# 18th INTERNATIONAL CONFERENCE ON MACHINE DESIGN AND PRODUCTION

## CONFERENCE PROGRAMME AND BOOK OF ABSTRACTS

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S. Engin KILIÇ
Bahram LOTFISADIGH

umtik 2018
**3-6 July 2018**
Eskişehir- TURKEY

**MATIMAREN**
**DEPARTMENT OF MECHANICAL ENGINEERING**
**MIDDLE EAST TECHNICAL UNIVERSITY**
**ANKARA-TURKEY**

This book can be obtained from the following addresses:

**UMTIK**
**Mechanical Engineering Department**
**Middle East Technical University**
**06800 Ankara- Turkey**

**Manufacturing Engineering Department**
**ATILIM University**
**06830 Ankara- Turkey**

**Cover Print:**
METU- Ankara

**Printing and Binding:**
METU- Ankara

**Printed by:**
Dereağzı Fotokopi

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## PREFACE

The world population is still growing although at a decreasing rate. It is expected to continue growing until the next century raising the population from about 7.5 billion of today to about 11billion at the end of this century. This means that the available resources will be getting less and less for the life on Earth, the nature becoming more and more polluted. Besides, the aged population of over 60 years old is expected to be rising from 962 million globally to 3.1 billion in 2100 according to UN reports, meaning that there will be less and less people actively involved in contributing to the world economy and global wealth. People are becoming more demanding in satisfying their diversified needs with high quality, low cost but customized products and services. Need to adapt to these conditions leads to a new era of disruptive innovations for the industry: the fourth industrial revolution, Industry 4.0. The theme of the previous conference UMTIK 2016 in Bursa was "Industry 4.0 and its Implementation". The requirements in terms of technological and physical infrastructure for the companies to become active players in Industry 4.0 and to implement it were discussed and presented, in the first day panel, keynote sessions, special and regular sessions and in the brokerage event organized during the last day of the conference. All these; however; were quite limited to the success of the industry through scientific and technological research activities to create new products, technologies and processes giving some reference to the essential components of the Industry 4.0, paying little or no attention to the impact of these revolutionary changes to the people's life.

The theme of this conference is selected to be "Technological developments and innovations in machine design and production for better and sustainable life". First day of the conference is particularly devoted to this theme focusing particularly the life in Eskişehir. As the Organizing Committee we had several meetings with the Eskişehir Metropolitan and the two local Eskişehir municipalities: Odunpazarı

and Tepebaşı, Eskişehir Chamber of Industry, Anadolu and Eskişehir Osmangazi University Rectors, Regional Development Agency and with Eskişehir Governor's office to shape the First Day's Program. As an outcome of those meetings, a panel discussion session on "Expectations from technological developments and innovations in machine design and production for better and sustainable life" is organized. The Panel will be moderated by Mr. Murat Yetkin, the editor-in- chief of the Hürriyet Daily News. Panelists are mainly chosen to represent local academia, industry and agencies. Panel members and the moderator are chosen to provoke discussions interactively between the panel and the participants. Three prominent keynote speakers will deliver keynotes on the transformations needed in three main areas for the positive impacts of the technological developments and innovations; namely: "New generation universities focused on societal impact" by Prof. Dr. İhsan Sabuncuoğlu, Rector of Abdullah Gül University, "Innovation dynamics" by Mr. Cengiz Ultav, Chairman of the Executive Board of TTGV, Turkish Technology Development Foundation, "Impact of energy research and technologies on people's lives" by Prof. Dr. Pınar Mengüç, Director of the Centre for Energy, Environment and Economy (CEEE), Özyeğin University. After the keynote presentations there will be a session of four papers on "Innovations in design and technology for better life". Two of the papers are about the implementation of Industry 4.0 for smart manufacturing in Taiwan and in Croatia with pilot and case studies. The other two papers are on the new design concepts to have positive impacts on the lives of elderly and disabled people.

We would like to express our sincere thanks to the Metropolitan Municipality and Odunpazarı and Tepebaşı municipalities for their warm welcome to UMTIK 2018 and their great support. We are quite sure that all the participants will feel the warm and positive atmosphere here in Eskişehir. There will be a full day city tour for the accompanying

persons and spouses and a half day tour for the participants arranged by the Eskişehir Metropolitan Municipality.

Use of software packages, especially the integrated ones, are indispensable in solving complex engineering problems. They are also necessary implementing Industry 4.0 to comply with the Industry 4.0 requirements, such as big data management and horizontal and vertical integration and in certain cases industrial internet of things and the cloud. We therefore invited some leading companies to give introductory seminars about software packages less known but with high potential to raise the engineering capabilities of the companies and the university students. Our invitation was accepted by them and a room of 25 person capacity was allocated for those seminars. The seminar program is announced at our web site. Registered participants have the right to enroll any of those seminars free of charge, provided that there are still vacancies in the seminar intended to be enrolled. We thank all the software companies who accepted our invitation and participated in the program.

Additive and hybrid manufacturing is an important component of the Industry 4.0. There will be 4 papers in hybrid manufacturing session and 14 papers in four additive manufacturing sessions. Most of the papers are coming from the industry. This shows that the industrial companies have already started to show a serious attention to additive and hybrid manufacturing and Industry 4.0 applications becoming widespread.

Surface integrity of manufactured components is very important for their use in some critical applications, such as those in aerospace industry. A symposium within UMTIK is organized on surface integrity for the first time. 17 papers were accepted to be presented in the symposium. This shows that the topic is attracting attention from academia and industry.

There will be about 100 papers to be presented in all the regular, special and symposium sessions except for the keynote and invited papers. More than 30% of the papers to be presented in the conference are either outcome of a joint research project between university and industry or of a research project conducted by an industrial company alone. This is a good sign of the growing interest of the industry to the UMTIK conferences.

Special sessions and the regular sessions will be conducted in three parallel sessions. The First Day program, keynote presentations, panels and the sponsor sessions; however, will be organized as plenary sessions in order that all the participants can attend with one exception of the keynote presentation on the 5th of July. Mini Symposium on Surface Integrity will take place as the third track of the parallel sessions on the 5th of July.

We highly acknowledge the Honorary Chair Persons of the Conference: Presidents of the four universities, Professor Mustafa Verşan Kök of the Middle East Technical University, Professor Yıldırım Üçtuğ of Atılım University, Professor Naci Gündoğan of Anadolu University and Professor İhsan Sabuncuoğlu of Abdullah Gül University for their kind support. We would like to thank all keynote speakers, Professor İhsan Sabuncuoğlu, Mr. Cengiz Ultav, Professor Pınar Mengüç, Professor Yusuf Altıntaş, Professor Carla Tatiana Mota Anflor and Professor Osman Eroğul, First Day Panel Moderator Mr. Murat Yetkin and the panelists, organizers of the Panel on “Additive manufacturing in Turkey: Developments, applications, opportunities and difficulties” and the Mini Symposium on Surface Integrity Professor Oğuzhan Yılmaz and Assoc. Prof. Dr. Yusuf Kaynak, panelists, special session organizers, session chair persons, authors and all participants for their valuable contributions. Asst. Prof. Dr. Bahram Lotfi Sadigh is gratefully acknowledged for the tremendous time and effort he spent in every phase of the conference organization

and in the editorial work of the Conference Proceedings and the Abstracts Book.

Last, but not the least, we would also like to thank our golden sponsor Informatics, TUBITAK, “The Scientific and Technological Research Council of Turkey”, Turkish Machinery Exporters Union, silver, bronze, seminar and symposium sponsors, BEBKA, Bursa, Eskişehir, Bilecik Development Agency, ESO, Eskişehir Chamber of Industry, software companies, the International Program Committee Members, our Conference Secretariat, ORIGINEMC, all conference participants and all those who contributed to the success of UMTIK 2018.
We wish all the participants a highly memorable time during their stay in Eskişehir.

The Organizing Committee
UMTIK 2018, 3-6 July 2018
Eskişehir, Turkey

## PREFACE TO SURFACE INTEGRITY SYMPOSIUM

In manufacturing processes, one of the important criteria manufacturers are trying to meet is to generate surface and subsurface aspects that help to improve the functionality and performance of manufactured components. These surface and subsurface aspects-induced from manufacturing operations can be defined as “Surface Integrity”. This term is the interest of many industries in manufacturing world including aerospace, automobile, biomedical, etc.; thus, contributing to advance the knowledge in this field is also expectation of all these industries. One of the ways of advancing knowledge is to organize collaborative platform that provides opportunities to engineers, scientists, and researchers to present their recent research and findings, establish collaborations and exchange ideas and experience in the field of surface integrity. This Mini Symposium on Surface Integrity in Conventional and Nonconventional Manufacturing Processes is intended to create such environment in Turkey. We are proud of being organizer of initiating an international event solely focusing on Surface Integrity in Turkey. We would like to sincerely thank all contributors to this organization by participating, presenting, and sharing their recent research work with their colleagues in this symposium.

We also thank to UMTIK 2018 conference and organizers of UMTIK 2018 conference for giving us an opportunity to organize this Mini Symposium as a part of UMTIK 2018 that is one of the largest and well-known international event focusing on machine design and production. We also would like to thank all referees and international scientific committee members of UMTIK 2018 for reviewing the papers submitted to Mini Symposium.

We also sincerely appreciate both Journal of the Faculty of Engineering and Architecture of Gazi University and Marmara Journal of Pure and Applied Sciences for accepting to publish selected research works submitted and presented in this Mini Symposium.

We wish all participants will enjoy and fulfill their technical and scientific expectations from this Mini Symposium.

Organizers of Mini Symposium
Assoc. Prof. Dr. Yusuf KAYNAK
Prof. Dr. Oğuzhan YILMAZ
Eskisehir, Turkey

| | ***JULY 3, 2018- TUESDAY*** |
|---|---|
| 8:00 – 9:00 | **REGISTRATION** |
| 9:00 – 10:30 | **OPENING SESSION** |
| 10:30 – 11:00 | **COFFEE BREAK** |
| 11:00 – 13:00 | **(I1) HALL İNFORMATİK**<br>**PANEL**<br>"Expectations from technological developments and innovations in machine design and production for better and sustainable life"<br>**Moderator:** Murat YETKİN<br>The editor-in- chief of the Hürriyet Daily News |
| 13:00 – 14:00 | **LUNCH** |
| 14:00 – 16:15 | **(I2) HALL İNFORMATİK**<br>**KEYNOTES SESSION**<br>**NEW GENERATION UNIVERSITIES FOCUSED ON SOCIETAL IMPACT**<br>**Keynote Speaker:** Prof. Dr. İhsan SABUNCUOĞLU<br>**INNOVATION DYNAMICS**<br>**Keynote Speaker:** Cengiz ULTAV<br>**IMPACT OF ENERGY RESEARCH AND TECHNOLOGIES ON PEOPLE'S LIVES**<br>**Keynote Speaker:** Prof. Dr. Pınar MENGÜÇ |
| 16:15-16:30 | **COFFEE BREAK** |
| 16:30 – 18:00 | **(A0) HALL İNFORMATİK**<br>**INNOVATIONS IN DESIGN AND TECHNOLOGY FOR BETTER LIFE**<br>(U18-18, U18-11, U18-95, U18-38) |
| 20:00 | **WELCOME COCTAIL** |

| JULY 4, 2018- WEDNESDAY | | | |
|---|---|---|---|
| 9:00-9:45 | **(I3) HALL İNFORMATİK**<br>**Keynote Speaker:** Prof. Dr. Yusuf Altıntaş<br>"Digital machining" | | |
| 9:45-11:15 | **HALL 1**<br>**A1**<br>**Metal Cutting I**<br>57, 96 | **HALL 2**<br>**B1**<br>**Special Session: Design for Transport Safety I**<br>SA1, SA2, SA3 | **HALL 3**<br>**C1**<br>**Special Session: Hybrid Manufacturing**<br>HM1, 97, HM3, 98 |
| 11:15-11:30 | **COFFEE BREAK** | | |
| 11:30-13:00 | **HALL 1**<br>**A2**<br>**Metal Cutting II**<br>25, 29, 121 | **HALL 2**<br>**B2**<br>**Special Session: Design for Transport Safety II**<br>SA5, SA6, SA7 | **HALL 3**<br>**C2**<br>**Special Session: Additive Manufacturing I**<br>7, 78, 84, 83 |
| 13:00-14:00 | **LUNCH** | | |
| 14:00-14:45 | **(I4) HALL İNFORMATİK**<br>**SPONSORS SESSION** | | |
| 14:45-16:15 | **HALL 1**<br>**A3**<br>**Process Modeling**<br>90, 94, 87 | **HALL 2**<br>**B3**<br>**Special Session: Design for Transport Safety III**<br>SA8, 43, 52 | **HALL 3**<br>**C3**<br>**Special Session: Additive Manufacturing II**<br>**Keynote Speaker:**<br>Prof. Dr. O. Eroğul<br>80, 67, 20 |
| 16:15-16:30 | **COFFEE BREAK** | | |
| 16:30-18:00 | **HALL 1**<br>**A4**<br>**Talaşlı İmalat**<br>19, 2,23,26 | **HALL 2**<br>**B4**<br>**Çeşitli İmal Usulleri**<br>50, 120, 66 | **HALL 3**<br>**C4**<br>**Special Session: Additive Manufacturing III**<br>85, 48, 76 |
| 20:00 | **COCTAIL PROLONGE** | | |

| JULY 5, 2018- THURSDAY | | | |
|---|---|---|---|
| 9:00-9:45 | (I5) HALL İNFORMATİK<br>Keynote Speaker:<br>Professor Carla Tatiana Mota Anflor<br>"The use of boundary element method and topological derivative for designing components" | | HALL 3<br>C5<br>Symposium Program |
| 9:45-11:15 | HALL 1<br>A5<br>**Computational Mechanics**<br>42, 13, 36 | HALL 2<br>B5<br>**Industry 4.0 Related Topics**<br>125, 126, 93, 91 | |
| 11:15-11:30 | **COFFEE BREAK** | | |
| 11:30-13:00 | HALL 1<br>A6<br>**Aerospace Engineering**<br>35, 55, 15, 46 | HALL 2<br>B6<br>**SPECIAL SESSION: Additive Manufacturing IV**<br>58, 112, 113, 114 | HALL 3<br>C6<br>Symposium Program |
| 13:00-14:00 | **LUNCH** | | |
| 14:00-14:45 | (I6) HALL İNFORMATİK<br>SPONSORS SESSION | | |
| 14:45-16:15 | HALL 1<br>A7<br>**Computational Fluid Dynamics**<br>49, 51, 54, 45 | HALL 2<br>B7<br>**Electrical Discharge Machining**<br>110, 117, 118 | HALL 3<br>C7<br>Symposium Program |
| 16:15-16:30 | **COFFEE BREAK** | | |
| 16:30-18:00 | HALL 1<br>A8<br>**Otomotiv Mühendisliği**<br>53, 56, 79, 99 | HALL 2<br>B8<br>**Malzeme ve Malzeme Mekaniği**<br>27, 86 | HALL 3<br>C8<br>Symposium Program |
| 20:00 | **GALA DINNER** | | |

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| | | ***JULY 6, 2018- FRIDAY*** | |
| 9:00-9:45 | **(I7) HALL İNFORMATİK SPONSORS SESSION** | | |
| 9:45-11:15 | **HALL 1** | **HALL 2** | **HALL 3** |
| | **A9** | **B9** | **C9** |
| | **Mechanical Design**<br><br>129, 108, 65, 63 | **Materials Behavior**<br><br>69, 40, 127, 128 | **Lazerle Kesme: Tezgah Tasarımı**<br><br>21, 30, 72 |
| 11:15-11:30 | **COFFEE BREAK** | | |
| 11:30-13:00 | **(I8) HALL İNFORMATİK PANEL**<br>"Additive manufacturing in Turkey: Developments, applications, opportunities and difficulties"<br>**Moderator:** Prof. Dr. Yusuf Kaynak<br>Department of Mechanical Engineering, Marmara University | | |
| 13:00-14:00 | **LUNCH** | | |
| 14:00-18:00 | **City Tour** | | |

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| | ***JULY 5, 2018, THURSDAY*** |
| | ***MINI SYMPOSIUM ON SURFACE INTEGRITY*** |
| 9:15 – 9:25 | **OPENING SPEECHES**<br>**Assoc. Prof. Dr. Yusuf KAYNAK**<br>**Prof. Dr. Oğuzhan YILMAZ** |
| 9:25- 11:15 | **SESSION 1**<br>***Chair:*** **Prof. Dr. Oğuzhan YILMAZ** |
| 9:25- 9:45 | **CNC Tel Elektro Erozyon Tezgahında Tel Elektrot Özelliklerinin Yüzey Pürüzlülüğüne Etkisinin Taguchi Yöntemiyle Modellenmesi**<br>Hüseyin GÜRBÜZ, Şehmus BADAY, İbrahim HAMARAT |
| 9:45 – 10:05 | **UZAY VE HAVACILIK ALAŞIMLARININ ELEKTRİKSEL EROZYONLA DELİNMESİ İŞLEMİNDE YÜZEY BÜTÜNLÜLÜĞÜNÜN İNCELENMESİ**<br>Tohid ABBASI, Merve EKİCİ, Oğuzhan YILMAZ |
| 10:05 – 10:35 | **Rene 65 Süper Alaşımının Delik Delme Işleminde Farklı Parametrelerin Taguchi Yöntemiyle Analizi**<br>Furkan BİLGİÇ, Ümit ER, Mustafa ULUTAN |
| 10:35-10:55 | **3B Yazdırılmış Kompozitlerin Yazdırma Parametrelerinin Yüzey Pürüzlülüğüne Etkisinin Deneysel İncelenmesi**<br>Tuğçe TEZEL, Volkan KOVAN, Eyüp Sabri TOPAL |
| 10:55- 11:15 | **Seçici Lazerle Ergitme Yöntemi ile Üretilen Inconel 625 Alaşimli Parçada Yüzey Bütünlüğünün İncelenmesi**<br>Özhan KITAY, Emre TASCIOĞLU, Mustafa KAŞ, Şafak NESLİ, Yusuf KAYNAK, Oğuzhan YILMAZ |
| 11:15- 11:30 | **COFFEE BREAK** |
| 11:30- 13:00 | **SESSION 2**<br>***Chair:*** **Assoc. Prof. Dr. Yusuf KAYNAK** |
| 11:30- 11:50 | **AA 7075 Yaşlandırılmasında Farklı Ön Gerinmelerin Mekanik Özelliklere Etkilerinin İncelenmesi**<br>Süleyman KILIÇ, İlyas KACAR, Fahrettin ÖZTÜRK, Mevlüt ŞAHİN, Oğuz ERDEM |
| 11:50-12:10 | **Şekil Hafızalı NiTi Alaşımın Kuru, MQL ve Kriyojenik Koşullarda İşlenmesinde Kesici Takım Aşınmasıyla iş Parçası Yüzey Kalitesi Arasındaki İlişkinin Araştırılması**<br>Özhan KITAY, Yusuf KAYNAK |
| 12:10-12:30 | **AISI 316L Çeliğinin Tornalanmasında Kesici Takım Formlarının Yüzey Bütünlüğü Üzerine Etkisi**<br>Hüseyin GÜRBÜZ, Ulvi ŞEKER, Fırat KAFKAS |
| 12:30-13:00 | **Pirinç Malzemelerin Delinmesi Sürecinde Kesici Takım Yuvarlanma Yarıçapının İş Parçası Yüzey Bütünlüğüne Etkisi**<br>Süleyman ÇİÇEK, Kadir İLBAY, Emre TASÇIOĞLU, Yusuf KAYNAK |

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|---|---|
| 13:00- 14:00 | **LUNCH** |
| 14:45- 16:15 | **SESSION 3**<br>***Chair:*** **Assoc. Prof. Dr. Yusuf KAYNAK** |
| 14:45- 15:05 | **Ti6Al4V Surface Modification by Hydroxyapatite Powder Mixed Electric Discharge Machining for Medical Application**<br>Tahsin T. ÖPÖZ, Hamidullah YAŞAR, Mark F. MURPHY,Nihal EKMEKCİ, Bülent EKMEKCİ |
| 15:05- 15:25 | **Powder Mixed Electrical Discharge Machining And Biocompatibility: A State of the Art Review**<br>Sudi KALAMAN, Hamidullah YAŞAR, Nihal EKMEKCİ, Tahsin T. OPOZ, Bülent EKMEKCİ |
| 15:25- 15:45 | **An Experimental Investigation of the Ultrasonic-Assisted Machining of Ti-6Al-4V**<br>F. Hayati ÇAKIR, Selim GÜRGEN,Sezan ORAK,M. Cemal KUŞHAN, M. Alper SOFUOĞLU |
| 15:45- 16:15 | **The Effect of Processing on the Surface and Subsurface Characteristic of Plastic Injection Mold Steel**<br>O. Saban KAMBER, Emre TASCIOĞLU |
| 16:15- 16:30 | **COFFEE BREAK** |
| 16:30- 17:50 | **SESSION 4**<br>***Chair:*** **Prof. Dr. Oğuzhan YILMAZ** |
| 16:30- 16:50 | **Effect of Machining Parameters on Workpiece Surface Characteristics in Electric Discharge Drilling (EDD)**<br>Oğuz ERDEM, Can ÇOĞUN, İbrahim USLAN |
| 16:50- 17:10 | **Design, Manufacturing And Evaluation of A DMLS Test Artifact for Surface Texture and Form Characterization**<br>Özgür POYRAZ, Ezgi Uğur SOLAKOĞLU, Güray AKBULUT, Soner ÖREN, Cansinem TÜZEMEN |
| 17:10- 17:30 | **Abrasive Flow Machining of Aerospace Alloys**<br>Kürşad GÖV, Ömer EYERCİOĞLU |
| 17:30- 17:50 | **Effects of Electrodes on Aerospace Alloys in Hole-EDM Process**<br>Ömer EYERCİOĞLU, Kürşad GÖV |
| 17:50- 18:00 | **CLOSING SPEECHES**<br>**Prof. Dr. Oğuzhan YILMAZ**<br>**Assoc. Prof. Dr. Yusuf KAYNAK** |

## *JULY 3, 2018 (TUESDAY)*

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| (I1) | Panel | HALL İNFORMATİK | 11:00 – 13:00 |

**"Positive reflections of the advances in machine design and production technologies to the people' s life in all aspects"**

***Moderator*:** Murat YETKİN

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| (I2) | Keynotes Session | HALL İNFORMATİK | 14:00 – 16:15 |

***Chaired by:*** Prof. Dr. Yusuf ALTINTAŞ

**"New generation universities focused on societal impact"**
***Keynote Speaker:*** Prof. Dr. İhsan SABUNCUOĞLU

**"Innovation dynamics"**
***Keynote Speaker:*** Cengiz ULTAV

**"Impact of energy research and technologies on people's lives"**
***Keynote Speaker:*** Prof. Dr. Pınar MENGÜÇ

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|---|---|---|---|
| (A0) | Session: Innovations in design and technology for better life | HALL İNFORMATİK | 16:30 – 18:00 |

***Chaired by:*** Mr. Cengiz ULTAV

**The development of pilot production line of smart manufacturing in Taichung City in Taiwan (U18-18)**

Jiun CHEN and Tzuo-Liang LUO

**Innovative smart enterprise-case studies (U18-11)**

Marina CRNJAC, Marko MLADINEO, Ivica VEZA

**Elderly and disabled centered design(U18-95)**

Bülent YILMAZ

**Walkmech 2.0: Conceptual design and structural analyses of an energy-recycling transfemoral prosthesis for activities of daily life (U18-38)**

Ramazan ÜNAL, Furkan BALTACIOĞLU

## *JULY 4, 2018 (WEDNESDAY)*

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| (I3) | Keynote Lecture | HALL İNFORMATİK | 9:00 – 9:45 |

***Chaired by:*** Prof. Dr. Pınar MENGÜÇ

**"Digital Machining"**

***Keynote Speaker*:** Prof. Dr. Yusuf ALTINTAŞ

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|---|---|---|---|
| (A1) | Session: Metal Cutting I | HALL 1 | 9:45 – 11:15 |

***Chaired by:*** Prof. Dr. Stuart BARNES

**Effects of the rotational speed on the dynamics of micro cutting tools (U18-57)**

Bekir BEDIZ

**Virtual process simulation of orbital drilling operations (U18- 90)**

Z. Murat KILIÇ, Yusuf ALTINTAŞ, Byron REYNOLDS, O. Mert ÖZTÜRK

**Investigation of effect of minimum quantity lubrication technique on surface roughness during milling of titanium alloy (ti-6al-4v) (U18- 96)**

Khaled Ali OSMAN, Volkan YILMAZ, Hakkı Özgür ÜNVER, Ulvi ŞEKER, S. Engin KILIÇ

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| (B1) | Special Session: Design for Transport Safety I | HALL 2 | 9:45 – 11:15 |

***Chaired by:*** Prof. Dr. Serpil ACAR

**Impact performance evaluation of a crash cushion design using finite element simulation and full-scale crash testing (U18- SA1)**

Murat BÜYÜK, Ali Osman ATAHAN, Kenan KURUCUOĞLU

**Derivation of stiffnesses for comparison of vehicle performance in frontal impacts (U18-SA2)**

Selçuk HİMMETOĞLU

**Investigating the effects of materials, geometric properties and modifications on the crashworthiness of bumper and chassis system (U18-SA3)**

Batuhan GÜRER, Volkan ESAT

## *JULY 4, 2018 (WEDNESDAY)*

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| (C1) | Special Session: Hybrid Manufacturing | HALL 3 | 9:45 – 11:15 |

***Chaired by:*** Assoc. Prof. Dr. Gregory GIBBONS

**Hybrid technologies: Technology overview and applications (U18- HM1)**

Gregory J GIBBONS

**Investigating the effects of process parameters on residual stress evolution in Plasma Transfer Arc (PTA) cladding of Ti-6Al-4V (U18- 97)**

Hadi MOZTARZADEH, Sampan SETH, Hoda AMEL, Gregory J. GIBBONS

**The tool life investigation in hybrid manufacturing processes (U18-HM3)**

Riccardo TOSSI

**Automated remanufacturing enabled by hybrid manufacturing technologies (U18- 98)**

Peter-Jon SOLOMON

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|---|---|---|---|
| (A2) | Session: Metal Cutting II | HALL 1 | 11:30 – 13:00 |

***Chaired by:*** Prof. Dr. Ali ÜNÜVAR

**Grinding operation of a workpiece with an unknown shape considering tool deflection compensation (U18- 25)**

Abdulhamit DONDER, Masoud LATIFINAVID, E. ilhan KONUKSEVEN

**Design for manufacturability: Determination of minimum manufacturable wall and floor thickness of machined parts by utilizing finite element analysis (U18-29)**

Candaş URUNGA

**Investigating the effect of milling parameters on residual stresses of Ti64 (U18- 121)**

Ramazan NAMLU, Okan Deniz YILMAZ, Caner SIMSIR

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| (B2) | Special Session: Design for Transport Safety II | HALL 2 | 11:30 – 13:00 |

***Chaired by:*** Prof. Dr. Memiş ACAR

**Evaluation of soil conditions and post embedment depth on guardrail safety performance (U18- SA5)**

Ali Osman ATAHAN, Murat ÖRNEK, Murat BÜYÜK, Ercan EPSİLELİ

**Hazard perception test design suitability for older drivers (U18-SA6)**

B. Serpil ACAR, Grace SMALLEY

**Traffic safety at median ditch: Steel vs concrete barrier performance comparison using computer simulation (U18-SA7)**

Ayhan Öner YÜCEL, Ali Osman ATAHAN, Turan ARSLAN, Umur Korkut SEVİM

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|---|---|---|---|
| (C2) | Special Session: Additive Manufacturing I | HALL 3 | 11:30 – 13:00 |

***Chaired by:*** Assoc. Prof. Dr. Özgür ÜNVER

**A technological and business perspective of additive manufacturing for defense industry (U18- 7)**

Kıvılcım ERSOY

**Effects of liquefier design on thermal profile in fused filament fabrication based additive manufacturing process (U18-78)**

Tuğrul ÖZEL

**Design and fabrication of large-size FFF 3D printer (U18-84)**

Gökberk SERİN, Hakkı Özgür ÜNVER

**Coaxial additive manufacturing of continuous carbon fiber composites (U18-83)**

Bahattin KOÇ, Gizem GÖKÇER

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|---|---|---|---|
| (I4) | Sponsors Session | HALL İNFORMATİK | 14:00 – 14:45 |

***Chaired by:*** Mr. Tahir FİDAN

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| (A3) | Session:<br>Process Modeling | HALL 1 | 14:45 – 16:15 |

***Chaired by:*** Prof. Dr. Ali Rıza YILDIZ

**An alternative approach for thermal modeling of welding operations: semi-analytical source method (U18-94)**

Barış ÇETİN, Barbaros ÇETİN, Yiğit KUŞÇU, Kevin COLE

**Finite element modeling of machining particle-reinforced aluminum metal matrix composites (U18-87)**

Nakka LOTFY RAKE, Samad NADIMI BAVIL OLIAEI, Sadık Engin KILIÇ

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|---|---|---|---|
| (B3) | Special Session:<br>Design for Transport Safety III | HALL 2 | 14:45 – 16:15 |

***Chaired by:*** Dr. Selçuk HİMMETOĞLU

**Crash safety protection for wheelchair occupants using human body models (U18-SA8)**

Susana LOPEZ-SANCHEZ, B. Serpil ACAR, Richard Frampton

**Analysis of a coach side flap under cyclic loads (U18-43)**

Burkay DEMIR, Zeki Mert BARUT, Umut AKTAŞ

**Topology optimization of an automobile brake system component under dynamic loading conditions (U18-52)**

Betül S. YILDIZ

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| (C3) | Special Session: Additive Manufacturing II | HALL 3 | 14:45 – 16:15 |

***Chaired by:*** Prof. Dr. Nuri DURLU

**"applications of additive technologies in medicine"**
***Invited Speaker:*** Prof. Dr. Osman EROĞUL

**Additive manufacturing of the military oriented medical devices with stereolithography method (U18-67)**

Erdem İnanç BUDAK, Osman EROĞUL

**Practice-oriented metal AM process simulation and optimization (U18-80)**

Michel PEREME, Patrick MEHMERT

**Effects of structural hybrid design of CoCr-alloy scaffolds fabricated by selective laser melting for biomedical applications (U18-20)**

EMRE ÖZEREN, Mihrigül ALTAN

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| (A4) | Session: Talaşlı İmalat | HALL 1 | 16:30 – 18:00 |

***Chaired by***: Prof. Dr. Ali ORAL

**Jant üretimi talaşli imalat prosesinde parametrik programlama (U18-19)**

Kağan DALAK, Kaan GÜNGÖR, İsmail ÇAKIRGÖZ, Uğur AYBARÇ

**GH4169 süperalaşiminin yüksek hizli işlemede testere dişi talaş oluşumunun sayisal simülasyonu (U18-2)**

Mehmet AYDIN

**CFRP/Al istifli yapının geleneksel matkaplarla delinebilirliği (U18-23)**

Erman AYDIN, Muammer NALBANT

**Dövme piston üretiminde süreç geliştirilmesi (U18-26)**

Ali ÜNÜVAR, Hüseyin SARIKAYA

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| (B4) | Session:<br>Çeşitli İmal Usulleri | HALL 2 | 16:30 – 18:00 |

***Chaired by:*** Asst. Prof. Dr. Cemal Merih ŞENGÖNÜL

**Şekil hafizalı poliüretanın enjeksiyonla kalıplanmasında eksik baskı (U18-50)**

Şükran KATMER, Çetin KARATAŞ

**Tokluğu yüksek WC-Co T kanal çakının performans araştırması (U18-120)**

Harun KOÇAK, Mehmet SUBAŞI, Asghar SAFARIAN, Çetin KARATAŞ, Ulvi ŞEKER

**Kaynak hücrelerinde endüstri 4.0 uygulamaları (U18-66)**

Gökhan YENİKAYA, Sibel YENİKAYA, Uğur HATİPOĞLU

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|---|---|---|---|
| (C4) | Special Session:<br>Additive Manufacturing III | HALL 3 | 16:30 – 18:00 |

***Chaired by:*** Asst. Prof. Dr. Evren YASA

**Design of a quadcopter arm for additive manufacturing using optimization and lattice structures (U18-85)**

Recep Muhammet GÖRGÜLÜARSLAN, Şükrü Taha AKSOY, Tarkan TURNACILAR, Aybars Feyzi KÖKSAL

**Selective laser melting process simulation of AlSi10Mg alloy to predict part distortions (U18-48)**

Emrecan SÖYLEMEZ, Ebubekir KOÇ, Mert COŞKUN

**High vibration absorptive body production for turning cutting tools with additive manufacturing technology (U18-76)**

Tuğrul SOYUSİNMEZ, Özgücan GÜZELİPEK, Gökçe AKKUŞ

**Plasma Transfer Arc (PTA) cladding for additive manufacturing (AM) of metal alloys (U18-58)**

Hadi MOZTARZADEH, Sampan SETH, Hoda AMEL, Gregory J. GIBBONS

## *JULY 5, 2018 (THURSDAY)*

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|---|---|---|---|
| (I5) | Keynote Lecture | HALL INFORMATIK | 9:00 – 9:45 |

***Chaired by:*** Prof. Dr. Sergey SHEVTSOV

**"The use of boundary element method and topological derivative for designing components"**

***Keynote Speaker*:** Prof. Dr. Carla Tatiana Mota ANFLOR

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| (A5) | Session: Computational Mechanics | HALL 1 | 9:45 – 11:15 |

***Chaired by:*** Assoc. Prof. Dr. Hakan ARGEŞO

**Damage identification in a cantilever beam using modal strain energy (U18-42)**
Allan DOMINGUES, Tharcísio SANTOS, Carla ANFLOR, Sergio CARNEIRO

**Performance evaluation of micro-textured cutting tools in dry machining of Inconel 718 using FE simulation (U18-13)**
Eren KAYA, İrfan KAYA

**Finite elements analyzing of the effect of crack on stress and strain in honeycomb structure from ABS polymer materials (U18-36)**
Bekir YALÇIN, Berkay ERGENE

**Numerical analysis for non-linear heat transfer problems using DRM (U18-130)**
Daniel FURTADO, Guilherme GONÇALVES, Carla ANFLOR, Besim BARANOĞLU

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| (B5) | Session: Industry 4.0 related topics | HALL 2 | 9:45 – 11:15 |

***Chaired by:*** Dr. Z. Murat KILIÇ

**Determination of the spring-back angle by image processing in bending of high strength steels (U18-93)**
Barış ÇETİN, Eren BİLLUR, Besim BARANOĞLU, Murat Mutlu YILMAZ, Türkay MURATOĞLU

**Literature-based identification of behavioral modules for social robots using design structure matrix (U18-91)**
İlayda ÖZER, Zühal ERDEN

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| (A6) | Session: Aerospace Engineering | HALL 1 | 11:30 – 13:00 |

***Chaired by:*** Prof. Dr. Carla Tatiana Mota ANFLOR

**Lay-up design optimization for the loaded-carrying tubular structure made of orthotropic composite (U18-35)**

Sergey SHEVTSOV, Igor ZHILYAEV, Natalia SNEZHINA, Jiing-Kae WU

**Numerical simulation of lateral jet in a supersonic missile using computational fluid dynamics (U18-55)**

Efe C. DAĞLI, M. Halûk AKSEL

**Prediction and prevention of manufacturing distortion of aerospace composite structures (U18-15)**

Nursev ERDOĞAN, Selim DİNÇER, Güray ERTEĞİ, R. Ecmel ECE

**Design and cold flow experimental procedure of a pintle injector (U18-46)**

Berksu ERKAL, Bülent SÜMER, M. Haluk AKSEL

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| (B6) | Special Session: Additive Manufacturing IV | HALL 2 | 11:30 – 13:00 |

***Chaired by:*** Asst. Prof. Dr. Besim BARANOĞLU

**Design and development of an additive manufacturing system for metal printing (U18-112)**

S. Shahid MUSTAFA, Ismail LAZOĞLU

**Using multi-axis additive manufacturing in support-less part fabrication (U18-113)**

Mohammed A. ISA, Ismail LAZOĞLU

**Robotic additive manufacturing of tooling for composite structures (U18-114)**

I. E. YİĞİT, Shaheryar A. KHAN, Ismail LAZOĞLU

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| (I6) | Sponsors Session | HALL INFORMATIK | 14:00 – 14:45 |

***Chaired by:*** Assoc. Prof. Dr. Zühal ERDEN

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| (A7) | Session: Computational Fluid Dynamics | HALL 1 | 14:45 – 16:15 |

***Chaired by:*** Asst. Prof. Dr. Besim BARANOĞLU

**CFD simulation of train fire in the Istanbul metro tunnel (U18-49)**

M. İlter BİLGE, Haluk AKSEL

**Cartesian mesh generator with adaptation to boundary layer (U18-51)**

Merve ÖZKAN, Özgür Uğraş BARAN, M. Halûk AKSEL

**Experimental and numerical investigation of coaxial pressure swirl injectors (U18-54)**

Onur BARAN, Yusuf ÖZYÖRÜK

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| (B7) | Session: Electrical Discharge Machining | HALL 2 | 14:45 – 16:15 |

***Chaired by:*** Prof. Dr. Abdülkadir ERDEN

**Stamping die production with wire electro-discharge machining of Vanadis 10 and K393 tool (U18-110)**

Orhan ÇAKIR, Aliseydi ÇELİK, Emre ÇELİK

**Experimental Investigation of Machining Characteristics for Al2014 Alloy Reinforced with TiB2 Composites in Powder-Mixed EDM (U18-117)**

Gökhan KÜÇÜKTÜRK, Javad JOUDI, Recep ÇALIN, Ulvi ŞEKER, Hakan GÜRÜN, Omid Farid AHMADINIA

**An Investigation of Material Removal Rate and Tool Wear Rate in Powder Mixed EDM Machining Process of Al2014 Alloy Reinforced with B4C Composites (U18-118)**

Gökhan KÜÇÜKTÜRK, Omid Farid AHMADINIA, Recep ÇALIN, Ulvi ŞEKER, Duran KAYA, Javad JOUDI

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| (A8) | Session: Otomotiv Mühendisliği | HALL 1 | 16:30 – 18:00 |

***Chaired by:*** Assoc. Prof. Dr. Selçuk HİMMETOĞLU

**Taşıt elemanlarının optimum yapısal modelinin belirlenmesi (U18-53)**

Ali Rıza YILDIZ

**Yeni nesil yüksek mukavemetli çelikler ile çarpışma performansı yüksek taşıt tampon ve darbe emici geliştirilmesi (U18-56)**

Ali Rıza YILDIZ, Emre DEMİRCİ

**Termoplastik çarpışma kutularında alüminyum köpük takviyesinin çarpışma karakteristiğine etkisi (U18-79)**

Betül Gülçimen ÇAKAN, Murat REİS, Cihat ENSARİOĞLU, Hüseyin KÖLÜK, Harun YENİ, Agah UĞUZ, Mustafa Cemal ÇAKIR

**Yol dışı (off-road) araç için çift enine yön vericili bağımsız askı sisteminin tasarımı ve analizi (U18-99)**

Görkem BALKAN, Nusret Sefa KURALAY, Mustafa Umut KARAOĞLAN

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| (B8) | Session: Malzeme ve Malzeme Mekaniği | HALL 2 | 16:30 – 18:00 |

***Chaired by:*** Assoc. Prof. Dr. Orhan ÇAKIR

**Düşük yoğunluklu hafif AZ91 Mg alaşımının aşınma davranışının ETİAL 150 Al alaşımı ve FR-4 cam takviyeli epoksi kompoziti ile deneysel karşılaştırılması (U18-27)**

Bekir YALÇIN, Emre AYKAN

**Kompozit sargılı basınçlı kaplarda çatlak analizi (U18-86)**

Muzaffer ÇETİN, Kemal YAMAN, Bora YILDIRIM

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| (I7) | Sponsors Session | HALL INFORMATIK | 9:00 – 9:45 |

***Chaired by:*** Mr. Barış ÇETİN

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| (A9) | Session: Mechanical Design | HALL 1 | 9:45 – 11:15 |

***Chaired by:*** Prof. Dr. Ulvi ŞEKER

**Lab-scale ribbon winding machine design and fabrication (U18-129)**
Tolga AKIŞ, C. Merih ŞENGÖNÜL, Asude AYDOĞAN, Burak BAĞCI, Kaan İNAM, Özgün ÖĞRETMEN

**Design and manufacture of a roller bender machine for bicycle rims (U18-108)**
C. Merih ŞENGÖNÜL, Hakan KALKAN, Tolga AKIŞ, Burak BAĞCI, Kaan İNAM, Özgün ÖĞRETMEN, Asude AYDOĞAN

**Analytical method for bending stress of internal asymmetric spur gears (U18-65)**
Mahir Gökhan ORAK, Metin AKKÖK

**2D manufacturing equipment for the glass-mosaic products (U18-63)**
Murat ŞAHİN, Bülent YILMAZ

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| (B9) | Session: Materials Behavior | HALL 2 | 9:45 – 11:15 |

***Chaired by:*** Assoc. Prof. Dr. Volkan ESAT

**A comparative study on hydrogen embrittlement mechanisms (U18-69)**
Burak BAL, Mustafa YERLİTAŞ, Barış ÇETİN, Halim MEÇO

**The effect of insert surface roughness on shear strength of inserted metal injection molded components (U18-40)**
Asghar SAFARIAN, Mehmet SUBAŞI, Çetin KARATAŞ

**Design and Manufacture of a Melt-Flow Indexer (U18-127)**
Merih Şengönül, Hakan Argeşo, Berat Şerefoğlu, Bahtiyar Duran, Deniz Nikbay, Derya N. Koyuncu, Tuğçe Özkan, Gülsen Köroğlu, Çağlar Ceylan, M. Heval Demirci

**Prediction of tensile mechanical properties of Tin-Bismuth alloys by Vickers hardness test (U18-128)**
Nuri Alkilani, Rasim Köksal Ertan, Caner Şimşir, Merih Şengönül

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| (C9) | Session:<br>Lazer Kesme: Tezgah Tasarımı | HALL 3 | 9:45 – 11:15 |

***Chaired by:*** Prof. Dr. M. Cemal ÇAKIR

**Kesim kontrolü yapabilen, yüksek proses hızına sahip gelişmiş lazerli saç kesim tezgahının tasarımı (U18-21)**

Sinan GANDAŞ, Oktay ÇELENK, Feridun AY, Cem SEVİK, Nihan KOSKU PERKGÖZ

**Lazer kesim tezgâhı için kompozit Y-eksen köprü imalatı (U18-30)**

Oktay ÇELENK, Ali DURMUŞ, Kadir ÇAVDAR

**Endüstriyel fiber lazer makinesinde köprü tasarimi ve Optimizasyonu (U18-72)**

Abdullah ÖZKAN, Haşmet Çağrı SEZGEN

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| (I8) | Panel | HALL INFORMATIK | 11:30 – 13:00 |

**“Additive manufacturing in Turkey: Developments, applications, opportunities and difficulties”**

***Moderator*:** Assoc. Prof. Dr. Yusuf KAYNAK

# KEYNOTE PAPERS

| NO | TITLE | AUTHOR |
|---|---|---|
| **I2-1** | New generation universities focused on societal impact | İhsan SABUNCUOĞLU |
| **I2-2** | Innovation dynamics | Cengiz ULTAV |
| **I2-3** | Impact of energy research and technologies on people's lives | Pınar MENGÜÇ |
| **I3** | Digital machining | Yusuf ALTINTAŞ |
| **I5** | The use of boundary element method and topological derivate for designing components | Carla Tatiana Mota ANFLOR |
| **C3** | Applications of Additive Technologies in Medicine | Osman EROĞUL |

## About the Speaker

### Prof. Dr. İhsan SABUNCUOĞLU

Prof. Sabuncuoğlu is the founding rector of Abdullah Gul University. He earned his BS and MS in industrial engineering from Middle East Technical University (Turkey), in 1982 and 1984, respectively. He earned his PhD in industrial engineering from Wichita State University (USA) in 1990. Dr. Sabuncuoğlu worked for companies such as Boeing, Pizza Hut and the National Institute of Health in the United States during his PhD studies. He joined Bilkent University (Turkey) in 1990, where he worked as a full-time faculty member until 2013. In the meantime, he held visiting positions at Carnegie Mellon University in the United States and at Institut Français de Mécanique Avancée (IFMA) in France. His research interests are in real-time scheduling, simulation optimization, and applications of quantitative methods to cancer-related health-care problems. His research has been funded by TBITAK (The Scientific and Research Council of Turkey) and EUREKA (a European-wide initiative to foster European competitiveness through cooperation among companies and research institutions in the field of advanced technologies). Dr. Sabuncuoglu also has significant industrial experience in aerospace, automotive, and military-based defense systems. His industrial projects are sponsored by a number of both national and international companies. In addition to publishing more than a hundred papers in international journals and conference proceedings, Prof. Sabuncuoğlu has edited five books. He is on the editorial board of a number of scientific journals in the areas of industrial engineering and operations research. He is a member of the Institute of Industrial Engineering, the Institute of Operations Research, the Management Sciences, and the Simulation Society. He is also a member of the Council of Industrial Engineering Academic Department Heads (CIEADH) and various other professional and social committees.

## NEW GENERATION UNIVERSITIES FOCUSED ON SOCIETAL IMPACT

The world is changing at an accelerated rate. Today, technological advances and innovations are to explode. At the same time we face new global challenges (sustainability, health and food, security, etc.). Because of all these changes and disruptions, radical changes in the higher education sector is also inevitable. Unfortunately, the existing educational institutions have been using old paradigms with some minor modifications since the 16th century (class setting, instructor/student relationship, grading system, etc.).

Universities now need to adapt to the new expectations of students, academicians, employers and societies as a whole. A new kind of graduates, equipped with the most updated and relevant skills is required and great responsibilities lie with educational institutions.

In this talk, we present an innovative Higher Education Model that blends Education, Research and Social Impact. Unique Coordination Impact Centre, Curricula, Competency Integrating Learning Units, Courses, Research approaches and methods are also discussed as a part of the new concept of New Generation Universities".

## About the Speaker

### Cengiz ULTAV

Born in Eskişehir on the 26th of February in 1950 . Mr. Ultav was graduated from Ankara Science High School and received his BSc and MSc degree from Electrical and Electrical Engineering Department (Computer and Control Option) from Middle East Technical University in Ankara, Turkey. He also has a diploma from Philips International Institute in Eindhoven, Holland.

After working in technical and administrative departments of Bimsa, Info (in Turkey) and Dornier Syatem GmBh (in Germany) repectively, he worked as Vice General Manager of NCR Turkey and as General Manager of Sun Microsystems in Turkey.

During the same period, he offered consultancy services to some big group companies such as Koç, Sabancı and Eczacıbaşı. He has been supporting Vestel's Executive Committee since 1995 in the areas of strategic planning and investor relations. He is currently Executive Board Member of Vestel.

As an UNDP consultant in Vietnam, he conducted a study for the development of local electronics industry. He is founding member of the Turkish Informatics Society (TBV) and the Turkish Unix Users Group. He is also certificated consultant of the Microsoft in the area of Solution Development Discipline. Besides, he had been awarded by TUBİSAD with "Lifelong Service Reward" in 2005.

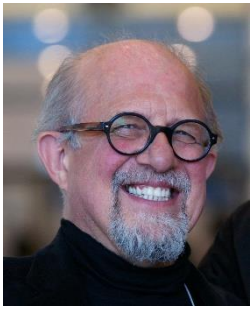
Mr. Ultav has been serving in TTGV as Chairman of Executive Board since August 2005.

## INNOVATION DYNAMICS

Next two decades will witness the creation of radically different institutions and systems to make more than 7 billion people of the world happy and prosperous.
The platforms that will help create fast value added solutions and opportunities for the Z generation will be discussed.

## About the Speaker

### Prof. Dr. Pınar MENGÜÇ



Professor M. Pinar Mengüç received his PhD on Mechanical Engineering from Purdue University, USA in 1985. The same year he joined the University of Kentucky, Lexington, as an assistant professor, and became a professor in 1993. He was a visiting professor at the Harvard University in Boston, during 1998-99, and was awarded an Honorary Professorship at ESPOL, Guayaquil, Ecuador in 2006. At the end of 2008, he was promoted to Engineering Alumni Association Chair Professor at Kentucky. He holds five patents, and has two patent applications. He is the author of more than 140 articles in international journals and 175 conference papers. He is a co-author of two books and has 5 granted patents. He has worked with more than 60 MS, PhD and Post-Doc researchers. He joined Ozyegin University in Istanbul in 2009 as the founding Head of Mechanical Engineering. The same year, he established the Centre for Energy, Environment and Economy (CEEE), which he is still directing. He is a fellow of ASME and ICHMT, a Senior Member of OSA; in 2016 he was elected to Science Academy, Turkey. His research areas include radiative transfer, applied optics, nano-scale thermal transport, sustainable energy science and applications.

## IMPACT OF ENERGY RESEARCH AND TECHNOLOGIES ON PEOPLE'S LIVES

In this presentation, the impact of sustainable energy research and the development of new technologies on the lives of people are discussed. The research carried out at CEEE during the last eight years as related to buildings, industry, and cities is outlined. The presentation emphasizes the importance of human comfort and the operation of buildings, and how they can be part of the design principles starting from the integrated engineering and architecture concepts. To achieve thermal and visual comfort and energy efficiency in buildings, sensor and automation networks can be employed. Yet, these can be most effective if the building-user interactions are streamlined, which may require the modeling of human behavior. In addition, the buildings need to be responsive to human needs and to be designed considering the details of light, flow, heat and temperature distributions, and with the help of interactive ventilation and solar shading systems. All these ideas need to be coupled not only for buildings, but also for regions and cities of the future. The presentation will also address the development of sustainable and inexpensive materials to be used at larger scales, from buildings to industrial systems.

## About the Speaker

### Prof. Dr. Yusuf ALTINTAŞ

Professor Altintas obtained his Bachelor from Istanbul Technical University (1975), M.Sc. (1980) and Ph.D. (1987) in Canada. He worked as a machine tool manufacturing engineer in Turkey (1977-1978), process development engineer in Pratt & Whitney Canada in Montreal (1980-1981), and the principal engineer of Canadian Institute of Metalworking in Hamilton (1981-1982). He joined University of British Columbia and founded Manufacturing Automation Laboratory in 1986. He conducts research on metal cutting, machine tool vibrations, control and virtual machining. He has published 141 archival journal and 95 conference articles with over 12300 citations with h index of 60 (Google Scholar), and a widely used "Manufacturing Automation: Principals of Metal Cutting Mechanics, Machine Tool Vibrations and CNC Design. 1st ed. 2000, 2nd ed.:2012. His research laboratory created advanced machining process simulation (CUTPRO), virtual part machining process simulation (MACHPRO) and open-modular 5 axis CNC system (Virtual CNC), which are used by over 180 companies and research centers in the field of machining and machine tools worldwide.

Professor Altintas is the fellow of Royal Society of Canada, CIRP, ASME, SME, CAE, EC, Tokyo University, P&WC, AvH and ISNM. He received Pratt & Whitney Canada's (P&WC) university partnership (1997), APEG BC's Meritorious Achievement (2002), APEG BC R.H. McLachlan (2010), UBC Killam Teaching Prize of Engineering (2011), Gold Medal of Engineers Canada (2011), SME Albert M. Sergent Progress Award (2012), NSERC Synergy Award, ASME Blackall Machine Tool and Gage best journal paper award, and the special scientific award of Republic of Turkey in Science and Engineering (2013). He holds an Honorary Doctorate Degrees from Stuttgart University (2009) and Budapest University of Technology (2013).

He currently directs NSERC CANRIMT Machining Research Network across Canada. He holds the NSERC - P&WC Industrial Research Chair

Professorship to develop next generation Virtual High Performance Machining Technology since 2002.

## DIGITAL MACHINING

The aim of our research is to develop mathematical models of metal cutting operations, machine tool vibrations and control. The science based digital models allow the virtual design of machine tools, and testing and optimization of machining operations.
The model predicts the cutting forces, torque and power consumed in machining parts by considering material properties, cutter geometry, structural flexibilities, and cutting conditions along the tool path. The structural dynamics of the machine tool can either be imported from Finite Element analysis if the machine tool is at the design stage, or from the experimental modal measurements if the machine is already built. The simulation system predicts chatter free cutting conditions within the work volume of the machine tool, or detects the presence of chatter vibrations along the tool path. The dynamics of servo drive control systems, and trajectory generation as a function of jerk, acceleration and velocity profiles of machine tools are considered in simulating the machine tool behavior. An in-house developed virtual and real time CNC system allows the design and analysis of any five axis machine tool controller.
The algorithms are published in open literature (Google Scholar h-76 with over 22500 citations), and packaged in industrial software tool box which can be used as a process planning tool by production engineers or as an analysis module by machine tool builders (over 250 companies and research centers world-wide). We are currently developing a controller for a 9 axis precision micro machine built in our laboratory, investigating damping of machine tool vibrations, and the stability of turning, drilling, boring, micro-cutting, threading of pipes and mill turn operations.

## About the Speaker

### Prof. Dr. Carla Tatiana Mota ANFLOR

Professor of Computational Mechanics at University of Brasilia. Her expertise is in the field of computational modelling of engineering problems. Her research interests range from thermo-mechanical problems to the modelling and optimization of mechanical devices. Her research has been funded by the Brazilian agencies National Council for Scientific and Technological Development (CNPq) and Federal District Research Support Foundation (FAPDF).

## THE USE OF BOUNDARY ELEMENT METHOD AND TOPOLOGICAL DERIVATIVE FOR DESIGNING COMPONENTS

This keynote will explain how computational modelling can be used to support the development and performance optimization of devices such as trusses, automotive and those submitted to heat transfer. The optimization of solids using the boundary element method (BEM) as a numerical solver is introduced. A topological shape sensitivity approach is used to select the points showing the lowest sensitivities. As the iterative process evolves, the original domain has portions of material progressively removed in the less efficient areas until a given stop criterion is achieved. Some benchmarks tests regarding to thermal and elasticity are investigated to demonstrate the final topology reached with this methodology. In special a suspension trailing arm is also optimized and a new design is proposed as an alternative to commercially available methods. A postprocedure of smoothing using Bézier curves was employed for the final topology of the trailing arm. This process allowed the external irregular shapes to be overcome. The BEM coupled with the topological derivative was shown to be an alternative to traditional optimization techniques using the finite element method. The present methodology has been shown to be efficient for delivering optimal topologies with few iterations.

## About the Speaker

**Prof. Dr. Osman EROĞUL**

Received his BSc degree from the Electrical-Electronics Engineering Department of Military Academy, MSc degree from the Department of Electrical-Electronics Engineering of Middle East Technical University and PhD degree from the Department of Electronics Engineering of Ankara University. He was the head of Biomedical Engineering Centre, and Medical Design and Manufacturing Centre in Gülhane Military Medical Academy (GATA). He also worked as a research scientist in Communications Research Centre (Ottawa / Canada). He is currently the head of Biomedical Engineering Department and director of Graduate School of Natural and Applied Sciences in TOBB University of Economics and Technology. Author of many scientific papers and patents on medical devices.

## APPLICATIONS OF ADDITIVE TECHNOLOGIES IN MEDICINE

A technique of converting virtual Three Dimensional (3D) model into a physical object by laying down successive layers of material is called as additive manufacturing and the printers used in additive manufacturing are named as 3D printers respectively. 3D printers can be used in wide variety of applications in medicine such as producing tissues with blood vessels, low–cost prosthetic parts, drugs, tailor-made sensors, medical models, bone, heart valve, ear cartilage, medical equipment, cranium replacement, synthetic skin, and organs. Depending on technological developments, according to the needs, there are various 3D machines, software and hardware used in medicine. In this study, various applications of additive manufacturing technologies are discussed in detail and some examples are given.

# ABSTRACTS

# THE DEVELOPMENT OF PILOT PRODUCTION LINE OF SMART MANUFACTURING IN TAICHUNG CITY IN TAIWAN (U18-18)

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## ABSTRACT

Smart manufacturing or Industry 4.0 , in which digital technologies such as, IOT, cloud computing, etc. are applied to manufacturing systems, has been one of the primary tools developed in recent year among the industrialized countries for making the economic going further or even solving social issues, especially in the case of Taiwan encountering the turning point of its industry.

The sharing including state of the art processes, tooling and application of IT technology across the activity of manufacturing, is about the establishment of the pilot production line of smart manufacturing for the purpose that the evolution could be accelerated and make impact of the industry, to deliver quality of better working life and solve the issue of ageing population of workforce in Taiwan as a consequence of improved efficiency.

As far as the smart manufacturing is concerned, according to the industrial survey in Taiwan, there are more than 80% of companies which are small and medium enterprises contributing the foundation of production value and workforce, but less than 20% of them have adopted digital technologies due to less comprehension of those tools. However, it is important that smart manufacturing is not only implemented mostly by large companies, there should be more SME being able to catch up the path. The public demonstration as a learning model, is designed and selectively located in the Taichung city which is a highly industrialized city surrounding with the manufacturing sectors like aerospace, machinery, bicycle and their supply chains, for SME to gain knowledge of the application as the solution for strengthen their business competiveness and expand the beneficial result throughout the industry in Taiwan.

**Keywords:** Smart manufacturing, Industry 4.0, Taichung City, Pilot production line

**INNOVATIVE SMART ENTERPRISE – CASE STUDIES (U18-11)**

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**ABSTRACT**
The innovative smart enterprise represents new ways of production and organization within manufacturing company. Digitalization has a big progress and it affects production systems. It changes the way of work in manufacturing companies. The digitalization impacts every step in the production system and brings more flexible manufacturing processes. To introduce digitalization in manufacturing processes, it is necessary to create better conditions for easier and more meaningful implementation. It means that standardized and well organized work is crucial. The lean methodology could be the first step for the innovative smart enterprise. This paper shows Croatian model of innovative smart enterprise that serves companies to find a way for implementation and definition of their own objectives and priorities according to the current state of Croatian industry. Two case studies show that it is possible to improve their work with Croatian model of the innovative smart enterprise.

**Keywords:** Industry 4.0, Innovative Smart Enterprise, Croatian model (HR-ISE model)

## ELDERLY AND DISABLED CENTERED DESIGN (U18-95)

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**ABSTRACT**

The number of elderly and disabled people in the world population is increasing dramatically. According to the data of United Nations Population Fund, OECD-EU and TUIK-Turkey; nearly 12.3% of the world's population is elderly (60 years and over) and 15% is individuals with disabilities (such as in seeing, hearing, walking, touching, speaking and learning). With this data; it can be concluded that today, approximately 900 million elderly and 1 billion disabled individuals live in the world. In addition, about 200 million of these disabled people are in need of special care. Demographic shows that societies are getting elder and number of the disabled individuals is on increase. For today and future, this is a crucial problem. Daily routine for elders and disableds is very tough. They can experience hardness on entertainment, education, working life and health. Some scientific and technological disciplines, such as industrial design, industrial engineering, ergonomics, geriatrics, make effort for the needs of these individuals. To increase the quality of life of these people, new products and technologies are being developed.

In this study, we discussed the the needs of the elderly and disabled individuals in the context of the “elderly and disabled centered design”. We hope that this point of view has potential to form a new area in universal design.

**Keywords:** Elderly and disabled individuals, universal design, elderly and disabled centered design

**WALKMECH2.0: CONCEPTUAL DESIGN AND STRUCTURAL ANALYSES OF AN ENERGY-RECYCLING TRANSFEMORAL PROSTHESIS FOR ACTIVITIES OF DAILY LIFE (U18-38)**

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**ABSTRACT**
This paper presents the conceptual design of an energy-recycling transfemoral prosthesis providing daily activities, e.g. walking, sit-to-stand and stair climbing. The design is the second phase of a prosthesis called WalkMECH which was designed for providing ankle push-off power during walking by storing and exchanging energy for the ankle and knee joints. In this study we improved the design for providing weight acceptance with a knee flexion, sit-to-stand and stair climbing motions with defining elastic elements according to biomechanical data. Following the CAD model of the conceptual design, we implemented structural analysis for ankle and knee to evaluate the design.

**Keywords:** Elderly and disabled individuals, universal design, elderly and disabled centered design

# IMPACT PERFORMANCE EVALUATION OF A CRASH CUSHION DESIGN USING FINITE ELEMENT SIMULATION AND FULL-SCALE CRASH TESTING (SA1)

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## ABSTRACT

Crash cushions are designed to gradually absorb kinetic energy of an impacting vehicle and bring it to a controlled stop within an acceptable distance while maintaining a limited amount of deceleration acting on the occupants. These cushions are used to protect errant vehicles from hitting rigid objects, such as poles and barriers located at exit locations on roads. Impact performance evaluation of crash cushions are attained according to EN 1317-3 standard based on various speed limits and impact angles. Crash cushions can be designed to absorb the energy of an impacting vehicle by using different material deformation mechanisms, such as metal plasticity supported by airbag folding or damping.
In this study, a new crash cushion system, called Ulukur Crash Cushion or UCC, is developed by using linear low-density polyethylene (LLDPE) containers supported by embedded plastic energy absorbing tubes as dampers. Steel cables are used to provide anchorage to the design. Crashworthiness of the system was evaluated both numerically and experimentally. Finite element model of the design was developed and solved using LS-DYNA, where the impact performance was evaluated considering the EN 1317 standard. Following the simulations, full scale crash tests were performed to determine the performance of the design in containing and redirecting the impacting vehicle. Both the simulations and crash tests show acceptable agreement. Further crash tests are planned to fully evaluate the crashworthiness of the new crash cushion system.

**Keywords:** Crash Cushion; Crash Test; Simulation; LS-DYNA; EN 1317; Road Safety; Energy Absorption, Linear Low Density Polyethylene.

# DERIVATION OF STIFFNESSES FOR COMPARISON OF VEHICLE PERFORMANCE IN FRONTAL IMPACTS (SA2)

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## ABSTRACT

The stiffnesses of the structural elements of a vehicle plays an important role in the vehicle's crash performance and in the design of restraint systems. In this study, crash test data obtained from US New Car Assessment Program (NCAP) are utilised to derive the overall frontal stiffnesses of selected cars that underwent full-width fixed rigid barrier (FWRB) impact at impact speeds of 40 km/h and 56 km/h. A method to derive the stiffnesses is proposed which is used in conjunction with a generic lumped-mass car model. The presented lumped-mass modelling approach is an efficient tool that can be used in several stages of design for vehicle safety and in accident reconstruction.

**Keywords:** Vehicle stiffness, Head-on frontal collision, Lumped-mass modelling

# INVESTIGATING THE EFFECTS OF MATERIALS, GEOMETRIC PROPERTIES AND MODIFICATIONS ON THE CRASHWORTHINESS OF BUMPER AND CHASSIS SYSTEM (SA3)

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## ABSTRACT

Accidents are one of the main reasons of death for people across the globe, among which automobile accidents are a major portion resulting in fatalities and various injuries. Crashworthiness aims to affect the design of the structure of the vehicle so that it absorbs as much energy as it can which is sustained from an impact by plastically deforming in a controllable behaviour. The current trend in automobile design and manufacturing is to increase the number of lightweight and recycled components that forms the vehicle. However, using unconventional materials might affect the strength and energy absorption capabilities of the automobile chassis and body that may induce a change in the crashworthiness of the vehicle. This study aims to bring insight into the effects of various conventional as well as lightweight and recycled bumper-chassis systems on vehicle crashworthiness subjected to full-frontal impacts through computational modelling. Investigations are carried out for improving crashworthiness through the use of different materials, various profile thicknesses andmodifications on the system geometry. Various finite element models embodying several bumper-chassis systems such as with crush zone, with hexagonal cross-section, with runner, and with range hood are generated and simulated to evaluate the design choices and modifications. Crush force efficiency and specific total strain energy absorbed are used as decisive parameters in assessing the systems. It is observed that some of the geometrical modifications have improved crash performance of the bumper and chassis system. The best alternative as a material is suggested to be “Recycled 7175 aluminium” with its light weight and considerably high impact energy absorption performance.

**Keywords:** bumper, chassis, finite element analysis, crush force efficiency, specific energy absorption.

# EVALUATION OF SOIL CONDITIONS AND POST EMBEDMENT DEPTH ON GUARDRAIL SAFETY PERFORMANCE (SA5)

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## ABSTRACT

Guardrails are passive road restraint systems used at roadsides and medians to improve road safety. Crashworthiness of guardrail systems is evaluated through full- scale crash testing. Design parameters, such as post type, soil characteristics, guardrail properties, post-soil interaction and post embedment depth play an important role in the test outcome. In this paper, effect of guardrail post embedment depth and soil characteristics on dynamic impact behavior of a guardrail design is evaluated. Field tests as well as finite element simulation results were used to compare impact performance. Three different soil properties and seven different post embedment depths are assessed as test parameters. A 1000 kg pendulum device was used to apply the dynamic load on guardrail posts. Deceleration as well as post movement during impact were recorded to make comparisons. Optimum post embedment depth charts were constructed based on soil properties.

**Keywords:** Guardrail; post; soil properties; embedment depth; impact; safety.

## HAZARD PERCEPTION TEST SUITABILITY FOR OLDER DRIVERS (SA6)

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**ABSTRACT**

Research has shown that an increase in life expectancy and quality of life in the Western world has similarly given rise to increases in the number of older licenced drivers using their automobile as their primary mode of transport. Older drivers typically drive far less than younger drivers however, 'fatalities per mile driven' data indicates that older drivers have the greater risk of being involved in a fatal crash.

In this study, the experiments were conducted with 50 drivers representing a range of different age groups. A sample of the UK driving licence examination is 'Hazard Perception' video clips were used to measure the drivers' reaction time for the apparent risks. An Eye tracking device was also used to trace and record eye fixations. Reaction time and gaze related data were collected while drivers were asked to identify hazards in the video clips. Case studies were used to simulate driving in various environments such as town, urban, rural and motorway driving.

Analysis of the reaction time data sets reveals that the older drivers' hazard perception do not follow a regular pattern and is in general inconsistent. Further comparisons, by including the eye-tracking data, reveal the reasons behind the inconsistencies. The research suggests that the reaction time data collected by using hazard perception tests alone are not suitable to measure the hazard perception of older drivers.

**Keywords:** hazard, perception, age, elderly, eye-tracking, safety.

# TRAFFIC SAFETY AT MEDIAN DITCHES: STEEL VS CONCRETE BARRIER PERFORMANCE COMPARISON USING COMPUTER SIMULATION (SA7)

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## ABSTRACT

In Turkey, concrete V-shaped ditches are formed at the median section of divided highways to provide drainage. Recent accidents showed that these ditches actaully present safety risks for vehicles entering medians. Vehicles either cross over the ditch, roll over or are trapped inside the ditch depending upon the mass, size, speed and angle of the vehicle entered. To overcome this safety risk and reduce the severity of these accidents longitudinal barriers are installed along these ditches. Currently in Turkey steel barriers are extensively used to improve traffic safety at median ditches. In this paper, crash performance of a steel and a concrete barrier used at medians with ditches are compared. A standard steel EDSP-1.33 barrier and a newly developed concrete C470 barrier models have been constructed and impact simulations were performed when they are installed at ditch slope break point. A nonlinear finite element program LS-DYNA is used for the analysis. A 13,000 kg bus model is used to impact both barriers in accordance with European standard requirements. Simulation results show that when steel EDSP-1.33 barrier is used the bus has the potential for excessive penetration into the ditch with significant barrier deformation. Moreover, the barrier damage is extensive resulting increased maintenance costs. On the other hand, concrete C470 barrier successfully contains and redirects 13,000 kg bus impact with minimal barrier deformation and safety risk. Even though concrete barrier slides toward inside the ditch bus does not enter the ditch area and exits the barrier in a stable manner. Therefore, to increase traffic safety at ditches located at median section of divided highways in Turkey utilization of newly developed concrete barrier C470 is recommended.

**Keywords:** Ditch; Traffic Safety; Simulation; Concrete Barrier; Steel Barrier; LS-DYNA; Divided Highway.

## CRASH SAFETY PROTECTION FOR WHEELCHAIR OCCUPANTS USING HUMAN BODY MODELS (SA8)

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**ABSTRACT**

In motor vehicle crashes, wheelchair occupants have an increased risk of death and serious injury compared to non-disabled adults. Despite this, vehicle safety design is still currently assessed with crash test dummies and computational dummy/human models that only represent the non-disabled population. Even for this population, only a small number of body and seating attitudes are used. Available anthropometric data for the wheelchair user population revealed substantial differences in sitting height and body dimensions of the pelvic and shoulder regions compared to the corresponding values for standard adult crash test dummies. Hence, there is a need for improved tools to address wheelchair occupant safety when developing and evaluating the performance of the restraint systems used by wheelchair- seated occupants, and a need for wheelchair designs that facilitate the correct use and positioning of belt restraints. In this paper we present a preliminary modelling study to investigate the effects of the anthropometric features of wheelchair users on occupant responses in frontal crashes using Human Body Models. In this study, a subject-specific human body model scaled from the MADYMO human body model mid-size male to the average anthropometry of twenty wheelchair users was developed. Occupant responses between the Hybrid III model, the MADYMO human body model mid-size and the scaled human model were compared in frontal crash (20g/48km/h) sled simulations with the occupant models sitting on a manual wheelchair secured with 4-point tiedowns and restrained with a 3-point occupant restraint system. The results suggest that in frontal impact sled tests, the scaled human model experienced greater head and hip excursions and torso angle, which indicates a higher submarining risk. Simulations of wheelchair occupants predicted significantly higher risks of injuries to the thorax and lower extremities and a higher submarining risk compared with non-disabled occupants. Simulations with parametric human body models capable of representing the diversity of the wheelchair population can provide a means of improving protection for individuals who differ in size, shape and position from the surrogates typically used for restraint optimisation.

**Keywords:** disable, occupants, safety, modelling, human

## ANALYSIS OF A COACH SIDE FLAP UNDER CYCLIC LOADS (U18-43)

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### ABSTRACT

The main objective of this study is to determine whether the coach side flap material and supports are strong enough for a certain amount of life cycle, also to optimize the weight by eliminating unnecessary supports and cost by choosing an optimum material. This study is aimed to model coach side flaps kinematically to obtain the forces acting on the flap cover and carrying out non-proportional fatigue analysis based on opening and closing cases. The flap is modeled and also the Rigid Body Simulation is performed in CATIA. The piston forces modelled as preloaded linear springs with a small amount of damping which is determined based on real opening timing of the flaps. The fatigue analysis is performed in ANSYS Workbench according to the reaction forces obtained from the simulation results from CATIA. Since there is no correlation between the boundary and load conditions in opening and closing cases, non-proportional fatigue method is used. The results were compared with two different available aluminum materials. Also some case studies with elimination of some support structures are performed.

**Keywords:** Coaches, side flaps, fatigue, AlMg3 H12, AlMg3 H22

**TOPOLOGY OPTIMISATION OF AN AUTOMOBILE BRAKE SYSTEM COMPONENT UNDER DYNAMIC LOADING CONDITIONS (U18-52)**

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**ABSTRACT**

The topology of the structure has an important effect in achieving the design goals. The purpose of topology optimization is to find the best use of material in a specific design area. Topology optimization provides an initial design concept for designers in R&D departments of the automobile companies. In this research, the optimal design of a vehicle brake pedal was determined using a topology optimization approach. The solid model of a brake pedal was design using Catia software. Altair Optistruct was used for topology optimization. After topology optimization, material was removed from some region of the initial design. In this research, optimal layout of vehicle brake pedal under dynamic loading conditions is determined using topology optimisation approach. The result shows that the weight of a new designed brake pedal was reduced as compared to the initial design.

**Keywords:** Structural design, Gravitational search, Hybrid Optimization

## HYBRID TECHNOLOGIES: TECHNOLOGY OVERVIEW AND APPLICATIONS (U18-HM1)

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**ABSTRACT**

Hybrid Manufacturing is an exciting emerging range of technologies that take the advantages of Additive Manufacturing (e.g design freedom, design complexity, material efficiency, component integration) and subtractive manufacturing (e.g low cost, high accuracy, good surface finish) to provide environmentally and financially sustainable manufacture of high value products, and / or repair and remanufacturing of used products.

**Keywords:** Hybrid manufacturing, sustainable manufacturing, remanufacturing

**INVESTIGATING THE EFFECTS OF PROCESS PARAMETERS ON RESIDUAL STRESS EVOLUTION IN PLASMA TRANSFER ARC (PTA) CLADDING OF TI-6AL-4V (U18-97)**

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**ABSTRACT**
The evolution of residual stresses during Plasma Transferred Arc (PTA) cladding of Ti-6Al-4V was investigated. The PTA cladding was used as an Additive Manufacturing (AM) process to build parts in a layer-by-layer fashion. The process parameters were therefore defined based on the PTA cladding and AM process. A series of results from two residual stress measurement techniques provided a baseline to understand the effect of this metal-based AM technology on residual stress evolution and hence geometrical accuracy of the PTA AM components.

**Keywords:** Plasma Transferred Arc (PTA), Additive Manufacturing (AM), Titanium Alloy, Residual Stress, Neutron Diffraction, Synchrotron X-ray Diffraction, Contour Method

**THE TOOL LIFE INVESTIGATION IN HYBRID MANUFACTURING PROCESSES (U18-HM3)**

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**ABSTRACT**

Despite the many benefits which additive manufacturing brings compared to traditional manufacturing methods, it suffers from limitations in the size, accuracy/surface of parts which can be produced and the speed of production. Hybrid AM offers a potential solution to these and helps to integrate AM into conventional manufacturing process chains. This paper presents the results of the EU H2020 funded Open Hybrid project, where a flexible solution based around interchangeable processing heads is being developed. We demonstrate 5 axis machine tool and large scale gantry systems for repair of high value engineering parts from the energy, mining and automotive sectors.

**Keywords:** Additive manufacturing, Open Hybrid, hybrid manufacturing, direct energy deposition, platform.

## AUTOMATED REMANUFACTURING ENABLED BY HYBRID MANUFACTURING TECHNOLOGIES (U18-98)

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**ABSTRACT**

Hybrid Manufacturing is an exciting emerging range of technologies that take the advantages of Additive Manufacturing (e.g design freedom, design complexity, material efficiency, component integration) and subtractive manufacturing (e.g low cost, high accuracy, good surface finish) to provide environmentally and financially sustainable manufacture of high value products, and / or repair and remanufacturing of used products.

**Keywords:** Hybrid manufacturing, sustainable manufacturing, remanufacturing

## A TECHNOLOGICAL AND BUSINESS PERSPECTIVE OF ADDITIVE MANUFACTURING FOR DEFENSE INDUSTRY (U18-7)

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**ABSTRACT**
In the recent years the enhancements in destructive technologies necessitate higher requirements for survivability; both for mine, ballistic and IED protection. At the same time, payloads increase and mobility requirements are becoming more and more challenging. These trends make lightweight design indispensable. Besides, another trend is the increasing the number of variants for different missions, which results in smaller amounts of serial production. The need of prototypes often utilized in land vehicle industry as technology demonstrators necessitate the use of fast and flexible manufacturing techniques. All these trends and needs make additive manufacturing (AM) technologies a favorable production process if combined with the appropriately optimized design for AM. On the other hand, cost efficiency is becoming more and more important. Additional constraint for ground vehicles in AM is the large component sizes. This study presents the view of FNSS Savunma Sistemleri A.Ş. on additive manufacturing technologies taking all these constraints and boundary conditions into account to determine the deployment and road mapping strategy.

**Keywords:** Additive Manufacturing, Land Vehicles, Road mapping Techniques

# EFFECTS OF LIQUEFIER DESIGN ON THERMAL PROFILE IN FUSED FILAMENT FABRICATION BASED ADDITIVE MANUFACTURING PROCESS (U18-78)

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## ABSTRACT

Material extrusion processes such as fused filament fabrication (FFF) are among the most widely used additive manufacturing (AM) technologies. The fused filament fabrication process consists of simultaneously feeding and melting a filament of polymer material through a computer controlled liquefier. The material then flows through the nozzle under pressure, which must fully solidify while remaining in extruded shape. Deposited layers are fused together as the melted material quickly solidifies to form layers of a solid 3-D object. The key elements are material feed mechanism, liquefier, print nozzle, build surface and environment. The general applications are production of prototypes during product development phase, short series production runs where tooling cost is high, and parts with high geometrical complexity which cannot be produced by means of conventional manufacturing. The liquefier, core of a material extrusion system, is a metal block with a channel designed for the filament to flow through. Often, time evolution of temperature as recorded by thermography and adhesion behavior of filament are investigated by considering main process parameters, such as filament dimensions and material, sequence of deposition and environment temperature. In this paper, thermal behavior of material extrusion liquefier with varying heat sink designs and cooling fan speeds is analyzed.

**Keywords:** Fused filament fabrication, liquefier, temperature, heat sink

## DESIGN AND FABRICATION OF LARGE-SIZE FFF 3D PRINTER (U18-84)

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### ABSTRACT
Additive manufacturing, also known as “3D printing” keeps diffusing into many industries with a rapid pace. The greatest advantage of 3D printers is that it allows the designers to produce a prototype in a very short time that can be tested and quickly remodeled if necessary. This significantly reduces the required time to advance from the design phase to the final product. Another great advantage is manufacturing components which have very complex and precise forms through this technique. It is also possible to speed the process of manufacturing of complex parts which can be produced in a long time with conventional methods. In this paper, the design and fabrication of a large size FFF 3D delta printer, also the challenges encountered during the fabrication are presented.

**Keywords:** 3D Delta Printer, Fused Filament Fabrication (FFF), Thermoplastic Polymer Materials

## COAXIAL ADDITIVE MANUFACTURING OF CONTINUOUS CARBON FIBER COMPOSITES (U18-83)

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**ABSTRACT**

In this paper, a extrusion based coaxial additive manufacturing method has been developed for additively manufacturing of continuous carbon fiber reinforced thermoplastic (PLA) composites for improving the mechanical properties of the manufactured parts compared to pure thermoplastic materials. The effect of embedding continuous carbon fiber as a reinforcement and PLA, in the form of a pellet, as a thermoplastic matrix material is examined experimentally. A special coaxial nozzle, which supplies the continuous carbon fiber and PLA pellets separately, is developed for printing continuous carbon fiber reinforced thermoplastic composites. After the 3D printing process, the tensile and flexural (3-point bending) mechanical tests were conducted. The results from the mechanical tests showed that continuous carbon fiber reinforced PLA composite resulted in higher tensile and flexure test values than pure PLA.

**Keywords:** Additive Manufacturing, Continuous Carbon Fiber Composites, 3D Coaxial Printing.

**PRACTICE-ORIENTED METAL AM PROCESS SIMULATION AND OPTIMIZATION (U18-80)**

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**ABSTRACT**
Although powder bed fusion metal additive processes such as Selective Laser Melting offer unique advantages in the production of light weight, complex parts, major challenges, such as keeping stress and distortion levels as low as possible remain. This is achieved by performing a number of stages such as 3D-printing, heat treatment and machining. The final result depends on a combination of parameters through the process chain, which leads to time consuming and costly trial-and-error iterations.
Numerical simulation can help shorten the process design stage and improve quality by virtually opimizing the different parameters involved. Distortions, can be predicted at an early stage and minimized by improving the support structures and pre-distorting the part. A concept based on the Simufact Additive software is presented and discussed. Examples are shown and an outlook into future developments is given.

**Keywords:** Additive Manufacturing, Powder Bed Fusion, Process Chain, Numerical Simulation, Finite Element Method, MARC Solver, Analysis Scale, Optimization

## ADDITIVE MANUFACTURING OF THE MILITARY ORIENTED MEDICAL DEVICES WITH STEREOLITHOGRAPHY METHOD (U18-67)

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**ABSTRACT**
The additive manufacturing have been used by researchers in academy, engineers in industry and other users for consumer products over the 30 years. On the contrary of machining, additive manufacturing has some serious advantages which are production complexity, process speed, less swarf during manufacturing and nullary operation to setup manufacturing. In addition to various material which is using in additive manufacturing make possible for production in medical sector with additive manufacturing technologies. In this study an additive manufacturing technique, which is stereolithography, have been used to produce a military oriented medical device. 5 different version have been designed and one useful prototype have been produced with downward stereolithography printing using with photopolymer resin. The developed medical device, which is called military tourniquet system, is a smart system which can communicate with GPS, GSM and Bluetooth for different task. Thanks to the system's robust structure, injured person can be applied the system both are their arm and leg extremities. When the system starts, the required force is applied on the injured extremities, then the injured location information, the tourniquet force and application time information is sent a central to inform injured health conditions and call a medics or first aid teams. The smart tourniquet system is not only use in the military field but also it can use in civilian area to prevent emergency injuries.

**Keywords:** Additive manufacturing, stereolithography, medical device, smart tourniquet, extremity injury

# EFFECTS OF STRUCTURAL HYBRID DESIGN OF CoCr-ALLOY SCAFFOLDS FABRICATED BY SELECTIVE LASER MELTING FOR BIOMEDICAL APPLICATIONS (U18-20)

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## ABSTRACT

The production of scaffold structures for biomedical applications by using Additive Manufacturing (AM) has become widespread due to possibility of the customized fabrication depending on the demands of the patient. However, design of the scaffold is seriously important in improving the mechanical and biological properties of the product. In this study, Selective Laser Melting (SLM) was used to fabricate CoCr-alloy scaffolds consisting of different hybrid designs with the constant porosity ratio and strut diameter. In designing the scaffolds, a computed tomography of a human femur was processed by medical image processing software and 3D model of the human femur was obtained. The hybrid designs of scaffolds were composed of dodecahedron, grid, grid+dodecahedron structures with partially-dense and fully-dense external sidewalls. After designing, scaffold samples for compression test and cell adhesion test were fabricated from CoCr-alloy powders on the SLM machine. In order to observe the variation in mechanical strength of the scaffolds according to the developed designs, compression test was performed. Cell adhesion test (MTT-cytotoxicity) was applied to investigate the cell adhesion ability of the scaffolds. The results indicated that although hybrid scaffolds had the same porosity ratio and the same strut diameter, they showed apparent variations both in mechanical and biological properties.
It has been seen that scaffold having partial dense sidewall within hybrid structure showed %14,6 of higher mechanical strength in comparison with non-hybrid structure. Cell viability of the scaffolds showed variations due to the developed designs. As a result, it could be claimed that scaffolds with complex designs fabricated by SLM method are promising for future applications due to the satisfactorily increments in mechanical strength and cell viability

**Keywords:** Additive manufacturing, selective laser melting, scaffold, porous scaffold, lattice structure, hybrid design, medical image processing

## DESIGN OF A QUADCOPTER ARM FOR ADDITIVE MANUFACTURING USING OPTIMIZATION AND LATTICE STRUCTURES (U18-85)

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**ABSTRACT**
A quadcopter arm design optimization process using lattice structures is presented. A linear elastic finite element analysis of the lattice-based arm is developed by modeling the strut members using beam elements. The optimal lattice-based design is obtained using size and topology optimization methods. Minimum printable diameter and the inclination angle of the struts are considered for additive manufacturing. The designed structure is successfully fabricated by using an in-house developed 3D printer. The comparison of the FEA results with an existing design in the literature proved that the proposed lattice-based arm design has better weight-to-stiffness performance.

**Keywords:** Optimization, Lattice Structure, Additive Manufacturing, Quadcopter

## SELECTIVE LASER MELTING PROCESS SIMULATION OF ALSI10MG ALLOY TO PREDICT PART DISTORTIONS (U18-48)

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**ABSTRACT**
Selective laser melting is one of the most extensively used metal additive manufacturing method. Although many industries adopt the method, it requires a comprehensive insight to produce reliable parts. Therefore, process monitoring and process simulations are key methods to optimize the process and to reduce the product development time. This study focuses on AlSi10Mg alloy selective laser melting simulations to predict the part deformations accurately. Commercial finite element analysis (FEA) software package allowed to combine fine-scaled details into the part-scaled simulation. Thermo-mechanically coupled FEA simulations predicted the experimental results down to 10 µm proximity.

**Keywords:** Selective laser melting, Metal additive manufacturing, Numerical modeling, Finite element analysis

# HIGH VIBRATION ABSORPTIVE BODY PRODUCTION FOR TURNING CUTTING TOOLS WITH ADDITIVE MANUFACTURING TECHNOLOGY (U18-76)

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## ABSTRACT

The dynamic behaviour of a machine tools body directly influences key metal cutting performance like cutting speed, cutting depth or minimize movements on the high-speed movements. That will affect directly results of the parts surface quality, cutting time and also tool life.

In this study, usage of the alternative material with complex geometry for tool body with additive manufacturing methods had been experimentally checked for effects on the surface quality, machining parameters, dimensional changes and tool life. Alternative body material usage effect which can absorb high vibration on the system and experimentally test results had compared on different materials like grey and ductile iron casting and SAE 1117 steel.

**Keywords:** Vibration, Cutting tools, Additive manufacturing

**PLASMA TRANSFER ARC (PTA) CLADDING FOR ADDITIVE MANUFACTURING (AM) OF METAL ALLOYS (U18-58)**

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**ABSTRACT**
Plasma Transferred Arc (PTA) cladding has been recently used as a metal-based Additive Manufacturing (AM) technique, which could be integrated with machining and surface finishing towards Hybrid Additive Manufacturing.
As a typical challenge with metal AM parts, PTA AM components suffer distortion and shape and size inaccuracy, mainly due high deposition rate of material combined with repetitive heating and cooling phenomena. Macro and micro residual stress evolution during the process could cause internal defects and geometrical inaccuracy. This research work introduces a range of non-destructive and destructive techniques to determine residual stress in metal-AM and specifically for PTA AM parts.

**Keywords:** Additive Manufacturing (AM), Directed Energy Deposition (DED), Distortion, Residual Stress, Plasma Transferred Arc (PTA)

# DESIGN AND DEVELOPMENT OF AN ADDITIVE MANUFACTURING SYSTEM FOR METAL PRINTING (U18-112)

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## ABSTRACT

Direct metal laser sintering (DMLS) is an additive manufacturing (AM) technology, based on powder bed fusion (PBF) process. By layer-wise selective melting of metal powder, it can fabricate functional parts of any geometrical complexity. However, the challenge of exploring the metal powder processing from the research point of view is impeded by the predominance of commercial systems. Which are costly and offer very limited access to underlying operations and hence appear to be a black box to its users. In this article, the development of an open control-architecture DMLS machine, designed specifically for research in this area is presented.

**Keywords:** Metal AM, PBF, SLM, DMLS.

## USING MULTI-AXIS ADDITIVE MANUFACTURING IN SUPPORT-LESS PART FABRICATION (U18-113)

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**ABSTRACT**
Additive manufacturing can be enhanced through augmentation of additional axes of motion. This paper shows that such improvement allows support-less additive manufacturing of parts that will otherwise require support structures. By utilizing multi-axis additive manufacturing, model can be divided and sliced to avoid using support. The possibility of laying an unsupported roofing layer using our created path is also studied. In addition, through manual mixing of the 3D printer's motion, it is demonstrated that other kinds of geometric samples can also be manufactured. Beyond the shown samples, considering applicational purposes, the relevance of a general multi-axis path planner is acknowledged.

**Keywords:** Additive manufacturing, Support-less, Multi-axis, 5-axis

**ROBOTIC ADDITIVE MANUFACTURING OF TOOLING FOR COMPOSITE STRUCTURES (U18-114)**

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**ABSTRACT**

The use of composite materials in the aerospace and automotive industries have been increasing rapidly. The molds, also known as tools, used for laying the composites are generally made from metals which are manufactured by subtractive manufacturing. This is not only an expensive option but also results in long lead times. Additive manufacturing (AM) is an alternative method for manufacturing the tooling. With robotic additive manufacturing (RAM), tools for large parts can be manufactured relatively quickly. After the tooling has been manufactured, non-autoclave processing methods such as the vacuum molding (VM) is used to obtain the final desired part geometry.

**Keywords:** Robotic, Additive manufacturing, Composites, Carbon fiber

## EFFECTS OF THE ROTATIONAL SPEED ON THE DYNAMICS OF MICRO CUTTING TOOLS (U18-57)

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**ABSTRACT**

This paper investigates the rotational dynamics of the micro cutting tools using a spectral modeling approach. To accurately model the dynamics of micro cutting tools, a three dimensional (3D) solution approach is needed since the fluted section of the cutting tool presents 3D coupled motions especially at high rotational speeds and for high aspect ratio tools. In this technique, the integral boundary value problem derived using Hamilton's principle is solved using a spectral method where Tchebychev polynomials are used as basic functions. The calculated natural frequencies are compared to those found using a finite element solution approach.

**Keywords:** Rotational dynamics, micro cutting tool, spectral-Tchebychev

## EFFICIENCY OPTIMIZATION METHOD OF STABILITY PARAMETERS FOR THINWALLED WORKPIECE MILLING PROCESS (U18-73)

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**ABSTRACT**
Thin-walled structures are common in aerospace machines, like turbo blades and blisks, but these kinds of structures are difficult and time-consuming to be machined. The dynamics of the workpiece may be changed continuously during machining. In this study, the prediction technology of processing simulation is presented to solve the manufacturing problems of flexible structures. Each FRF is used to integrate a 3-D stability lobe diagram which can also be called as a whole process diagram of each operation. The optimized material moving rates computed from the chosen parameters on stability lobe diagrams can increase the maximum processing efficiency.

**Keywords:** Thin wall, Stability lobe diagram, Material removal rate

**INVESTIGATION OF EFFECT OF MINIMUM QUANTITY LUBRICATION TECHNIQUE ON SURFACE ROUGHNESS DURING MILLING OF TITANIUM ALLOY (TI-6AL-4V) (U18-96)**

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**ABSTRACT**
This study deals with experimental investigation of the effect of minimum quantity lubrication (MQL) on the surface roughness (Ra) of slot milled titanium alloy parts in comparison to those obtained under dry and flood lubrication conditions. The results revealed that with all cooling/lubrication conditions, surface roughness (Ra) is sensitive to changes in the feed per tooth, the axial depth of cut and the cutting fluid flow rate; but not sensitive to changes in the cutting speed. In addition, the Ra values with MQL were found to be lower in most of the conditions than those under flood lubrication. Dry cutting gave the highest surface roughness values for all conditions.

**Keywords:** Minimum Quantity Lubrication (MQL), Slot Milling, Surface Roughness, Response Surface Methodology (RSM).

## GRINDING OPERATION OF A WORKPIECE WITH AN UNKNOWN SHAPE CONSIDERING TOOL DEFLECTION COMPENSATION (U18-25)

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**ABSTRACT**
In robotic-machining, the effort on the pre-processes, such as path planning, is felt deeply as the customized products are in demand. In this study, the elimination of these preprocesses was aimed and a novel method, which considers the tool deflection compensation, for grinding operation of a workpiece with an unknown shape was proposed. The algorithm was tested on a robotic-grinding setup and experimental result were discussed.

**Keywords:** Grinding, Unknown shape, Tool deflection compensation

# DESIGN FOR MANUFACTURABILITY: DETERMINATION OF MINIMUM MANUFACTURABLE WALL AND FLOOR THICKNESS OF MACHINED PARTS BY UTILIZING FINITE ELEMENT ANALYSIS (U18-29)

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**ABSTRACT**

During manufacturing of a machined part, cutting forces may create excessive stresses and strains in the part. Design engineers should take into account not only the loads that their designs shall encounter during their life cycle but the forces exerted during manufacturing processes. Finite element analysis can be used also for analysis of these manufacturing effects. This study uses finite element analysis. The results of these analyses are used to find generic formulas for determination of manufacturable thicknesses of walls and floors of any design. The findings may be very useful for designing manufacturable parts and reduce scraps and costs.

**Keywords:** Manufacturability, Wall thickness, Floor thickness

# INVESTIGATING THE EFFECT OF MILLING PARAMETERS ON RESIDUAL STRESSES OF Ti-6AL-4V (U18-121)

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## ABSTRACT

Titanium alloy Ti-6Al-4V is broadly used in aerospace industry, biomechanical applications and additive manufacturing because of its low density, excellent corrosion resistance, and high strength. Residual stress has a major effect on reliability and product life of the components on these areas. Machining of the titanium alloys results in change of the subsurface layer. This paper presents number of trials, changing the milling parameters on Ti-6Al-4V and their effect on the residual stresses. Experiments were done in different stages of cutting speed and feed rate. Residual stress measurement was done by X-Ray diffraction method. There is lack of study investigating the effect of milling parameters on residual stresses of Ti-6Al-4V. The result shows that the subsurface residual stresses can be adjustable by selection of milling parameters.

**Keywords:** Ti-6Al-4V; Milling; Residual Stress; X-Ray diffraction

## VIRTUAL PROCESS SIMULATION OF ORBITAL DRILLING OPERATIONS (U18-90)

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### ABSTRACT
This work presents a virtual simulation model which simultaneously predicts tool – workpiece engagement, chip geometry, cutting forces, chatter stability and hole surface errors of orbital drilling operations. The cutting mechanics includes the contribution of bottom edges. The dynamics of the system have been modeled including time-varying delay contributed by the combination of spindle speed and orbital tool motion. The stability of the orbital drilling is solved in discrete-time and frequency domains. Three dimensional stability lobes and hole surface errors are predicted as a function of tool position along the orbital path, spindle speed and pitch length of the path. The mechanics, stability and dimensional error models have been experimentally validated by conducting orbital drilling of holes. The final section presents the software which is developed to help the process planner selecting the tool geometry, orbital and tangential feeds, and spindle speeds without causing chatter, violating dimensional tolerances and overloading of the machine.

**Keywords:** Orbital drilling, cutting forces, chatter, hole surface errors

## AN ALTERNATIVE APPROACH FOR THERMAL MODELING OF WELDING OPERATIONS: SEMI-ANALYTICAL SOURCE (SAS) METHOD (U18-94)

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**ABSTRACT**

In order to predict the final properties of the joined components in the design stage or to optimize the process parameters, modelling of welding operation is widely used in industrial applications. Welding modeling could be conducted by finite element method (FEM) based software. However, with the help of the symbolic computation software, advanced mathematical methods such as the Green's function method (GFM) can be implemented in the analytical solution of such engineering problems recently. Analytical solutions, especially for linear problems, always provide much more accurate and quick solutions compared to numerical methods. However, for the cases where the problem is transient with moving heat source, it is necessary to implement advanced numerical solution strategies such as semi analytical source (SAS) method which is integrated to GFM solutions. In this contribution, a semi-analytical source (SAS) method is applied for a two dimensional (2D) transient thermal problem with a moving heat source. This model is created for the thermal analysis of a laser welding operation. The SAS method is compared with the results of a finite difference method analysis for which a specific MATLAB script is created. The results showed good correspondence. The 3D thermal modeling of laser welding operation with SAS method is intended to be treated as a future work.

**Keywords:** Thermal modeling, Green’s function method, Semi analytical source method Finite difference method

**FINITE ELEMENT MODELING OF MACHINING PARTICLE-REINFORCED ALUMINUM METAL MATRIX COMPOSITES (U18-87)**

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**ABSTRACT**
This paper investigates the application of finite element method to model orthogonal cutting of particle-reinforced aluminum metal matrix composites (p-Al-MMCs).The matrix material is selected as aluminum alloy A359 reinforced with silicon carbide (SiC) particles having a diameter of 20 μm with a volume fraction of 20%. The accuracy of three different modeling strategies to predict machining forces has been studied. In the first approach, p-Al-MMC is modeled as a homogeneous material, where the plastic deformation and damage evolution are governed by high-strain rate deformation behavior of A359/SiC/20p composites and Johnson-Cook damage models, respectively. The second and third approaches try to model p-Al-MMCs as a two-phase heterogeneous material, where it is assumed that the matrix consists of a periodic array of non-agglomerated particles with identical size, shape, and distance. The second and third approaches rely on the periodic square and periodic hexagonal distributions of reinforcement particles, respectively. The developed FE model captures the interaction between matrix/cutting tool, matrix/reinforcement and reinforcement/ cutting tool. The results of FE compared with experimental data from literature review. The results of FE analysis revealed that, modeling p-Al-MMCs as a homogeneous material under estimates machining forces, which necessitates the use of a two-phase heterogeneous material models when modeling machining of p-Al-MMCs. It is shown that, a good agreement between FEM results and experimental data can be achieved when considering a periodic hexagonal distribution of reinforcement particles in the matrix.

**Keywords:** Finite element modeling, Particle-reinforced Al-MMC, Particles distribution, debonding of reinforcement particle, tool particle interface.

**DAMAGE IDENTIFICATION IN A CANTILEVER BEAM USING MODAL STRAIN ENERGY (U18-42)**

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**ABSTRACT**
This paper aims to analyze the modal strain energy method for damage identification. It is a non-destructive method that compares the deformation energy of a structure with and without damage through its modal characteristics. For this, a beam model was elaborated using the finite element method with and without damage and its deformation energy was numerically analyzed using MATLAB.

**Keywords:** Modal Strain Energy Method, Damage Identification, Finite Element Method

# PERFORMANCE EVALUATION OF MICRO-TEXTURED CUTTING TOOLS IN DRY MACHINING OF INCONEL 718 USING FE SIMULATION (U18-13)

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## ABSTRACT

This paper presents 2D FE simulation results of dry machining of Inconel 718 using micro-grooved cutting tools. FE model is validated by comparing the simulative results with reference experimental study. Mainly, influences of groove size and groove position on cutting force components, contact length and force ratio are investigated. The results of micro-grooved tools are compared with non-textured tool. These results showed that micro-grooved tools are effective in improving tribo-mechanical behaviors such as cutting force, feed force, contact length, and friction coefficient even in dry cutting. Furthermore, action mechanism of micro-grooves is discussed in detail.

**Keywords:** Textured cutting tool, Inconel 718, FEM modelling, Machining, Cutting force

# FINITE ELEMENT ANALYZING THE EFFECT OF CRACK ON STRESS AND STRAIN IN HONEYCOMB STRUCTURE FROM ABS POLYMER MATERIALS (U18-36)

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## ABSTRACT

Advanced technology requires new light materials, efficient structures and also new manufacturing methods. A typical conventional cellular example is the regular honeycomb structure produced by additive manufacturing. After doing new researches about fracture behaviour of honeycomb structure, the honeycomb structures with the three different rib thicknesses of 1 mm, 1.5 mm and 2 mm were designed, and then ABS material for structures were selected to use in finite element analyses (FAE). Also, the crack was created on structures, and then 2-D FAE were carried out for un-cracked and the cracked regular honeycomb structure under tensile forces. Finally, the results were interpreted with respect of stress values and strain concentration areas, effect of crack on stress-strain distributions and the crack tip opening through y axis. As results, the equivalent stresses ($\sigma_{vm}$) increase with a decrease in rib thickness and the crack in honeycomb structures leads to an increase in stresses and heterogeneous distribution of the stresses on the closest rib and rib joint to crack. In addition, the heterogeneous stresses distribution in the cracked honeycomb structure gives information about not to be the possible crack advance at lay on continuous patch in structure and but the crack advance will be in possible tortuous patch.

**Keywords:** Fracture behaviour, Honeycomb structure, Tensile forces

**DEVELOPMENT OF AN EMBEDDED SYSTEM FOR 5-AXIS MACHINE TOOL DYNAMIC TEST AND CLOUD STORAGE (U18-125)**

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**ABSvTRACT**

Nowadays, many countries develop specialized or general measurement systems actively because how to measure the errors and improve the performance of five- axes machine tool is an important issue. With the development of science and technology and the government promotion, the networking, cloud computing, industrial robotics, artificial intelligence and other technologies that will change our current lives. With the various technologies development, many companies observe the future trends obviously. The concept of Industry 4.0 came into being and many companies start to integrate these technologies. This research follows the trend to improves the commercial measurement instrument (Laser R-test) through an embedded system, which is based on the MTK LinkIt Smart 7688 Duo. The purpose of this presented system is to replace PC by LinkIt Smart 7688 Duo. It used LinkIt Smart 7688 Duo to do calculation and reduce power consumption in instrument. And changing the ADC module of the NON-BAR system. The system resolution is about 0.13μm and signal stability is about 0.06μm. This paper used Arduino and Python to build measurement system and control system, and upload measured data to cloud platform. It is a bridge of Internet of Things.

**Keywords:** CNC Five-axis machine tool, Internet of Things, Cloud, Laser R-test

## AN IMAGE PATTERN RECOGNITION SYSTEM FOR EVALUATION OF TOOL SCRAPING WEAR CONDITIONS (U18-126)

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**ABSTRACT**

An image pattern recognition system, consisting of a CMOS camera, a set of illumination devices, and a lab-developed image analysis program, has been developed for evaluation of tool scraping wear conditions. The images of the scraped surface texture on the workpiece were first transformed by Haar wavelet transform with Otsu's algorithm to discriminate the vertical details of surface patterns, they were then emphasized by weighted calculations according to tool scraping wear conditions. The experimental results show that the average difference between the data obtained from the surface image analysis and the roughness measurement is about ±2%, proving the feasibility of the proposed system. Furthermore, a statistic analysis reveals that the standard deviation of the non-zero proportion of the medium frequency domain obtained by image processing might be considered as a significant reference for tool replacement.

**Keywords:** Machine Vision, Tool Scraping Wear, Surface Texture

**DETERMINATION OF THE SPRING-BACK ANGLE BY IMAGE PROCESSING IN BENDING OF HIGH STRENGTH STEELS (U18-93)**

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**ABSTRACT**
Precise determination of the spring-back angle plays an important role in bending of high strength steels (HSS). Since the desired final geometry is totally dependent on the amount of spring-back any under-estimation would also result in under-estimation of the bending force. For that reason, especially in the modelling of HSS bending the spring-back should be verified with experimental studies. This contribution deals with the determination of the spring-back angle in HSS bending operations. To do that a simple set-up designed with a digital camera and the images at the bottom dead center (BDC) and the final position is recorded. Then a specific MATLAB script is designed which uses image processing approach for the determination of the angles. Sample results are shared in this contribution in both rolling and transverse directions.

**Keywords:** Spring-back, image processing, high strength steels

# LITERATURE-BASED IDENTIFICATION OF BEHAVIOURAL MODULES FOR SOCIAL ROBOTS USING DESIGN STRUCTURE MATRIX (U18-91)

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## ABSTRACT

Design of platform-based modular social robot families is important in order to quickly meet a diversity of needs regarding these types of robots. This paper describes a method for designing social robot families using behavioral modules. In this study, the tasks and behaviors of a group of social robots are compiled by using the literature and the relationships between the physical elements required for these behaviors are grouped by Design Structure Matrix method and social robot modules are identified. Within the scope of the study, some of these modules were designed and manufactured and physical models were developed.

**Keywords:** Platform-based robot family, modular robot, social robot, design structure matrix, behavioural module

**LAY-UP DESIGN OPTIMIZATION FOR THE LOADED-CARRYING TUBULAR STRUCTURE MADE OF ORTHOTROPIC COMPOSITE (U18-35)**

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**ABSTRACT**

The main requirements for high loaded composite structures experiencing the forces and torques with varied intensity and orientation, are the specified mechanical stiffness to prevent the inadmissible deformations and some structural failure. Examples of these structures are aircraft spars, stringers, wing panels etc. Usually, such parts are manufactured using reinforced composites with orthotropic structural symmetry, which provides the best combination of mechanical stiffness, strength and weight parameters. This paper considers a cantilevered long tube-like composite structure with varied cross-section that is manufactured by winding of glass fiber unidirectional tape. The operational loads include the bending forces, which cause the beam deflections along the directions of maximum and minimum stiffness of the tube, and also distributed torque causing the twist deformations. To increase the stiffness of the structure, hence to reduce the strain energy and peak von Mises stress the search of the best lay-up scheme and its angles is performed. The wall thickness, lay-up scheme, and the total number of layers are assumed as unchanged along the tube, whereas its mechanical properties are considered as homogenized and depending on the lamina properties and its lay-up scheme only. This search is performed by using the finite element model of the structure for three different, and most critical load scenario. The choice of the pseudo-optimal solution is made on the basis of an expert decision that excludes from the consideration of the solution with sharply degraded indicators at least at one load scenario.

**Keywords:** Structural optimization, composite structures, lay-up design

## NUMERICAL SIMULATION OF LATERAL JET IN A SUPERSONIC MISSILE USING COMPUTATIONAL FLUID DYNAMICS (U18-55)

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**ABSTRACT**
Missiles need control mechanisms for maneuverability during the flight. Conventional method for missile control is deflecting control surfaces. However at low dynamic pressures control surfaces lose their effectiveness. An alternative method for missile control is side jet control. The ejection of jet in a direction perpendicular to missile axis causes a force in the reverse direction, therefore agile movement of the missile. In this study, effect of side jet control on missile aerodynamic performance and flow physics will be investigated using Computational Fluid Dynamics (CFD).

**Keywords:** Lateral jet control, Computational Fluid Dynamics, Numerical simulation

## PREDICTION AND PREVENTION OF MANUFACTURING DISTORTION OF AEROSPACE COMPOSITE STRUCTURES (U18-15)

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**ABSTRACT**
Autoclave manufacturing technique is a common method to produce composite aerospace structures. Resin pre-impregnated fiber which is called prepreg are subsequently laid on the hand lay up mold during autoclave manufacturing. Pressure and heat are applied in order to complete the curing cycle. Fiber reinforced composite structures generally take a different shape from the intended one during the curing process because of the anisotropic nature of the composite materials. In the literature, these distortion problems are represented by spring-in, spring-out in curved parts and warpage in flat parts. . An experimental study was performed on L and U shaped test specimens to investigate the effects of tool-part interaction, resin cure shrinkage, thermal expansion coefficient difference between tool and part, cure gradients and volume fractions. The main reason behind the distortion is the process induced residual stress occurring during the manufacturing process. The unbalanced distribution of the residual stress which occurs between layers of the composite materials results in, deformation and shape distortion.

**Keywords:** Composite manufacturing, Hand layup, Spring-in, Spring-out, Warpage

**DESIGN AND COLD FLOW EXPERIMENTAL PROCEDURE OF A PINTLE INJECTOR (U18-46)**

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**ABSTRACT**
An injector, which is the main component of the liquid rocket engine, has major effects on liquid rocket engine's mission. Pintle injector has two major effects on the engine performance. Although, for other types of injectors need more than one injector for the chamber, single pintle injector can cover entire chamber itself. This makes the pintle injector cheaper to manufacture and launch. Secondly, it has the ability to throttle by controlling the area at injection gaps. In this study, a design methodology is developed for a pintle injector. Following this methodology, a 750 N pintle injector is designed and then analyzed by computational fluid dynamics (CFD) analysis to predict the cone angle. Finally, the injector is manufactured and cold flow tests with air and water are conducted to validate the cone angle found by the analysis. Moreover, cone angles are measured with high-speed shadowgraphy system and Sauter mean diameter is measured by Phase Doppler Particle Analysis (PDPA) system.

**Keywords:** Injector, Pintle Injector, Computational Fluid Dynamics

**CFD SIMULATION OF TRAIN FIRE IN THE ISTANBUL METRO TUNNEL (U18-49)**

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**ABSTRACT**
This research thesis presents the simulation of a fire scenario in the tunnel of the Marmaray Metro Line by the use of Fire Dynamics Simulator (FDS) Computational Fluid Dynamics (CFD) Software. The main goal of the simulation is to determine the efficiency of the emergency ventilation system in case of a mid-train fire in the metro tunnels and investigate the ways to develop the safety degrees in underground metro tunnels.
On site measurements are carried out for the selected fire scenarios in the tunnel network and measured values are used as boundary conditions to the CFD simulation.

**Keywords:** Metro Tunnel, CFD, Fire Simulation

## CARTESIAN MESH GENERATOR WITH ADAPTATION TO BOUNDARY LAYER (U18-51)

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**ABSTRACT**
A new mesh generator, which is developed for producing body-fitted boundary layer mesh, is presented. The generated mesh is composed of prismatic, tetrahedral and pyramid cells with Cartesian core mesh. Triangular prismatic mesh generator is derived from an open source code SUMO, and the customized prismatic mesh generator allows building high quality meshes near solid boundaries for the calculation of viscous flow. The Cartesian core mesh is generated staring from the surface mesh located at the outermost layer of prismatic boundary layer mesh. The connection between the boundary layer and the Cartesian core mesh is provided by filling the gap between pyramid and tetrahedral volume elements. The tetrahedral volume elements are generated by an open source Delaunay tetrahedralization program, TetGen. In this study, the boundary layer mesh and Cartesian mesh generation modules are developed and all of the sub-mesh generation modules are integrated to achieve the new mesh generator.

**Keywords:** Computational fluid dynamics, Mesh Generation

# EXPERIMENTAL AND NUMERICAL INVESTIGATION OF COAXIAL PRESSURE SWIRL INJECTORS (U18-54)

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## ABSTRACT

To investigate the spray characteristics of liquid-liquid coaxial injector, numerical analysis and cold flow tests have been performed. Research is planned to carry out by changing recess length and outer injector's type as well as injection pressures. For inner injector of coaxial swirl injector closed-end type injector is used, whereas for outer injector open-end type is used. Tests are performed with high speed camera to determine the spray cone angles. Phase Doppler Particle Analyzer (PDPA) is used to characterize spray characteristics. Two dimensional velocity profile is obtained for both separately and together for inner and outer injectors. Also, Sauter Mean Diameters (SMD) is found for each case. So far, as a test results when both inner and outer injectors are supplied spray cone angle of outer injector decreases and cone angle of inner injector increase and they merge at some point.

**Keywords:** Coaxial Pressure Swirl Injector, Phase Doppler Particle Analyzer (PDPA), Volume of Fluid (VOF), Sauter Mean Diameter (SMD)

**UNSTEADY SOLUTION OF 2D CONVERGING-DIVERGING NOZZLE USING LINEARIZED HARMONIC METHOD (U18-45)**

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**ABSTRACT**
The aim of this study is to develop a model for applying harmonic method into periodic problems without concerning geometry and mesh complexity. So, a 2D inviscid, subsonic flow through a converging-diverging nozzle is studied with a harmonically-alternating back pressure as boundary condition with definite frequency and amplitude. Steady state solution is obtained by time averaged back pressure and coupled with harmonic solver, which is based on linearized Euler methods to solve perturbation effects. Harmonic and steady-state solutions are consolidated to achieve time-accurate solution.

**Keywords:** CFD, frequency, linearized, harmonic

# STAMPING DIE PRODUCTION WITH WIRE ELECTRODISCHARGE MACHINING OF VANADIS 10 AND K393 TOOL (U18-110)

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## ABSTRACT

A stamping die is special precision equipment for cutting and forming sheet metal into the desired part production. The production of this type of die is necessary to select optimum machining method. Wire electrodischarge machining, which is one of the major nontraditional machining methods, is the vital manufacturing process for stamping die production. This machining method has parameters effecting performance of stamping die's industrial life time.

As a stamping die material, special materials which are called tool steel are selected due to some important properties such as hardness and wear resistance, toughness, shock resistance, corrosion resistance. These features are also expected to be a combination of all to maintain the expectations.

In this experimental study, two well-known tool steels (Vanadis 10 and K393) have been machined using wire electrodischarge machining method. The effects of pulse on, pulse off and wire speed parameters on surface roughness and heat affected zone have been examined. The production of stamping die has been tested industrial application to determine the life time or pressed part quantity.

**Keywords:** Stamping Die, Wire Electrodischarge Machining, Tool Steels

# EXPERIMENTAL INVESTIGATION OF MACHINING CHARACTERISTICS FOR AL2014 ALLOY REINFORCED WITH TIB2 COMPOSITES IN POWDER-MIXED EDM (U18-117)

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## ABSTRACT

This study investigates the machining properties of TiB2 reinforced Al 2014 metal matrix composite (MMC) with electro-discharge machining (EDM) and powder-mixed electro-discharge machining (PMEDM). Three different types of Al 2014 composite specimens reinforced with 2 vol%, 4 vol%, and 8 vol% TiB2 were fabricated in optimum conditions using vacuum infiltration method. The composite specimens with different reinforced ratios were investigated to illustrate the influence of different fractions ratios and different process parameters on machinability of MMCs. The experiments were performed with different currents and reinforcement ratios to determine the effect of TiB2 content on material removal rate (MRR) and tool wear rate (TWR). Experiments indicate that compared with EDM, MRR and TWR machined by using PMEDM are improved. The discharge current and the reinforcement ratio also have a significant effect on the value of the material removal rate (MRR). Investigations show that with increasing of applied current, MRR increases, however, MRR decreases at higher reinforcement ratios. The results also show that in higher currents and reinforcement ratios, tool wear rate increases.

**Keywords:** Metal matrix composite, powder-mixed EDM, Material removal rate, Tool wear rate

# AN INVESTIGATION OF MATERIAL REMOVAL RATE AND TOOL WEAR RATE IN POWDER MIXED EDM MACHINING PROCESS OF AL2014 ALLOY REINFORCED WITH B4C COMPOSITES (U18-118)

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## ABSTRACT

Metal matrix composites (MMC) are the superior materials that have high elastic modulus, high strength, high toughness, lower density and high wear resistance compared to alloys. These materials are widely used in various industries such as aerospace and automotive. In this study ($B_4C_p$ / 2014Al) composite was fabricated in %0, %5 and %10 volume ratio by vacuum infiltration method. For machining of produced work pieces, powder-mixed electro discharge machining (PMEDM) was employed and the results compared with EDM. The effects of parameters such as material removal rate (MRR) and tool wear rate (TWR) were investigated by changing the processing parameters such as current and reinforcement rate. The experiments show that MRR of specimens increases with increasing of current. On the other hand, MRR decreases with increasing of particle reinforcement rate. Investigations also show that current and particle reinforcement ratios don't have a significant influence on TWR. The addition of graphite powder to the dielectric fluid improved the process parameters.

**Keywords:** Metal matrix composite, Powder-Mixed EDM, Vacuum Infiltration, Tool wear rate, Material removal rate, $B_4C_p$/2014Al

## LAB-SCALE RIBBON WINDING MACHINE DESIGN AND FABRICATION (U18-129)

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**ABSTRACT**
Traditionally filament winding is a process that wraps resin impregnated fibers around a mandrel to form hollow composite structures with exceptional mechanical properties. In this present work, a machine that can both wind paper ribbons and natural cellulosic fibers was designed and manufactured based on the working principles of traditional filament winding machine. Hence, a mandrel with circular, square and hexagonal cross-sections was enrolled with epoxy impregnated craft paper ribbons as well as industrial hemp/linen fibers to construct tubular hollow composite structures with various cross-sections. The frame of the 2-axis winding machine was assembled by joining of the aluminum sigma profiles mechanically, which makes the machine lighter and also portable. Distinct helical patterns as a function of winding angle is controlled independently by rotational motion of the mandrel and translational motion of the carriage on the lead screw. Trial experiments showed that at constant tension, it is possible to fabricate hollow tubular structures with helical angles of 50-80o for paper ribbons and 30-85o for natural cellulosic fibers successfully.

**Keywords:** Filament winding, ribbon winding, tubular structures, cellulosic composites, cross-section, hemp fiber, craft paper

**DESIGN AND MANUFACTURE OF A ROLLER BENDER MACHINE FOR BICYCLE RIMS (U18-108)**

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**ABSTRACT**
In this work a roller bender machine to shape circular structures with off-standard cross-sections such as rims for boutique bicycles was designed and manufactured. The machine main body was assembled by joining the I beams via welding operation and fasteners and the rotational motion of the rollers is provided by an electric motor. Manually controlled hydraulic jack changes the height of the rollers incrementally at each step of the rolling process to bring the profiles to their desired radius. Stress distribution analyses of the metal profiles were modeled and were compared with the actual case. The existing roller bender machines used in industry are generally large and clumsy and conditioned for standard products. In this design we aimed to manufacture a portable and lighter machine compared to its commercial ones.

**Keywords:** Profile bending, bicycle rim, profile, bending

# ANALYTICAL METHOD FOR BENDING STRESS OF INTERNAL ASYMMETRIC SPUR GEARS (U18-65)

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**ABSTRACT**
There are no standards available to determine the bending stress of the internal asymmetric spur gears, in the literature. In this paper, standard ISO method is modified to determine the internal asymmetric spur gear bending stress. In this method, the drive side tangent angle at the critical bending stress section is equal to 60° for internal asymmetric spur gear tooth, but the coast side tangent angle at the critical section is calculated by using the kinematics of the generation of the gear coast side root fillet. The analytical results are verified by FEA results.

**Keywords:** Internal asymmetric spur gear, bending stress

## 2D MANUFACTURING EQUIPMENT FOR THE GLASS-MOSAIC PRODUCTS (U18-63)

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**ABSTRACT**

Glass-mosaic is a decorative and functional coating material which is used for providing rich, nice and tasteful view in the exterior and interior spaces in terms of architecture. The mosaic arrangement made as a hand job has a high margin of error in production and increases costs. Today, production systems are transforming rapidly into flexible manufacturing system. For global competition, this production process is realized economically, more functionally and by using technology. On this work, a flexible production system has been developed for mosaic collate of glass mosaics which are performed by human hands for thousands of years. A two-axis counter (matrix) and sequencing system (operator) are designed and manufactured for sequencing of the mosaic pattern. Information about the mosaic pattern geometry are taken by a 2D graphics software with a bmp / jpeg format. Positioning of glass/ceramic mosaics in the color cartridge are realized into the mosaic pattern by a software which is developed by Mat lab programming language.

**Keywords:** Flexible manufacturing system, Glass-mosaic, New production requirements, Sequencing system, Mosaic patterns.

**A COMPARATIVE STUDY ON HYDROGEN EMBRITTELEMENT MECHANISMS (U18-69)**

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**ABSTRACT**
Hydrogen embrittlement (HE) is a common engineering definition, which can involve different types of fracture modes. Hydrogen embrittlement may come to scene as hydrogen attack, hydrogen blistering, hydriding phenomena and etc. Unfortunately, hydrogen may enter the steels from several sources during steelmaking or manufacturing processes, which lead to drastic degradation of the final performance of the products. As the high strength steels have a superior tendency in HE, the subject become crucial for the defense industry where the strength requirements are relatively high. Thanks to the researches which are mostly performed in last decade, the driving mechanism of HE can be modeled with finite element techniques. Advanced crystal plasticity codes are also commonly applied to HE modeling studies. More particularly, it could be stated that there are several solution approaches such as hydrogen enhanced decohesion (HEDE), hydrogen enhanced localized plasticity (HELP) and etc. in modeling of HE. The experimental studies show that the HE modeling results in successful prediction in hydrogen induced fractures. In this contribution a summary is provided regarding different modeling approaches in HE. And finally, some comparison is also made to observe the powerful and problematic sides of the present techniques.

**Keywords:** hydrogen embrittlement, crystal plasticity models, high strength steels

# THE EFFECT OF INSERT SURFACE ROUGHNESS ON SHEAR STRENGTH OF INSERTED METAL INJECTION MOLDED COMPONENTS (U18-40)

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## ABSTRACT

Inserted metal injection molding has been introduced as an alternative to produce large-sectioned components. However, what should be taken into consideration in this method is the bonding of insert to the outer injected section. In this study, the effect of insert surface roughness on the amount of shear strength at the interface of insert and outer injected section has been investigated. Inserted components with diameter of 20 mm were fabricated consisting 12 mm inserts with varying surface roughness of Ra 0.4, 1.6 and 6.3. It is revealed that shear strength of bonding zone is depended on the interface surface roughness. The amount of shear strength is increased with specimens containing inserts with rough surfaces.

**Keywords:** Inserted metal injection molding; Surface roughness; insert bonding, shear strength

## DESIGN AND MANUFACTURE OF A MELT-FLOW INDEXER (U18-127)

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### ABSTRACT

The aim of this work is to design and manufacture an easy to use melt flow index device to measure the single point melt viscosity of the thermoplastic polymers at a particular intermediate shear rate and temperature. Such a domesticly buit-in instrument will have low manufacturing cost so that it can be readily available for use in plastic processing facilities and laboratories at an affordable price. Melt flow index device is a quick and simple tool that can be used to compare various thermoplastic polymers according to their flow properties in shaping processes like extrusion and injection molding. Thus it represents a typical index which is commonly used for quality control of thermoplastics mainly polyethylene (PE) and polypropylene (PP). It is generally defined as the weight of the polymer extruded in ten minutes (g / 10 min) through a capillary die under pressure applied by dead weight. During the design stage of this work, we tried to ensure that the capillary die and piston are readily removable from the assembly so that cleaning after different polymer runs can be easily performed. Device calibration runs is performed by the commercially available HDPE Marlex 50100, Marlex 5502 BN and Sabic 5823 grades whose MFI values are well-established.

**Keywords:** Melt-flow Indexer (MFI), Melt Viscosity, Polymer Processing

# PREDICTION OF TENSILE MECHANICAL PROPERTIES OF TIN- BISMUTH ALLOYS BY VICKERS HARDNESS TEST (U18-128)

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**ABSTRACT**
Determination of static mechanical properties of alloys; such as yield strength and UTS, by simple hardness test is a popular research field because of ease of application, ability to determine local properties, lower cost of equipment. In this study, empirical correlations between mechanical properties of Sn-Bi alloys and their Vickers hardness values are derived by applying linear regression analysis on hardness and strain rate controlled tensile test results. For this, the amount of soft pro-eutectic phase is varied by casting alloys with 30%, 40%, 50% Bi up to eutectic composition (57%Bi). The results indicate very good linear correlations between the Vickers hardness and yield strength, UTS and strength coefficient. However, statistically meaningful correlation could not be established between the hardness and the strain hardening exponent.

**Keywords:** Vickers hardness, tensile strength, strain hardening exponent, Tin, Bismuth, Sn-Bi alloy

# TÜRKÇE BİLDİRİLER

# (İngilizce Özetler)

# PAPERS IN TURKISH

# (with English Abstracts)

# JANT ÜRETİMİ TALAŞLI İMALAT PROSESİNDE PARAMETRİK PROGRAMLAMA (U18-19)

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## ÖZET

Bireysel taşıt kullanıcıları için jantlar sadece emniyet parçası değil aynı zamanda estetik bir niteliğe de sahiptir. Bu nedenle özellikle son yıllarda jantların görünen (stil) yüzeyleri daha ince federler ve geometrik olarak üretilebilirliği daha hassas tasarımlara sahip olmaktadır. Gerçekleştirilen tasarımların kompleksliğinin artması nedeniyle talaşlı imalat süreçlerine yönelik proses çalışmaları da artmaktadır. Gerçekleştirilen bu çalışma; alçak basınç döküm yöntemi ile üretilen alüminyum alaşımlı jantların ön yüzey geometrilerinde üretim kaynaklı nedenlerden dolayı oluşan şekilsel deformasyonları, nihai ürün üretim toleransları içinde kalacak şekilde talaşlı imalat sürecinde kompanze edebilecek yeni bir takım yolunun işlenen her bir janta özgü otomatik olarak oluşturulabilmesini esas almaktadır. Böylece jant üretiminde talaşlı imalat süreçlerinden kaynaklanan fireler azaltılmaktadır.

**Anahtar Kelimeler:** Talaşlı imalat proses iyileştirme, Üretim verimliliği, Fire azaltma, Süreç iyileştirme

## PARAMETRIC PROGRAMMING OF METAL CUTTING PROCESSES IN RIMS PRODUCTION

**ABSTRACT**

Wheels are not only a safety feature but also an aesthetic quality for individual vehicle users. For this reason, the visible surfaces of wheels have more critical designs that are finer feders and geometrically producible especially in recent years. Process works for machining processes are also increasing, due to the increase in the complexity of the final product designs. This study is based on the fact that a new tool path which can compensate for the geometrical deformations caused by production-related reasons in style surface geometries of aluminum alloy wheels produced by low pressure die casting method can be automatically generated in the final product production tolerances for each wheel processed. Thus the amount of wastage resulting from machining processes in wheel manufacturing is reduced.

**Keywords:** Machining process improvement, Production efficiency, Wastage reduction, Process improvement

## GH4169 SÜPERALAŞIMININ YÜKSEK HIZLI İŞLEMEDE TESTERE DİŞİ TALAŞ OLUŞUMUNUN SAYISAL SİMÜLASYONU (U18-2)

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**ÖZET**

Bu çalışmada, GH4169 süper alaşımının testere dişi talaş oluşumu mekanizması simülasyonunu yapmak için iki boyutlu dik kesme sonlu elemanlar modeli kurulmuştur. Sonlu elemanlar yöntemi yazılımı ABAQUS/Explicit kullanılarak yüksek hızlı işleme süreci incelenmiştir. İlk olarak talaş morfolojisi ele alınmış ve daha sonra sırasıyla talaşta oluşan efektif plastik gerinim, gerilme dağılımı, sıcaklık alanı ve kesme kuvveti eğrisi analiz edilmiştir. Sonuçlar, GH4169 süper alaşımını yüksek hızlı işlemede testere dişi talaş oluşumu mekanizmasının adyabatik kaymaya dayalı olduğunu göstermiştir.

**Anahtar Kelimeler:** Sonlu elemanlar yöntemi, GH4169 süper alaşımı, yüksek hızlı işleme, testere dişi talaş

**NUMERICAL SIMULATION OF SERRATED CHIP FORMATION IN HIGH SPEED MACHINING OF SUPERALLOY GH4169**

**ABSTRACT**

In this paper, two-dimensional orthogonal cutting finite element model was constructed to simulate the serrated chip formation mechanism of superalloy GH4169. The high speed machining process was studied using the finite element method software ABAQUS/Explicit. The chip morphology was firstly considered, and then the effective plastic strain, the stress distribution, the temperature field in the chip and the cutting force curve were analyzed. The results showed that the serrated chip formation mechanism was based on the adiabatic shearing in high speed machining of superalloy GH4169.

**Keywords:** Finite element method, GH4169 superalloy, high speed machining, serrated chip

## CFRP/AL İSTİFLİ YAPININ GELENEKSEL MATKAPLARLA DELİNEBİLİRLİĞİ (U18-23)

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**ÖZET**

Bu çalışmada, CFRP/Al7075 istifli yapının farklı matkap kaplama türleri ve farklı delme yöntemleri ile işlenmesinde kaplama türleri ve delme yöntemlerinin karşılaştırılması amaçlanmıştır. Bu bağlamda kuru kesme şartlarında 50m/dk sabit kesme hızı ve 0.05mm/dev sabit ilerleme değerinde, üç farklı kaplama türü (TiAlN kaplamalı karbür, elmas kaplamalı karbür, kaplamasız karbür) ve üç farklı delme metodu (doğrudan delme, talaş boşaltarak delme, gagalama) kullanılmıştır. Kaplama türüne ve delme metotlarına göre takımlar karşılaştırılmıştır. Özellikle CFRP delik girişlerinde oluşan kusurlar, kuvvet değerleri, takımlardaki aşınmalar ve talaş yapıları incelenmiştir. Sonuç olarak CFRP/Al7075 istifli yapının kaplamasız karbür takım ile doğrudan delme yönteminde daha iyi sonuçlar verdiği gözlenmiştir.

**Anahtar Kelimeler:** Karbon Fiber, CFRP/Al istifli delme, delaminasyon

## MACHINABILITY OF CFRP/AL STACKED MATERIAL WITH CONVENTIONAL DRILLS

**ABSTRACT**

In this study, it is aimed to determine the most suitable coating type and drilling method when CFRP/Al7075 stacked is processed with different types of drilling and different drilling methods. The stacked material was processed without using a cutting fluid at a cutting speed of 50m/min and feed rate of 0.05mm/rev. Three different coatings (TiAlN and diamond coated wolfram carbide (WC) and uncoated WC) and three different drilling methods (direct, evacuation and pecking) was used. The sets were compared in terms of the coating types and drilling methods. Especially delaminations at the CFRP hole entry, tool wear, formation chip formation and cutting forces were observed. In conclusion, it was found that the direct drilling with uncoated carbide tools gave better results in stacked drilling of CFRP/Al7075 in comparison to those obtained with other tools and using other methods.

**Keywords:** CFRP, CFRP-Al stacked drilling, Delamination

**DÖVME ÇELİK PİSTONLARIN İŞLENMESİ İÇİN SÜREÇ GELİŞTİRİLMESİ (U18-26)**

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**ÖZET**

Son yıllarda alüminyum pistonlara alternatif olan dövme çelik piston üretimi ve üretim süreçlerinin geliştirilmesi bir gereksinim haline gelmiştir. Çelik pistonların üretimi dövme, hassas döküm, sürtünme kaynağı ve talaşlı imalat yöntemleri kullanılarak yapılmaktadır. Bu çalışmada yeni bir tornalama işlem planlama metodolojisi dövme çelik piston için uygulanmıştır. Çelik piston üretim süreçleri tek tek ele alınarak geliştirilmesi ve her bir sürecin optimizasyonu yapılmıştır. Yapılan deneysel çalışma sonrasında 4140 malzeme için ikinci dereceden takım ömür denklemi elde edilmiş ve üretim zamanının minimizasyonu düşünülerek süreç parametrelerinin optimizasyonu gerçekleştirilmiştir. Mevcut üretim süreçleri ile optimize edilen yeni üretim süreçlerinin karşılaştırması yapılarak sonuçlar değerlendirilmiştir.

**Anahtar Kelimeler:** Dövme Çelik Piston, Piston Talaşlı İmalat Süreci, Kesme Parametreleri Optimizasyonu

## PROCESS DEVELOPMENT FOR MACHINING FORGED STEEL PISTONS

**ABSTRACT**

Being an alternative to aluminum pistons, the manufacturing of forged steel pistons and improvement of manufacture processes has become a necessity. The manufacturing of steel pistons are carried out using the methods forging, precision-casting, friction welding and machining. In this study, a new process planning methodology is implemented for turning forged steel pistons. Steel piston manufacturing processes are treated one by one and each process is improved and optimized. An experimental study is performed to find the relationship between the cutting parameters and the tool-life for C4140 material that pistons are made from. A second-degree equation for tool-life is obtained based on the experimental results. Process parameters are then optimized to minimize the unit production time. Optimized results are compared against the existing conditions to show how much improvement is obtained.

**Keywords:** Forged Steel Piston, Process Improvement, Steel Piston Machining Process, Cutting Parameters Optimization

## ŞEKİL HAFIZALI POLİÜRETANIN ENJEKSİYONLA KALIPLANMASINDA EKSİK BASKI (U18-50)

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**ÖZET**

Şekil hafızalı polimerler (ŞHP) iki veya daha fazla şeklin aynı parça üzerinde depolanabildiği ve bir uyarıcı (sıcaklık, nem, elektrik akımı, pH vb.) vasıtasıyla parçanın sahip olduğu şekiller arasında form değiştirebilmesine imkân veren malzemelerdir. Bu tip malzemelerden üretilen parçaların genellikle bir kalıcı şekli ve bir veya birden çok geçici şekli olabilmektedir. Şekil hafızalı parçaların kalıcı şekli genellikle kalıplama yöntemleriyle verilmektedir. Bu da kalıplama yöntemlerinin parçaların kalıcı şekli üzerindeki etkilerini önemli kılmaktadır. Bu çalışmada sıcaklık duyarlı şekil hafızalı termoplastik poliüretanın (ŞHPU) enjeksiyonla kalıplanmasında gerçekleşen eksik baskılara kalıplama şartlarının etkileri incelenmiştir. Enjeksiyonla kalıplama süreci altı farklı enjeksiyon kalıplama parametresiyle irdelenmiştir. Kalıplama sonucunda eksik dolan numuneler “1”, tam dolan numuneler “2” grubunda sınıflandırılmıştır. Sonuçlar enjeksiyonla kalıplanmış ŞHPU numunelerdeki eksik baskı üzerinde en etkili parametrenin enjeksiyon sıcaklığı olduğunu ve bunu enjeksiyon basıncının takip ettiğini göstermiştir. Yüksek enjeksiyon sıcaklığında numuneler tam dolarken enjeksiyon sıcaklığı düştükçe eksik baskılar oluşmuştur. Orta ve yüksek enjeksiyon basınçlarının etkisi neredeyse aynı olurken düşük enjeksiyon basıncı eksik baskıya neden olmuştur.

**Anahtar Kelimeler:** Şekil hafızalı poliüretan, kalıcı şekil, enjeksiyon kalıplama, eksik baskı, enjeksiyon sıcaklığı, enjeksiyon basıncı

# SHORT SHOT IN INJECTION MOLDING OF SHAPE MEMORY POLYURETHANE PARTS

## ABSTRACT

In this study, the effects of molding conditions on short shot of a temperature sensitive thermoplastic shape memory polyurethane (SMPU) (Diaplex MM 4520 (Ether type)) during injection molding were investigated. Some properties of SMPU are glass transition temperature (Tg): 45°C, melt flow index (MFI): 48 g/10min, tensile strength at glassy phase: 55 MPa and at rubbery phase: 10 MPa, density: 1,25 g/cm3. Injection molding process was examined with six different molding parameters. These are injection (500-600-700 bar) and packing (%40-%50-%60 of the injection pressure) pressures, melt (195-200-205°C nozzle temperature) and mold (30-40-45°C) temperatures, packing (6-9-12s) and cooling (15-22,5-30s) times. Taguchi's orthogonal design table was applied as the table of design of experiment.

The specimens were molded in a shape circular tensile test bar as a special formed. At the end of molding process, the specimens have short shot were classified as "1" and the specimens have full shot were classified as "2". The obtained data were processed by analysis of variance (ANOVA) (α = 0,05) via the SN Ratio (Signal/Noise Ratio) of the Taguchi test design evaluation criterion. SN ratio was calculated by the formulation "larger is better". The results show that the most effective parameter on the short shot of molded SHPU samples was the melt temperature, followed by the injection pressure. The packing time (p = 0,07) was also found to be significant at α = 0,1 significance level. At higher injection temperatures, the specimens were fully filled but when the injection temperature decreased, short shots occurred. While the effect of medium and high injection pressures was almost the same, the lower injection pressure caused the short shot. The specimens were fully filled at the long packing time. Full filling of the specimens was observed at the higher levels of mold temperature and packing pressure, although they were found to be insignificant as a result of the ANOVA. No significant difference was observed between the levels of cooling time.

**Keywords:** Shape memory polyurethane, permanent shape, injection molding, short shot, melt temperature, injection pressure

**TOKLUĞU YÜKSEK WC-Co T KANAL ÇAKININ PERFORMANS ARAŞTIRMASI (U18-120)**

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**ÖZET**

Bu çalışmada, Toz Enjeksiyon Kalıplama ile üretilen tokluğu yüksek WC-Co T kanal çakının talaş kaldırma performansı araştırılmıştır. Deneyler, 0,01-0,025 mm/diş ilerleme, 200-300-400 m/dak kesme hızların da ve Al 7075 T6 malzemesi üzerinde yapılmıştır. İlerleme ve kesme hızına bağlı olarak ölçülen kesme kuvvetleri ve yüzey pürüzlülük değerleri yekpare karbür T çakı sonuçları ile karşılaştırılmıştır. Çalışmada her iki takım incelendiğinde dişlerde kırık, birleşme bölgesinde ayrılma veya herhangi bir sorun olmadığı, ilerleme değeri arttıkça yüzey pürüzlülük değerinin her ikisinde de yükseldiği belirlenmiştir. Kesme kuvvetleri ve yüzey pürüzlülüğü bakımından takımlar karşılaştırıldığında yekpare karbür takıma göre yeni geliştirilen takımla, kesme kuvvetlerinin ortalama % 25,69 ve yüzey pürüzlülüğünün % 5 daha düşük çıktığı tespit edilmiştir.

**Anahtar Kelimeler:** WC-Co kesici takım, Toz enjeksiyon kalıplama, T kanal çakı, Al 7075

# THE PERFORMANCE INVESTIGATION OF HIGH TOUGHNESS WC-Co T CUTTING TOOL

## ABSTRACT

In this study, cutting performance of the high toughness WC-Co T cutting tool produced by Powder Injection Molding was investigated. The experiments were carried out with 0,01-0,025 mm/tooth feed rates and 200-300-400 m/min cutting speeds on Al 7075 T6 material. Measured values of cutting forces and surface roughness depends on feed rate and cutting speed were compared with results of solid carbide T cutting tool. They were determined that teeth were no broken, there was no separation in joining area or there was no any problem when both cutting tools were examined, and value of surface roughness increased as feed rate increased. Compared T cutting tools in terms of cutting forces and surface roughness, they were found that obtained 25.69 % lower cutting forces and 5 % lower surface roughness on average by the newly developed T cutting tool according to the solid carbide T cutting tool.

**Keywords:** WC-Co cutting tool, Powder Injection moulding, T channel tool , Al 7075

**KAYNAK HÜCRELERİNDE ENDÜSTRİ 4.0 UYGULAMALARI (U18-66)**

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**ÖZET**

Endüstri 4.0 devrimi, özellikle son yıllarda popülerliğini giderek arttırmaktadır. Endüstri 4.0 kapsamında birçok endüstriyel donanım üzerinde çalışılmış, endüstriyel ekipmanların çoğunun süreç bilgileri sayısallaştırılmış ve merkezi bir sunucuya aktarılmıştır. Bu endüstriyel donanımlar takım tezgâhları, endüstriyel robotlar ve presler, bükme veya kesme makinelerini içerir, ancak bunlarla sınırlı değildir. Çalışmamızda, özellikle nadiren çalışılmış bir alan olan kaynak makinelerine odaklandık. Bu çalışma, bir test düzeneği üzerinde gerçekleştirilmiştir. Test düzeneği, bir kaynak makinesi, bir operatör, bir kaynak parametre sensör grubu, bir operatör izleme ve veri girişi yazılımı ve bir merkezi sunucudan oluşur. Test düzeneği vasıtasıyla kaynak parametreleri algılanır, toplanır ve gerçek zamanlı olarak işlenir ve bilgi sunucusuna aktarılır. Toplanan parametreler kaynak akımı, kaynak gerilimi ve tel besleme hızıdır. Amaç OEE'yi (Genel Ekipman Verimliliği) belirlemek ve kaynak parametrelerini takip etmektir. Sistem kaynak parametrelerini takip ederek kaynak kalitesi ile ilgili uyarılarda bulunmaktadır. Çalışmada ayrıca kestirimci bakım çalışmaları için bir altyapı oluşturulması amaçlamaktadır.

**Anahtar Kelimeler:** Endüstri 4.0, Gazaltı Kaynak, Kestirimci Bakım

## INDUSTRY 4.0 APPLICATIONS AT WELDING CELLS

**ABSTRACT**

Industry 4.0 revolution have been increasing its popularity in recent years. Within the scope of Industry 4.0, many industrial equipment have been studied, the process information of majority of industrial equipment have been digitized and transferred to an information server. These industrial equipment include but not limited with machine tools, industrial robots, and presses, bending or cutting machines. In our study we especially focused on welding machines, as a rarely discussed case. In this research, a test layout have been implemented. Using the test layout, the welding data are sensed, aggregated and processed in real-time and transferred to the information server. The test system consists of a welding process sensor, an operator dashboard software and an information server. The parameters that it collects are welding current, welding voltage and wire feed speed. The aim is to determine the OEE (Overall Equipment Efficiency) and follow-up the process parameters. The study also aim to build an infrastructure for predictive maintenance studies.

**Keywords:** Industry 4.0, Predictive Maintenance, Arc Welding

## TAŞIT ELEMANLARININ OPTİMUM YAPISAL MODELİNİN BELİRLENMESİ (U18-53)

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**ÖZET**

Günümüzde rekabet şartlarının gitgide zorlaşması, yakıt emisyonlarının azaltılması yönünde firmalara gelen yoğun baskılar yeni yaklaşımların geliştirilmesini ve kullanılmasını zorunluluk haline getirmiştir. Yapısal optimizasyon yöntemleri özellikle topoloji optimizasyon yaklaşımı bu bağlamda en yaygın kullanılan yöntemlerden birisidir. Bu çalışmada özellikle ticari araçların sürgülü kapılarının açma-kapama sırasında kızak üzerinde belirlenen bir eksende kaymasını sağlayan taşıt sürgü kolunun optimum yapısal modelinin belirlenmesi çalışması yapılmıştır. Taşıt sürgü kolunun optimum yapısal modelinin belirlenmesi için topoloji optimizasyonu yaklaşımı kullanılmıştır.

**Anahtar Kelimeler:** Taşıt sürgü kolu, Yapısal optimizasyon, Bilgisayar destekli tasarım

# DETERMINATION OF OPTIMUM STRUCTURAL MODEL OF VEHICLE ELEMENTS

## ABSTRACT

Today, competitive pressures are becoming increasingly difficult and the intense pressure from the firm to reduce fuel emissions has made it necessary to develop and use new approaches. Structural optimization methods, especially topology optimization approach, are one of the most widely used methods in this context. In this study, a study was made to determine the optimum structural model of the vehicle slider arm, which provides sliding of the sliding doors of commercial vehicles on a specified axis on the slide. A topology optimization approach has been used to determine the optimum structural model of the vehicle slider arm.

**Keywords:** Computer aided design, Structural optimization, Vehicle components

# YENİ NESİL YÜKSEK MUKAVEMETLİ ÇELİKLER İLE ÇARPIŞMA PERFORMANSI YÜKSEK TAŞIT TAMPON VE DARBE EMİCİ GELİŞTİRİLMESİ (U18-56)

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**ÖZET**

Rekabet şartlarının çok fazla artması nedeniyle otomotiv endüstrisi karayolu taşıtlarının güvenliğini artırırken eş zamanlı olarak araç hafifletme çalışmalarına da odaklanmak zorunda kalmıştır. Bu bağlamda taşıt güvenlik sistemlerinin geleneksel malzemeler yerine yeni geliştirilen malzemeler kullanılarak tasarlanması en güncel araştırma konularından birisidir. Yeni nesil yüksek mukavemetli çelikler yapısal özellikleri nedeniyle taşıt güvenliğinin arttırılmasını sağlamak yanında taşıtın hafifletilmesine de çok önemli katkıda bulunmaktadır. Bu çalışma kapsamında, taşıtlarda pasif güvenlik sistemi olarak kullanılan ve yeni geliştirilen bir tampon ve darbe sönümleyiciden oluşa ön gövde sisteminin yeni nesil çelikler kullanılarak çarpışma analizleri yapılmıştır.

**Anahtar Kelimeler:** Çarpışma analizi, Tampon, Enerji yutucu, Yüksek mukavemetli yeni nesil çelikler

## DEVELOPMENT OF VEHICLE BUMPER BEAM AND ENERGY ABSORBERS USING NEW GENERATION HIGH STRENGTH MATERIALS

**ABSTRACT**

In recent years, there have been lots of studies in automotive industry to improve safety (crash) and fuel economy of vehicles. Advanced high-strength steels (AHSS) are new generation steels that provide extremely high strength for crash safety. Also, AHSS contribute to produce lightweight cars with their characteristic of usability with thinner sheet thickness than conventional steels. In this study, crash box and bumper beam used as passive safety systems in vehicles were analyzed numerically by using conventional and new generation steels. As a result of the analysis, crash performance parameters such as energy absorption and reaction forces were compared for different materials.

**Keywords:** Crash analysis, Crash box, Advanced high-strength steels

# TERMOPLASTİK ÇARPIŞMA KUTULARINDA ALÜMİNYUM KÖPÜK TAKVİYESİNİN ÇARPIŞMA KARAKTERİSTİĞİNE ETKİSİ (U18-79)

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## ÖZET

Çarpışma kutuları, araçların pasif güvenlik sistemi bünyesinde, çarpışma enerjisini emmekte kullanılan önemli elemanlardır. Bu elemanlar, otomotiv endüstrisinde genellikle çelik veya alüminyumdan oluşan ince cidarlı boş kutular olarak karşımıza çıkmaktadır. Bu çalışmada, farklı olarak, termoplastik (poliamid karışımı) çarpışma kutularının çarpışma performansı değerlendirilmiş ve alüminyum köpük takviyesinin, çarpışma performansına etkisi, deneysel düşürme testleriyle araştırılmıştır. Düşürme testleri sonucunda, alüminyum köpük takviyesinin, ortalama çarpışma kuvvetini ve çarpışma kuvveti verimliliğini artırdığı görülmüştür. Ayrıca, toplam deplasman daha düşük olmasına rağmen, emilen enerji miktarı yaklaşık %27 artmıştır.

**Anahtar Kelimeler:** alüminyum köpük, çarpışma kutusu, termoplastik, çarpışma performansı

# THE EFFECT OF ALUMINIUM FOAM REINFORCEMENT ON CRASHWORTHINESS OF THERMOPLASTIC CRASH-BOXES

## ABSTRACT

Crash-boxes are vital components of the passive safety in vehicles to absorb the crash energy. These components are usually thin walled boxes made of steel or aluminium. Distinctively in this study, crash performance of thermoplastic (polyamide blend) crash-boxes and the effect of reinforcement of these boxes with aluminium foam were investigated by experimental drop tests. It was observed that aluminium foam reinforcement provided a higher mean load and a higher crash force efficiency. Also, despite a lower total displacement, the absorbed energy increased by nearly 27%.

**Keywords:** aluminium foam, crash-box, thermoplastic, crash performance

# YOL DIŞI (OFF-ROAD) ARAÇ İÇİN ÇİFT ENİNE YÖN VERİCİLİ BAĞIMSIZ ASKI SİSTEMİNİN TASARIMI VE ANALİZİ (U18-99)

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## ÖZET

Off road araçların akslarında büyük çoğunlukla rijit akslar kullanılmaktadır. Bu çalışma ile daha iyi bir yol tutuş performansı ve konfor için rijit aks yerine yapılan bağımsız askı sistemi tasarımı, askı sistemi noktalarının kinematik analizi ve askı sisteminin parçaları için statik analizleri sunulmaktadır. Çift enine yön vericili askı sistemi Catia® programında tasarlanmış ve kinematik analizi MSC AdamsTM programıyla yapılmıştır. Gerilme analizi, ana süspansiyon bileşenleri için Ansys Workbench®'de sonlu elemanlar yöntemiyle statik olarak gerçekleştirilmiştir. Sonuçlar tasarımın, hem dikey hareket, hem de teker hareketleri için iyi bir kinematik karakteristiğe sahip olduğunu ve sisteminin gerilme sonuçları, aracın çeşitli yol durumları için uygun olduğunu göstermektedir.

**Anahtar Kelimeler:** Yol Dışı (off-road) araç, ön süspansiyon sistemi, kinematik analiz

# DESIGN AND ANALYSIS OF DOUBLE WISHBONE FRONT SUSPENSION SYSTEM FOR AN OFF-ROAD VEHICLE

## ABSTRACT

Off-road vehicles are mostly equipped with solid axles. This study presents design of independent suspension instead of solid axle for better handling and comfort, kinematic analysis of suspension geometry and static analysis for parts of suspension. Double wishbone suspension system is designed by Catia® and kinematic analysis are performed in MSC AdamsTM. Stress analysis are carried out by statically with finite element method in Ansys Workbench® for the main suspension components. The results show that good kinematic characteristics for both vertical movement and turning of the tire. Stress values of suspension components can be defined as proper for the various road conditions of the vehicle.

**Keywords:** Off-road vehicle, front suspension, kinematic analysis

# DÜŞÜK YOĞUNLUKLU HAFİF AZ91 MG ALAŞIMININ AŞINMA DAVRANIŞININ ETİAL 150 AL ALAŞIMI VE FR-4 CAM TAKVİYELİ EPOKSİ KOMPOZİTİ İLE DENEYSEL KARŞILAŞTIRILMASI (U18-27)

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**ÖZET**

Havacılık ve otomotiv endüstrilerinde, ağırlık ve gaz emisyonunu düşürmek için hafif ve özgül dayanıma sahip malzemelerin kullanılma eğilimi giderek artmaktadır. Çalışmada, bu sektörlerde kullanılan hafif AZ91 Magnezyum (Mg) alaşımı, Etial-150 Alüminyum (Al) alaşımı ve FR-4 cam takviyeli polimer matrisli epoksi kompozitinin (FR-4 CTPE) tribolojik özellikleri ileri-geri aşınma testi ile belirlenmiştir. Aşınma deneyleri, kuru kayma ve oda sıcaklığı şartlarında 60 HRC sertliğindeki AISI 52100 çelik bilyaya karşı, farklı sürtünme yükleri (10 N, 20 N ve 30 N), farklı kayma hızları (0.1 m/s, 0.4 m/s ve 0.75 m/s) ve farklı kayma mesafeleri (500 m, 1000 m ve 2000 m) ile gerçekleştirilmiştir. Aşınma deneyleri sonrası, sürtünme katsayısı ve aşınma iz alanları (kütle kaybı) belirlenmiş ve ayrıca oluşan aşınma mekanizmalarının nitelendirilmesi için aşınmış yüzeylerde optik mikroskop analizleri yapılmıştır. Sonuç olarak, Etial-150 Al alaşımının, FR-4 CTPE ve AZ91 Mg malzemelerine göre daha fazla aşındığı ve FR-4 CTPE kompozitinin en iyi sürtünme katsayısına ve aşınma dayanımına sahip olduğu görülmüştür. Ayrıca, yüksek kayma hızı ve sürtünme yükü altında uzun süreli kayma durumunda, Etial-150 Al alaşımında en fazla kütle kaybı ile birlikte yorulma çatlağının meydana geldiği, daha çok adhezyon aşınma mekanizmasının etkili olduğu deneysel olarak belirlenmiştir. AZ91 Mg alaşımının Etial-150 Al alaşımına göre daha iyi tribolojik davranışa sahip olduğu ve ayrıca AZ91 Mg malzemesinde oluşan MgO tabakasının, tribolojik davranışa olumlu yönde etki ettiği ve MgO' lu AZ91 Mg alaşımının FR-4 epoksi kompozitine yakın tribolojik davranış sergilediği sonucuna varılmıştır.

**Anahtar Kelimeler:** AZ91 Mg Alaşımı, Etial 150 Al Alaşımı, FR-4 CTPE, Triboloji

# EXPERIMENTAL COMPARING THE WEAR BEHAVIOUR OF LIGHTWEIGHT AZ91 MAGNESIUM ALLOY WITH ETIAL 150 ALUMINIUM ALLOY AND FR-4 COMPOSITE

## ABSTRACT

The tendency to use materials with low-weight and specific strength in used aircraft and automotive industries is increasing to decrease their weights and gas emission. The tribological properties of lightweight AZ91 magnesium (Mg) alloy, Etial-150 aluminum (Al) alloy, FR-4 glass-fiber reinforced polymer based epoxy composite (FR-4 GRPC) used in these sectors automotive were determined by reciprocating wear test in this study. Wear experiments were performed at conditions of different friction loads (10 N, 20N and 30N), different sliding velocities (0.1 m/s, 0.4 m/s and 0.75 m/s), different sliding distances (500 m, 1000 m and 2000 m) against the hardened (60 HRC) AISI 52100 steel ball, dry sliding and room temperature. After doing wear experiments, friction coefficient and wear track areas (mass lose) were obtained, in addition, the optical surface analyses were performed to characterize wear mechanism on worn surfaces. As a result, Etial-150 Al alloy worn higher than FR-4 GRPC and AZ91 Mg alloy, and also FR-4 GRPC composite showed the best wear resistance and friction coefficient. Furthermore, the highest wear mass losses together with fatigue crack were experimentally identified at Etial-150 aluminum alloy in case of long sliding term with high friction load and sliding velocity. In addition, it was concluded that the adhesion wear mechanism was more effective at Etial-150 material. It was determined by experiments that MgO layer improved tribological behaviour of AZ91 Mg alloy. Besides, MgO layered AZ91 Mg alloy showed similar tribological characteristic with FR-4 GRPC composite.

**Keywords:** AZ91 Mg Alloy, Etial 150 Al Alloy, FR-4 GRPC Composite, Tribology.

**KOMPOZİT SARGILI BASINÇLI KAPLARDA ÇATLAK ANALİZİ (U18-86)**

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**ÖZET**

Bu çalışmada, uzay alanında uydu itki sisteminde kullanılacak olan metal nüveli (liner) ve kompozit sarımlı basınçlı bir yakıt tankının çatlak oluşumu ve gelişimi ANSYS sonlu elemanlar analiz yazılımı kullanılarak analiz edilmiştir. Yapılan sonlu elemanlar analizlerinde, astarda ve kompozit gövdede oluşabilecek çatlak senaryolarına göre analizler gerçekleştirilmiş ve sayısal sonuçlar elde edilmiştir. Kompozit yapıda oluşabilecek hasarı belirlemek için yaygın olarak kullanılan Tsai-Hill, Tsai-Wu ve Hashin teorileri dikkate alınmıştır.

**Anahtar Kelimeler:** Filaman sarım, Kompozit malzeme, Basınçlı tank, Çatlak analizi, Hasar analizi

## CRACK ANALYSIS FOR COMPOSITE WOUND PRESSURE VESSELS

**ABSTRACT**

In this study, the crack formation and development of a metal core (liner) and a composite wound pressurized fuel tank to be used in the satellite propulsion system in space are analyzed using ANSYS finite element analysis software. Finite Element analyzes were performed according to the crack scenarios that could occur in the liner and composite body. The Tsai-Hill, Tsai-Wu and Hashin theories, which are widely used to determine the damage that can occur in a composite structure, are taken into account.

**Keywords:** Filament wound, Composite material, pressurized tank, Crack analysis, Damage analysis.

# KESİM KONTROLÜ YAPABİLEN, YÜKSEK PROSES HIZINA SAHİP GELİŞMİŞ LAZERLİ SAÇ KESİM KESİM TEZGAHININ TASARIMI (U18-21)

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**ÖZET**

Gelişen süreçte pek çok farklı sektörde kullanılan lazer kesim tezgahlarında hız, ivmelenme ve kesme hassasiyeti önemli parametreler olarak karşımıza çıkmaktadır. Tasarımı yapılan ileri teknolojiye sahip daha kompakt yapıdaki yeni nesil lazer kesim tezgahı ile birlikte yüksek hassasiyetli, daha hızlı kesimler mümkün olabilecektir. Kesilecek malzemenin sabit kaldığı kesme kafasının hareketli olduğu uçan optik işleme tezgahından oluşan fiber lazer kesim makinesi tasarımı esnasında yüksek hız ve ivmelere sahip olabilmek için yapılan geliştirmeler, mühendislik hesaplamaları ve analizler bu bildirinin konusudur.

**Anahtar Kelimeler:** Fiber Lazer Kesim, Yüksek Hız, Hassasiyet, Tasarım

**DESIGN OF A HIGH SPEED LASER CUTTING MACHINE**

**ABSTRACT**

The widespread use of laser cutting machines in different sectors and their continuous development define the cutting precision, speed and acceleration as the most critical parameters of the development process. With the newly designed next generation compact cutting table it will be possible to perform more precise and faster cutting operations. Improvements, engineering calculations and analyzes realized in order to achieve high speeds and accelerations, throughout the design study of the fiber laser cutting machine, consisting of a flying optical cutting table in which the material is fixed and the cutting head is moving, is the subject of this paper.

**Keywords:** Fiber Laser Cutting, High Speed, Precision, Design

## LAZER KESİM TEZGÂHI İÇİN KOMPOZİT Y-EKSEN KÖPRÜ İMALATI (U18-30)

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**ÖZET**

Bu çalışmada yassı sacların istenilen şekillere göre ve yüksek hassasiyette kesilmesine imkân veren fiber lazer kesim makinesinin bir bileşeni olan Y-eksen köprüsünün kompozit malzemeden üretilmesi sürecindeki nümerik analizler, tasarım adımları ve üretimi için yapılan faaliyetler sunulmuştur. Mevcut lazer kesim makinelerinde kullanılan Y-eksene göre ağırlık azaltılması için yapılan çalışmalara yer verilmiştir. Bilgisayar destekli tasarım ve analizler, kompozit köprünün hareket analizleri yapılıp mevcut durumla performans testleri karşılaştırılmıştır. Yapılan çalışmanın sonucunda fiber lazer kesim tezgâhındaki Y-eksen köprüsünün ham kütlesinin 240 kg' dan 84 kg' a, Y-eksenin köprüsünün toplam kütlesinin ise 440 kg' dan 280 kg' a düşürülebildiği görülmüştür.

**Anahtar Kelimeler:** Lazer kesim makinesi, kompozit köprü, Y-eksen.

# MANUFACTURING OF THE Y-AXIS BRIDGE OF LASER CUTTING MACHINES FROM COMPOSITE MATERIAL

## ABSTRACT

In this study, numerical analysis, design steps, production process of Y-axis bridge from composite material is presented, which is a part of laser cutting machine that enables cutting sheet metals at high sensitivity and desirable shapes. Studies to reduce weight on current laser machines with respect to Y-axis are covered. Computer aided design and analysis, composite bodies movement analysis were carried out and compared with current situation. As a conclusion it was seen that the gross weight of Y-axis bodies on a fiber laser cutting machine could be reduced from 240 kg to 84 kg. Similarly Y-axis total weight could be reduced from 440 kg to 280 kg.

**Keywords:** Laser cutting machine, composite bridge, Y-axis.

# ENDÜSTRİYEL FİBER LAZER MAKİNESİNDE KÖPRÜ TASARIMI VE OPTİMİZASYONU (U18-72)

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## ÖZET

İlerleyen dijitalleşmeyle beraber bilgisayar programlarının kapsadığı mühendislik desteği alanı da artmaktadır. Yapısal tasarımda istenilen mukavemet ve rijitlik değerlerini elde edebilmek için hesaplanması gereken gerilme, uzama değerleri, dayanım ve rijitlik değerlerinde düşüş olmadan kütle azaltma gibi bir çok parametreye bilgisayar destekli mühendislik programlarıyla yaklaşım yapılabilmektedir. Bu çalışmada fiber lazer makinesinin köprü olarak adlandırılan üç eksende hareket eden yapının, çalışma koşulları altındaki gerilme ve uzamaların sonlu elemanlar programı ile tespit edilmesi, topolojik optimizasyon ile kütle azaltılarak, rijitliğin artırılması amaçlanmıştır. Topolojik optimizasyon sonrası tasarımlar karşılaştırılmış, sonuçlarda iyileşme gözlemlenmiştir.

**Anahtar Kelimeler:** Topolojik optimizasyon, Yapısal tasarım

**MANIPULATOR DESIGN AND OPTIMIZATION IN INDUSTRIAL FIBER LASER MACHINE**

**ABSTRACT**

Along with the progressive digitalization, the field of engineering support covered by computer programs is also increasing. In order to obtain the desired strength and stiffness values in the structural design, many parameters such as stress, elongation values, mass and stiffness without decreasing the values of stiffness and stiffness can be approximated by computer aided engineering programs. In this study, it is aimed to increase the rigidity of the fiber laser machine by means of topological optimization and to reduce the mass by determining the stresses and extensions under the working conditions by using the finite element program. After topological optimization, designs were compared and improvement was observed in the results.

**Keywords:** Topological optimization, Structural design

# ABSTRACTS

# OF

# MINI SYMPOSIUM ON SURFACE INTEGRITY IN CONVENTIONAL AND NONCONVENTIONAL MANUFACTURING PROCESSES

# EFFECT OF MACHINING PARAMETERS ON WORKPIECE SURFACE CHARACTERISTICS IN ELECTRIC DISCHARGE DRILLING (EDD) (U18-SI2)

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## ABSTRACT

In electric discharge drilling (EDD), rapid local heating and cooling of the workpiece surface by means of electric discharges results in surface layers (recast, heat affected and base material). In this study, the main workpiece surface texture measures, namely the recast layer thickness (RLT) and average surface roughness (Ra) characteristics were investigated for varying machining parameters (discharge current and pulse on time). The conducted experiments revealed the strong dependence of surface characteristics on machining parameters.

**Keywords:** Electric discharge drilling, Recast layer thickness, Average surface roughness, Ti6Al4V, Inconel 718, AISI4140

# DESIGN, MANUFACTURING AND EVALUATION OF A DMLS TEST ARTIFACT FOR SURFACE TEXTURE AND FORM CHARACTERIZATION (U18-SI3)

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## ABSTRACT

The surface quality obtained after DMLS is one of the limitations for dimensional accuracy and the use of the process without any surface treatment. This is mainly due to the layered process nature like other AM technologies resulting in a stair effect. Besides, the process variables such a build direction and layer thickness may significantly alter the surface quality. This talk aims to contribute to the current state-of-the-art by the experimental study of a unique design to form a database for influencing factors on the surface quality. A benchmark part was designed to reflect different radii of curvature both in convex and concave forms. A further design feature of circumferential arrangement is added to the benchmark part to investigate the variations along different axes. The resulting geometry is produced and the surface quality was evaluated. The benchmark geometry can be conveniently used for surface texture and form characterization to compare different machines, materials or even process parameters.

**Keywords:** DMLS, additive manufacturing, surface quality, stair effect

## TI6AL4V SURFACE MODIFICATION BY HYDROXYAPATITE POWDER MIXED ELECTRIC DISCHARGE MACHINING FOR MEDICAL APPLICATION (U18-SI5)

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### ABSTRACT

Titanium surface modification by the Hydroxyapatite (HA) mixed Electric Discharge Machining (EDM) is an alternative and promising technique to enhance the biocompatibility and to promote the biological performance in bone, which is dependent on surface properties, such as surface roughness, chemistry, and wettability. HA powder is used for the first time with electrical discharge machining to improve osteoblastic cell activity on the developed surfaces for TI6AL4V. Different HA concentrations in deionized water were tested as an experimental variable during EDM. Abrasive polishing and electrical discharge machined control surfaces without powder addition also analyzed to compare the results. The surface characteristics of analyzed samples were evaluated by Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), X-Ray Diffractometry (XRD), white light interferometry, and contact angle measurements. The wettability tests suggest that the hydroxyapatite powder mixed EDM'ed surfaces shows highly hydrophilic characteristics compared the other surfaces, abrasive polished and EDM'ed without powder addition in the dielectric. The results from the MTT assay revealed that those surfaces modified using HA powder addition in distilled water dielectric liquid promoted the most significant cell attachment/growth. The results indicate that HA powder mixed EDM offers a promising method for the surface modification of biomaterials such as titanium alloys.

**Keywords:** Ti6Al4V, surface modification, Hydroxyapatite, Powder Mixed Electrical Discharge Machining, Osteoblast, Cell Attachment and Growth

**POWDER MIXED ELECTRICAL DISCHARGE MACHINING AND BIOCOMPATIBILITY: A STATE OF THE ART REVIEW (U18-SI8)**

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**ABSTRACT**

Electrical Discharge Machining (EDM) is a well-known process for machining of difficult to cut materials. Along with adding the powder in dielectric liquid, change in properties of machining gap results in a variety of sparks forms and lead different mechanisms under specific operational conditions during machining. The discharge models significantly differ from conventional EDM and leave its characteristics surface features. Primary studies of Powder Mixed Electrical Discharge Machining (PMEDM) focused on the understanding of material removal rate, surface quality, and tool wear rate concerning the widespread of the operational conditions evolved in the process. Then, the interactions with the powder material during discharging and the resultant surface properties impel the researcher's interest to achieve functional surfaces. In this respect, PMEDM is a significant concern in recent years as an alternative and simple production technique to obtain functional surfaces for specific needs. Nowadays, among the specific needs, production of biocompatible surfaces with the use of the technique provides a challenging opportunity to the researchers to address osseointegration issues. The study presents an introduction and review of the research work in PMEDM. The studies concerning machining efficiency, surface integrity, and generation of functional surfaces are presented and discussed in the light of current research trends. Attempts made to improve biocompatible surfaces with the use of the process also included to clarify the future trends in PMEDM.

**Keywords:** Powder Mixed Electrical Discharge Machining, Machining Efficiency, Surface Integrity, Biocompatibility, PMEDM

## ABRASIVE FLOW MACHINING OF AEROSPACE ALLOYS (U18-SI9)

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**ABSTRACT**

Abrasive flow machining is a non-traditional finishing process by means of which a wide range of applications, from die-mold industry to medical, aircraft and aerospace components in which critical components must be finished to within precise or especially demanding tolerances. Inconel 718 was selected for this study for its high strength, corrosion and heat resistant properties and are commonly used in high temperature applications such as turbine blades and rocket engines. It is considered more difficult to finish using conventional techniques (grinding, lapping, etc.) than other metallic materials. This paper conducted on the finishing of the difficult to machine material of Inconel 718. The influence of the Abrasive flow machining process on Inconel 718 workpiece was investigated. The results show that the white layer formed during wire electrical discharge machining is successfully removed by abrasive flow machining in a few cycles for each workpiece. Although the surface quality is improved by abrasive flow machining for wire electrical discharge machined difficult to machine material as the level of lapping process.

**Keywords:** Abrasive Flow Machining, Surface Roughness, EDM, Inconel 718

**EFFECTS OF ELECTRODES ON AEROSPACE ALLOYS IN HOLE-EDM PROCESS (U18-SI10)**

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**ABSTRACT**
Hole-EDM drilling is a special type of electrical discharge machining (EDM) processes, i.e. sink-EDM and wire-EDM. Although hole-EDM drilling uses the same principles as other EDM methods, a constantly rotated hollow electrode and pumping of dielectric liquid through the electrode tube are the two distinct features. This process has been alternatively used for producing holes in turbine blades, fuel injectors, medical equipment, cutting tool coolant holes, hardened punch ejectors, plastic mould vent holes and wire EDM starter holes. In this study, a comparative investigation of fast hole drilling of aerospace alloys, namely as Inconel 718 using EDM method was performed in order to explore the influence of electrode material, i.e. brass and copper electrode materials. The comparisons were made from the results of material removal rate (MRR), electrode wear rate (EWR) and scanning electron microscope (SEM) images of the white layer thickness (WLT) taken from the machined hole surfaces. The experimental results reveal that the brass electrode has comparatively better MRR and lower EWR. However, the SEM images show that brass electrode produces less damage and WLT on machined surfaces than copper electrode for this material.

**Keywords:** Electrical discharge machining, Fast hole drilling, Electrode, Surface Roughness, Inconel 718

# AN EXPERIMENTAL INVESTIGATION OF THE ULTRASONIC-ASSISTED MACHINING OF Ti-6Al-4V (U18-SI13)

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## ABSTRACT

In this study, an experimental study was performed for the ultrasonic-assisted turning of Ti-6Al-4V. The surface properties of titanium alloy machined by ultrasonic-assisted turning method were examined. Also, chip morphology was investigated. These measurements were compared with conventional turning operations performed with same cutting parameters. It was seen that ultrasonic-assisted turning affects surface properties. Average surface roughness was reduced, and less deformation was observed on the workpiece surface. Also, serrated and irregular chips were observed.

**Keywords:** Ultrasonic-assisted turning, Ti-6Al-4V, Surface roughness, Chip morphology

# THE EFFECT OF PROCESSING ON THE SURFACE AND SUBSURFACE CHARACTERISTIC OF PLASTIC INJECTION MOLD STEEL (U18-SI14)

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## ABSTRACT

AISI P20 is pre hardened mold steel that is commonly used to manufacture plastic injection molding. The surface characteristics of molds play crucial role to control plastic injected molds parts. Besides, the characteristic of molds is mainly influenced by machining process, the manufacturing process to produce molds. This study presents the extensive experimental work focusing on the machining processing conditions on the surface characteristics of Plastic Injection mold steels. The input parameters are cutting speeds, feed rates and cutting inserts' geometry (wiper and non-wiper). The measured output parameters are subsurface hardness of machined parts and phase transformation induced from cutting process. Experimental results show that wiper insert significantly helps to improve surface quality of components. Besides, micro hardness measurement shows that thermal softening occurs resulting from machining of this alloy. XRD data illustrates peak broadening and increased intensity with machined samples.

**Keywords:** AISI P20, Wiper, Micro hardness, XRD

# MİNİ SEMPOZYUM: GELENEKSEL VE GELENEKSEL OLMAYAN İMALAT SÜREÇLERİNDE YÜZEY BÜTÜNLÜĞÜ

## TÜRKÇE BİLDİRİLER

## (İngilizce Özetler)

# MINI SYMPOSIUM ON SURFACE INTEGRITY IN CONVENTIONAL AND NONCONVENTIONAL MANUFACTURING PROCESSES

## PAPERS IN TURKISH

## (with English Abstracts)

# YOL DIŞI (OFF-ROAD) ARAÇ İÇİN ÇİFT ENİNE YÖN VERİCİLİ BAĞIMSIZ ASKI SİSTEMİNİN TASARIMI VE ANALİZİ (U18-SI1)

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## ÖZET

Bu çalışmada, geleneksel olmayan imalat yöntemlerinden olan CNC tel elektro erozyon tezgâhında tel elektrot özelliklerinin yüzey pürüzlülüğüne etkisi Taguchi deneysel tasarım yöntemi ile modellenmiştir. Yüzey pürüzlülüğü deneyleri tel elektrot çapı, tel malzemesi ve kaplama türü, soğutma yöntemi ve iki farklı tip iş parçası malzemesi göz önünde bulundurularak gerçekleştirilmiştir. Deneyler sonucunda elde edilen yüzey pürüzlülüğü değerleri bağımlı değişken olarak seçilirken bağımsız değişken olarak tel elektrot kaplama türü, tel elektrot çapı, soğutma yöntemi ve iş parçası malzemesi olarak seçilmiştir. Bağımsız değişkenler her biri için iki seviye ve dört faktör belirlenerek L16 (2**4) ortogonal deney tasarım yöntemi seçilmiştir. Belirlenen ortogonal Taguchi tasarım yöntemi ile yüzey pürüzlülüğü üzerinde kontrol faktörlerini etkisi Sinyal/Gürültü (S/N) oranlarına göre tespit edilmiştir. Ayrıca kontrol faktörlerinin yüzey pürüzlülüğü üzerindeki etkisi ANOVA testi yapılarak ortaya konulmuştur. En yüksek yüzey pürüzlülük değerleri kaplamasız tel elektrotlarla en düşük yüzey pürüzlülük değerleri ise Zn (çinko) kaplı tel elektrotlarla ortaya çıkmıştır. İş parçası türüne bağlı olarak, AISI D2 çeliğinin işlenmiş yüzeyinde elde edilen yüzey pürüzlülük değerleri daha düşük olduğu tespit edilmiştir.

**Anahtar Kelimeler:** CNC tel elektro erozyon, tel elektrot çapı, tel malzemesi, soğutma yöntemi, Taguchi deney tasarımı, ANOVA testi

# MODELING THE EFFECT OF WIRE ELECTRODE PROPERTIES ON SURFACE ROUGHNESS IN CNC WIRE ELECTRO DISCHARGE MACHINING BY TAGUCHI METHOD

## ABSTRACT

In this study, the effect of wire electrode properties on the surface roughness in CNC wire electro discharge machining which is one of non-traditional manufacturing methods was modeled by Taguchi experimental design method. Surface roughness tests were performed considering wire electrode diameter, wire material and coating type, cooling method and two different types of workpiece material. The surface roughness values obtained as a result of the experiments were selected as dependent variables, while the wire electrode coating type, wire electrode diameter, cooling method and workpiece material were selected as independent variables. The L16 (2**4) orthogonal test design method was chosen by determining two levels and four factors for each of the independent variables. With the determined orthogonal Taguchi design method, the effect of the control factors on the surface roughness was determined according to the Signal to Noise (S/N) ratios. In addition, the effect of control factors on the surface roughness was determined by performing ANOVA test. The highest surface roughness values emerged with uncoated wire electrodes while the lowest surface roughness values emerged with Zn (zinc) coated wire electrodes. Depending on the workpiece type, the surface roughness values obtained on the machining surface of the AISI D2 steel were found to be lower.

**Keywords:** CNC wire electro discharge, Wire electrode diameter, Wire material, Cooling method, Taguchi design method, ANOVA test.

# AA 7075 YAŞLANDIRILMASINDA FARKLI ÖN GERİNMELERİN MEKANİK ÖZELLİKLERE ETKİLERİNİN İNCELENMESİ (U18-SI4)

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## ÖZET

Bu çalışmada havacılık sanayinde yaygın kullanıma sahip 7075 alüminyum alaşımının yaşlandırılmasında farklı ön gerinmelerin alaşımın mekanik özelliklerine etkileri incelenmiştir. Çalışmadaki temel amaç farklı oranlarda şekillendirilmiş parçaların boya fırınlaması esnasındaki mekanik ve mikroyapı özelliklerinin değişiminin belirlenmesidir. Boya fırınlama işlemlerinde 120-200 ºC sıcaklıkları kullanılmaktadır. Bu kapsamda çalışmamızda yaşlandırma sıcaklıkları 120, 160 ve 200 ºC olarak seçilmiştir. Numunelere farklı ön gerinmeler uygulanarak ön gerinmenin yaşlandırmadaki etkisi detaylı olarak incelenmiştir. İncelemeler sonucunda ön gerinmenin artmasıyla, 200 ºC yaşlandırma sıcaklığında akma mukavemeti ve geri esneme düşerken, altındaki yaşlandırma sıcaklıklarında artmaktadır. Bunun sebebi ise mikroyapıdaki MgZn2 katı çökeltilerinin hacimsel miktarıdır.

**Anahtar Kelimeler:** Ön gerinme, MgZn2 katı çökeltileri, AA 7075, mekanik özellikler, XRD, boya fırınlama.

**INVESTIGATION ON EFFECTS OF DIFFERENT PRE-STRAINING ON MECHANICAL PROPERTIES OF AA7075 ALUMINUM ALLOYS DURING AGING**

**ABSTRACT**

In this study, effects of different pre-straining on mechanical properties of AA7075 aluminum alloys during aging, which has been widely used in aerospace industry, are investigated. The purpose of this study is to determine changes in mechanical and microstructural properties of different level deformed parts during paint baking process. The paint baking process is generally performed between 120 and 200 ºC. In this concept, aging temperatures of 120, 160 and 200 ºC are selected. Different pre-strainings were applied on samples to investigate the effects of pre-straining on aging in detail. With increasing the pre-straining, yield strength and springback decreased and increased at aging temperatures of 200 ºC and below 200 ºC, respectively. This is due to the volume content of MgZn2 solid precipitates in microstucture.

**Keywords:** Pre-straining, MgZn2 precipitates, AA 7075, mechanical properties, XRD, paint baking.

# UZAY VE HAVACILIK ALAŞIMLARININ ELEKTRİKSEL EROZYONLA DELİNMESİ İŞLEMİNDE YÜZEY BÜTÜNLÜLÜĞÜNÜN İNCELENMESİ (U18-SI6)

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**ÖZET**

Bu çalışmada, elektriksel erozyonla işleme yöntemi kullanılarak, havacılık uzay sanayisinde kullanılan alaşımlar üzerinde delik delme operasyonları gerçekleştirilmiş ve elde edilen delik yüzeylerinin yüzey bütünlükleri incelenmiştir. Deneylerde Ti-6Al-4V ve Inconel 718 alaşımları iş parçası malzemesi olarak ve pirinç, bakır ise elektrot malzemesi olarak kullanılmıştır. Deliklerin çap ölçümleri alınmış ve EEİ işlemleri sonuçlarına göre küçük elektrot çaplarında daha fazla çap büyümesi olduğu görülmüştür. En yüksek ergimiş katılaşmış tabaka kalınlığı Inconel 718 iş parçasında delinen deliklerde görülmüş ve Ti-6Al-4V alaşımlarında pirinç elektrotla delinen deliklerde oluşmuştur. Ti-6Al-4V alaşımında, Inconel 718 alaşımında elde edilen yüzeylere kıyasla daha fazla yüzey çatlakları görülmüştür. Yüzey pürüzlülük sonuçlarına kıyasla Inconel 718 alaşımının her iki elektrotta Ti-6Al-4V alaşımına göre yüzey pürüzlülük değeri az oluşmuştur.

**Anahtar Kelimeler:** Elektro erozyon ile işleme, Ti-6Al-4V, Inconel 718, yüzey bütünlüğü

# INVESTIGATION OF SURFACE INTEGRITIES OF ELECTRICAL DISCHARGE DRILLED HOLES ON AEROSPACE ALLOYS

## ABSTRACT

This research work presents an investigation of surface integrities of electrical discharge drilled holes on aerospace alloys. Ti-6Al-4V and Inconel 718 alloys were drilled via brass and copper electrodes in the conducted experiments. Drilled hole diameters were measured after operations and high overcut ratios were obtained for smaller diameter electrodes. Larger white cast layer was produced on both alloys when using brass electrodes. More micro cracks were observed on Ti-6Al-4V alloy then Inconel 718. Surface roughness measurements have shown that the smoother surfaces were obtained on Inconel 718 alloy.

**Keywords:** Electrical discharge Machining, Ti-6Al-4V, Inconel 718, Surface Integrity

# 3B YAZDIRILMIŞ KOMPOZİTLERİN YAZDIRMA PARAMETRELERİNİN YÜZEY PÜRÜZLÜLÜĞÜNE ETKİSİNİN DENEYSEL İNCELENMESİ (U18-SI7)

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## ÖZET

3B yazdırma, karmaşık endüstriyel tasarım ve diğer zaman alıcı süreçleri içeren geleneksel üretim yöntemleriyle karşılaştırıldığında, parçaları üretmek için sadece dijital teknolojiyi kullanan bir üretim yöntemidir. Aynı zamanda eklemeli imalat olarak da adlandırılan üretim yönteminde, ABS ve PLA en yaygın kullanılan malzemelerdir. Bu malzemeler prototip imalatında yaygın olarak kullanılmasına rağmen, fonksiyonel parçalar için gerekli olan mekanik özellikleri yeterli değildir. Bu nedenle, imal edilen parçaların mekanik özelliklerini iyileştirdiği için 3B yazdırma malzemesi olarak karbon fiber takviyeli kompozitlerin potansiyeli dikkat çekicidir. Bu malzemeler, birçok metalin mekanik özelliklerini sağlarken, hafif olmaları nedeniyle ön plana çıkmaktadır. Bununla birlikte, 3B yazdırılmış parçalar için, yazdırma parametrelerinin kompozit malzemenin özelliklerini etkilediği bilinmektedir. Bu çalışmada, %15 karbon fiber takviyeli kompozit malzemeler, ergiyik biriktirme tekniği (FDM) kullanılarak imal edilmiştir. Yazdırma yönüne bağlı olarak ekstrüder sıcaklığının ve katman kalınlığının yüzey pürüzlülüğü üzerindeki etkisi incelenmiştir.

**Anahtar Kelimeler:** 3B yazdırma, Karbon fiber kompozitler, Yüzey Pürüzlülüğü

# EXPERIMENTAL INVESTIGATION OF PRINTING PARAMETERS EFFECT ON SURFACE ROUGHNESS OF 3D PRINTED COMPOSITES

## ABSTRACT

3D printing is a manufacturing method that uses only digital technology to fabricate the parts, compared to the traditional manufacturing methods involving complex industrial design and other time-consuming processes. ABS and PLA are the most commonly used materials in this manufacturing method, also called the additive manufacturing. Although these materials are widely used in the prototype fabrication, the mechanical properties required for functional parts are not sufficient. Therefore, the potential use of carbon fiber reinforced composites as 3D printing materials is remarkable as it improves mechanical properties of the fabricated parts. These materials come into prominence due to their lightweight while providing the mechanical properties of many metals. However, for 3D printed products, it is known that the printing parameters affect the properties of the composite material. In this study, 15% carbon fiber reinforced composite materials was fabricated using fused deposition modelling (FDM). The effects of the extruder temperature and the layer thickness on the surface roughness depending on the printing orientation were investigated.

**Keywords:** 3D printing, Carbon fiber composites, Surface roughness

## 3B YAZDIRILMIŞ KOMPOZİTLERİN YAZDIRMA PARAMETRELERİNİN YÜZEY PÜRÜZLÜLÜĞÜNE ETKİSİNİN DENEYSEL İNCELENMESİ (U18-SI11)

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**ÖZET**

Bu çalışmada, AISI 316L çeliğin işlenmesinde kesici takım formlarının ve kesme parametrelerinin yüzey bütünlüğü üzerine etkileri deneysel olarak araştırılmıştır. Kesme deneylerinde, PVD kaplı MM ve MF formlu sementit karbür kesici takımlar ve PSBNR 2525M12 formunda takım tutucu kullanılmıştır. Kesme parametreleri dört farklı kesme hızı, üç farklı ilerleme ve iki farklı kesme derinliği şeklinde belirlenmiştir. Yüzey bütünlüğü; yüzey pürüzlülüğü, kalıntı gerilmeler, mikrosertlik ve mikroyapı analizleri açısından değerlendirilmiştir. Bütün kesme şartlarında, kesme derinliği ve ilerleme değeri arttığında yüzey bütünlüğünün kötüleştiği, buna karşın kesme hızındaki artışla birlikte yüzey bütünlüğünün iyileştiği görülmüştür. Kesici takım formları karşılaştırıldığında en iyi yüzey bütünlüğü sonuçları MF formlu kesici takımlarla, en kötü yüzey bütünlüğü sonuçları ise MM formlu kesici takımlarla elde edilmiştir. Talaş açısı artıkça yüzey bütünlüğü iyileşmiştir. En kötü yüzey bütünlüğü kesme hızı 200 m/dak, ilerleme 0,1 mm/dev ve kesme derinliği 1,25 mm olduğunda, en iyi yüzey bütünlüğü ise kesme hızı 125 m/dak, ilerleme 0,3 mm/dev ve kesme derinliği 2,5 mm olduğunda elde edilmiştir.

**Anahtar Kelimeler:** Yüzey bütünlüğü, AISI 316L, Kesici takım formu, Kalıntı gerilmeler, Mikrosertlik ve Mikroyapı.

# EFFECTS OF CUTTING TOOL FORMS ON THE SURFACE INTEGRITY IN TURNING OF AISI 316L STAINLESS STEEL

## ABSTRACT

In this study, the effects of the cutting tool forms and cutting parameters on the surface integrity were experimentally investigated in machining of AISI 316L steel. In cutting tests, PVD coated MM and MF formed cutting tools and tool holder suitable for these cutting tools were used. Cutting parameters were determined by using three different feed rate, four different cutting speeds and two different depths of cut. The surface integrity was evaluated in terms of surface roughness, residual stress, micro hardness and microstructure analysis. In all cutting conditions, it was observed that the surface integrity worsened when the depth of cut and feed rate increased, whereas the surface integrity improved when the cutting speed increased. When the cutting tool forms were compared, the best surface integrity results were obtained with the cutting tools which had MF form, while the worst surface integrity results were obtained by the cutting tools which had MM form. As rake angle increased, surface integrity improved. The worst surface integrity was obtained with the cutting speed 125 m/min, feed rate 0.3 mm/rev and depth of cut 2.5 mm, while the best surface integrity was obtained with the cutting speed 200 m/min, feed rate 0.1 mm/rev and depth of cut 1.25 mm.

**Keywords:** Surface integrity, AISI 316L, Cutting tool Form, Residual stress, Micro hardness and Microstructure.

# RENE 65 SÜPER ALAŞIMININ DELİK DELME İŞLEMİNDE FARKLI PARAMETRELERİN TAGUCHI YÖNTEMİYLE ANALİZİ (U18-SI12)

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**ÖZET**

Bu çalışmada, Rene 65 süper alaşımına uygulanan delik delme işleminde kullanılan üç farklı matkap takımının; tezgâhın çektiği yüke, takım aşınmasına ve yüzey pürüzlülüğüne olan etkileri incelenmiştir. Farklı özellikteki matkaplar, üç farklı tezgâh devri ve üç farklı ilerleme parametrelerinde Taguchi L9 ortogonal dizisine göre analiz edilmiştir. Deney sonuçlarına göre, tezgâhın çektiği yük açısından, içten soğutmalı matkap, 300 devir ve 1 inch/dk ilerlemenin en iyi sonuçlar olduğu belirlenmiştir. Takım aşınması ve yüzey pürüzlülüğü dikkate alındığında ise TiAlN kaplamalı matkap, 500 devir ve 2 inch/dk parametrelerinin en iyi sonucu verdiği tespit edilmiştir.

**Anahtar Kelimeler:** Nikel-esaslı süper alaşım, Rene 65, delik delme, kesme parametreleri, Taguchi yöntemi

**EFFECTS OF CUTTING TOOL FORMS ON THE SURFACE INTEGRITY IN TURNING OF AISI 316L STAINLESS STEEL**

**ABSTRACT**

In this study, the effects of three different drill sets used for drilling process to Rene 65 super alloy on the power consumed by the machine, tool wears and surface roughness were investigated. Different drill types were analyzed for three different spindle speeds and three different feed rates of the tools by using Taguchi L9 orthogonal array. According to the results, the internal cooling drill at 300 rpm and 1 inch/min feed of the tool has the best result in terms of power consumed by the machine. By the view of tool wear and surface roughness, the TiAlN coated drill at 500 rpm and 2 inch/min has the best result.

**Keywords:** Nickel-based super alloy, Rene 65, drilling, cutting parameters, Taguchi method

# SEÇİCİ LAZERLE ERGİTME YÖNTEMİ İLE ÜRETİLEN INCONEL 625 ALAŞIMLI PARÇADA YÜZEY BÜTÜNLÜĞÜNÜN İNCELENMESİ (U18-SI15)

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## ÖZET

Eklemeli imalat, geleneksel imalat yöntemleriyle üretimi mümkün olmayan parçaların üretiminde kolaylık sağlayan bir yöntem olarak görülmektedir. Ancak eklemeli imalatla üretilen parçaların yüzey kalitesinin beklenen seviyede olmaması önemli bir problem olarak karşımıza çıkmaktadır. Bu çalışmada, Inconel 625 toz malzemesi kullanılarak, toz yataklı seçici lazer ergitme (SLM) yöntemiyle üretilen parçaların yüzey kalitesi ve yüzey bütünlüğü karakteristikleri incelenmiştir. Yapılan analizlerde, lazer tarama yönüne paralel ve dik düzlemlerde incelemeler gerçekleştirilmiş olup iki düzlem arasındaki farklılıklar kıyaslanmıştır. Yüzey kalitesine tarama yönüne farklı düzlemlerde bakıldığında önemli farklılıkların oluştuğu gözlemlenmiştir.

**Anahtar Kelimeler:** Seçici Lazer Ergitme, Inconel 625, Eklemeli imalat

# ANALYSIS ON SURFACE QUALITY AND SURFACE INTEGRITY OF THE PARTS PRODUCED BY SELECTIVE LASER MELTING (SLM) USING INCONEL 625 POWDERS

## ABSTRACT

Additive manufacturing has been alternatively used for the parts which cannot be produced traditional manufacturing processes. However, poor surface quality of the parts produced via additive manufacturing is a challenging point. This paper presents the analysis on surface quality and surface integrity of the parts produced by selective laser melting (SLM) using Inconel 625 powders. The analyses were conducted on parallel and normal direction of laser scan and the comparison were made. There are some differences such as surface roughness, micro hardness, microstructure and phases were observed in the analyses.

**Keywords:** Selective Laser Melting, Inconel 625, Additive Manufacturing

# ŞEKİL HAFIZALI NiTi ALAŞIMIN KURU, MQL VE KRİYOJENİK KOŞULLARDA İŞLENMESİNDE KESİCİ TAKIM AŞINMASIYLA İŞ PARÇASI YÜZEY KALİTESİ ARASINDAKİ İLİŞKİNİN ARAŞTIRILMASI (U18-SI16)

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**ÖZET**

Uzay, otomotiv ve biyomedikal alanlarında kullanılan Şekil Hafızalı NiTi Alaşımın talaşlı imalatı sırasında karşılaşılan en büyük sorunlardan biri kesici takımda meydana gelen aşınmalar ve bunun sonucu oluşan kötü yüzey kalitesidir. Özellikle biyomedikal alanında tercih edilen NiTi alaşımın yüzey kalitesi önem arz etmektedir. Bu çalışmada, kesici takım aşınmasının ilerleyişi ile NiTi alaşımın yüzey kalitesi arasındaki ilişki sabit kesme parametrelerinde minimum miktarda yağlama (MQL), Kriyojenik koşulda (sıvı azot, LN2) ve kuru kesme koşullarında tornalama operasyonunda test edilmiştir. Elde edilen bulgular kuru kesme ile kıyaslanmıştır. Kuru ve MQL kesmeye kıyasla, kriyojenik koşulda yüzey kalitesinde önemli ölçüde iyileşme görülmüştür.

**Anahtar Kelimeler:** Kriyojenik talaşlı imalat, MQL, Şekil hafızalı NiTi alaşım, Yüzey kalitesi

# INVESTIGATION ON THE RELATIONSHIP BETWEEN PROGRESSION OF WEAR AND SURFACE QUALITY OF THE NITI ALLOY WITH MINIMUM QUANTITY LUBRICATION (MQL), AND DRY MACHINING UNDER CRYOGENIC CONDITION USING LIQUID NITROGEN (LN2)

## ABSTRACT

One of the biggest problems encountered during machining of NiTi Shape Memory Alloy (SMA) used in space, automotive and biomedical sector is the poor surface quality due to extremely high tool wear. The surface quality of NiTi alloy, which is preferred especially in biomedical industry, is important. In this study, turning operation was performed under cryogenic condition using liquid nitrogen (LN2), minimum quantity lubrication (MQL) condition, and dry machining conditions at constant cutting parameters to investigate the relationship between progression of wear and surface quality of the NiTi alloy. The findings were compared with dry cutting. Significant improvement in surface quality was observed in the cryogenic condition.

**Keywords:** Cryogenic machining, MQL, NiTi shape memory alloy, Surface quality

# PİRİNÇ MALZEMELERİN DELİNMESİ SÜRECİNDE KESİCİ TAKIM YUVARLANMA YARIÇAPININ İŞ PARÇASI YÜZEY BÜTÜNLÜĞÜNE ETKİSİ (U18-SI17)

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## ÖZET

Bu çalışmada pirinç alaşımın delinmesi sürecinde kesici takım yuvarlanma yarıçapının işlenen parçanın yüzey bütünlüğü karakteristiklerine etkisi araştırılmıştır. Ölçülen yüzey bütünlüğü karakteristikleri iş parçası yüzey pürüzlülüğü, iş parçası yüzey altı mikrosertliği ve iş parçasının yüzey altında talaş kaldırmadan etkilenen katman derinliğidir. Elde edilen bulgulara göre, kesici takımın yuvarlanma yarıçapının büyümesi iş parçası yüzey kalitesinde iyileşmeyi sağlamış olup, aynı zamanda işlenen parçanın mikroyapısında daha fazla pekleşmeye sebep olmuş bunun sonucunda ise işlenen yüzey ve yüzeyaltında mikrosertlikte kayda değer artış gözlemlenmiştir. İlaveten, mikroyapıda etkilenen takabadaki tanelerde ikizleme mekanizmasının etkin olduğu görülmektedir.

**Anahtar Kelimeler:** Pirinç alaşım, delik delme, yuvarlanma yarıçapı, yüzey bütünlüğü

# INVESTIGATION ON THE EFFECTS OF EDGE RADIUS ON SURFACE INTEGRITY CHARACTERISTICS OF DRILLED BRASS ALLOY

## ABSTRACT

In this study, the effects of edge radius on surface integrity characteristics of drilled brass alloy have been investigated. Measured surface integrity characteristics are the surface roughness of drilled work material, micro hardness and the depth of drilling-induced layer beneath the surface. Obtained results showed that increasing edge radius of cutting tool resulted in improving surface quality of work material and also resulted in work hardening of drilled surface and subsurface and consequently considerable increases in micro hardness of drilled surface and subsurface observed. Besides, twinning mechanism on the surface and subsurface was observed.

**Keywords:** Brass alloy, drilling, edge radius, surface integrity

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