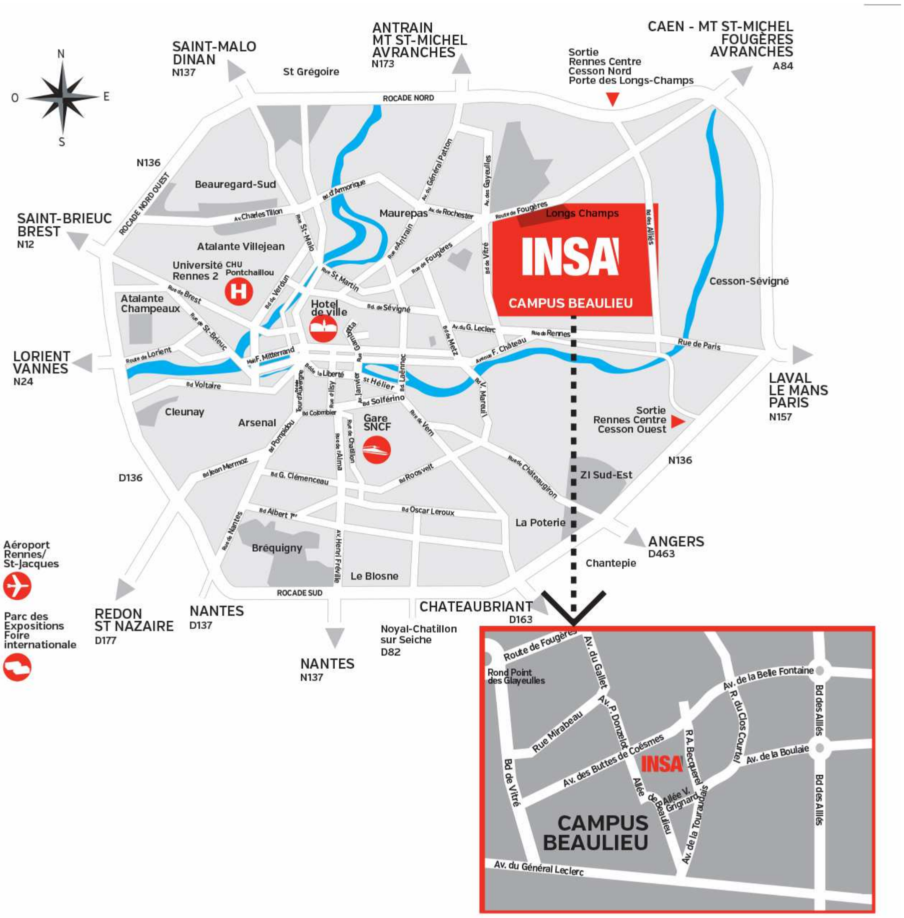

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PLENARY LECTURES

Thursday, September 08, 2022

Prof. Dr. Mohammed EL MANSORI,

Arts et Métiers Paris Tech, ENSAM Aix-en-Provence, Director AM2 Transatlantic Partnership, Director Mechanics, Surfaces and Material Processing Laboratory (MSMP-EA7350), Head Engineering and Multi-physics of Multiscale Manufacturing Research Group, France

Convergent manufacturing to leverage sustainability anddigitalisation of industrial production

Prof. Dr. Miroslav PÍŠKA
Brno University of Technology, CZECH REPUBLIC

The new technologies for advanced joint implants

Friday, September 09, 2022

Prof. Dr. Dumitru NEDELCU
Gheorghe Asachi Technical University of Iasi, ROMANIA

Coated Biodegradable Polymers

Prof. Dr. Vidosav D. MAJSTOROVIC
University of Belgrade, SERBIA

Management of tools in digital manufacturing. A case study

INSTRUCTIONS FOR THE CHAIRPERSONS

Chairpersons should be present in the computer desk at least 10 min before the beginning of the session. Please check the e-program (e-Program Booklet) to confirm the schedule of your session.

A technical staff will help to solve technical problems occurring during the session and hand out the microphones in the audience during the discussions.

Please check the presence of all the speakers scheduled for your session before the beginning of the session.

You are in charge of animating the discussion following each lecture. If necessary you can skip or shorten the discussion.

If a speaker is absent, please do not advance the following talk. You must make the audience wait until the next presentation, as defined in the initial program, by suggesting a discussion of earlier presentations.

Please note that presentation time is depending in the type of the oral presentation according to:

	Lecture time	Discussion time	Total time
Plenary lectures	30 min	10 min	40 min
Full papers presentation	15 min	5 min	20 min

To leave the required time for discussion, you are adviced to interrupt the oral presentation of any speaker who exceeds his allowed time.

All presentations are registred by organizators.

INSTRUCTIONS FOR ORAL PRESENTATIONS

Please check the e-Program Booklet to confirm the schedule of your presentation.

On the e-booklet or on the website (Program Tab), you may refer to the List of Oral Presentations ordered by IDs.

Try to be in your presentation computer desk 10 minutes prior to the starting time. Please indicate your presence to the chairperson of your session. You are expected to be present for the entire time of each session.

Please note that presentation time is depending in the type of your oral presentation according to:

	Lecture time	**Discussion time**	**Total time**
Plenary lectures	30 min	10 min	40 min
Full papers presentation	15 min	5 min	20 min

A simple rule is to consider 1 slide equals 1 minute of presentation. For example: a full paper presentation will have around 15 slides (15min of lecture) and for plenary lecture is around 30 slides maximum (30 min of lecture).

Please respect your presentation time. If not, the chairperson is asked to interrupt your presentation at the prescribed time to leave the required time for discussion.

All presentations are registred by organizators.

CONFERENCE PROGRAM

FINAL PROGRAM INTERNATIONAL CONFERENCE NEWTECH2022
8 – 10 September 2022
Amphitheater André BONNIN – Bat. 5 INSA Rennes, Rennes, FRANCE

THURSDAY 8 SEPTEMBER 2022

8h30 – 9h30 : **PARTICIPANTS REGISTRATION** – Front of Amphitheater André BONNIN – Bat. 5 INSA Rennes, Rennes, FRANCE

9h30 -10h00 : **OPEN CEREMONY**

- Prof. Hervé FOLLIOT Research Director of INSA Rennes
- Assoc. Prof. Habil. Dr. Adinel GAVRUS – Chairman of NEWTECH 2022
- Prof. Dr. Viorel PAUNOIU – Vice-President of NEWTECH 2022

10h00-10h30 : Coffee Break

10h30 – 11h10 : FRENCH MECHANICAL YEAR 2021-2022 - **Introduction by President Representing of French Mechanical Association – AFM and by Mandatory Deputy of Manufacturing'21**

- Prof. Tanguy ROUXEL Responsible of "MecaScience" Seminaries or UR1/INSA Rennes/ENS Cachan – Mechanics Year 2021-2022/Prof. Valérie BOTTON representing the President of AFM (France) – visio-conférence
- Prof. Guenael GERMAIN – Manufacturing'21

11h10 – 11h50 : **PLENARY LECTURER** - **Convergent manufacturing to leverage sustainability and digitalisation of industrial production**

- Prof. Mohammed EL MANSORI, Arts et Métiers Paris Tech, ENSAM Aix-en-Provence, Director AM2 Transatlantic Partnership, Director Mechanics, Surfaces and Material Processing Laboratory (MSMP-EA7350), Head Engineering and Multi-physics of Multi-scale Manufacturing Research Group, France

11h50-12h30 : **ONLINE SCIENTIFIC SESSION** (2 speakers x 20' – online presentations) – Session Chairman: Assoc. Prof. Adinel GAVRUS

https://zoom.us/j/93457457343?pwd=djdad3M3T2IzTHovWitmYmxuTUdaZz09

Bernd Peukert, Adithya Rangaraju, Andreas Archenti, In-situ prediction of the spatial surface roughness profile during slot milling

Nikolaos Vaxevanidis, Laser cutting of FFF PLA/wood *and* Machinability optimization of dry CNC turning of UNIMAX® tool steel under annealed and hardened states by implementing swarm intelligence algorithms

12h30-12h40 : Group Photo – in the front of INSA Rennes Administrative Building (Bat. 2)

12h40 – 14h00 : LUNCH – Staff Cafeteria

14h00 – 14h40 : **PLENARY LECTURER - The new technologies for advanced joint implants**

- Prof. M. PISKA, Brno University of Technology, Faculty of Mechanical Engineering, Department of Manufacturing, Cehia

14h40-15h40 : **SCIENTIFIC SESSION** (3 speakers x 20') – Session Chairman: Prof. Viorel PAUNOIU

Philippe SEITIER, Patrick GILLES, Valérie BOUDIER, Michel GALAUP and Pierre LAGARRIGUE, Getting started procedure of a NC machine simplified by the use of a mixed-reality training scenario

Gabriela-Petruța RUSU, Valentin Ștefan OLEKSIK, Radu Eugen BREAZ, Dan DOBROTĂ, Ilie Octavian POPP, Analysis of the metal sheets formability at single point incremental forming process

Mihai-Octavian POPP, Sever-Gabriel RACZ, Mihaela OLEKSIK, Claudia GÎRJOB, Cristina BIRIȘ, Analysis of forming forces at SPIF using Taguchi method

15h40 – 16h00 : Coffee Break

16h00 – 17h20 : **SCIENTIFIC SESSION** (4 speakers x 20') – Session Chairman: Prof. Mohammed EL MANSORI

Teodor Costinel Popescu, Alexandru-Polifron Chiriță, Ana-Maria Carla Popescu, Andrei Vlad, Gheorghe Alexandru Trăneci, Alina Iolanda Popescu, Optimization of Manufacturing Processes by Reducing the Costs of Tools and Equipment on Hydraulically Operated High-Pressure Technological Lines

Cătălin Dumitrescu, Adinel Gavrus, Radu Rădoi, Ștefan Șefu, Alexandru-Polifron Chiriță, Ana-Maria Popescu and Dragoș Preda, Modern Techniques for Remanufacturing Hydraulic Equipment in the Context of Circular Economy and Energy Efficiency

Vasile Ermolai, Alexandru Sover, Marius Andrei Boca, Adelina Hrițuc, Laurențiu Slătineanu, Gheorghe Nagîț and Răzvan Cosmin Stavarache, Mechanical Behaviour of Macroscopic Interfaces for 3D Printed Multi-material Samples

Miroslav Piska and Katerina Urbancova, On the Machining of Joint Implant UHMWPE Inserts

19h00 – 22h30 : **OFFICIAL DINNER – RESTAURANT « LA TAVERNE »**, Place de Colombier/Charles de Gaulle, 2 Rue d'Alma, Rennes

FRIDAY 9 SEPTEMBER 2022

9h00 – 9H40 : **PLENARY LECTURER - Coated Biodegradable Polymers**

- Prof. D. NEDELCU, Technical Univ. « Gheorhe Asachi » Iasi, Romania, Manager of Fine Mechanics and Nanotechnology Laboratory, Romania

9h40 – 10h40 : **SCIENTIFIC SESSION** (3 speakers x 20') – Session Chairamn: Prof. Dumitru NEDELCU

Vidosav Majstorovic, Vladimir Simeunovic, Radivoje Mitrovic, Dragan Stosic, Sonja Dimitrijevic and Zarko Miskovic, How to apply the ERP model for Smart Mining?

Enora LEVREL, Siti Nursyafinaz Binti Mohd Safie, Pierrick Malécot, VirgileLambert, Michael Fontaine, Loic Hallez, Séverine Lallemand, Functional correlation surface texture / grip of a deposit : case of NiP

Vojin Vukadinović, Jovan Živković, Dragan Đurđanović, Vidosav Majstorović, Management of tools in digital manufacturing - A case study

10h40 – 11h00 : Coffee Break

11h00 – 12h00 : **Scientific Session** (3 speakers x 20') – Session Chairman Prof. Vidosav MAJSTOROVIC

Gheorghe Nagîț, Laurențiu Slătineanu, Oana Dodun, Viorel Păunoiu, Marius-Andrei Mihai, Marius-Ionuț Rîpanu, Adelina Hrițuc, Ioan Surugiu, The Influence of Lubrication on the Roughness of the Vibroburnished Surface

Vytautas Ostasevicius, Sandra Mikuckyte, Rimvydas Gaidys, Vytautas Jurenas, Vytautas Daniulaitis, Digital Twins for Micro Machining

Alina Marguta, Simona-Nicoleta Mazurchevici, Constantin Carausu and Dumitru Nedelcu, Biodegradable polymer properties through ceramic coatings

12h00 – 13h40 : LUNCH – Staff Cafeteria

13h40-14h20 : **PLENARY LECTURER** - **Management of tools in digital manufacturing. A case study**

- Prof. V. MAJSTOROVIC, University of Belgrade, Faculty of Mechanical Engineering, Serbia

14h20 – 15h40 : **Online Scientific Session** (3 speakers x 20') – Session Chairman: Assoc. Prof. Adinel GAVRUS

https://zoom.us/j/94108154964?pwd=US9wSXh1TWIrUG5jZW52L0ViQ21PZz09

N. Baroiu, V.G. Teodor, V. Paunoiu, G.A. Morosanu and R.S. Craciun, Study of the enwrapping of the front profiles of the active elements of a three-screw compressor

G.A. Morosanu, V.G. Teodor, V. Paunoiu, R.S. Craciun and N. Baroiu, Quality characteristics analysis for the assembly of the elements from the construction of a mechanism for adjusting the seats in the automotive industry

Cezarina Afteni, Mitica Afteni and Gabriel-Radu Frumusanu, Study on the Application of the Holistic Optimization Method of the Manufacturing Process in the Case of a Reduced Instances Database

Viorel PAUNOIU, Virgil TEODOR, Nicusor BAROIU, Georgiana-Alexandra MOROSANU, and Alexandru EPUREANU, Contribution to a new method for deep drawing with kinetic control

15h40 – 16h00 : Coffee Break

16h00 – 17h00 : Meeting of Steering International Committee

SATURDAY 10 SEPTEMBER 2022

Excursion to Mont Saint-Michel, Normandie (France)

9h30 Departure to Mont Saint-Michel – in the front of INSA Rennes Administrative Building (Bat. 2)

17h00 Arrival from Mont Saint-Michel – in the front of INSA Rennes Administrative Building (Bat. 2)

NEWTECH - 2022: The 7th International Conference on Advanced Manufacturing Engineering and Technologies

8-10 Sep 2022
RENNES
France

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How to apply the ERP model for Smart Mining?

Vidosav Majstorovic[1[0000-0001-9534-8461]], Vladimir Simeunovic[2], Radivoje Mitrovic[1[0000-0003-0513-6540]], Dragan Stosic[2], Sonja Dimitrijevic[2[0000-0002-9981-077X]] and Zarko Miskovic[1[0000-0002-8320-7191]]

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Abstract. For a long time, and especially today, the energy crisis has been and still is a limiting factor for the growth and development of the world economy. On the other hand, improving the reliability and readiness of energy production systems is becoming a first class priority for research and development institutions around the world. Therefore, the process of production, transport, distribution and usage of energy is increasingly becoming a very important part of smart systems, whose basic framework is Industry 4.0. Thus, starting from the analogies between industrial production and mining (i.e. "ore production"), the concept of smart mining has been developed. This model has three dimensions: (i) application of advanced digital technologies (Cloud Computing and Internet of Things) with automated Cyber-Physical Systems (CPS), Adaptive Production Processes (depending on working conditions) and Control of Production Processes (with optimal resource usage); (ii) Smart Maintenance of CPS (for machinery and equipment); and (iii) Smart Supply Chains (procurement of materials and spare parts / delivery of final products). Deeper analyses have shown that most of the Industry 4.0 elements could be applied with some modifications in mining (there are 45 in total, and analyses have shown that 32 of them can be successfully applied in smart mining). This was the starting point for the ERP model presented in this paper. The developed ERP model has three main parts: a virtual part, based on the Cloud Computing model (SaaS model) and usage of Internet of Things to connect different business processes (procurement, sales, management, finance, warehousing, downtime monitoring etc.), the production part (coal production in open-pit mine) and the technology process part (monitoring and maintenance of auxiliary machinery). This paper presents the developed and partially implemented ERP model for Industry 4.0 in smart mining at one surface coal mine in the Republic of Serbia.

Keywords: Industry 4.0, Mining, ERP.

Study of the enwrapping of the front profiles of the active elements of a three-screw compressor

Nicușor BAROIU, Virgil Gabriel TEODOR, Viorel PĂUNOIU, Georgiana Alexandra MOROȘANU, Răzvan Sebastian CRĂCIUN

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Keywords: reverse engineering, enwrapping profiles, „virtual pole" method.

Abstract

Fluid transport requires specific equipment, such as pumps and compressors.

Currently, the emphasis is on the ease of transport of liquids and gases so that their handling can be done with the highest possible efficiency and safety.

One way to increase efficiency is to change the front profile of the active elements of compressors and pumps. But, a side effect of this change is the difficulty of securing the necessary spare parts in case one of these items is damaged.

The usual solution, to completely change the pump or compressor, is not always possible or effective.

The paper proposes a method for identifying the front profile of a snail-type active element, consisting of a three-screw compressor.

The purpose of this identification is to study the frontal enwrapping between the profiles of the driver and the driven element, in order to produce a possible replacement element.

As is it well known, the two profiles are mutually enwrapping profiles, which means that the problem can be treated as a plane enwrapping problem.

The identification of the profiles was performed by specific reverse engineering methods, the parts being scanned on an ATHOS 500 scanning system.

Subsequently, the analytical shape of the driven screw was identified and, applying the "virtual pole" method, the corresponding shape of the guide screw profile was deduced.

The obtained profile was compared with the real profile, obtained by 3D scanning.

The obtained results demonstrated not only the good match between the theoretical and the real profile but also the simplicity and robustness of the method applied for the study of the enwrapping, namely the "virtual pole" method.

2

References

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Quality characteristics analysis for the assembly of the elements from the construction of a mechanism for adjusting the seats in the automotive industry

G.A. Moroșanu, V.G. Teodor, V. Păunoiu, R.S. Crăciun, N. Baroiu

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Abstract. Statistical control of a technological process is a method that is based on a series of tools that allow documentation, understanding, monitoring and supervising of the entire process, in order to ensure quality finished products. When the technological process is complex, statistical methods contribute to an early identification of systematic deviations, so that the quality characteristics are within the allowable tolerance limits. Thus, statistical control is a preventive method of quality management. The analysis of the capability of a production process is mainly used to determine the capability of the process to ensure compliant products, by analyzing certain monitored data that are representative of that process. The paper presents a study on the statistical control of some pieces from the construction of electric motors used to adjust the seats of vehicles. For each piece, 8 measurements were made, the volume of each measurement having 50 elements and the results were interpreted through a software application developed for this purpose and made in the Java language. The software analyzes a database consisting of the values of the dimensions of the measured pieces and identifies whether these values have a statistically normal distribution and falls within the permissible tolerance limits.

Keywords: statistical control, capability, automotive industry.

The 7th International Conference NEWTECH 2022, 08th – 10th September 2022, Rennes, France.

Tools Management in Digital Manufacturing – A case study

Vojin Vukadinovic[a], Jovan Zivkovic[a], Vidosav Majstorovic[b,]*, Dragan Djurdjanovic[c]

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Summary: Rapid changes in the market, with additional requirements for personalization of products, create new needs for great flexibility in manufacturing management, but on a new basis. The answer to all these challenges is the Industry 4.0 model. Digital manufacturing is the basis for Industry 4.0, and it has the following dimensions: (i) is based on the application of advanced digitally oriented technologies, (ii) smart products are increasingly being developed and marketed, the characteristics of which meet unexpected customer requirements, and (iii) smart supply chain (procurement of raw materials and delivery of finished products). In this concept, there is a two-way exchange of information in collaborative manufacturing, and their exchange through digital platforms for smart manufacturing. Tool management in this model is part of this platform and this concept, and is extremely important for manufacturing organizations. Therefore, this paper presents a developed model of a digital factory with a detailed presentation of the model for management tools in workshop, as part of the ERP and MES modules.

Key words: *Digital manufacturing, Tools Management, ERP, MES.*

The influence of materials in contact, tool geometry, cutting regime and cutting environment on surface roughness when machining hard materials at high speeds

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Abstract. This article presents some aspects related to the analysis of the quality of surfaces obtained by high-speed machining (HSM) of hard materials from the steels category. Studies on these aspects: the topography of the generated surfaces, the residual stresses and the structure of the superficial layer are found in the literature, but always insufficient when referring to a certain material. The authors present the theoretical and experimental studies performed in connection with the factors that have a major impact (materials in contact, tool geometry, cutting regime and conditions) on the surface roughness of parts made of hard steels. Experimental tests were performed by turning heat-treated 100Cr6, C120 and 90MnCrV8 steels, according to an own research plan in which the considered factors presented three levels of variation. The experimental results obtained allowed the study of the influence of the cutting speed (v_c), feed (f), cutting depth (a_p) and the side cutting edge angle (k) when cutting with and without cutting fluid. The evolution of the roughness values of the machined surfaces, according to the previous variables at the high-speed turning of the 3 steel grades, using CBN, PcBN and CBN + TiN cutting inserts, is analyzed and the related dependence curves were drawn.

Keywords: High Speed Machining, Hard Part Machining, Surface Quality, Cutting Regime.

Advanced Production of Aluminum and Steel Cans

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Abstract. Production of thin walled products in the shape of aerosol cans presents a booming technology, esp. in the time of pandemics when many disinfectants are urgently needed. Several materials for the aerosol cans be used, however, the chemical means are basically stored in metallic containers made of aluminum alloy or steel. Both these materials can be fully recycled, but the carbon track for steel is four times lower compared to the carbon track for aluminum alloys. Moreover, the tensile strength of steels for such purposes is three times higher, what can result in applications of thinner can walls, lighter products, their higher endurance or a better safety of the products. Back extrusion is typically performed technology with the aluminum can. A pellet is placed in an open top cylinder, and a piston with a diameter smaller than the cylinder, is forced down into the blank. The result is that the product flows back between the space created by the piston and the cylinder. However, this technology can´t be used at steels directly due to its limited plasticity, higher mechanical properties and material hardening so welding and other technologies should be taken into consideration, but new problems like corrosion can be invoked. The paper deals with selected problems of the technologies and highlights their pros and cons in today´s time, when the material resources are limited and demands on efficient material processing are rising due to many factors.

Keywords: Thin walls, forming, steel cans, surface integrity, corossion.

Contribution to a new method for deep drawing with kinetic control

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Abstract. The paper presents a new deep drawing sheet metal method in which, due to the complex geometric shape of the part, there are significant variations in the level of deformation in different areas of the piece. The method aims to improve the quality in the deep drawing process by reducing the variation of the wall thickness of the part, caused by the different degree of stretching of the sheet in different areas of it. In the proposed method the vertical movement of the punch is completed by two vertical rotational movements of it which will have the effect the increasing the flexibility of the deformation process, the active elements occupying the most favorable position dictated by the material flow in the die. It results an improved material deformability and a higher degree of deformation. Also, the new method offers a relatively simple constructive solution of the press and does not require long auxiliary times for assembly-disassembly.

Keywords: deep drawing, deformability, hydraulic presses, kinetic control

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Analysis of forming forces at SPIF using Taguchi method

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Keywords: single point incremental forming, forming forces, Taguchi Method.

Abstract

Incremental sheet metal forming process has seen one of the highest increases in diversity in the last years. Single point incremental forming (SPIF) has become more attractive due to multiple benefits it possesses over other conventional cold forming processes such as deep-drawing. However, the process has yet to arise in the large-scale industrial implementation because of its drawbacks such as high production time and low accuracy, which lead to prototype production.

A very important aspect for this manufacturing process is the analysis of the forming forces in terms of process energy especially when using industrial robots.

The aim of this paper is to investigate the influence of material and vertical step over the forming forces. Thus, aluminium and steel sheets with a thickness of 0,8mm were incrementally deformed as a truncated cone with an angle of 50°, respectively 60° at a depth of 30mm and 40mm. Experiments were performed using a KUKA KR 210-2 robot which allows to measure the forces using a piezoresistive sensor.

After performing the analysis of the forming forces using the Taguchi method, it can be observed that the material has the highest influence.

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Analysis of the metal sheets formability at single point incremental forming process

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Keywords: single point incremental forming, deformability, aluminium alloy, steel.

Abstract

Although research on incremental forming process began a few decades ago, it is still a process in development phase. Single point incremental forming is a simple process and the deformation of the sheet blank is done with the help of a punch that follows a known toolpath.

In the case of this process, one important aspect is the prediction of material failure. To achieve this with the help of a finite element analysis, a series of experiments were performed to determine the forming limit diagram. In this paper, an attempt has been made to determine the forming limit diagram for the AA1050 aluminium alloy and DC01 steel sheets. The experiments were performed with the help of an industrial robot, KUKA KR 210-2, thus the part can be measured with an optical measuring instrument obtaining the major and minor strain from forming limit diagram.

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A CAD-CAE-CAM approach to manufacture the car door handle through SPIF

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Keywords: single point incremental forming, deformability, steel.

Abstract

The car industry is looking for less expensive ways to produce various car body components. One of those processes is the single point incremental forming process which doesn’t require a mold or die for each component, but only a good knowledge of the process to obtain a good accuracy of the components.

The purpose of this paper is to present the stages necessary to manufacture a portion of a car body. Thus, a CAE and CAM model is proposed for an existing model of door handle CAD to be produced through SPIF. After running the finite element method analysis it is shown that certain car body parts can be produced successfully through SPIF for which the process was developed in the first place.

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Getting started procedure of a NC machine simplified by the use of a mixed-reality training scenario

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Abstract. To allow increased manufacturing quality and integration in Industry 4.0, machines have become increasingly complex, resulting in increasingly difficult operating procedures and therefore a longer and more expensive operator-training period. Moreover, to be competitive in a global market where competition is sometimes distorted by local aid, European companies must be innovative and flexible. They must therefore be able to count on competent and responsive staff capable of adapting to the various workstations. The initial and continuous training of personnel is therefore a crucial need today [1]. The arrival on the market of AR and VR technologies makes it possible to imagine new training models generally taking into account the technical possibilities, without rethinking the educational scenarios [2,3]. The work carried out in this study consists of offering novice users a set of educational scenarios and an augmented reality device for handling a 3D printer. A first work carried out on a small group of students tests the autonomy of the users with this new material. A second experiment carried out on 80 first-year engineering school students made it possible to quantify usability using a standardized SUS questionnaire. The results show that the level of usability varies from good to excellent, regardless of whether the user has used a VR headset before. They also validate the transmission of technical skills. To obtain this result, the observed criterion is the effective printing of a part in an autonomous manner. The global work in progress aims at providing relevant training scenarios for the use of machine tools.

Keywords: Mixed reality, NC machine, training scenarios.

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Biodegradable polymer properties through ceramic coatings

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Abstract. Coating of bio-based polymers with ceramic layer has attracted interest recently, the research topic raising difficulties regarding the technology of obtaining layers that involve very high working temperatures. The study aims to analyse the mechanical / tribological, thermal and structural characteristics of the Arboblend V2 Nature biodegradable polymer after the deposition of ceramic microlayers. The micro powders used were Amdry 6420 (Cr2O3), Metco 143 (ZrO2 18TiO2 10Y2O3) and Metco 136F (Cr2O3-xSiO2-yTiO2). The coated samples were obtained by injection moulding and the deposition was achieved by using Atmospheric Plasma Spray (APS) method. The results of the related analyses showed that, in general, the deposits of ceramic micro particles increased the material surface characteristics (hardness, scratch resistance, apparent friction coefficient), due to the uniformity of the ceramic coating on the polymeric substrate. Based on these, it was possible to recommend the use of coated bio-based polymer - Arboblend V2 Nature in harsh operating conditions, such as the automotive industry.

Keywords: lignin-based polymer, coating, micro powders, structure, wear, micro hardness.

An Energy Approach Applied to Define Elasto-Plastic Constitutive Models Describing Thermomechanical Metallic Materials Behavior During Forming Processes

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Abstract. A new formalism for the definition of metallic materials constitutive laws expressing the stress as a function of the plastic deformation energy it is proposed. This new approach, called energy approach, can integrate physical mechanisms governing the microstructure changes during a plastic deformation. It is also important to emphasize that the proposed energy formulation is more relevant since it can describe physical phenomena taking place in a material forming process characterizing at the different scales the material properties evolution. This formulation remains valid for a large field of deformation, the whole spectrum of loading conditions and remains able to predict rigorously the material response for all types of stresses states: static, transient or dynamic.

Keywords: Energy Approach, Differential Equation's Constitutive Models, Plastic Deformation Energy, Work Hardening and Dynamic Softening.

1 Introduction

Metallic materials are used intensively in the majority of engineering sectors through a very wide range of forming operations dedicated to the manufacture of various components and structures. It is therefore important to define their thermomechanical behavior to be used by predictive numerical simulations in order to limit the use of expensive experimental studies and to be able to achieve the forming processes optimization. The technical and scientific literature offers a very wide class of constitutive laws modeling the thermomechanical behavior of materials subjected to different loading conditions. The classic formulations of the rheological laws express the Cauchy stress tensor as a function of instantaneous internal variables such as the strain tensor, the strain rate tensor and the temperature, making it possible to give with sufficient precision the response of materials under quasi- static, but not very precise for fast or severe dynamic stresses. Indeed in these last cases resorted to parametric calibration techniques coming out of the physical framework which requires a rather fine description of the microstructural mechanisms Moreover in the majority of cases, in order to describe the behavior of work hardening under specific conditions, the traditional methods reduce the effect of strain history only through the cumulative plastic strain defined by generalized strain rate integration. However, during the hardening mechanisms, the stress undergone by the material on the scale of an infinitesimal volume element is rather linked to the locally dissipated plastic deformation energy responsible for any change in the structural state of the material.

This research work proposes the application of a new formalism for the definition of the hardening laws expressing the stress as a function of the energy dissipated by the plastic deformation. This approach was firstly mentioned by R. HILL [1], indicating that the work hardening depends on the plastic deformation energy. Then a new formalism is introduced by M. YOSHINO and T. SHIRAKASHI [2] by expressing a reference stress as a function of the plastic deformation energy. The energy approach can also be seen as a consequence of the thermodynamics principles and of the constructual law which postulates that any system finds its evolution over the time minimizing the losses energies and minimizing the entropy rate (Prof. A. BEJAN - [3]).

2 Computational Principles

After a short presentation of the problem formulation, it is described a more general mathematical formulation of the metals constitutive models with the consideration of dynamic softening phenomena (restoration and recrystallizations) through the above mentioned energy approach [4-5]. It is demonstrated that in certain special cases, linked only to work hardening for example, the expressions of usual laws van be obtained and, conversely, the constitutive equations known as energy formulations can be expressed from the classical formulations i.e.:

$$\sigma_h = H(\bar{\varepsilon}) \Leftrightarrow \sigma_h = f(W) \text{ with } W = \int \sigma_h d\bar{\varepsilon} \quad (1)$$

The new constitutive energetic model will be discussed with respect to a numerical implementation in the resolution of the Prandtl-Reuss equations specific to a 3D description of the elasto-plastic deformation starting from an energy description of the variation of the equivalent stress expressed by a set of differential equations defined in terms of plastic strain energy *W*.

$$g\left(W, \frac{d\bar{\sigma}}{d\bar{\varepsilon}}\right) = 0, h\left(W, \frac{dW}{d\bar{\varepsilon}}\right) = 0, W = \int \bar{\sigma} d\bar{\varepsilon} \Leftrightarrow \sigma_h = f(W) \quad (2)$$

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Digital Twins for Micro Machining

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Abstract. The digital twin is a virtual mirror of the physical world throughout its life cycle. A cutting process controlled by digital twins can be a modern solution for manufacturing. Continuous data collection using virtual twin simulation and physical twin experimentation is related to modified vibration micro drilling processes, improving the quality of operations. The main research question is how to quickly create a virtual model, and the mechanism for deploying the connection between the physical world production system and the virtual model it reflects. Over the last two decades, the demands of drilling small holes (Ø 0.5 mm) at high rotational speed (80.0÷180.0 rpm) are increasing due to the trend towards higher density circuits of computer parts and microelectronic packaging products. Compared to various micro machining methods, the main advantages of mechanical micro drilling are: less complicated equipment is necessary, the process is cheaper, the electrical properties of the workpiece do not influence the process, and machining time can be controlled easily. Buckling stiffness of micro drill bit is essential factor in order to secure the quality of micro drilling process, most of micro drill bit failures happen because of buckling. The aim of this study is to investigate the possibilities to increase micro drill stiffness by buckling it on a higher mode of the tool. This would allow to use higher cutting parameters and to increase efficiency of the micro drilling process.

Keywords: Data Collection, Vibration Drilling, Buckling Stiffness, Higher Mode, Process Efficiency.

Characterization of mechanical behavior of macroscopic interfaces for multi-material 3D printed samples

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Abstract. The development of Additive Manufacturing technologies introduced new possibilities regarding multi-material part production. Fused Filament Fabrication (FFF) is one of those technologies suitable for multi-material 3D printing. Usually, multi-material parts are manufactured from different blends of the same material, also known as multi-color 3D printing, or from materials with good chemical compatibility. However, the mechanical performance of multi-material parts is frequently based on a simple face-to-face contact interface between parts bodies and a physical bond between thermoplastics. In this regard, the paper aimed to investigate the performance of the contact interface of multi-material components using a geometrical approach. Therefore, multiple interlocking interfaces were investigated, such as Ω-shape, T-shape, dovetail, and others. For a broader understanding of the interlocking interfaces, the experimental runs consisted of a group of compatible thermoplastic materials, acrylonitrile styrene acrylate (ASA) and thermoplastic polyurethane (TPU), and low-compatible, i.e., polyethylene terephthalate glycol (PETG) and polyamide (PA). The results showed that macroscopic interlocking interfaces could enhance the mechanical properties.

Keywords: Fused Filament Fabrication, Multi-material, Interlocking Mechanism, Contact Interface.

Lap-shear performance of 3D printed multi-material samples by Fused Filament Fabrication

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Abstract. Multi-material 3D printing offers new possibilities regarding product development, allowing design freedom and multiple materials choices in terms of color and material behavior. Material extrusion technologies are among the most popular choices regarding multi-material printing due to their access to equipment and a great variety of thermoplastic materials. However, designing parts for multi-material 3D besides material compatibility contact interface must be considered. Material Extrusion creates the parts layer by layer with a defined thickness, and each layer is characterized by multiple lines of extruded thermoplastic at a defined width. Therefore, regardless of the 3D model’s surfaces, those are composed of multiple lines of material and voids. Depending on the 3D Printing process setup, the bonding mechanism between materials can be influenced due to the different characteristics of horizontal and vertical contact interfaces. For this reason, this paper aims to study the influence of process parameters over horizontal adhesion through lap-shear tests for multi-materials samples made of acrylonitrile butadiene styrene (ABS), acrylonitrile styrene acrylate (ASA), and polycarbonate (PC). The result shows that process parameters influence the mechanical performance of the bonding of multi-material samples.

Keywords: Fused Filament Fabrication, Multi-material, Horizontal Adhesion, Process Parameters, Lap Shear.

Vibration Transmissibility of Aluminum Foam for design as a Bearing Damper

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Abstract. Metal foams materials energy absorption, thermal insulation, and damping resistance will make it a special item for new development in rotor vibration control. The vibration of a shaft supported by ball bearings is analyzed based on metallic foams. Modern gas turbine engines typically utilize squeeze film dampers as flexible damped support to attenuate vibration amplitude and to reduce transmitted forces. The mechanical and damping properties of metal foams will be used as a damper absorber to reduce the vibration of a simple Jeffcott rotor system. This paper's aim is to explore the characterization of metal foam as a source of dampening in a simple Jeffcott rotor system. also, to reduce the detrimental vibration effect on rotor dynamics supported especially by ball bearing with squeeze film metal foam damper. The adapter covering the outer rings of the ball bearings will be modified to obtain a vibratory analysis with or without the use of a porous metal foam damper. The vibration transmissibility through the metallic foam sample will be presented to figure out the damping coefficient and vibration isolation efficiency.

Keywords: Vibration, Metal Foam, Transmissibility, Damping, Shaft, SFD.

1 Introduction

Nowadays, the ball bearings are computed with specific software, whose use is not so easy for the engineers, because the definition of a bearing remains much more complex than expected. The space mechanisms use pre-loaded ball bearings to withstand the severe vibrations during launch strength, and the last one requires the calculation of the bearing's stiffness, but this calculation of bearings stiffness is complex. Bearing's stiffness calculation is usually done using an iterative algorithm such as Newton Raphson because the contact angle depends on the loadings. There is no analytical solution giving the bearings stiffness [1]. Rotor mounted on fluid film bearings can experience fluid induced instabilities that occurs as severe vibration. The formulation of the fluid film bearings greatly contributes to the dynamic characteristics of these systems. The basic components of the rotor are the shaft, a disk with variable imbalance, a sleeve and a fluid film bearing.

SUNAR, M et al [2] were analyzed the experimental shaft vibration data of RK4 Rotor kit by using computer program. They used to simulate the rotor model by finite element method. The shaft, disk and bearings are modeled. The stiffness and damping maps and Campbell diagram were produced and used to analyze the system stability. Usually, whirl and whip are referred to as most significant fluid induced instabilities. They concluded that any increasing in the distance of the disk from the fluid film bearing increases the instability threshold, whereas the instabilities of the system are heavily de-pendent on the rotor speed and the behaviour of the shaft journal inside the fluid film bearing.

Permeability is an important property for flow-through metal foam application such as thermal application, filtration, electrochemistry, acoustic absorption, vibration damping and porous implants. New models should be developed and the methods to measure permeability should be reevaluated, especially when the material thicknesses is small and the fluid velocity is high. Porous metals and metallic foams have been commercially used for many years and various companies are producing these materials for different applications. Important commercial development took place in the last 30 years on closed cell aluminum foams and sandwich panels for structural application and various companies are now commercializing these materials. The most important commercial application of porous metal and metal foams remain open cell materials to produce filters, gas flow con-trolling devices, batteries, biomedical implants and bearings [3]. For the five decades squeeze film dampers SFD have been used extensively in aircraft engines, and in more than 300 industrial compressors for providing damping at bearings location. The high damping forces of the SFD combined with low support stiffness, decrease the vibration levels and dynamics loads, and improve rotor dynamics stability. However, despite its useful characteristics, the SFD has some inherent disadvantages. damping being de-pendent on the viscosity of the oil, the performances of the SFD decreases considerably at very high and very low temperatures. The SFD cannot sustain high vibration amplitudes, such as from large imbalance. Air ingestion into the SFD creates bubbles in the oil and makes its performances unpredictable, ad make it less attractive especially with the growing interest towards oil-free machinery [4].

SHIPING Zhang et LITANG [5] Yan have developed an efficient oil film damper known as porous squeeze film damper (PSFD) for more effective and reliable vibration control of modern gas turbine engines and or other high speed rotating machinery based on the conventional squeeze film damper (SFD). The outer race of the PSFD is made of permeable sintered porous metal material as shown in figure 01. The metal material permeability allows some of the oil to permeate into and seep out the porous matrix, with remarkably improvement of the squeeze film damping properties. They characterized the PSFD oil film stiffness and damping coefficients and permeability, also they investigated the steady state unbalance response of a simple rigid rotor and flexible Jeffcott rotor supported on PSFD and SFD. The provided investigation of PSFD present a primary under-standing of permeability effected porous squeeze film damper, and a proposed manner to assess potential benefits of passive oil film dampers for rotor vibration control and has potential advantages to operate effectively under relatively large unbalance conditions. DE CARVALHO et al [6] investigated numerically the applicability of Recemat 1723 metal foams as discs in aero engine separators calls breathers for its transport properties. The pore scale topology is represented by an idealized geometry called weaire-Phelan cells. They took into consideration the structural properties such as porosity, specific surface area and pore diameter. They compare the Representative Elementary Volume of the foam with the representative Recemat 1723 metallic foams sample, generated by Xray Tomography scans. They conclude that the W P structure of the correct geometrical parameters to much WP structure with a real one is still a subject of future study.

Because of their unique structure and properties metal foams today is focus of much research in porous/cellular materials field. Metal foams prepared by different methods and techniques developed an open or closed cell met-al foam [7] [8]. Recently for closed cell foams most relevant commercially methods divided into two groups those called the melt and the powder metallurgical methods, also the most relevant commercial products of metal foams originally referred to direct and indirect foaming routes, respectively according to [9]. The open cell metal foams also called metal cell sponges which can divided into two families [10] the first based on a polymeric sponge's structure and the second on a place holder that can be removed. Their use in mechanic and thermal ap-plications such as shock absorption, mechanic and phonic vibrations absorption and reducing weight exploits their capacity to undergo large deformations at almost constant stress. For both fundamental research and engineering application metal foam has studied dynamically. The cellular material as aluminum foam is excellent material for energy absorber in packaging and protection applications because they have a long flat load deflection curve and excellent plastic energy absorbing characteristics.

The main intent of this paper is to evaluate the metal foams as an alternative approach for integrating with SFD to channel the vibration energy to where it can be absorbed and dissipated safely in simple Jeffcott rotor system. The adapter covering the outer rings of the ball bearings will be modified to obtain a vibratory analysis with or without the use of porous metal foam damper as modified for old squeeze film damper.

2 Materials and Methods

In large scale rotating machinery, the resonance amplitude during the passage through resonance is a matter of consideration because of its influence in the surrounding environment of the rotational system and foundation. Especially in this part of the article we are going to use the simple Jeffcott rotor model. In fact, increasingly high rotational speeds cannot be reached without passing through the critical speeds, synonymous with ruin of the machine if the vibrations are not dissipated. Among the frequently used sources of dissipation, we can cite friction (eg in leaf bearings), the use of viscoelastic materials (eg rubber silent blocs), the crushing effect of an incompressible fluid (eg SFD or Squeeze Damper Film). In the first two cases, the supported radial load is very quickly limited. In the second case, it is necessary to use an external pressure source as well as a complementary mechanical element (e.g. squirrel cage) to the guidance system (e.g. ball bearings). The search for ever greater rotational speeds in turbomachines requires designers of shaft lines to find an ever-better match in the choice of the guiding and sealing components that compose it. Among the guide components, ball bearings are one of the most popular solutions. However, if critical speeds must be crossed to reach the nominal speed, the ball bearings, which have a very high stiffness but little or no damping, must be supplemented by damping devices such as the squeeze film damper (SFD). The level of depreciation provided by these depreciation devices has become neither too high nor too low, it is essential to be able to characterize and predict it

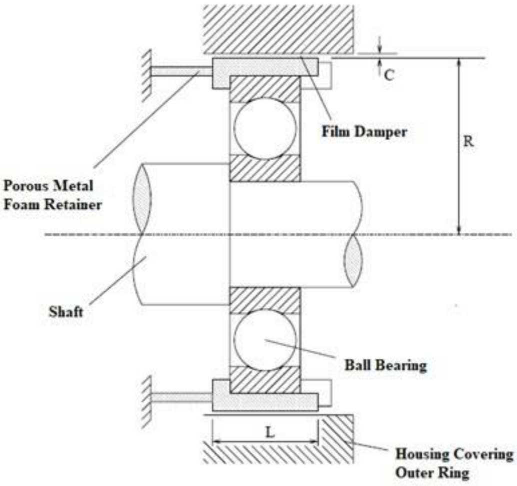


Fig 1: The cross section of a bearing with q squeeze film damper and retaining spring

The intent of this part of article is to evaluate the permeability of metal foam in order to test their isolation efficiency with or without adding composite materials besides testing it under different vibration amplitude regimes. The static vibration calibrator is very useful system to understand the behaviour of metallic foam under small vibration amplitude responses.

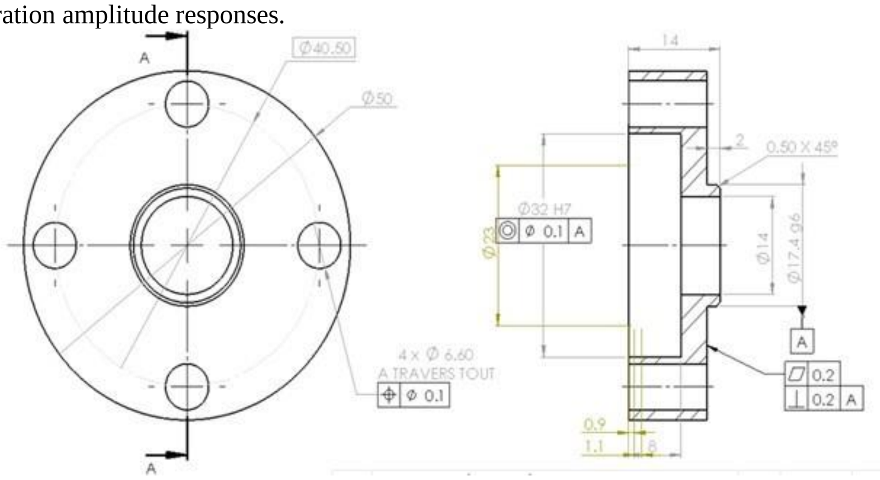


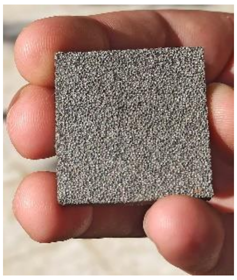
Fig 2: The bearings adapter element of the rotor kit

The rotor kit composed from many important parts. The objective of our study is to make some modification to the bearings adapter element in order to integrate the metal foam disc (donuts) between the outer race of the Misumi bearing and the cage. The metal foam sample should be cut as donuts with precise dimensions, the outer diameter, the inner diameter, the radial thickness and axial thickness. The bearing adapter element of the rotor kit support the ball bearings during their high-speed rotating. The metal foam do-nuts could be perhaps a solution as porous squeeze film damper to minimize the instabilities of rotor kit during the passage of the critical speed means the resonance. The pro-posed modification surrounding the bearing adapter as you can see in the figure bellow based on create a small gape to put the porous metal foam damper.

The metal foam donuts sample may have to be a good solution to minimize vibration producing from the rotating shaft and the instabilities. The Recemat open cell metal foams have a good damping property with high acoustics attenuating capacity could be a solution for our problem related to attenuating vibration during the passage from the low speed to the high speed of the rotor system

The figure 03 present the Recemat metal foam specimen and the proposed porous metal foam disc damper replaced the conventional SFD. The proposed porous metal foam damper presents energy plastic dissipation role. Here the cause of this dissipation of energy is the plasticity of this kind of porous materials in origin. High external loads generate significant internal stresses. If these exceed a threshold the system is irreversibly altered (plasticity of the materials for example) but retains its integrity. The integrity of the system can be destroyed if the effort is too large and then there is ruin.

(**A**)



(**B**)

Fig 3: Alumina Metal Foam rectangular sample for preused as damper (a) trimetric view (b) front view

This device for absorbing energy by plastic deformation of metallic materials is used, for example in the aeronautical sector to absorb the slight shocks and is present at the front of the cockpit of the aircraft.

The same principle is used in the automotive sector for absorbing shocks at low speeds: metal profiles in the shape of tubes of rectangular cross-section, attaching the front and rear automobile bumpers to the body of the vehicle, deform by buckling in the event of an impact and thus absorb kinetic energy for low speeds (of the order of 10 km/h). [11].

The porous metal foam disc damper should be replaced in modified adapter bearing element. This modification dedicated to the use of ball bearing in sample Jeffcott rotor system with shaft and disc rather than the Misummi bearing TBB6900ZZ. The bearing adapter should be modify to replace the metal foam donuts to play the role of squeeze film damper (SFD).

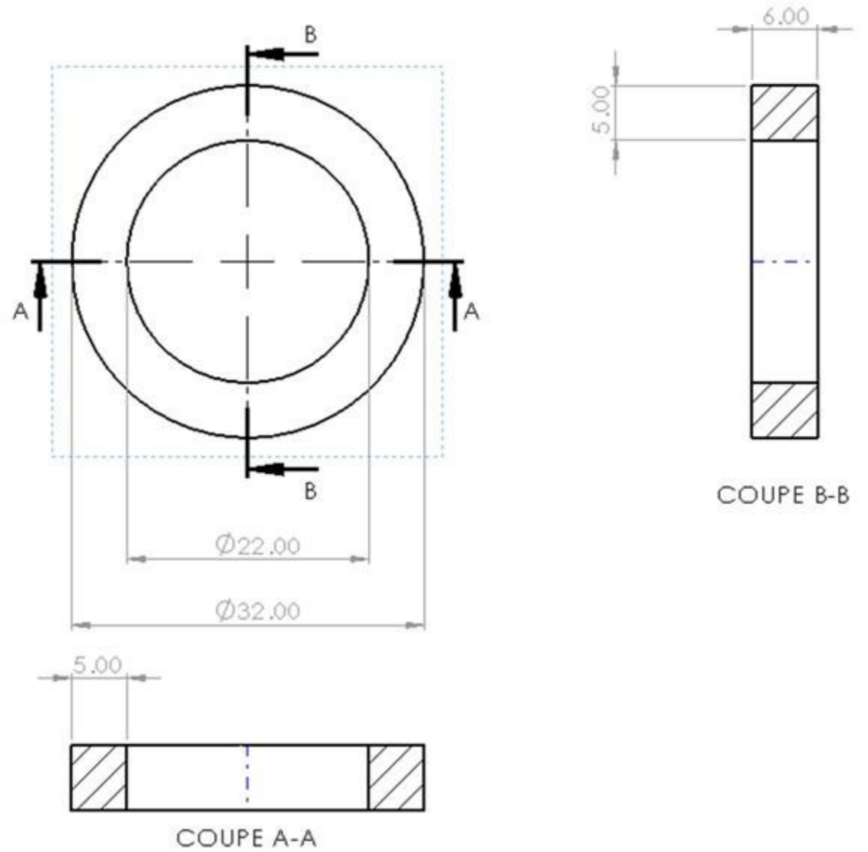


Fig 4: The Proposed Technical Design of The Porous Metal Foam Disc Damper

2.1 A Transmissibility Measurements

Transmissibility of vibration through metallic porous medium not yet known by most of researchers worldwide. The last decades many searchers focus their studies in production characterization processes and application of metallic foams. Metal foams generally classified as new and emerged material since 2000. The relative density and porosity remain the important factor of metallic foams before going towards any application process. Here testing vibration by using static and dynamics systems will be a new axe of research in future in materials.

Transmissibility is a measurement used in the classification of materials for vibration management characteristics. It is a ratio of the vibrational force being measured in a system to the vibrational force entering a system presented in the law below:

$$T = \left|\frac{A_0}{A_i}\right| = \sqrt{\frac{1 + \left(2\xi \frac{f_d}{f_n}\right)^2}{\left[1 - \left(\frac{f_d}{f_n}\right)^2\right]^2 + \left[2\xi \frac{f_d}{f_n}\right]^2}} \quad (1)$$

Which is
A_0=Amplitude of the Vibrational Response
A_i=Amplitude of the Vibrational input
ξ =Damping ratio
f_d=Driving frequency
f_n=Natural frequency
Transmissibility is more easily defined as the percent of vibrational energy that is being transmitted through a structure here (metal foam sample structure element)

The experimental setup is similar to the one proposed in GOLETTI, Massimo et al [12].

The vibration characteristics of materials are typically represented by a graph of transmissibility vs frequency. The vibration exciter of the VC21D has a tapped M5 hole with 7 mm depth for the attachment of the metal foam specimens under test. The supplied stud bolts and stud adapters or a clamping magnet can be used for mounting. After attaching the sample under test, the vibration signal becomes stable.

Metal foam exhibit higher damping characteristics than their parent metals. Consider a single degree of freedom spring mass system as shown in the figure 02. The mass is fastened to base with the support of a spring and viscous damper. The oscillates at single frequency ω and has an amplitude of X, the displacement of the base will accordingly be expressed as $X=Xe^{iwt}$. Therefore, the relative displacement of the supported mass is expressed by $Y=Ye^{iwt}$

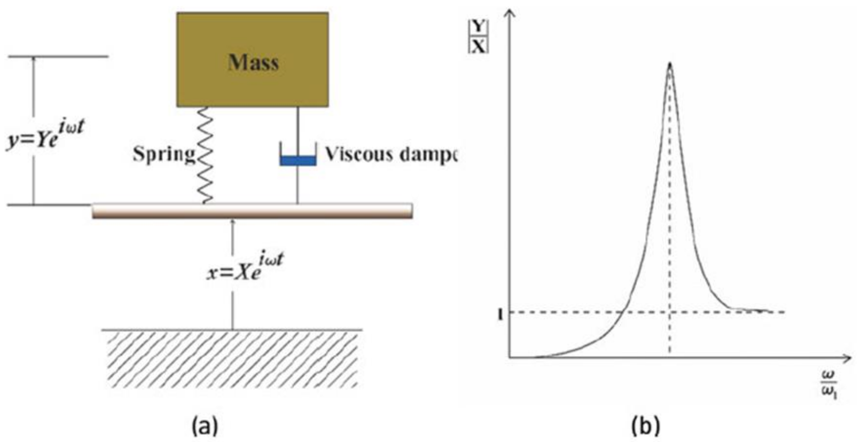


Fig 5: (a) schematic diagram of a single degree of freedom spring mass oscillator system. (b) approximate transfer function for relative displacement y of mass [13].

The transfer function (F (w)) is presented by Eq:

8

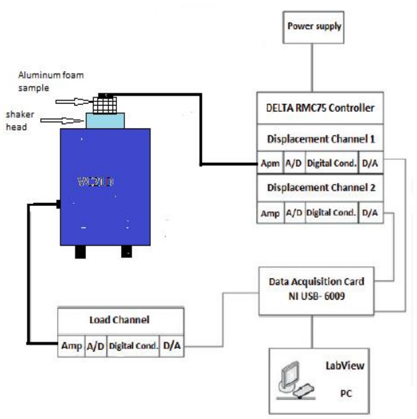
$$F_{(\omega)} = \frac{Y}{X} = \frac{(\omega/\omega 1)^2}{1-\left(\frac{\omega}{\omega 2}\right)^2 + i\eta(\frac{\omega}{\omega 1})} \qquad (2)$$

Which is
ω1= undamped natural frequency of spring mass oscillators
η=damping factor

2.2 Experimental Apparatus

The purpose from this experiment is to study the transmissibility of vibration through porous metallic medium with-out any elastomer materials added to the pore cell of aluminum foams. The vibration calibrator will be used for that purpose. The metal aluminum foam will be calibrated between the two clamps of the device and then tested the sample sheet investigated under different input frequencies and amplitudes. The result present that the damping coefficient always less than 0.16. of aluminum foam of 84% porosity.

The aluminum foam specimen was prepared and cut as a rectangular piece of 50mm*50mm*10mm. Transmissibility is defined as the ratio of the magnitude of the force transmitted to the foundation to the magnitude of the unbalance force. If a rigid support is used, the transmissibility would simply be one.



(A) (B)

Fig 6: (A) Schematic illustration of the non-rotating test setup, (B) The Vibration Calibrator VC 21D with clamping devices

3 Results

The vibration characteristics of metal foam are typically represented by a graph of transmissibility versus frequency .as you can see from figure 07 is a typical plot of a mate-rial's transmissibility curve. From the graph we notice that this aluminum foam has very important damping coefficient the circled region represented the value of the damping efficiency against the insolation below 0. The natural frequency zone could be beneficial for attenuating the high value of resonance pic of the vibration amplitude pass through the foam specimen. The rest part minus 1 show the permeability or the porosity of this aluminum foam. Using this curve engineers can ex-tract useful information about the material's properties in regard to vibration, including natural frequency, damping ratio, and isolation.

The peak on the curve at around 40 Hz is representative of the material's natural frequency. using this peak and some math, engineers calculate the amount of damping in a material. When the curve crosses the Y-axis into negative values (at approximately 80 Hz on the plot above), the material begins to isolate vibrations. As frequencies increases, the amount of energy transmitted from vibration is reduced means isolation performance increase.

The input value of amplitude between 00 Hz to 1285Hz produced by the Vibration calibrator. For any results the metal foam specimen should be calibrated and clamped between two sensors as presented in figure 06 a.

3.1 Transmissibility Results

Table 1: input and output frequency during calibrating metal foams and transmissibility

Frequency	Input amplitude	Output amplitude	Transmissibility
(Hz)	(m/s^2)	(g)	(dB)
15.82	2	0.20	0.06
40	2	0.21	0.11
40	5	0.50	0.02
80	5	0.50	0.03
80	10	1.02	0.07
159.2	20	1.02	-2.59
159.2	20	1.34	-1.73
320	20	1.44	-1.41

10

640	20	1.52	-1.18
1280	20	0.92	-3.38
1280	10	0.47	-3.32

The input value of amplitude between 00 Hz to 1285Hz produced by the Vibration calibrator VC 21 D. For any results the metal foam specimen should be cali-brated and clamped between two sensors as presented in figure 4 (a). The table below pre-sents the value of transmissibility through the metal foam sample and the input and output value of amplitude shown.

Frequency is plotted on the X-axis in Hertz (HZ) and Transmissibility is plotted on the Y-axis in decibels. The equation for covering the ratio into decibels is below:

$$dB = 10LOG\ (A_0/A_i) \quad (3)$$

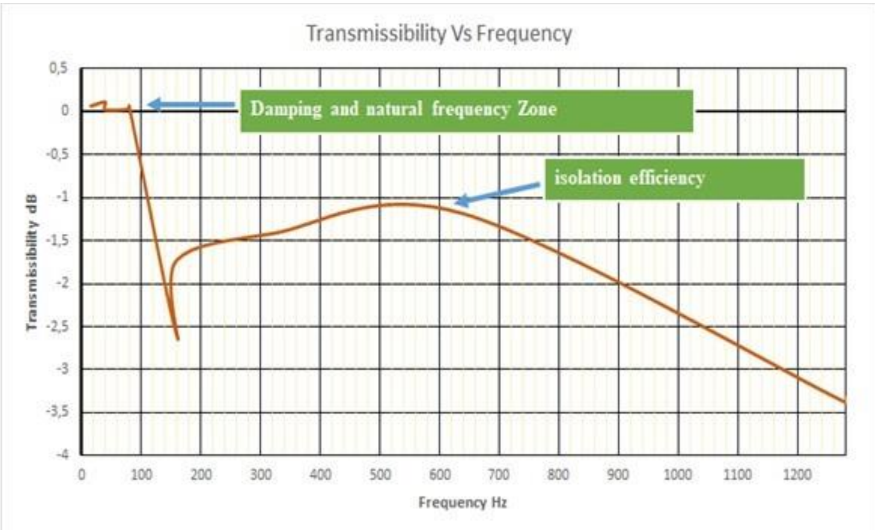


Fig 7: Transmissibility versus frequency curve

4 Conclusion

- From above approach of using metallic foam as damping source, the aluminum foam with high porosity could absolutely test the vibration permeability to absorb large amount of vibration if it’s used with rubber materials.
- The donuts metal porous squeeze film damper may could be good solution in bear-ings adapter to reduce the instabilities during the passage through resonance
- The characteristics of this kind of foams have good ability to filter vibration and sound specially when we add a foamed samples between the clamped prob as goal the permeability of vibration has the same value of the rela-tive density.

- From the graph of transmissibility vs frequency, we notice that the damping coefficient is slightly small that means this foam is very useful for isolation and vibratory attenuating and noise applications.
- The isolation region of this foam is highly efficient to use in future for rotating system as ball bearing shaft with high radial velocity is recommended and when we need to have the vibration minimization as objective in rotor sys-tem.
- The study of metal foam and their use as damper still continuing but this time with the 3D characterization and making series of testing on the mechanical and vibration-al properties by using sophisticated tools.
- The damping offering by the metal foams it's very necessary for important for application where energy ab-sorbing is demanding.

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Infill parameters influence over strength of 3D printed samples by Fused Filament Fabrication

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Abstract. Fused Filament Fabrication (FFF) is an extrusion-based technology that uses molten thermoplastic material to build 3D models additively. Each part is built in a layer-wise fashion and is composed of walls, bottom/top layers, and internal structure. Regarding the internal structure, also known as infill, many studies adopted 100 percent infill density for the tested samples, which logically, is the strongest. However, there are still other infill parameters that were not thoroughly studied. Thus, this research aimed to investigate the influence of nine infill parameters and two travel parameters over the tensile properties of 3D printed samples. The experiment was designed using a mixed Taguchi L36 matrix. All samples were printed with gyroid infill without bottom and top layers using a polylactic-acid-based (PLA) material. The results show that the strength of samples can be increased by multiplying the infill line along with an increased overlap between the infill line and the inner wall.

Keywords: Fused Filament Fabrication, infill, infill parameters, tensile strength.

The influence of some printing parameters on the mechanical properties of PETG parts

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Abstract. The scientific literature regarding additive manufacturing shows that for most engineering applications, one of the widely used material for printing parts using the Fused Filament Fabrication (FFF) method is Polyethylene Terephthalate Glycol (PETG). The mechanical characteristics of the parts obtained by this technology depend on a number of the input factors of the printing process, of which major influence is exercit by the printing temperature, the tool trajectory, the height of deposited material layer, etc. This paper presents an investigation on the influence of the printing direction, the thickness of the deposited material layer (nozzle diameter) and the (initial) temperature of the previously deposited material layer, on the part tensile strength. A Taguchi L9 DOE plan was developed for this purpose. The test specimens (dimensions according to ISO 527-2 type B) were printed on a 3D printer, Creality type CR6-Se. Also, a thermal imaging camera, type FLIR type x6540sc was used for temperature evaluation and a Quasar 600 type tensile test machine for tensile strength estimation. The results obtained show that the variation of the temperature of the layers influences the tensile strength of the tested parts.

Keywords: Additive Manufacturing, PETG, FDM, Printing Temperature.

Neural networks for predicting kerf geometry and surface roughness of CO_2 laser-machined FFF PLA/WF plates

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Extended abstract

Wood flour (WF) mixed with poly-lactic acid (PLA) is an eco-friendly composite material used in the fused filament fabrication (FFF) process. Laser beam machining (LBM) is a non-conventional process that can achieve high dimensional accuracy, surface quality, and process efficiency [1]. This work investigates the effect of CO_2 laser cutting (LC) with variable cutting parameters of thin 3D printed PLA/WF plates on kerf angle (KA) and mean surface roughness (Ra) of the resulted slot. This research work is a follow-up of previous reports related to the field [2-3].

The experimental design follows the response surface methodology (RSM) in order to formulate a continuous experimental domain. All twenty-four experiments were repeated three times for the three PLA/WF plates (deposition angle/DA: 0^o, 45^o, and 90^o from X-axis, respectively). Table 1 summarizes the parameters and the levels corresponding to the full factorial experimental design.

Full factorial design of experiments						
Parameter	Symbol	Level				
		1	2	3	4	Unit
Stand-off Distance	SoD	7	8	-	-	rpm
Traverse Speed	TS	8	13	18	-	mm/rev
Beam Power	BP	82.5	90.0	97.5	105	Mm
Cutting Direction	CD	0	45	90	-	(deg.)

Table 1. Parameters and levels.

The results were statistically processed using Analysis of Variance (ANOVA), to study the significance of independent parameters to the responses of kerf angle and surface roughness. To allow for rigorous investigation in terms of independent parameters, contour plots were created to interpret interaction effects. The physical meaning of the influence of each parameter on the laser cut attributes has also been discussed. Fig. 1 shows the laser-cut procedure on PLA/WF experimental plates.

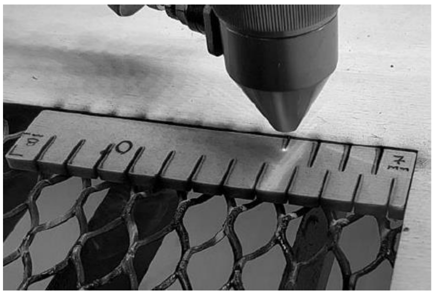

Fig.1. Laser cutting procedure.

A number of Artificial Neural Network (ANN) architectures were tested for predicting the responses of kerf angle (KA) and mean surface roughness (Ra) as two of the most critical quality objectives. The results have shown that the ANN architecture finally implemented can adequately predict KA and Ra responses while during experimentation it was observed that a cutting path parallel to the filament beads produced the best results for surface roughness Ra.

Keywords: Hybrid manufacturing, CO_2 Laser cutting, 3D Printing, PLA/wood flour composite, Optimization.

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An Inverse Analysis Method Applied to Optimization of Specimen's Shape for Performing Hot Rapid Crushing Tests from Homogeneous Initial Temperature Field

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Abstract. Specific experimental tests with loadings conditions close to those of industrial fast forming processes as rapid forging, rapid stamping or high speed machining, characterized by large plastic strains, localized deformations and important gradients of strain rates, strain and temperature, requires to analyses material flow behavior at different initial temperatures. One of the more important conditions to obtain intrinsic rheological constitutive equations is to have a quasi-homogenous initial temperature distribution and especially to keep constant the material microstructure during the specimens heating. The rapid induction heating seems to be one of the most reliable processes. This scientific study proposes an inverse analysis technique based on numerical finite element modelling to define on the thermal point of view, optimal specimen shapes for performing hot rapid crushing tests from homogenous initial temperature field.

Keywords: Hot SHPB pressing, Thermal Cooling, FEM, Inverse Analysis.

1 Experimental and Computational Principles

Metals with high thermal diffusivity as aluminum or cooper alloys require short times between the stop of the heating process and the start of mechanical loadings.

Outside the possibility to have a real time loop to launch a mechanical experimental test, generally a short thermal cooling period occurs between the two different stages: thermal heating and mechanical loading. Identification of thermomechanical behavior properties requires to control the homogeneity of specimen initial temperature field and to keep the initial material microstructure. According to these needs this scientific paper proposes to analyses shape optimization of material specimen for a hot rapid crushing test. An Inverse Analysis Method [1-3] will be applied to a Non-Linear Finite Element Model describing here the short thermal cooling during a specified time period, in order to obtain specimen's shape sizes corresponding to the need to have initial material temperatures close to an imposed value, minimizing the temperature gradient on all the useful sample area. All thermal phenomena as conduction, convection and tool's heat transfers will be taken into account. To avoid mechanical buckling and contact friction during the specimen deformation, corresponding constraints will be added along a specific formulation of the cost function. A strong numerical coupling between the direct FE model and an improved gradient Gauss-Newton optimization algorithm, based on a multi-objective cost function formulation, is performed. Starting from standard uniform specimens generally used by mechanical tests, optimal dumbbell samples and cap specimen shape are identified to be the most reliable in order to can achieved SHPB hot rapid crushing tests from a quasi-homogeneous distribution of material initial temperatures.

2 Results and Conclusions

After a short presentation of the problem formulation, details will be making for the corresponding thermal finite element model, the numerical optimization strategy and especially concerning the used inverse analysis technique. Based on specific numerical simulations and optimizations applications for the optimal design of AA5083 specimens shape will be given concerning a hot rapid SHPB crushing test [1].

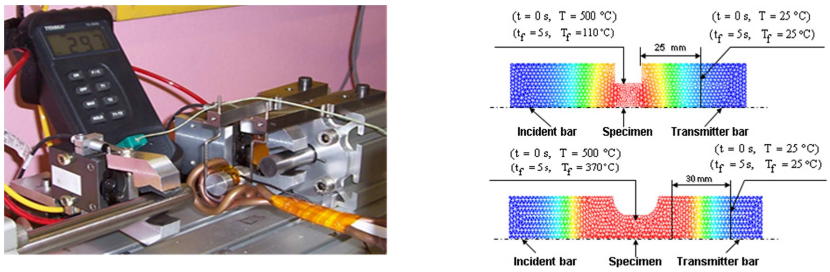

Fig. 1. a) Hot SHPB rapid compression test device, b) Comparisons of Finite Element temperature fields obtained after a time of 5s corresponding to a material cooling from a setting temperature of 500°C reached by a rapid induction heating in the case of an uniform cylindrical specimen and of a dumbbell shape sample [1].

It is shown that the dumbbell specimen with identified specific geometric dimensions permits to have a quasi-homogeneous initial temperature field with average material temperature close to the rapid induction heating's setting value.

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In-situ Prediction of the Spatial Surface Roughness Profile during Slot Milling

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Abstract. Quality inspection is traditionally considered non-productive. That is why the manufacturing industries aim to decrease inspection times to a bare minimum without sacrificing part quality. Alongside the implementation of the Industry 4.0 paradigm, data-driven in-situ quality control is a potential enabler for minimizing inspection times. In that. The surface roughness parameter prediction is the subject of a large body of research, but studies on the spatial surface roughness profile prediction are limited. This research contributes to this field by using vibration signals for the in-situ prediction of the surface roughness profile. A tri-axial accelerometer mounted on the CNC spindle is used to capture the vibrations during a slot-milling process. For one tool revolution during a stable cut, the observed acceleration in the three axes and the surface roughness profile are periodic. Data-driven models are con-structed to establish the correlation between the input signals and spatial surface roughness profile, i.e., by utilizing the machine learning models Gaussian Process Regression (GPR) and Bagged Ensemble Tree (BET). The results show a good correlation between the spatial surface roughness and the accelerometer signals. Furthermore, the addition of denoised velocities and displacements derived by the numerical postprocessing of the acceleration signals improves the performance of the models with minimum overfitting. With tri-axial acceleration, velocity, and displacement as input data, the BET was the best performing model suitable for real-time monitoring of surface roughness with high accuracy and reliability.

Keywords: Surface Roughness, Data-Driven Modelling, Machining Capability.

1 Introduction

1.1 Machining Surfaces

Surface quality is among the most important performance criteria of machined components [1].

- Motivation
    - Surfaces are the main driver for friction
    - Friction is the main driver for energy consumption and wear (ener. 25%)
- Explain different orders of surface profiles

2

- o Scope -> first order

Since the beginning of this century, there has been significant progress in developing in-dustry-driven predictive models for metal cutting. The use of machine learning and AI in improving manufacturing processes has drastically increased in recent times. One such aspect of improvement is in the field of data-driven quality prediction. One of the critical aspects of machining is inspection, which is time and cost-consuming but necessary to verify that the parts manufactured are within tolerance. Machined Surfaces producing out-of-tolerance surface roughness values result from abnormalities in the machining process, such as worn-out tools, machine tool deterioration, varying cutting parameters, improper lubrication[1]. For a high stiffness machine tool, vibrations caused by abnormalities in spindle units should be projected onto the machined surface from a theoretical perspective as vibration affects the relative motion between the functional point of the cutting tool and the workpiece [2].

1.2 State of the Art

1.3 Scope and Methodology

2 Experiments

2.1 Setup

The machining operation performed for this study is slot milling with a 12 mm diameter two-flute solid carbide end mill tailored to cut Aluminum. The surface finish of the machined surface is affected by the feed marks on the surface [3, 4]. Aluminum is less hard than ferrous materials and requires less strength of the end mill core. Thus a two-flute end mill is selected. The machine tool used in this experiment is the AFM R1000 three-axis machine tool with a HSK 63 interface. A force platform is employed to capture forces in the (X-Y-Z) axes during machining, and it also serves as a fixture to clamp the workpiece rigidly. The Dytran triaxial accelerometer with a sensitivity of 10 mv/g measures accelerations in the (X-Y-Z) axis of the spindle unit. The sampling rate of both the acceleration and force signals is 12,800 Hz as the sensors transmit discrete data.

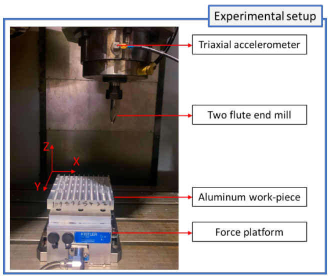

Fig. 1. Experimental setup.

Feasibility and parametrical study of an incremental sheet bending process using a finite element model

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Abstract. Metal sheet air-bending is a well-established forming process heavily used in different industrial sectors. It relies basically on a punch and a die with a v-opening that a have a specific depth for each bending angle and radius. Which induces a high-cost tooling, reduces the process's flexibility and make it suitable only for mass production. For medium or low quantity production more flexible forming processes are needed. In this work we evaluate the feasibility of incremental sheet bending. Where a hemispherical tool follows a trajectory to bend the sheet. Will the bending angle be uniform? How is this uniformity affected by the sheet's width and the trajectory parameters? To answer these questions, we conduct a parametrical study using a finite element model of bending of simply supported sheet and the tool follows a sinusoidal trajectory. We develop a procedure to measure the resulting bending angle and its uniformity. We increase the sheet's width and for each value we change the trajectory's spatial period. We obtain a good uniformity for small spatial periods and it decreases for larger values. We quantify springback variation with these two parameters. These results give a good evaluation of the feasibility of the process, shows the effect of the sheet's width and the trajectory's spatial period on the bending angle and its uniformity. This process is an alternative flexible bending process for low and medium productions. The results help the designer in choosing the right parameters to have a uniform bending angle.

Keywords: Incremental sheet bending, air-bending alternative, bending angle control.

Study on the Application of the Holistic Optimization Method of the Manufacturing Process in the Case of a Reduced Extension Instances Database

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Abstract. The optimal management of the manufacturing processes is achieved through a set of optimal decisions, which must be made for choosing the best way to follow, every time we find ourselves in a point from which several potential manufacturing paths start. A dedicated method, namely the Holistic Optimization Method has been already developed in this purpose, and validated in a number of studies based on artificial and real instances databases. In the current papers, which approach the optimal management of the manufacturing processes, in order to estimate the consequences of a decision, are used known methods, such as: NN methods, big data analysis, statistical methods, etc. In all these cases, the database size plays an essential role in terms of estimation quality. The present study aims to prove the feasibility of applying the Holistic Optimization Method when the decision-maker does not dispose of a consistent database. This can be a significant advantage relative to the other methods. The study is performed using an artificially generated instances database in the case of a turning process, and the results obtained are promising.

Keywords: Decision Making, Holistic Optimization Method, Instances Database, Comparative Assessment, Turning Process.

Modern Techniques for Remanufacturing Hydraulic Equipment in the Context of Circular Economy and Energy Efficiency

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Abstract. The article presents some current methods of remanufacturing hydraulic components, a trend that is encouraged, on the one hand, by concerns about reducing material consumption in the context of the circular economy - some of these materials being expensive or in short supply. On the other hand, remanufacturing by modern methods can lead to a decrease in energy consumption in the devices concerned, due to obtaining shapes that are difficult to achieve by classical procedures. Among the remanufacturing processes considered there are additive manufacturing, metal coating, reverse engineering, etc. An important step in the remanufacturing process is testing of components, which certifies the achievement of performances at least equivalent to those of the original products. To this end, the article presents a test bench solution with the help of which tests can be carried out on hydraulic devices such as hydraulic pumps and (linear or rotary) motors, hydraulic directional control valves or other types of valves.

Keywords: Remanufacturing, additive manufacturing, reverse engineering, circular economy, energy efficiency, test bench.

Functional correlation surface texture / grip of a deposit : case of NiP

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Abstract. This work studies a functional correlation between different texture parameters and the adherence of NiP coating on a metal substrate. Multiple surfaces with different milling feed rate and coated with NiP went through a pull-off adhesion test. This study determined through texture analysis functional correlation between characterization of surface topographies and the strength measured during the test. In order to study if a multi-scale approach improve the correlation, a “conventional” method based on ISO 25178 procedure and a multi-scale method based on wavelet filtering are compared.

Keywords: Surface Metrology; Multiscale; wavelet; Surface analysis; coating adhesion, ISO 4287-4288; ISO 25178

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On the Machining of Joint Implant UHMWPE Inserts

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Abstract. The modern orthopaedic implants for applications in hips, knees, shoulders, and spines are composed of hard metal alloys or ceramics. The tribological sub-component is composed of soft materials with good tribological properties – e.g. UHMWPE (Ultra High Molecule Weight Polyethylene). The UHMWPE implants need to be machined into their final shape after the polymerization and consolidation into a blank profile or near-net shaped implant.

So machining is a crucial technology that can generate an accurate and precise shape of the implant that should comply with the joints' function. However, the machining technology can affect the topography and integrity of the surface, and its resistance to wear. The technology, cutting tools, and cutting conditions can impact the physical and mechanical properties of the entire implant, limiting its life span and creating a need to be replaced.

The basic machining technologies are turning and milling (each can be used as roughing or finishing). There are many ways to machine these surfaces. Many problems such as low rigidity of the product, poor thermal properties of the material, high melt viscosities, and sticking of the material to the cutting edge (production of built-up edges) have been solved. UHMWPE can be damaged by excessive heat, feed rate, cutting force, and tool micro-geometry. The shapes and dimensions for the customized implants vary broadly for the humans this complicates the machining technology. No standard programs can be used repeatedly so each joint must be designed and produced individually. However, it results in the longer implant life and a better comfort of patients.

Keywords: Machining, UHMWPE, implant, surface integrity, tribology.

Optimization of Manufacturing Processes by Reducing the Costs of Tools and Equipment on Hydraulically Operated High-Pressure Technological Lines

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Abstract. Most technological manufacturing lines include hydraulically operated stationary tools, devices and equipment. During a manufacturing cycle, there are phases, usually short, in which part of the hydraulic cylinders of the drive systems concerned, with small gauges and displacement speeds, have to generate / maintain high clamping or pressing forces, which implies functioning at high working pressures.
The solution for such cylinders is to use modular hydraulic pumping units comprising: oil tank; low-pressure electric pump; hydraulic directional valve for starting, stopping and changing the direction of movement of the cylinder; electric pump pressure control valve; pressure filter; return filter; oscillating hydraulic pressure intensifier (minibooster mounted directly on the cylinder).
Such pumping modules, which consume low pressure (in the primary side of the minibooster) to generate high pressures (in the secondary side of the minibooster), are cost-effective when it comes to the purchase of components, installing them, the space required for installation, and their maintenance, too.
The classic applications of using them are for achieving and maintaining high pressure values, either in volumes of closed spaces (endurance tests for pipes and tanks), or at the active stroke end of hydraulic cylinders (hydraulic presses).
The authors demonstrate, on an experimental laboratory bench, the following:
- The range of applications of such pumping modules can be extended in a third direction, namely for actuation of hydraulic cylinders with low gauge / speeds and constant high load (high working pressure) over the entire stroke;
- Uniformity of movement of these cylinders with load over the entire stroke that are fed and operated by such pumping modules is weakly affected by the pulsating operating mode of the hydraulic pressure intensifier.

Keywords: low pressure; pumping module; oscillating hydraulic pressure intensifier; high pressure; hydraulic cylinder.

Machinability optimization of dry CNC turning of UNIMAX® tool steel in annealed and hardened states by implementing swarm intelligence algorithms

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Extended abstract

In this research work, the machinability of a special tool steel (UNIMAX® by Uddeholm, Sweden) under dry CNC turning is investigated. The working material was investigated under two states; annealed and hardened. As major machinability indicators, main cutting force Fz (N) and mean surface roughness Ra (μm) were selected and examined under different values for the cutting conditions; cutting speed, feed rate, and depth of cut [1-2]. A systematic design of experiments was established as per the Response Surface Methodology (RSM) [3]. The experimental design involved twenty base runs with eight cube points, four center points in the cube, six axial points and two center points in axial direction. The experimental design is summarized in Table 1.

Central composite design of experiments					
Parameter	Symbol	Level			
		Low (-1)	Center (0)	High (1)	Unit
Spindle speed	n	1500	1750	2000	rpm
Feed rate	f	0.050	0.125	0.200	mm/rev
Depth of cut	a	0.500	1.000	1.500	mm

Table 1. Cutting parameters and corresponding experimental levels.

Statistical analysis to examine the effect of cutting conditions on the responses of main cutting force and surface roughness included analysis of variance (ANOVA) and contour plots under the scope of studying the interaction effects among process parameters and generating a full quadratic model for predicting the two responses. To assess the significance of models in predicting the responses of main cutting force and surface roughness standard statistical indices were examined such as *F* and *P* values, whilst *Anderson–Darling* normality test was conducted to verify the suitability of the models corresponding to the main cutting force and surface roughness, for practical applications.

The two regression models served as the fitness functions and were iteratively evaluated by three swarm-based intelligent algorithms namely Grey-wolf optimization algorithm, Multi-verse optimization algorithm and Ant-lion optimization algorithm, for optimizing main cutting force and surface roughness.

The results obtained have shown that all algorithms were capable of producing robust Pareto fronts of non-dominated optimal solutions, yet with some differences in their quality from the perspective of coverage of the solution domain.

Keywords UNIMAX® tool steel, dry CNC turning, main cutting force, mean surface roughness, optimization.

Acknowledgement

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The Influence of Lubrication on the Roughness of the Vibroburnished Surface

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Abstract. The abstract should summarize the contents of the paper in short terms, i.e., 150-250 words. One of the processes by which a hardening of the surface layer and a diminishing of the heights of the surface roughness take place in the case of steel parts is vibroburnishing. In principle, vibroburnishing involves a vibratory motion and a rolling of a small diameter ball on the surface to be subjected to a vibroburnishing process.

There are a large number of factors that can influence the values of roughness parameters in vibroburnishing. These factors take into account the physical-mechanical properties of the workpiece material, the surface roughness before applying vibroburnihsing, the ball dimensions, the sizes that characterize the movement of the ball in relation to the workpiece surface, the pressure of the ball on the surface being processed, etc. The analysis of the conditions of use of the vibroburnishing process of some cylindrical surfaces showed that the heights of the asperities resulting from the processing can be influenced by the use of lubrication during the process. As such, the problem of conducting experimental research was formulated to highlight the intensity of the influence exerted by some input factors in the vibroburnishing process on the roughness of the processed surfaces, evaluated by using the roughness parameter *Ra*. An experimental program was designed aiming to use different values of ball diameter, ball pressing force, initial roughness, in conditions of dry processing and use of a lubricating oil. The experimental results were processed using a software based on the least squares method. The determined empirical mathematical models highlighted the possibilities of reducing by at least 10% the height of the surface roughness when lubricating liquids were used, compared to vibroburnishing without lubrication. It was considered that the presence of oil decreases the friction forces between the ball and the surface asperities and causes a wider deformation of the test sample material under the action of pressing the ball.

Keywords: Vibroburnishing, Lubrication Influence, Surface Roughness, Empirical Mathematical Model.

The appropriate topics: Modeling and simulation of processing technology

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