# TEI POST

The periodical of TUSAS Engine Industries, Inc. (TEI)

ISSUE 134 2018

## TS1400 CORE ENGINE FIRST IGNITION ACCOMPLISHED


## TEI IS AWARDED WITH EMPLOYEE ENGAGEMENT SUCCESS AWARD

## TWO INTELLIGENCE WORKSHOPS HELD BY TEI

TUSAŞ MOTOR SANAYİİ A.Ş.
TUSAŞ ENGINE INDUSTRIES, INC.

## CONTENTS



## EDITORIAL

Dear TEI Post Readers,

We are happy to meet you again with the first issue of TEI Post in 2018.

“Cover Story” of this issue features the TS1400 Turboshaft Engine to power the T625 Utility Helicopter.

Under “Activities & Projects” section, we have shared the latest developments about our company.

Under "Social Responsibility" section, we have mentioned about several projects we have realized keeping our responsibility towards Eskisehir in our minds.

"Achievement Board" section emphasized the awards we have been granted in consequence of our achievement in different areas.

“Travel” section features Japan, the mysterious country of the Far East, and Aizonai Ancient City, which was home to the ancient civilizations of the Anatolia.

See you in our 135th issue...


**For and On Behalf of TEI**
Prof. Mahmut F. Aksit

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## MESSAGE FROM THE PRESIDENT & CEO

# FIRST PROTOTYPE OF **THE TS1400 CORE ENGINE** RUN SUCCESSFULLY

The first half of 2018 witnessed important developments for our company. An important milestone was accomplished in the initiatives taken to develop the TS1400 turboshaft engine, which will power up the T625 Helicopter developed dedicatedly for our army, and which can also be integrated into ATAK Helicopter with some adaptations, marking the most important one of these developments. The preliminary prototype of the core engine, constituting the very heart of the indigenous and national TS1400 turboshaft engine developed by TEI, was manufactured completely, and the first ignition of it was performed successfully. I think running of the core engine, being the first jet engine across Turkey in real terms, is a giant step we have taken to achieve our vision of " To be globally competitive, original power systems OEM".

Under the so-called biggest defence systems supply project of all times titled as "Joint Strike Fighter (JSF) Project Engine Final Assembly Line Establishment, Activation and 1st Air Maintenance Factory Directorate T-11 Test Cell Modification Phase Project" for which TEI was assigned as the main contractor, we accomplished the milestones of Hangar #10 Pre-Design Review (PDR) , Critical Design Review (CDR), and T-11 Test Cell PDR in line with the project schedule, marking another important development in this period. Furthermore; the first F-35 JSF of the Republic of Turkey was released from hangar in a ceremony held at the premises of Lockheed Martin Aeronautics in Fort Worth, Texas, USA upon attendance of TEI and the other project stakeholders from Turkey on June 20-21, 2018.

The first flight tests for the PD155 turbodiesel engine we developed for ANKA, one of our national UAVs, were completed without any problem, and ANKA was powered up to the skies by means of a domestic engine for the first time. The PD170, another national engine of us to bring more power and altitude capacity for the new-generation UAVs, completed 2,500 hours in ground tests successfully. The endurance tests and continuously-improved design solutions enabled the maturity level of the PD170 to reach the sufficient level to initiate the flight tests.

Besides our achievements in design field, we also experienced many firsts in our manufacturing activities. The investments we have made to increase our capacity in the last 3 years enabled us to reach the weekly factory direct sales capacity of 25 million dollars for the first time. We included the new-technology turbine disk broaching process, as well as the special anti-corrosion coating processes, performed internationally before, in TEI, which improved our capabilities. We started to employ the new and improved cutting methods in blisk part manufacturing for LEAP engine, resulting in an increase by more than 20% in our capacity. All these initiatives of us carried our total order amount to around 4,6 billion dollars. We became the first defence industry company which was granted with the Part - 145 authorization across Turkey early this year. This certification is highly important in that a defence industry company was approved for the first time by a civil aviation authority. We proved that we have the competencies as necessary in the field of civil aviation, in addition to the military field, in aviation maintenance industry.

In addition to the activities we carried out in our business fields, we realized many social responsibility projects in the first half of 2018. The most important one of these projects was the organization we held to encourage female students to the aviation industry with the supports extended by the Provincial Directorate of National Education in Eskisehir as part of the "Women of Aviation Worldwide Week", like the one we did last year. Thanks to this original organization, we were granted with the "The Most Acclaimed Organization of the World" award by the “Institute for Women of Aviation Worldwide”.

We started to be rewarded for the efforts we exerted to provide our employees with a better working environment, and to make themselves at their homes in TEI. Based on the results obtained in 2017, we were selected as the "Best Employer", leaving behind many public and private giants engaging in the field of Defence and Aviation. We were also granted with the award of “Respect for Human” by "kariyer.net".

I'm sure that we will attain great achievements in the second half of 2018 that started with our achievements in the national projects. I would like to take this opportunity to thank all our employees for their efforts to enable us to achieve our vision of "becoming a leading manufacturer with globally competitive original power systems".

Greetings and best regards,

**Prof. Mahmut F. Aksit**
President & CEO, TEI

# TS1400 CORE ENGINE FIRST IGNITION ACCOMPLISHED

Taking firm steps forward to achieve its vision of "to be globally competitive, original power systems OEM", and mission of "becoming a leading engine manufacturer which designs, produces and services globally competitive, sustainable and original power systems and derivative products for aviation industry", TEI maintains its initiatives under the Turboshaft Engine Development Project, one of the most important projects accordingly, faithfully and rapidly.

Under the Turboshaft Engine Development Project carried out in accordance with the agreement executed with the Presidency of Defence Industries on February 7, 2017, TEI makes use of its original knowledge, testing capabilities and world-class experiences in manufacturing and assembly gained up until now, and increases its knowledge and experiences each passing day, and consequently, it maintains its initiatives accordingly under this project at the TEI's Campus in Eskisehir, as well as its Engineering Offices in Istanbul and Ankara concurrently and coordinately.

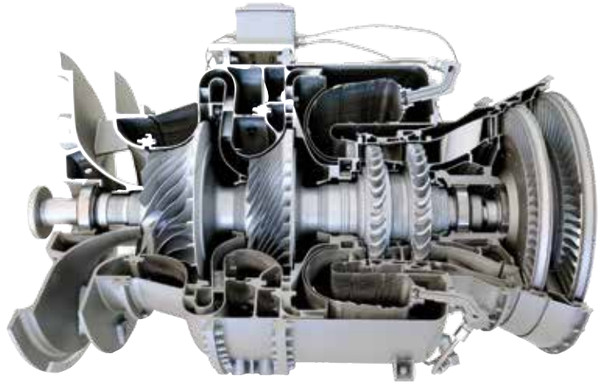




Turboshaft Engine Development Project serves for two basic purposes. The first purpose is to develop a turboshaft engine to be integrated into the T625 Multi Role Helicopter developed by Turkish Aerospace Industries, Inc. to be the first national helicopter engine of our country, this engine has max. take-off power at sea level of 1400 shp, and standard max. take-off power at sea level (single engine) of 1660 shp. The turboshaft engine will run in a manner to meet all these power requirements while ensuring the shaft output speed conditions of 23,000 at a service ceiling of 20,000 ft.

The second main purpose of the project is to develop the gas turbine engine design and development infrastructure and knowledge first to serve for such development process, and then to provide a contribution to our country while developing the turboshaft engine. "Material Database Development" and "Testing Infrastructure Design and Development", which can be considered as individual projects, are among the most important outstanding infrastructure development examples.

Design activities have been maintained in a close follow-up of performance analyses, aero-design, mechanical design, thermal analyses, structural analyses and material assessments in a manner to provide input for each other and to maintain the interactive cycle. In consequence of all these activities forming the basis of the design; an engine layout was developed to include 2-stage radial compressor, a reverse-flow combustion chamber, 2-stage gas generator turbine and 2-stage gas turbine.



*Turboshaft Engine Section*

We initiated the Core Engine process to perform the engine test to provide input to the design processes, and also to carry out the engine design, procurement, manufacturing, assembly and testing phases from beginning to end while maintaining design improvement and development activities. Following completion of the parts manufacturing process, the engine assembly process was performed including the instruments in a short period of time, and it was made ready for testing process, and the initial test was conducted through dry start-up. Upon smooth dry start-up testing process, the initial test with the pilot fuel line - i.e. the first ignition - and the Core Engine test along with all its main fuel lines were also completed successfully.

The test cell, prepared to conduct the Core Engine tests and serve for the subsequent tests, was designed, manufactured and made ready for use wholly domestically in cooperation with the 1st Air Maintenance Factory Directorate and TEI.

All information obtained from the tests conducted in relation to the Core Engine up until now provided critical knowledge for us to mature the design processes of the targeted turboshaft engine that will obtain the type certificate, and to develop the testing processes.

As a close follower of developments and innovations, TEI will reinforce the self-denying efforts exerted so far for the Turboshaft Engine Development Project, and crown its design with all information obtained from the Core Engine tests, and consequently, it will carry its engine design activities to a higher level and conduct the subsequent engine tests successfully. In consequence of all these efforts; TEI will make the turboshaft engine ready for use at the projected date.

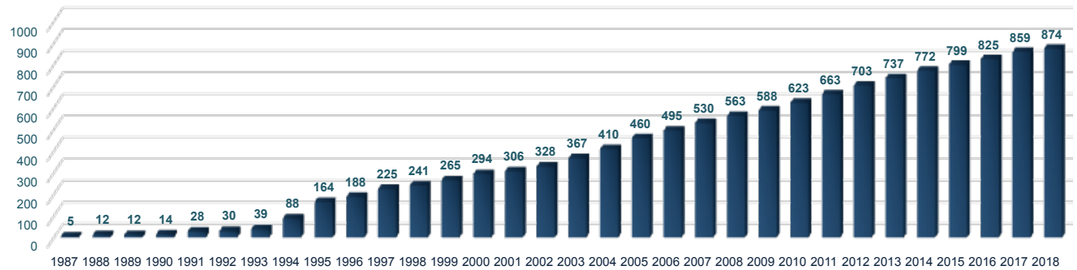

*T625 Multi Role Helicopter*


# ACTIVITIES **BETWEEN JANUARY - JUNE IN 2018**

## PART AND MODULE MANUFACTURING

### NEW PART INTRODUCTION (NPI)

In the first half of 2018, 15 NPI projects, 5 of them for General Electric (GE) and 10 of them for the Utility Helicopter Project, were completed and delivered to our customers on time. 10 of these completed NPI projects were for T700, 2 of them for LEAP, 1 of them for GEnx, 1 of them for LM9000, and 1 of them for LM2500 engine programs. With these new part introduction projects, TEI's product range has reached 874 items for 40 engine assemblies.




*Breakdown of the completed NPIs by years*

### INDIGENOUS ENGINE DEVELOPMENT PROGRAMS

As part of the PD170 Operative UAV Engine Development Project; 37 parts were manufactured initially, and started to be mass produced at TEI.
As part of the TJ90 Turbojet Engine Development Project; the main modules, manufactured by the prototype workshop, were completely manufactured, and started to be mass produced following the necessary adaptations to the manufacturing workshop of TEI. Moreover; as part of the Turboshaft, TJ1600, DP37 engine projects, the design activities were supported by the Manufacturing Engineering Department by means of concurrent engineering study.

*P10E-1P215-A05*
*COVER FIRST MASS BOTTOM*

*P10E-1P220-A03*
*COVER FIRST MASS TOP*

*P10E-2X010-A01*
*EXHAUST PIPE ASSY*

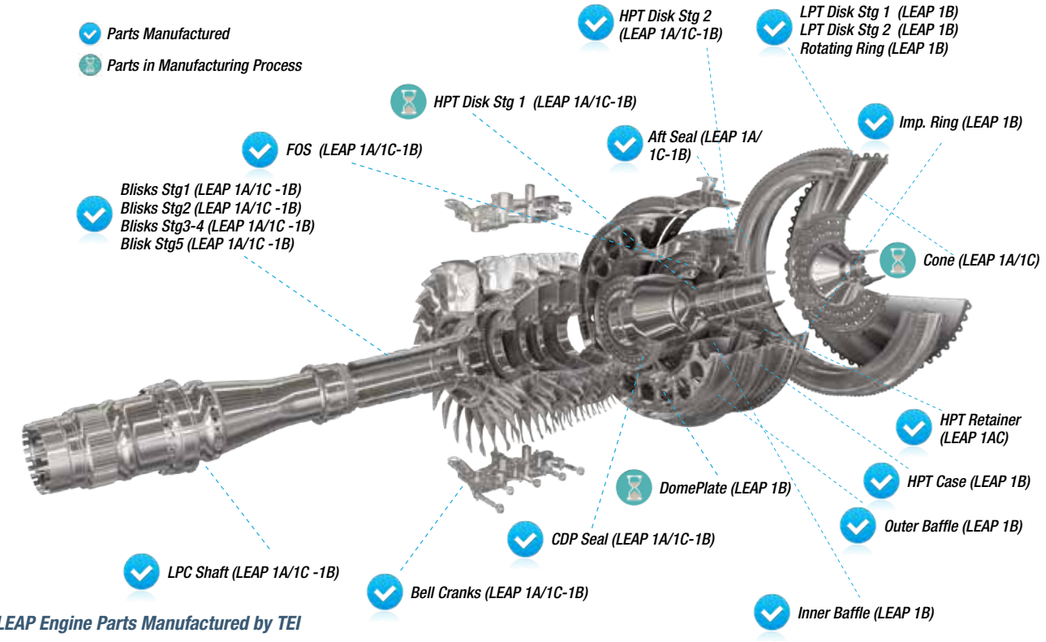
*P10E-1P135-A04*
*BASE SECOND MASS*

*P10E-2M230-A02*
*ENGINE MOUNT FRAME ASSY*

*P10E-2A025-A01*
*ADAPTOR ASSY MAP SENSOR*
*AIR INTAKE*

### LEAP PROJECTS

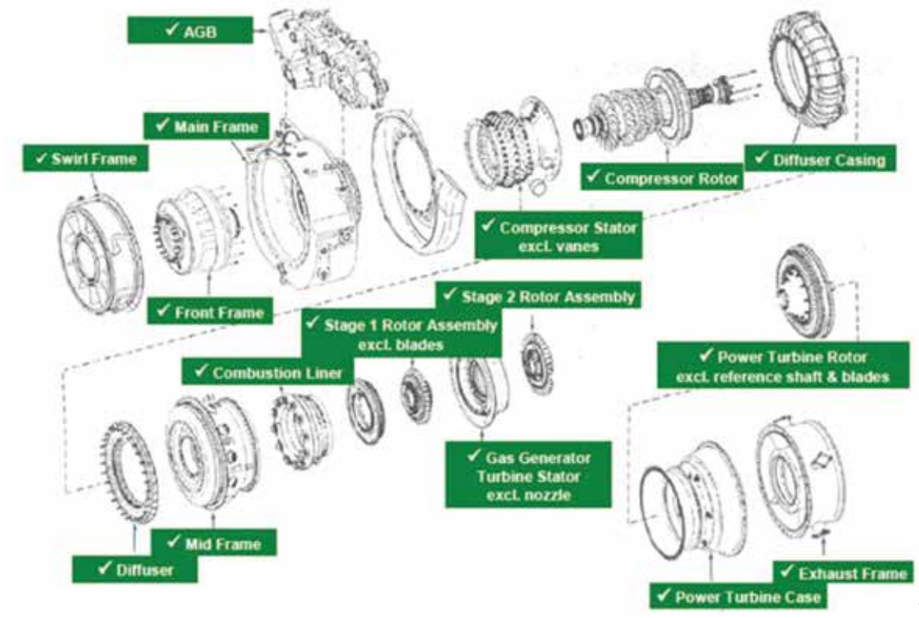
NPI projects for LEAP engine were substantially completed, and carried out through concurrent engineering works with SAFRAN and GE. So far, 29 different NPIs and 51 different configurations were completed for the LEAP engine program. TEI is the leader engine part manufacturer of LEAP engines worldwide with 32 different parts and a total 2.5 billion US Dollars backlog. The new configuration projects for the bell crank and domeplate were completed successfully in 2018. Additionally, NPI works for Stg1 HPT disk and LPT cone parts under the LEAP program are still ongoing in 2018.




*LEAP Engine Parts Manufactured by TEI*

## UTILITY HELICOPTER PROGRAM

Part and module production, the first phase of Utility Helicopter Program, is currently continuing with NPI projects covering also the complex parts, which are not included in previous production portfolio of TEI. A total of 24 NPI projects including the NPI projects for curvic coupling seal, actuating vane rings, C-sump cover, Stg2 air seal, IGV linkage support, deswirler, turbine disk Stg3, Stg2 actuating vane ring ve rotating ring parts have been completed so far in 2018. As part of the T700 program; NPI projects and productions, corresponding to 50% share of engine and more than 60 different parts including subparts, will be accomplished by TEI. In T700 program, 236 T700 - TEI - 701D turboshaft engines will be manufactured and delivered by TEI.




*TEI T700 Parts*





## INVESTMENTS

Initiatives for commissioning the below-given investments were completed in the first half of 2018.

As part of LEAP Blisk Project;

- 4 ea blisk blade airfoil milling machines,
- 5 ea vertical turning lathe,
- 1 ea 5-axis milling machine,
- 2 ea CSM (Curved Slot Milling) machines,
- 1 ea shot peening machine,
- 1 ea thermal spray coating machine,

As part of LEAP HPT Disk Project;

- 1 ea gear shaping machine,

As part of LEAP LPC Shaft Project;

- 1 ea horizontal multitasking machine,

As part of the other LEAP Projects;

- 1 ea 5-axis milling machine,
- 1 ea robotic sandblasting machine.

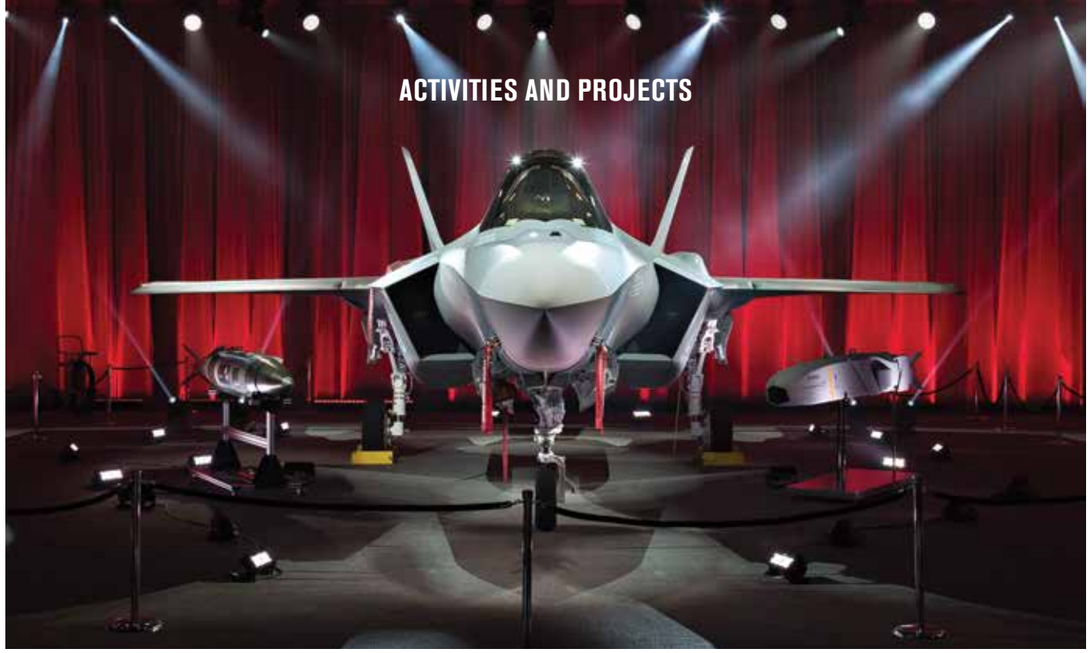
The following investments have been put into use as part of the investment plan:

- Technical assessments were completed for 2 ea horizontal turning machines, 1 ea high-speed edge processing machine, 1 ea 3-row broach machine, 1 ea 5-axis machine, 1 ea gear processing machine, 1 ea horizontal multitasking machine, 1 ea tool measurement machine, 1 ea tool grinding machine, and the orders were placed accordingly.
- Equipment for the Metallography Laboratory, established at B1000 building, were supplied and engaged.
- Ultra-sonic non-destructive inspection (UT) system was received in June 2018 by TEI, and system setup works were completed.
- Magnetic particle non-destructive inspection (MPI) system was completed.
- The FPI workstations, installed at B200 and B300 buildings, were renewed.
- 2 ea optical blisk CMMs were received by TEI, and setup works are still ongoing.
- 1 ea MRB vertical storage unit was set-up and engaged.
- 1 ea ATOS laser measuring device was engaged, and part measurement development works were initiated.
- Procurement process is still ongoing for update of 1 ea CMM.
- Procurement process is still ongoing for ATOS robotic preparation unit.
- Orders were placed for LEAP engine blisk parts blade processing ECM (Electro-Chemical Machining) machine, which is planned to arrive at TEI in January 2019.
- The works are still ongoing to engage the anti-corrosion robotic coating system for LEAP engine disk parts.
- An order was placed for 1 ea 6-axis fiber laser machine, which is planned to arrive at TEI in February 2019.
- The works are still ongoing to engage 1 ea robotic shot peening machine for shot peening of LEAP engine blisk parts.
- The works are still ongoing to engage 1 ea EDM.
- The works are still ongoing to engage 2 ea automatic part washing machines.

## NEW TECHNOLOGIES AND AUTOMATION APPLICATIONS

The development activities works and investments, accomplished in 2018, introduced the below-given new production capabilities:

- CSM (Curved Slot Milling) and PSM3 (Precision Step Milling) methods were started to be utilized for blade milling processes of LEAP blisk parts, and a blisk blade manufacturing infrastructure was built. The indigenous "Multiblade PSM3" method was developed across TEI to increase the productivity of blade milling processes.
- Robotic anti-corrosion coating application system for FOS and HPT disk parts of LEAP engine was commissioned, and the process development activities were completed.
- Digital error monitoring platform was developed to increase the first time yield and operational efficiency.
- A new electronic platform was established to ensure that all manufacturing and quality metrics are monitored on target basis across the entire plant with its breakdowns.
- NPI management system moved into a new platform established by the Manufacturing Engineering Department and developed.
- Grinding system was engaged to operate integrated with the horizontal turning machine.
- Stereomicroscope introduced the capability to measure the wear on tools in a more accurately.



# JOINT STRIKE FIGHTER (JSF) PROJECT ENGINE FINAL ASSEMBLY LINE ESTABLISHMENT, ACTIVATION AND 1ST AIR MAINTENANCE FACTORY DIRECTORATE T-11 TEST CELL MODIFICATION PHASE PROJECT

Following the planning and management phase completed as part of the activities for establishment of the Engine Final Assembly / Check-Out Line and European Region Depot-Level Maintenance (DLM) Center, the main contract for the "Joint Strike Fighter (JSF) Project Engine Final Assembly Line Establishment, Activation and 1st Air Maintenance Factory Directorate (1st AMF Dir.) T-11 Test Cell Modification Phase Project" was executed on March 23, 2017 by and between the Presidency of Defence Industries (SSB) and TEI, and it entered into effect on December 19, 2017 upon execution of the subcontracts with Pratt & Whitney and submission of them to the SSB for information purposes.

**Under this contract,**
• Establishment of the FACO Line at the Hangar #10 of the 1st AMF Dir., and modification of the T-11 Test Cell in the 1st AMF Dir. will be accomplished.
• The contractual term is 34 months for Establishment of the FACO line, and 33 months for Modification of the T-11 Test Cell.
As part of the JSF project, which is described as the largest defence industries supply project of all times, and under which TEI will act as the main contractor and multiple domestic sub-contractors will be engaged, the 1st AMF Dir. will not only acquire the capabilities for assembly and testing processes of the engines, to be included in the inventory of Turkey, but also be the first center to be established for the purpose of providing heavy maintenance and repair services (depot-level maintenance) for JSF aircraft of all participant countries and regional users across the European region.

**With respect to the facility to be established by TEI at the 1st AMF Dir. for manufacturing of F135-PW-100 engines as part of the Final Assembly Line (FACO line) establishment and activation works; TEI will create the infrastructure and provide the equipment required for;**
• Program, engineering and logistics management,
• Supply of goods, services, materials and industrial equipment (including support equipment, spare parts, etc.),
• Design of the line and layout plan, as well as development, manufacturing, establishment, calibration and testing of the line,
• Generation and provision of the entire documentation as necessary,
• Provision of any and all kinds of infrastructure as necessary for the facility,
• Provision of guarantee for the equipment to be supplied,
• Modification, qualification and acceptance of the facility,
• Ensuring that any and all necessary trainings are received on national and international basis,
• Meeting the requirements and needs to ensure security of the physical and information systems.

**With respect to the facility to be modified by TEI to perform the tests in a manner to meet the requirements, specified under the respective technical documents, of the F135-PW-100 type engines, with their manufacturing processes completed, and the F135-PW-100 and F135-PW-600 type engines, with their depot-level maintenance works completed at the 1st AMF Dir., TEI will carry out the below-given activities;**
• Program, engineering and logistic support management, and establishment planning activities,
• Supply of goods, services, materials and industrial equipment (including support equipment, spare parts, etc.),
• Manufacturing of mechanical and structural components, and transfer of the materials to the test cell,
• Satisfaction of the requirements for the test cell construction infrastructure (land survey, electricity, water, ventilation, etc.),
• Provision of the infrastructure and equipment for the physical and information systems, and supply, assembly and delivery, in usable condition, of all software and hardware tools to meet the security needs and requirements,
• Performance of the test cell modification processes, as well as the functional tests and calibration, qualification and acceptance processes,
• Ensuring that any and all necessary trainings are received on national and international basis,
• Provision of the guarantee and logistics support for the equipment to be supplied.

The project introduced the below-given advantages:
• The 1st AMF Dir. will become a center established to provide depot-level maintenance service for the JSF engines owned by the participant countries across the European region.
• T-11 test cell will become appropriate for the features to be tested on the 5th generation aircraft engines.
• FACO (Final Assembly and Testing) line will form the basis for the negotiations on the additional engine production.
• Upon completion of the engine production at the FACO line to be established, the existing capability will be able to be used to enhance the capacity of the DLM line.
• It is expected to provide a substantial financial added value to our country.
As part of the project; the milestones of Hangar 10 Pre-Design Review, Critical Design Review, and T-11 Test Cell Pre-Design Review were completed in line with the project schedule.

It is estimated that TEI might assume duty in the operational phase through the appropriate business models to be developed in line with the Performance-Based Logistics Follow-Up concept following the qualification of the first engine test and the test cell, planned to be completed in the third quarter of 2020.



Handover Ceremony for F-35 JSF of the Republic of Turkey was held at the premises of Lockheed Martin Aeronautics in Fort Worth, Texas, USA upon attendance of TEI and the other project stakeholders from Turkey, and the first F-35 JSF of the Republic of Turkey was released from hangar on June 21, 2018.

# GROUND TESTS OF PD170 ENGINE EXCEEDING 2500 HOURS

Design activities for PD170 turbodiesel aviation engine, developed under the scope of the Operative UAV Engine Development Project, have been completed to a large extent. Predominantly, validation tests and problem solving activities detected in these tests, are maintained. As part of the activities carried out on four different engine test stands, engine tests of more than 2.500 hours have been performed since January 2017, which marks the initial engine start-up. The endurance tests and continuously-improved design solutions, carried the engine maturity level to reach the required level to initiate the flight tests.

Through the intensive testing program to be maintained until the end of the project; it is aimed to increase the reliability level of the PD170 engine, which has already reached the performance targets beyond customers' expectation, to the level attained by the competitor engines. Preliminary works have been initiated for the PD210 engine at 210 HP, planned to be developed as the improved version of the PD170 engine. During the development of the PD170 engine; a PD170 engine prototype was calibrated to provide maximum 210 HP in order to verify that the engine block, designed in a manner to support the level of 210 HP, can endure under this pressure and temperature conditions, and that the improvement areas are determined in other subsystems. In-cylinder pressure, exhaust gas temperature and turbo compressor output temperature under 210 HP conditions were optimized through short-term tests. Following this optimization process during which the basic mechanical limits of the engine were not exceeded, the scope of the PD210 project will be defined.

It is aimed to launch the PD210 engine development project, under which the negotiations with the potential customers are ongoing, in 2019.





# NEW R&D PROJECTS OF TEI WERE INITIATED

On 26 January 2018, three new R&D projects were initialized in accordance with the Road Map on Technology Acquisition of TEI. The signing ceremony was held upon attendance of President of Defence Industries Prof. Ismail Demir, President & CEO of TEI Prof. Mahmut F. Aksit, and executives from the supporting institutions and organizations. These R&D projects are; Aviation Grade Stainless Steel and Nickel Based Super Alloy Development Project (DINC), Nickel Metal Powder Development for Additive Manufacturing Project (ATOM) and Electron Beam Melting Process Development for Titanium Alloys Project (ELEKTRON).

## DINC PROJECT

Within the scope of this project; aerospace grade stainless steel and nickel based superalloys will be produced to enable them for using in aviation platforms on defence and civil purposes. The required base alloys will be obtained by a primary melting method, then they will be converted to high quality aerospace grade stainless steel and nickel based superalloys through secondary melting methods. The mechanical properties of these alloys will be developed while performing the final characterization and verification processes.

As one of the leading casting companies of our country, Akdas Dokum participated to the DINC Project along with TUBITAK MAM as main subcontractors. Akdas Dokum and TUBITAK MAM will carry out process development and prototype production activities within the scope of this project. The DINC Project was launched in June 2018, and it will last for 60 months.

## ATOM PROJECT

Nickel alloy additive manufacturing powders will be developed to produce functional parts used under high load and temperature conditions in the gas turbine aero engines. Nickel alloy Inconel 718 and Inconel 625 powders appropriate for LAM (Laser Additive Manufacturing) process, and nickel alloy Inconel 718 powders appropriate for EBM (Electron Beam Melting) process, will be obtained by powder atomization method. Subsequent characterization and verification operations on samples will be carried out to confirm the powders. Ermaksan, one of the well-established machine developers and manufacturers companies of our country, joined the ATOM project as the main subcontractor. Previous year Ermaksan introduced ENA 250 model machine which enables laser melting process on the metal powder bed. Within the ATOM Project, Ermaksan will improve its manufacturing infrastructure for powder manufacturing and carry out the powder manufacturing process on pilot scale. The ATOM Project was started on April 12 2018, and it will last for 38 months.

## ELEKTRON PROJECT

Titanium aluminates are preferred due to their low density, high oxidation resistance and high temperature strengths while titanium alloys are used in cold zone parts in the aerospace industry thanks to their low density, high toughness and oxidation resistance. Nickel alloys are widely deployed in gas turbine engine parts which subjected high load and temperature. Within the scope of the ELEKTRON Project, Inconel 718 connection bracket, Ti6Al4V bearing house and Ti-48Al-2Cr-2Nb (Ti-Al) power turbine blade will be manufactured by using electron beam melting (EBM) additive manufacturing method. Characterization and verification activities will be carried out through prototypes and samples obtained by EBM process. The ELEKTRON Project was launched on April 4 2018 and it will last for 38.5 months.

# HUMAN RESOURCES PROCESSES

## WE MEET STUDENTS FOR "MY NATIONAL AVIATION ENGINE PROJECT"

As part of the activities held with "My National Aviation Engine Project" motto; we met 206 brilliant students from six universities in Ankara at Grand Ankara Hotel on April 19, and 236 brilliant students from nine universities in Istanbul at Cemile Sultan Korusu on May 4. During these activities; Prof. Mahmut F. Aksit, President & CEO at TEI, Ahmet Findik, TEI Design Engineering Director, and Yeliz Cetinkaya, TEI Human Resources Director delivered their presentations about TEI and the projects carried out by TEI. Design Engineering Directorate Executives and Human Resources Directorate Executives provided information about the most frequently asked questions raised by the students.






**TEI Career Development and Training Management participated many university activities with booth and met students between January 1 - June 30.**

February 20 - 21, 2018 - Istanbul Technical University Career Fair - Campus in Gumussuyu

February 20 - 21, 2018 - Istanbul Technical University Career Fair - Campus in Ayazaga

February 20, 2018 - Istanbul Technopark Career Fair

March 1 - 2, 2018 - Middle East Technical University Career Fair

March 6 - 7, 2018 - Istanbul Technical University 13th National Mechanical Engineering Career Summit

March 27, 2018 - Yildiz Technical University Business Administration Club Career Fair

April 10, 2018 - Sabanci University Career Fair

April 26, 2018 - Eskisehir Osmangazi University Career Fair

# CHANGES IN BOARD OF DIRECTORS OF TEI

**Melih Abis**
Starting to hold office as a Member of the Board of Directors of TEI as of May 14, 2018, Melih Abis serves as the Innovative Systems Group President at the Presidency of Defence Industries.

**Randall Hobbs**
Starting to hold office as a Member of the Board of Directors of TEI as of May 14, 2018, Randall Hobbs serves as the General Manager, Rotating Parts, Value Stream and Supply Chain at GE Aviation.

**Douglas Folsom**
We would like to thank Mr. Douglas Folsom for his valuable services as a Member of the Board of Directors between 2017 - 2018 at our company.

**Koksal Liman**
We would like to thank Mr. Koksal Liman for his valuable services as Chairman and a Member of the Board of Directors between 2013 - 2018 at our company.





# THE PRESIDENT MEETS YOUTH


The President Recep Tayyip Erdogan met youth on June 18, 2018 at Turkish Aerospace. TS1400 Turboshaft Core Engine and PD170 Turbodiesel Aviation Engine, two of the indigenous projects developed by TEI, made debut during the event. Prof. Temel Kotil, President & CEO at Turkish Aerospace, and Chairman of the board of Directors of TEI, Prof. Mahmut F. Aksit, President & CEO, TEI provided information about the indigenous engine projects, developed by TEI, to the President.

# TEI WAS CERTIFIED BY THE EUROPEAN CIVIL AVIATION AUTHORITY


EASA
MAINTENANCE ORGANISATION APPROVAL CERTIFICATE

Along with its maintenance organization approval certificate issued by the European Aviation Safety Agency (EASA), TEI proves that it has the required competencies not only in the military aviation maintenance but also in the civil aviation maintenance.
Part - 145 Maintenance Organization Approval is an approval granted by EASA (European Aviation Safety Agency) to the organizations which will be authorized to maintain civil aircraft, including any component for installation thereto, which are registered in EU Member States. This approval is granted to the maintenance organizations having their principle place of business in a Member State by the civil aviation authority designated by that Member State while it is granted directly by EASA to the organizations having their principle place of business located in a third country.
TP400 - D6 engine, for which TEI is acting as the risk and revenue partnership with ITP Aero Company in the design and manufacturing phases, is the first military engine certificated by EASA in accordance with the civil aviation regulations.
TEI applied to EASA to obtain the Part - 145 Maintenance Organization Approval to perform the depot level maintenance of the Front Bearing Structure Module of the TP400 - D6 engine for which TEI has responsibility in the design and manufacturing processes under the scope of the project. TEI successfully completed the audit conducted by EASA in the last quarter of 2017, and the Part - 145 Maintenance Organization Approval Certificate of TEI was issued on January 03, 2018.
Along with this certificate; TEI

- was approved by a civil aviation authority for the first time;
- became the first defence organization granted with the Part - 145 authorization by EASA in Turkey, and one of the 15 authorized maintenance organizations in the field of civil aviation;
- proved that it has the required competencies not only in the military aviation maintenance but also in the civil aviation maintenance;
- will move forward in the way of becoming a preferred leader company in the civil aviation maintenance industry with its determined steps.

# 5S INITIATIVES AT TEI

The purpose of 5S is to ensure that the working environment is and kept always clean, orderly, healthy and secure in order to increase the productivity. 5S originated in Japan in 1950s, consists of five stages expressed in five S-words. Namely;

- Sorting (Seiri)
- Straighten (in place) (Seiton)
- Sweep (Seiso)
- Standardize (Seiketsu)
- Sustain (Shitsuke)





Accordingly; 5S trainings were held for blue-collar workers, 5S Operator Manual was distributed, and 5S implementation procedures were explained and supported by means of the exemplary practices carried out across the plant in order to ensure continuity and discipline at TEI. Quarterly-held inspections were initiated by the Lean Manufacturing Team in order to evaluate the efficiency of these trainings.

In consequence of these inspections; the lean manufacturing area with the highest score is granted with the 3-star 5S flag, and the lean manufacturing areas with the second and the third highest scores are granted with the 2-star and 1-star 5S flag, respectively.
Grant of these flags aims to carry out the 5S practice in a disciplined manner, and to become a culture across the plant.

# CHAMPIONS OF 5S REVEALED

In consequence of the inspections held at the B1000 shop; it was observed that the 5S system was understood, and that the appropriate arrangements were made, and therefore, the 2017champions of 5S received their 3-star, 2-star and 1-star 5S flags from the managers of the respective departments and the Lean Manufacturing team. Within the blisk parts manufacturing line; the blade milling area and the grinding area became the champion of 5S and received the 3-star 5S flag, and the quality area received the 2-star 5S flag, and the milling / deburring area was granted with the 1-star 5S flag.



# COMBUSTION CHAMBER TESTS UNDER ATMOSPHERIC CONDITIONS

During the aviation engines development processes, a substantial progress was made thanks to the tools in relation to the computational fluid dynamics. However; it's generally preferred to validate performance of the parts / modules, designed by means of these softwares, through the tests. The combustion chambers, one of the main components of the aircraft engines, should be validated through the tests following the design process since they lead to thermochemical conversion during the operation and they have a high-turbulent inner environment. The combustion chamber tests, carried out in TEI, can be divided into two main groups in respect of the approaches.

1. Tests carried out across the entire combustion chamber.
2. Tests carried out on the testing parts, designed as optically accessible, by means of the laser diagnosis methods.

In the first group, tests carried out across the entire combustion chamber; it is validated that whether the design parameters of the combustion chamber have been fulfilled or not through the following means:

- Combustion chamber liner temperature measurements,
- Temperature gradient through thermal paint tests,
- Exhaust temperature measurements,
- Emission (CO, CO2, N2, O2, NOx) measurements,
- LBO, RBO (Lean Blowout Limit and Rich Blowout Limit) tests,
- Instability measurement tests through the dynamic pressure measurement method.

Atmospheric Combustion Chamber Test Rig is the property of the Engine Prototype and Test Division. It was revised in the first five months of 2018, in order to meet the requirements of the projects carried out in our company. The below-listed design and manufacturing activities were carried out as part of this revision.

- High-pressure fuel supply system setup
- Fuel Supply System Instrumentation Panel design and setup
- Fuel Pumping Station setup
- Fuel tank revision
- Fuel line revision
- Air Supply Line revision
- Heater revision
- Control System revision
- PLC panel installation
- Control interface design
- Standard cabling
- Control Desk revision
- Data Collection System revision
- Instrument junction box design and manufacturing
- Data collection cables and pressure hoses installation
- Data collection interface
- Combustion chamber connection method revision
- Other revisions
- Fire extinguishing system setup (Bonpet)
- Ventilation revision
- Test imaging system (camera) revision
- Rig warning and information boards manufacturing and installation

All parts, except for the fuel tank, of the testing system, which was fully designed at the Testing and Instrumentation Leadership, were manufactured in our company. Some outputs, obtained through the activities carried out during the revisions, are provided in Figure 1 below:

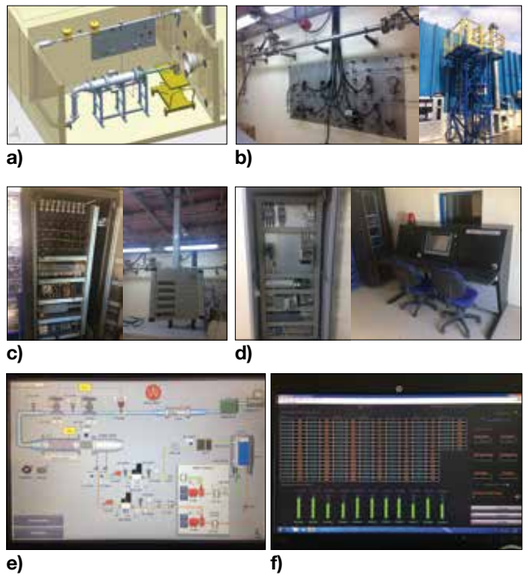



*Figure 1. Some hardware activities as part of the Combustion Chamber Test Rig*

**a)** Rig 3D design
**b)** Fuel instrumentation panel and the new 300 lt fuel tank
**c)** Data collection panel, and thermometer and manometer connection panel
**d)** PLC control panel and rig control desk
**e)** Control (PLC) system
**f)** Data collection system

Following the revisions; the operating range of the combustion chamber testing system became capable of fulfilling the critical values of the existing projects which are reduced to atmospheric conditions (Table 1).

| | | |
|---|---|---|
| Air Flow Rate Range | 0-0,4 | kg/s |
| Main Fuel Flow Rate Range | 0-18 | g/s |
| Main Fuel Pressure Range | 0-80 | barg |
| Pilot (First Ignition) Fuel Flow Rate Range | 0-8,3 | g/s |
| Pilot Fuel Pressure Range | 0-20 | barg |
| Combustion Chamber Inlet Temperature Range | 0-700 | K |
| Fuel Tank Volume | 300 | lt |

*Table 1. Combustion chamber test rig parameter operating ranges*





The new system is equipped with 31 pressure transmitters and 49 thermocouples which are controlled by the PLC and Labview software.

The tests carried out on the optically-accessible combustion chambers, designed specifically together with the subsystems of the combustion chamber such as swirlers and injectors are a part of the combustion chamber development process which includes the laser diagnostics methods.

These tests are carried out in order to access the detailed information which are needed but cannot be obtained through the tests carried out under the scope of the entire combustion chamber. The most advantageous aspect of the laser diagnostics methods is the ability to perform measurements without any interference to the flow. The rig, where the laser diagnostics methods are carried out, are now going through a revision phase similar to the test chamber, and its 3D design process is completed (Figure 2).

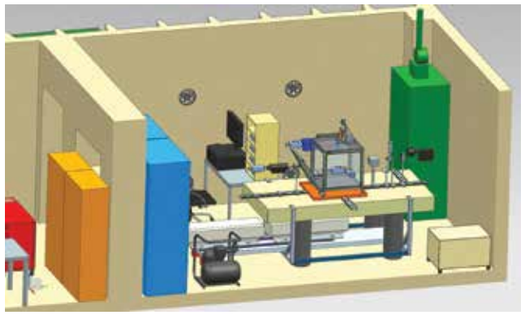


*Figure 2. Newly-designed laser diagnostics test chamber*

As part of the laser diagnostics setup planned to be commissioned in late October following completion of the currently ongoing manufacturing process; the below-given activities will be performed:

- Injector cold-flow tests (SMD-Average Droplet Diameter distribution and D32 diameters),
- Temperature and emission measurements at any point on the flow of the test part.

Cold-flow injector tests will be carried out using the "LIF" and "Mie" scattering,"Shadowgraphy" and "PIV" methods inside an optically-accessible cabin which is designed specifically. The shadowgraphy method will be employed in determination of the injector characterization by means of average droplet diameters with various optical instruments which have a wavelength of 532 nm, and LIF/Mie scattering method will be used for the measurements of the injector flow diameter distributions and flow cone angles. All these measurements will enable us to comment on the quality of the atomization caused by the injector. Temperature and emission measurements can be performed by means of the Raman and Rayleigh Scattering applications, caused by the laser light supplied at high-energy-rate (2.7 kJ) with a certain wavelength (355 nm) at a frequency of 10 Hz to the reaction area without any intervention.

Revision of the testing system, installed to carry out the tests of the combustion chambers under the Turboshaft Engine Development Project, was completed, and the laser diagnostics testing system revision will be completed by the end of October.

# NEW DEVICES ORDERED AS PART OF THE MATERIAL DATABASE ACTIVITIES

"Material Database" activities, planned to be created as part of the Turboshaft Engine Development Project, are maintained at full steam. Approximately 30,000 physical and mechanical tests are aimed to be performed as part of the project activities. These tests are now substantially conducted abroad. The plan, drawn up to make all tests fully domestic following the feasibility study which was conducted within the organization of the Design Engineering Directorate to provide a contribution to the targets of attaining fully domestic processes and decrease our international dependency, as well as to introduce the testing capabilities within the borders of our country under the project, was submitted to the Presidency of Defence Industries (SSB). In line with this plan approved by SSB, the order process for 11 mechanical test devices was completed in May.

The below-given devices, planned to be engaged in 2018, will be procured for the Design Engineering Directorate (TMD) Material Laboratory currently equipped with 1 tensile test device and 1 low-cycle fatigue test device:

- 1 ea High Temperature Tensile Test Device
- 2 ea Low-Cycle Fatigue (LCF) Test Devices
- 4 ea High-Cycle Fatigue (HCF) Test Devices
- 3 ea Creep Test Devices
- 1 ea Fatigue Crack Propagation Test Device.

# PRIZMA: PROJECT, WORK AND TIME MONITORING SYSTEM

The infrastructure works for the project, work and time monitoring system titled PRIZMA, to be employed at the Design Engineering Directorate were initiated upon completion of the joint works of the Senior Operations Team Leadership and the Information Technologies Management. PRIZMA, the project, work and time monitoring system, was established to monitor the efforts exerted for the existing and potential projects, to manage time / manpower effectively in the projects, to make the effective capacity plans for the future projects, and to make the project budgeting activities more efficient. The system will enable to digitize all efforts of employees ranging from annual project productivity to organizational productivity, and to obtain the accurate data instantly.

**PRIZMA, the project, work and time monitoring system;**

• Enables to monitor the project and remaining budgets on person and / or project basis in detail. It is an early warning mechanism in relation to the processes requiring corrective actions.
• Ensures time, workforce and budget feedback for the similar projects and the future implementation phases of project.
• Is beneficial in effective capacity / efficiency planning.
• Ensures fulfillment of the accountability requirements and evaluation of the development.
• Enhances productivity, concentration and motivation of the project members. Reduces and records off-duty lost time.
• Creates effective and beneficial working culture.

# B300 AND B700 BUILDINGS LIGHTNING AUTOMATION PROJECT

Although the lighting control systems were initially designed for comfort as mostly luxurious systems used in houses, the energy saving approach is now extensively employed at plants and enterprises, as well, which is well supported under the applicable laws and regulations.
In lighting system design processes; appropriate armatures, daytime running architecture, and energy saving lighting elements are preferred, ensuring a substantial amount of saving.
Therefore, use of lightning automation systems is significantly important. The main reasons of using the lighting automation systems are as follows:
• Decreasing fixed energy and personnel cost while increasing profitability,
• Increasing of energy costs,
• Statutory directives of the local and central administrations for energy efficiency,
• Positive impact of the green building concept on the corporate image,
• Environmentalist pressure.

The percentage of lighting in the total electrical energy consumption in our country is approximately 20%.
Efficiency in lighting will introduce both visual and budgetary advantages. Energy efficiency in lighting is achieved through provision of the lowest luminous intensity level as necessary, without compromising on visual comfort. For this; first of all, high efficiency light sources should be used instead of the low efficiency ones.

When the former lighting infrastructure of the B300 and B700 buildings at TEI Premises in Eskisehir was examined, it was found out that the average annual consumption of the 4x54W fluorescent armature was 1892,16 kWh at the B300 building, and the average annual consumption of the 400W halogen lamp was 3504 kWh at the B700 building. Instead of these old armatures which were used at these buildings, the 140W LED armatures with DALI and KNX DIMmable ballasts were installed, and it's now expected to achieve maximum annual consumption of 1226,40 kWh.

The consumption power of the renewed lighting armatures at both buildings is 140 W with efficiency of 138,5 lm / W and color temperature of 4000 K, which is the closest range to daylight.

In LED ceiling lighting armature installation, the cost-efficient lighting bus bar with a low level of labor costs which enable to supply all armatures with both energy and communication means through a single line was preferred instead of installation of the energy and data communication cable with a high level of labor costs that can increase depending on the number of armatures.

Furthermore; since the newly-installed LED armatures are DIMmable with DALI ballasts, the consumption ratio can be further reduced in line with the increasing / decreasing the luminous intensity that can be activated by TEI's Lighting Automation Control and Monitoring System based on the information obtained from the outdoor luminous intensity sensor. Another important feature of this activity is that everything, used in the Lighting Automation System, is high-quality and fully-domestic products.

Main components of the Lighting Automation Systems:
**1.** Control Devices: Panel-mounted (Touch Panel) and Distributed Tip (On / Off Buttons)
**2.** Area Sensors: Outdoor Luminous Intensity Sensor
**3.** Controlled Equipment: DIMmable LED Armatures, Electronic Ballasts (DALI)

HYPERION II monitoring / control software is used to monitor and report this system, and to change the local programs. This software enables the following activities:
• Operation of any lamp by means of any inlet on the network (photocell, switch, presence detector, etc.),
• Generation of the operational scenarios,
• Visualization of the system on the architectural project,
• Monitoring and controlling of the system,
• Obtainment of the status, failure, operational period, etc. reports from the system.

Consequently; popularization and perception of the Lighting Automation Systems as an unquestionable part of any site such as water and electricity installation are of critical importance for both our company and environment. From the corporate perspective; a Lighting and Automation System, designed in line with the needs and utilization of any environment, is one of the most important means to control the fixed energy and personnel costs of any business under the competitive conditions. From the perspective of our country; preference of fully-domestic products for the equipment and software, used in the lighting automation, promotes the domestic market. Lighting Automation System, an important part of the green building design, is also important for the corporate image. Moreover; productive use of the limited natural resources brings many advantages such as minimization of $CO_2$ emissions, and of energy consumption such as natural gas, oil, etc.

# NEW SAYP PROTOCOL EXECUTED

As part of the Researcher Training Program for Defence Industry (SAYP); the SAYP protocol was executed by and between TEI, Aselsan, Roketsan, Havelsan, FNSS, Turkish Aerospace Industries, Inc., Ctech, Bites, STM, BMC Power, Otokar and Sakarya University and the Presidency of Defence Industries during the "National Meeting and SAYP Protocol Signing Ceremony in Defence Industries" held on April 20, 2018 at the Cultural and Congress Center in Sakarya University under the coordination of Sakarya Teknokent A.S. .

# TEI KEEPS PROVIDING CONTRIBUTIONS TO ESKISEHIR



Three different ceremonies were held on February 13, Tuesday at TEI Facilities: Inauguration Ceremony of On-the-Job Training Program Trainees, Ceremony for Grant of Ambulance, owned by TEI, to the Provincial Directorate of Health, and Security Camera Surveillance Center Opening Ceremony. Stating that TEI provides contribution to our country with its domestic projects, and to the employment mobilization with its projects, carried out jointly with ISKUR (Turkish Employment Agency), during the keynote speech, Prof. Mahmut F. Aksit, President & CEO, TEI, said that TEI will maintain all these projects at full steam. Then, he said that they decided to grant the ambulance, which is owned by TEI but not used as it's not needed, to the Provincial Directorate of Health in order to ensure productive utilization of the national resources, and to provide service to many more people.

Lastly, he expressed the importance of opening of the Security Camera Surveillance Center, the most important security measure that needs to be enhanced due to TEI's participation in national projects, for TEI. Then, Ozdemir Cakacak, the Governor of Eskisehir, took the stage, and expressed how glad he was to participate in the inauguration ceremony held for the 36 trainees, who completed the respective course as part of the On-the-Job Training Program held for the third time this year jointly with ISKUR (Turkish Employment Agency), and extended his sincere thanks to TEI for its contributions to employment, and wished TEI good luck with the new projects. Continuing his words with the expression of thanks extended to TEI for grant of its ambulance, he emphasized how important the Security Camera Surveillance Center is for both our country and city. Following the speeches, Mr. Cakacak, the Governor, and Mr. Aksit, President & CEO, attached the personnel ID cards to the newly-employed personnel. Later than, they signed the signature board, prepared for grant of TEI's ambulance to the Provincial Directorate of Health, and examined the ambulance. The ceremony ended with opening of the Security Camera Surveillance Center.






# TEI RECERTIFIED AS A NONDESTRUCTIVE TESTING TRAINING CENTER

At the end of the audits, TEI has been re-approved as a Non-Destructive Testing Training Center on January 3, 2018 by Directorate General of Civil Aviation (DGCA) and National Aerospace Non-Destructive Testing Board - Turkey (NANDTB-Tr). Level 1 and Level 2 trainings on NDT methods, FPI (Fluorescent Penetrant Inspection), MPI (Magnetic Particle Inspection), Radiographic Testing (X-Ray), Ultrasonic Testing and Eddy Current Testing are given by TEI Level III qualified and certified experts in accordance with EN4179/ NAS 410 specifications. Within this context, Ultrasonic Testing - Level 1 General Theory training was given to six employees of EJS - Eskisehir Jant ve Makina San. Tic. A.S. between February 26, 2018 and March 2, 2018 by Ultrasonic-Level 3 Ersen ALTINTAS.

## BASIC FINANCE TRAINING DELIVERED

Employees of the Programs Directorate participated in the Basic Finance Training provided by the instructor of the International Air Transportation Association (IATA) at TEI premises in Eskisehir on February 16 - 18.

## CORPORATE RISK ACTIVITIES COMPLETED

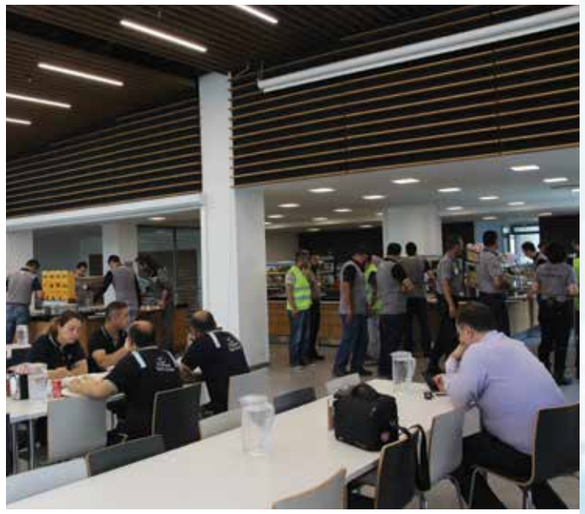
Corporate risk management activities are maintained to enable TEI to tolerate the risks and to achieve sustainable success. Accordingly; a workshop was held with participation of the directors and managers on May 22, 2018. During the workshop, the risks in relation to the corporate strategic priorities of TEI were determined and analyzed, and the current measures were assessed.

## GRADUATED CO-OP PROGRAM STUDENTS

Co-Op Program is carried out at TEI as part of the University - Industry Collaboration. The Students of the Aircraft - Airframe Engine Department at the Faculty of Aeronautics and Astronautics, Anadolu University, who received theoretical and practical trainings between February - May 2018, completed and graduated from the program successfully.

## CATERING SERVICE IMPROVED

In parallel with the increase in the number of our employees, the 3rd bain-marie was engaged in early 2018 with the new cooking equipment in order to decrease the time of waiting in lunch breaks, therefore, increasing the capacity to 4000 persons from 2500 persons. Moreover, the renewal processes were completed for the ventilation system of the kitchen and dish washing area.



## “INSPECTING LIKE TEI & F/O TRAINING” QUALITY TRAINING COMPLETED

Supplier Development, Quality, Strategy and Quality Systems Managements completed the quality trainings of “Inspecting Like TEI & F/O Training” held for TEI's suppliers.

## PERFORMANCE LEADERSHIP TRAINING HELD

"Performance Leadership - Training to Develop and Guide Others" was held for leaders on February 16 - 17, 2018.

## TEI AWARDED WITH THE TITLE OF "BEST EMPLOYER"


Aon Hewitt, the company conducting the Employee Engagement and Satisfaction Survey of TEI, grants "Best Employer Awards" and "Employee Engagement Awards" every year in Turkey. The award-winning companies are selected among the companies which show the highest increase in employee engagement terms. Showing an increase by 23% in 2017 on year-on-year basis, TEI ranked among the top-ranking seven companies among the leading 145 companies across Turkey, and became the only defence industry company granted with the "Employee Engagement Award" in 2017.

## RESPECT FOR THE HUMAN BEING AWARD

Responding to 20,000 job applications, filed for our company on Kariyer.net within an average period of 21 days in 2017, TEI was granted with the "Respect for the Human Being Award" by Kariyer.net. Our company was also awarded with the title of "Creating the Highest Level of Employment" in Anatolia by Kariyer.net.


## RUNNER-UP PRIZE BY DEFENCE AND AEROSPACE INDUSTRY EXPORTERS' ASSOCIATION

The biggest exporters of 2017 in the defence and aeronautics industry received their awards at the "2017 Successful Exporters Award Ceremony" and "2017 Shareholders' Ordinary General Assembly Meeting" of the Defence and Aeronautics Industry Exporters' Association (SSI) on April 3, 2018. TEI ranked second with its export operations of 268 million dollars in 2017 in the field of Defence and Aeronautics Industry, following Turkish Aerospace Industries, Inc. Ahmet Findik, Design Engineering Director at TEI, received the prize from Serdar Demirel, the Vice President of Defence Industries, and Latif Aral Alis, the Chairman of the Board of Directors of SSI.






## THE MOST ACCLAIMED ORGANIZATION OF THE WORLD AWARD

Prof. Mahmut F. Aksit, President & CEO, TEI, received "The Most Acclaimed Organizer Worldwide" award, granted for the original organization held by TEI during the Women of Aviation Worldwide Week.


## RUNNER-UP PRIZE IN DEFENCE AND AEROSPACE INDUSTRY BY TIM (TURKISH EXPORTERS ASSEMBLY)

Prof. Mahmut F. Aksit, President & CEO, TEI, received the runner-up prize under the category of "Exports in Defence and Aeronautics Industry" at the Award Ceremony for Export Champions of 2017 held by TIM (Turkish Exporters Assembly).

## AUTHORIZED ECONOMIC OPERATOR CERTIFICATE

TEI received the "Authorized Economic Operator Certificate" that is provided to the reliable companies, which can self-control, in order to minimize the customs clearance procedures in exports and imports operations, and grant some special privileges in customs clearance procedures.

# OPTIMIZATION: A NEW TREND IN MANUFACTURING OF THE AEROSPACE PARTS

**RECEP NAZIKGUL**
*Advanced Lead Engineer*
*Manufacturing Engineering*
*Management – TEI*

## SUMMARY

During the manufacturing by means of the machining method, one of the inputs determining the part cost is the processing time. Such time is a significant input item effecting the cost of all parts on direct basis. Each improvement, to be performed during the processing time, directly effects the competitive power, profitability and accordingly future of the enterprise. The developing software technology shows itself by means of the innovative approaches and methods on the tool path used for the milling cutter operations. One of the new techniques, effecting the cost directly, is optimization, and it rapidly finds implementation field within the industry. This letter studies the tool path optimization methods in order to decrease the cost inputs 2, 3 and 4 available in the Table 1.

| NO | COST ITEM |
|---|---|
| 1 | Raw material |
| 2 | Machining time |
| 3 | Labor hours |
| 4 | Tool, cutter cost |
| 5 | Fixture/fastening cost |
| 6 | Measurement/inspection cost |
| 7 | Operating expenses |
| 8 | Consumables expenses |
| 9 | Operating acquisition cost |

*Table 1*

## INTRODUCTION

The origin of the term "optimization", which means "making anything optimum", is French, and such term is used in many fields of our daily life. Its technical use may be summarized that all of the parameters are in best or most advantageous condition. The basic principle of the optimization, addressed and explained hereunder, is to increase the feed and to decrease the period down to the first parameter limit. The first parameter limit intended is the first obstacle enabling us to step on the brakes. Such obstacle varies from case to case. The following Table 2 includes some limits coming to mind firstly:

| NO | PARAMETER LIMIT |
|---|---|
| 1 | Geometrical tolerances |
| 2 | Surface quality tolerances |
| 3 | Metallurgical structure criteria |
| 4 | Tool breaking (Life) |
| 5 | Tool breaking (Strength) |
| 6 | Speed, acceleration limit (Machine) |
| 7 | Speed, feed limit (Process) |
| 8 | Torque, power limit (Machine) |
| 9 | Tool tightening force |
| 10 | Part fixturing strength |
| 11 | Chatter, vibration problems |

*Table 2*

Other limits than those specified in the table may also be available. Also, other restrictions are also possible based on the operation, enterprise, customer requests and also function of the part in the platform.

## THEORY

The main objective of the optimization is to increase the cutting parameters up to the limit, encountered firstly, on continuous basis. The key element, intended to be increased by means of optimization, is the material removal rate corresponding to the amount of material removed at the unit of time. The higher this amount is, the higher operational efficiency is. Simply, the following formula is used in order to calculate the material removal rate during any operation:

### Q=Ap x Ae x Vf

Q: Material removal rate ($in^3$/min)
Ap: Depth of cut (in)
Ae: Width of cut (Ae)
Vf: Table feed rate (in/min)

As it is seen in the formula, the method for increase of the material removal rate is to increase one of the connected parameters. The fact that which component will be increased determines the optimization type. There are two methods consisting of Optipath and Force. The calculation and approach criteria are different for such two methods. In the method of Optipath, the cross-section of material is removed as the basis during calculation; and in the method of Force, the force is calculated and Vf is increased accordingly. The optimization is carried out on the material removal rate by changing the speed without changing the Ap and Ae. Such methods are generally explained in the other sections hereof.

Optipath and Force optimization has focused on the efficiency in the active contact of the tool and part. However, there is also an optimization method for the auxiliary movements, in which the tool and part is not in contact during the operation.





Even if this method, known as the aircuts optimization, does not increase the material removal rate, it is based on decrease of the loss of efficiency resulting from the auxiliary movements during the operation.

## AIRCUTS OPTIMIZATION

It is the first step of the optimization stage, and it constitutes the acceleration of the auxiliary movements, performed during the operation, before the cutting parameters. It is a practical optimization method. A decrease by 1% - 15% is obtained based on the operation. The machine, fixture, stock, NC program and tools, to be used during the operation, are identified in the optimization software. The simulation is performed, and the software types the intended speed value in the program lines, in which the tool does not contact with the part. Accordingly, the period of the auxiliary movements, which have no value added during the operation, is decreased, and the lost time is saved.

Some adjustments are available for such process. The safety amount, obtained during approach to the part and separation from the part, should be entered. In the event that the acceleration process is not possible in single line, then the tool path may be interfered by adding the intermediary lines to the software. This adjustment is also up to the user's choice. As it is seen in the example specified in the Figure 1, processing time has been decreased by 11.75% in consequence of the optimization performed with respect to the auxiliary movements indicated as red, blue and yellow. Such rate may vary based on the amount of the auxiliary movements and cutting movements. However, the objective is to decrease the loss in the auxiliary movements independently from the active cutting conditions.

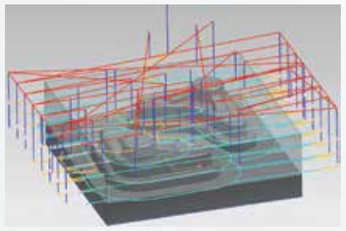


*Figure 1*

## CROSS-SECTION-ORIENTED OPTIMIZATION

In respect of this method, the basic parameter constitutes the cross-section of the material cut. The depth of cut of the cross-section of the material cut is indicated as Ap and the width of cut thereof is indicated as Ae, and the images of the parameters Ap and Ae are available in the Figure 2. The amount of material generally changes on the tool path. The programmer may identify only one feed rate for the classic CAM software. The programmer takes into account the cross-section, in which the amount of material is maximum, due to such restriction. However, any situation, which results in loss of efficiency in the regions with the less cross-section of material. The optimization may be performed for the purpose of efficiency increase.

The simulation software finds the Ap and Ae values for all NC program lines, and it decreases or increases the feed in comparison with the nominal values.

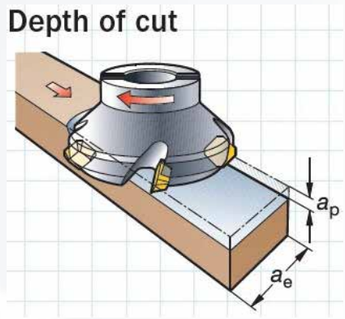



*Figure 2*

Any change occurs based on the feed, recorded on standard basis, in consequence of the analysis performed. Principally, the analysis performed is in some way an interpretation. Thanks to the parameters identified in the simulation software, the software acquires ability to decide, and it calculates the regions, where the pass is higher, and it decreases or increases the feed, accordingly. When considered from a point of view, it decides and becomes smart. How such analysis and interpretation has been performed through the Optipath module of the Vericut software is described in the Figure 3.

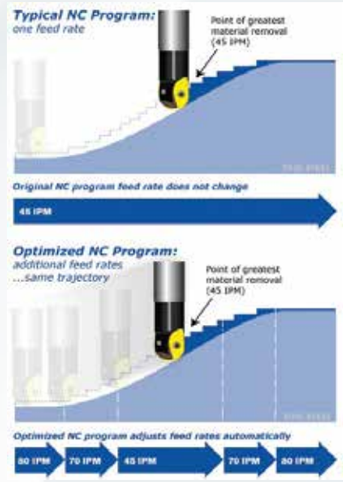



*Figure 3*

As it is indicated in the image, the table change its feed rate based on the amount of material per the cutter of the tool.

## FORCE-ORIENTED OPTIMIZATION

This method intends to increase the feed rate through the analysis for amount of material. When the table feed rate, which constitutes the real cutting feed rate of the tool, is increased, the amount of material per cutting edge decreases, and the tool exposed less cutting force and load. The major problem is that the volume of material to be cut in each line of the NC program by means of the tool, is not known, and also that it is unknown what the feed rate will happen based on such load.

At this point, the optimization software differs from the CAM software, which produces classic tool path, and it calculates such unknown matter for each NC line, and it assigns a separate feed rate for each line. Thanks to such development performed with the software, it has become possible to observe the forces, which will occur in the tool line by line, before cutting the part, and to take any precaution, accordingly, and also to perform adjustment, acceleration or deceleration.

*Figure 4*

NC program, tool, stock materials and material information are required to be identified in the software primarily. When the simulation is operated, the contact of the tool and part is calculated for each line, and the force value is found; and in the event that such value is higher than the value entered, then any lower value F is typed in the end of line and it is decelerated. Accordingly, the amount of material per cutting edge decreases; thus, the load and force exposed to the tool decreases. A representative image, indicating the status of the Thirdwawe software at the time of analysis, is provided in the Figure 4. Also, thermal analysis module is available. The chart, indicated in the Figure 7, has been obtained in consequence of the force optimization performed on the tool path of the part available in the Figure 1. The force value reaching the value of 1.750 lbf in consequence of the simulation performed through the original tool path has been fixed in the value of 650 lbf as the optimization criterion. Accordingly, the cutting forces, exposed to the tool, has been limited. Also, the feed rate has been intended to be increased up to 50 ipm in the regions where the cutting force is less than 650 lbf. In case of any conflict between such two criteria, the parameter is fixed in the first criterion. For example, in the event that the cutting force is still less than 650 lbf even though the feed rate is increased up to 50 ipm, the feed rate is not increased much more, and it remains at 50 ipm. The cutting force is less in such region. The Figure 5 indicates the optimized tool path. The value F required in the end of each line has been typed by the software.

```
N310 G1 X-3.5581 Y1.0022 Z1.4302
N320 G1 X-3.5581 Y1.0022 Z1.3302
N330 G1 X-2.6081 Y1.0022 Z1.3302 F18.3
N340 G1 X-2.6081 Y2.5591 Z1.3302 F32.6
N350 G2 X-2.5591 Y2.6081 R.049 F45.9
N360 G1 X2.5591 Y2.6081 Z1.3302 F32.6
N370 G2 X2.6081 Y2.5591 R.049 F45.9
N380 G1 X2.6081 Y-2.5591 Z1.3302 F32.6
N390 G2 X2.5591 Y-2.6081 R.049 F45.9
N400 G1 X-2.5591 Y-2.6081 Z1.3302 F32.6
N410 G2 X-2.6081 Y-2.5591 R.049 F45.9
N420 G1 X-2.6081 Y1.0022 Z1.3302 F32.6
N430 G1 X-1.917 Y1.0022 Z1.3302 F18.3
N440 G1 X-1.917 Y1.917 Z1.3302 F22.5
N450 G1 X.0463 Y1.917 Z1.3302
N460 G3 X-.09 Y1.5286 R.6293 F18.3
```

*Figure 5*

## RESULTS AND DISCUSSION

The processing time has decreased in the rate of 15% in consequence of the simulation performed. Thanks to such effect, which directly decreases the processing time, the cost of part has decreased; and also the machine capacity has increased while the cost of tool decreases. The possibility for tool breakdown decreases in consequence of elimination of the sudden increases occurring in the cutting forces. Also, the life of tool increases in consequence of decrease in the force modulation. Moreover, the CNC and spindle wear decreases in consequence of the forces fixed and remaining between any particular bandwidth, and also positive contributions are provided for the life of CNC in the long term. The images available in the Figure 6 indicate the examples for the abrasion and breakdown occurring in the tool optimized and not optimized.

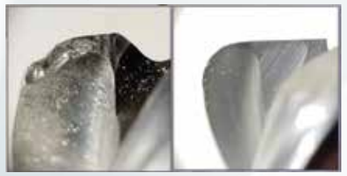


*Figure 6*

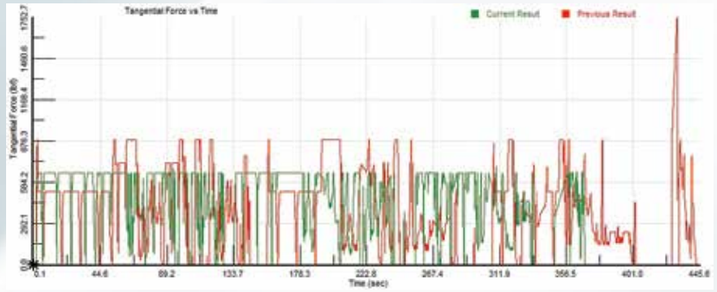



*Figure 7*

The fact that the forces, occurring during the cutting process, are known is also useful for determination of the fastening force in the fixture design stage. In the event that the force, trying to shift or tear the part from the fixture, is known, then the design may be performed based on such force.

## CONCLUSION

This compilation addresses the tool path optimization methods during the milling operations. Even though the methods have a wide range and many details, the key elements thereof are summarized hereunder. The engineering study is required to be carried out in order to create the outputs. Also, identification of such details in the software, performance of analysis and interpretation of the results take time. However, it is surely an efficient study when the engineering time spent per operation and the annual income obtained per part are compared.

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# OPTIMIZATION OF THE MECHANICAL PROPERTIES OF Ti-6Al-4V ALLOY FABRICATED BY SELECTIVE LASER MELTING USING THERMOHYDROGEN PROCESSES

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## ABSTRACT

2-step Thermo Hydrogen Process (THP) including hydrogenation and dehydrogenation steps was applied to Ti-6Al-4V alloy fabricated by selective laser melting (SLM) process to refine the microstructure and to increase the ductility of the alloy. It was observed that as-fabricated alloy's surface was composed of oxides of titanium and aluminum, which may alter the hydrogenation kinetics. The hydrogen treatment for 1 h at 650 °C, the maximum hydrogen solubility temperature of the alloy, transformed starting non-equilibrium α'-martensitic phase to β- and δ (TiH2) phases. On the other hand, very fine discontinuous β-phase was formed along with α-phase as a result of dehydrogenation at 700 °C for 18 h, which decreased the hydrogen level well below the starting value and caused transformation of δ-phase to fine α-phase.

In contrast to commonly used THP treatments consisting of betatizing at high temperature, 2-step treatment prevented grain boundary α-phase formation as well as excessive grain growth. About 110% and 240% increments were detected in % Elongation (EL) and % Reduction in Area (RA) values, respectively, as a result of 2-step THP, while the strength decrease was limited to 10%. The change in ductility of the alloy was also verified by transformation of flat and shiny fracture surfaces seen in SLM fabricated alloy to a fracture surface containing equiaxed dimples after THP treatment.

## 1. INTRODUCTION

Nowadays, by use of computer aided design (CAD), models with complex geometry can be produced easily without using expensive and time-consuming subsequent machining processes [1]. The success of the process was proved in achieving high density, complex and irregular shaped components that is nearly impossible to obtain in conventional methods [2]. Although SLM is capable of fabricating custom designed components in short durations, it yields microstructures similar to that of cast parts becauseof local melting and solidification, and residual stresses become unavoidable due to rapid cooling of melt pool formed during interaction [3]. Formation of nonequilibrium phases is also common in Ti-6Al-4V alloy samples. In contrast to equilibrium α+β microstructure, Ti-6Al-4V alloy processed by SLM contains fine, acicular martensitic phase, which is also known as α'with laser [4]. Therefore, to improve the ductility of SLM produced Ti-6Al-4V alloys and to make them suitable for load bearing applications in aerospace or biomedical industry, additional subsequent treatment is needed. Although annealing process increases the ductility it leads a considerable decrease in the strength of the alloy [5].

In this study, THP treatment was applied as an alternative technique for making SLM produced Ti-6Al-4V alloys suitable for load bearing applications by restoring α'-martensitic microstructure and by improving the ductility without losing too much strength. THP relieves the residual stresses appeared during SLM due to treatment at relatively

high temperature and refine the microstructure by alloying and de-alloying of hydrogen simultaneously. For this purpose, hydrogen absorption and desorption characteristics of the as-received SLM produced Ti-6Al-4V alloys were examined below α/β transition temperature of the alloy. Phase formation and microstructural development during each step were figured out by XRD and microscopy analysis. A series of tensile testing and hardness measurements were also carried out to reveal the effect of two step-THP on mechanical properties. Finally, results were compared with biomedical grade Ti-6Al-4V-ELI alloy containing equilibrium microstructure.

## 2. EXPERIMENTAL PROCEDURE

SLM fabricated Ti-6Al-4V samples were produced to have identical processing parameters such as the same layer thickness (t), scanning velocity (v), laser power (P), hatch spacing (h) to maintain the same volumetric energy density (E) of 10.8 J/mm3. The layer thickness was kept at 30 µm and spherical Ti-6Al-4V powders with a particle size between 5 and 50 µm were used during production. The as-received Ti-6Al-4V alloy produced by SLM was found to have 99.4% relative density. Both cylindrical and dog bone specimens with compatible dimensions to ASTM E8-16a standard [8] were produced for THP.

Hydrogen contents of the samples after hydrogenation and dehydrogenation steps were determined by a Leco TCH600 analyzer. Prepared samples' cross-sections were analyzed using Huvitz HDS-5800 optical microscope and also by using FEI NOVA 430 Nano Scanning Electron Microscope (SEM) equipped with Energy Dispersive X-ray Spectroscopy (EDX) detector. Bruker D8 Advance Eco device was used to obtain X-Ray Diffraction (XRD) patterns by using Cu-Kα radiation with continuous scanning at 40 kV between 30° and 80°, 2θ values. The surface chemical compositions of the as-received SLM fabricated sample were analyzed by XPS (PHI 5000 Versa Probe) with monochromatised Al radiation. Tensile tests were carried out using at least three samples at a constant cross head speed of 0.5 mm min–1 by a 100 kN capacity Instron 5582 Universal Testing Machine equipped with a video extensometer. The hardness test was conducted using a micro hardness-testing device of Shimadzu HMV-2T with a 500 g load and 20 s indentation time. At least, 15 hardness measurements were taken from each sample.

## 3. RESULTS AND DISCUSSION

### 3.1. Hydrogenation

Hydrogenation treatments, in the current study, were basically done to get information about the temperature dependent hydrogen solubility of the alloy. It has been found that the solubility of hydrogen first increases and then decreases after a certain temperature, Fig. 1.

Hydrogen concentration of the starting non-hydrogenated SLM fabricated alloy was measured as 0.0042 wt%. Hydrogen measurements have shown that temperature dependent hydrogen solubility did not change significantly until the hydrogenation temperature of 650 °C. Although the hydrogen solubilities were 0.07 and 0.15 wt%, respectively, for 550 and 600 °C, dissolved hydrogen content increased drastically to 1.19 wt % at hydrogenation temperature of 650 °C. The decreasing regimes of hydrogen concentration with increasing

| Alloy/Standard | Element (weight %) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Al | V | Fe | O | N | C | N | Ti |
| SLM Ti-6Al-4V alloy | 6.13 | 4.03 | 0.27 | 0.15 | 0,004 | 0,076 | 0,042 | Equilibrium |
| Wrought alloy Ti-6Al-4V-ELI | 6.01 | 4.04 | 0.16 | 0.12 | 0,003 | 0,015 | 0,009 | Equilibrium |
| Standard F136 | 5.50-6.50 | 3.50-4.50 | 0.25 | 0.13 | 0,012 | 0,080 | 0,050 | Equilibrium |

*Table 1: Chemical composition of as-received SLM fabricated and wrought Ti-6Al-4V-ELI alloys, and ASTM F136 standard.*

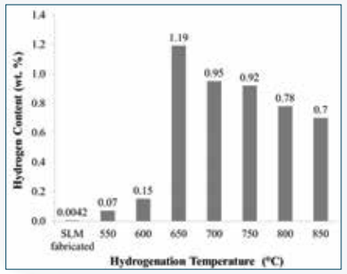


*Fig. 1. Hydrogen contents of the alloys after various hydrogenation temperatures for 1 h.*

temperature is because of the low solubility of hydrogen in Ti-6Al-4V alloy at higher temperature as also defined by Zhang et al. [9]. Presence of surface oxides (such as Al2O3, V2O5 as well as oxides of titanium) may change the hydrogen diffusion rate through the sample thereby changing the initial temperature dependence solubility behavior. XPS survey spectra given in Fig. 2(a) revealed Ti, Al, O, N and C elements on the surface of as-received SLM fabricated alloys. On the other hand, the oxide layer on the outermost surface region was composed of only titanium and aluminum oxides and no vanadium oxide was detected, Fig. 2(b) and (c). Ti 2p spectra displayed 2p3/2 peaks of Ti, TiO, Ti2O3 and TiO2 at 454.0, 455.3, 457.9 and 458.7 eV, respectively. On the other hand, Al 2p spectra exhibited deconvoluted peaks at 72.7 and 74.8 eV corresponding to 2p3/2 peaks of metallic aluminum and Al2O3.,

SLM fabricated Ti-6Al-4V samples (Fig.3(b)) fundamentally differ from annealed wrought Ti-6Al-4V (Fig.3(a)) alloys due to different thermal and processing history. In contrast to slow cooling which yields relatively ductile Widmanstätten structure containing equilibrium phases of lamellar α and β as observed in wrought Ti-6Al-4V-ELI alloys (Fig. 3(a)), SLM fabrication results in non-equilibrium needle like α' martensitic phase formation due to rapid solidification subsequent to large thermal inputs by laser, Fig. 3(b). The needle like microstructure was not changed considerably when the SLMed alloy hydrogenated at





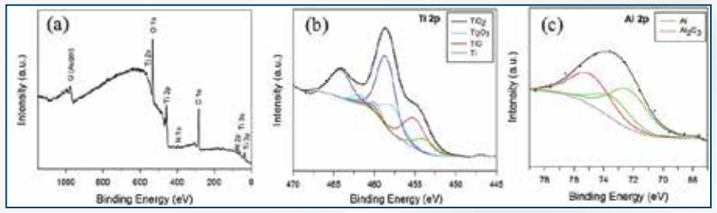


*Fig. 2. (a)XPS spectra of as-received SLM fabricated Ti-6Al-4V alloy; Deconvoluted XPS spectra of as-received SLM fabricated Ti-6Al-4V alloy (b) Ti 2p, (b) Al 2p. Experimental spectrum*

550 and 600 °C for 1 h. On the other hand, increasing the hydrogen content up to 1.19 wt% by introduction of hydrogen at 650 °C for 1 h drastically changed and coarsened the needle like structure.

The effect of hydrogenation on phase evolution of SLM fabricated samples at various temperatures for one hour is shown in X-ray diffraction patterns (XRD patterns can be reached from the full article of this manuscript). Formation of δ (TiH2) phase in Ti-6Al-4V alloy during hydrogenation is critical since the microstructure of the Ti- 6Al-4V alloys is refined by transformation of fine δ-phase to fine α-phase during the subsequent dehydrogenation step. Therefore, no δ-phase formation was detected for the samples containing 0.07 and 0.15 wt% hydrogen which were hydrogenated at 550 and 600 °C, respectively. δ-phase appeared in XRD pattern of the sample hydrogenated at 650 °C when the hydrogen concentration reached 1.19 wt%. Increasing hydrogen content also promotes the β-phase formation.

### 3.2. Dehydrogenation

In THP, microstructural refinement during dehydrogenation step depends on decomposition of fine δ-phase to fine α-phase and loss of dissolved hydrogen in both α and β phases. Therefore, in order to transform δ-phase to α-phase and to avoid the hydrogen embrittlement, specimens, which were previously hydrogenated at 650 °C for 1 h, were kept at elevated temperatures under high vacuum (~ 10–6 Torr). The final microstructure after dehydrogenation consisting of fine, equiaxed α and β phases with acceptable hydrogen content, at least equal to starting level, is considered to be ideal [6, 7, 11]. As illustrated

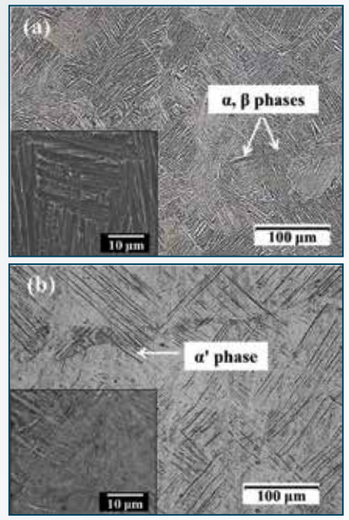


*Fig. 3. Optical micrographs of starting samples containing SEM micrographs (insets) (a) wrought Ti-6Al-4V-ELI alloy, (b) SLM fabricated Ti-6Al-4V alloy*

in Table 2, hydrogen contents of the samples which had been previously hydrogenated at 650 °C for 1 h, were lowered considerably when the samples were hold at various temperatures for 6, 18, 24 h. All the samples dehydrogenated at 700 and 800 °C temperatures met the hydrogen level defined by ASTM F2924-14 standard. However, minimum 18 h was needed at 600 °C to reduce hydrogen content to desired standard level. Determination of optimum THP variables in dehydrogenation step, minimum temperature and the shortest holding time is desirable in terms of shortening the process time and obtaining finer microstructure. Therefore dehydrogenation at 700°C for 18h was found as optimum process parameter for dehydrogenation. After this hydrogenation treatment, hydrogenated sample containing δ-phase and hydrogen loaded α and β phases was observed to contain only phases of α and β with reduced hydrogen level. Fig. 4 compares the effect of temperature on microstructure for 18 h dehydrogenation treatments. The bright phase in Fig. 4(d) was characterized as vanadium rich (11.5 wt% V and 4.1 wt% Al) β-phase, while the gray matrix phase was identified as α-phase with 2.2 wt% V and 6.5 wt% Al.

| Dehydrogenation Temperature (°C) | Hydrogen Content (in weight %) Dehydrogenation Period (Hour) | | |
|---|---|---|---|
| | 6 | | |
| 600 | 0.3807 | 0.0233 | 0.0176 |
| 700 | 0.1804 | 0.0019 | 0.0007 |
| 700 | 0.1586 | 0.0005 | 0.0001 |

*Table 2. The hydrogen contents contained by the alloys following the dehydrogenation processes performed at the different temperatures and for different periods.*

### 3.3. Mechanical properties

#### 3.3.1. Tensile test

Average values of tensile test results for the starting SLM fabricated alloy, 2-step THP (hydrogenated at 650 °C for 1 h and dehydrogenated at 700 °C for 18 h) alloy and the wrought Ti-6Al-4V-ELI alloy containing relatively ductile lamellar Widmanstätten structure are given in Table 3.

As-received SLM fabricated alloy had the highest yield strength along with the lowest ductility as shown in Fig. 5 and Table 3. The high yield and tensile strength with relatively low ductility undoubtedly resulted because of the presence of α'-martensitic phase that was initially present in the SLM fabricated alloy as shown in Fig. 3(b). Furthermore, extremely high thermal inputs during interaction with laser and subsequent fast cooling possibly induced internal stresses and lowered the ductility (% EL or % RA) of the

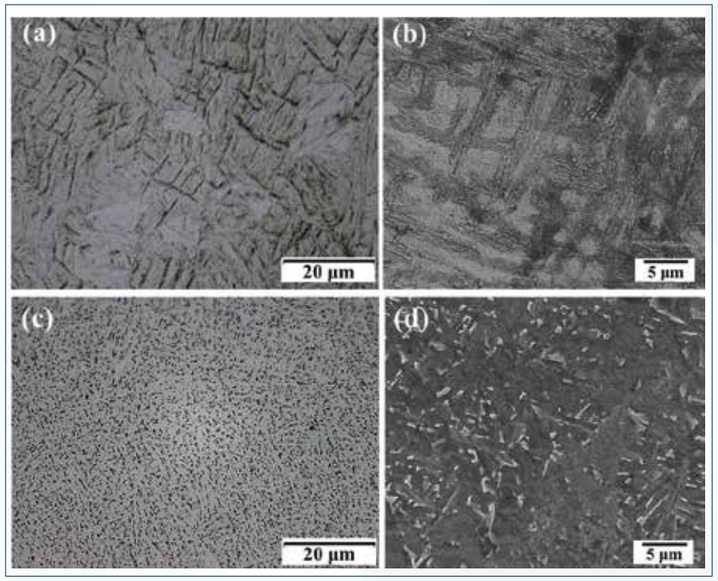


*Fig. 4. (a) Optical micrograph after dehydrogenation treatment at 800 °C for 18 h, (b) SEM image after dehydrogenation treatment at 800 °C for 18 h, (c) Optical micrograph after dehydrogenation treatment at 700 °C for 18 h, (d) SEM image after dehydrogenation treatment at 700 °C for 18 h.*

alloy, which was well below the value defined by ASTM F2924-14 standard. Application of 2-step THP increased the ductility significantly and about 110% and 240% increments were observed for % EL and % RA values, respectively. On the other hand, yield and tensile strength of the alloy decreased slightly, only by 10%. As a result of THP, SLM fabricated alloy had promising change in mechanical properties that make the alloy compatible with ASTM F2924-14 standard's mechanical requirements. The starting microstructure containing α'-martensitic phase in as-received SLM fabricated samples transformed to very fine α and β phases when THP was applied (Fig. 4(c) and (d)). Therefore, nominal tensile stress-strain curves for THP applied samples given in Fig. 5 exhibited longer plastic deformation regimes. On the other hand, heat-treated wrought Ti-6Al-4V-ELI alloy had the lowest strength with maximum ductility among the tested samples as expected since it contained equilibrium lamellar α and β phases (Fig. 3(a)). Although THP applied sample also contained α and β phases, it displayed different mechanical properties as the scale of the microstructure was very fine and not continuous as in the case of lamellar structure.

The tensile fracture surfaces shown in Fig. 6 clearly reveal the difference between ductility of starting SLM fabricated, THP treated and wrought Ti-6Al-4V-ELI alloys. The flat and shiny fracture surface with a few equiaxed dimples of as-received SLM fabricated alloy confirmed its relatively

| Sample | Yield strength σy (MPa) | Utmost tensile strength σU.T.S (MPa) | Elongation, EL (%) | Reduction of area RA (%) |
|---|---|---|---|---|
| SLM alloy | 1141.5 | 1246.7 | 4.7 | 5.0 |
| SLM + THP alloy | 1035.1 | 1110.2 | 9.8 | 16.9 |
| Wrought alloy | 742.8 | 866.5 | 15.3 | 21.4 |
| ASTM F2924-14 | 825.0 | 895.0 | 10.0 | 15.0 |

*Table 3. Mechanical properties of Ti-6Al-4V alloys in different conditions.*

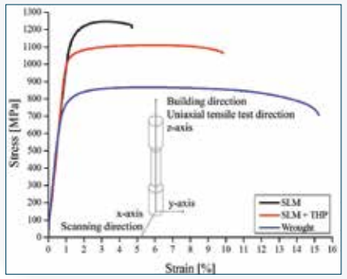


*Fig. 5. Stress-strain curves of room temperature tensile tests.*

low ductility. However, application of THP changed the fracture mode and fracture surface completely, and the samples fractured in cup and cone manner with a high degree of necking.

In Fig. 7(a), the scanning strategy for SLM fabricated tensile test samples was clearly observed by oriented relatively equiaxed grains intransverse cross-section. On the other hand, highly oriented grains were observed in materials' build or testing direction, Fig. 7(b). Despite the microstructural refinement, application of 2-step THP did not change the grain structure and the orientation of the grains observed in the starting SLM fabricated samples (Fig. 7(c) and (d)). In contrast to 4-step THP, 2-step THP applied in the present did not involve heating the alloy above β transition temperature, thereby preserving the starting oriented grain morphology. Therefore, when tested in different directions, THP applied samples would display anisotropic mechanical properties in contrast to wrought alloys containing equiaxed grains in both transverse and longitudinal directions (Fig. 7(e) and (f)).

## 4. CONCLUSION

2-step THP was applied to SLM fabricated Ti-6Al-4V alloys successfully with the aim of increasing ductility. In contrast to conventional 4-step THP, 2-step THP applied in the present study prevented grain growth and grain boundary α-phase formation. % EL and % RA values increased by 110% and 240%, respectively, as a result of THP, while the strength of the alloy decreased slightly by 10%. Ductility increase was also observed





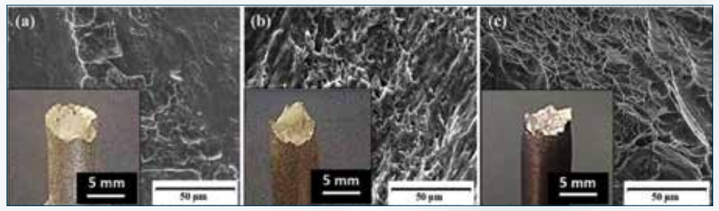


*Fig. 6. SEM images illustrating the tensile test fracture surfaces with the macro images (insets) of fractured samples (a) as-received SLM fabricated alloy, (b) 2-step THP treated SLM fabricated alloy, (c) wrought Ti-6Al-4V-ELI alloy containing Widmanstätten structure.*

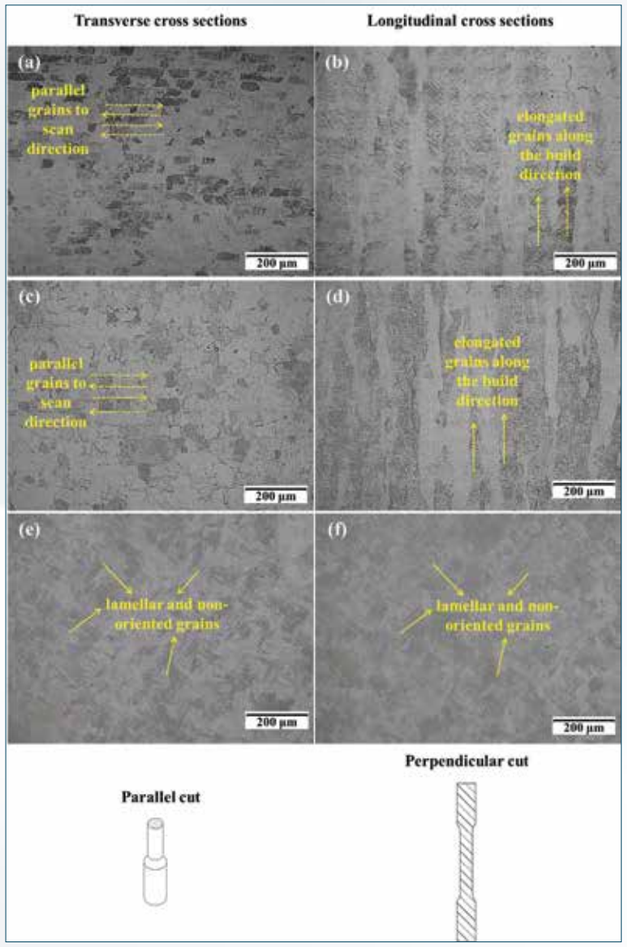


*Fig. 7. Optical micrographs of Ti-6Al-4V alloy; (a) parallel cut in as-received SLM fabricated alloy, (b) perpendicular cut in as-received SLM fabricated alloy, (c) parallel cut in 2-step THP treated SLM fabricated alloy, (d) perpendicular cut in 2-step THP treated SLM fabricated alloy, (e) parallel cut in wrought Ti-6Al-4V-ELI alloy containing Widmanstätten structure, (f) perpendicular cut in wrought Ti-6Al-4V-ELI alloy containing Widmanstätten structure.*

by transformation of flat and shiny fracture surfaces of SLM fabricated alloy to a surface composed of equiaxed dimples by 2-step THP. The maximum hydrogen level for 1 h hydrogenation was attained at 650 °C, which depends on composition of hydrogen gas source and the surface chemical composition of the alloy since the surface is composed of oxides like those of titanium and aluminum as in the present study. Moreover, hydrogenation at 650 °C and obtaining 1.19 wt% H resulted formation of δ-phase, which is prerequisite for microstructural refinement in Ti-6Al-4V alloys. Dehydrogenation treatment at 700 °C for 18 h was found to be optimum since it caused transformation of α'-martensitic phase to a microstructure containing very fine discontinuous α and β phases and decreased the hydrogen content to 0.0019 wt%, below the value defined by ASTM F2924-14 standard and that of the starting sample's hydrogen level (0.0042 wt.).

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# GAME CHANGER
# TERN

ALPER ÜNSAN'IN KALEMİNDEN

**When Unmanned Aerial Vehicles (UAVs) are mentioned, generally reciprocating internal combustion engines come to our minds. But, game-changing technological changes have started to arise recently in our world where technology develops each passing day. Realization of a special version of the T700 Turboshaft Engine, to be used in UAVs, by GE Aviation as part of the TERN UAV Program can serve as a good example to these changes.**

TTERN program fundamentally includes development of the "Medium-Altitude, Long-Endurance" (MALE) class UAVs equipped with the capability to land-take off vertically from the at-sea ship platforms.

Taking its power from the T700 engine developed exclusively for this program, TERN program is an UAV program in the category of MALE. The program's sponsor US Navy's catapult-launched Scan Eagle drones can see beyond the horizon, but they're too small to carry Hellfire missiles or guided bombs. The unmanned Fire Scout helicopters need only a small deck for takeoffs and landings, but generating lift solely with rotors means burning fuel faster than a fixed-wing plane would. For the Navy, the missing piece of the unmanned puzzle is a MALE UAV that could fly from its frigates and destroyers. DARPA and the Office of Naval Research set out in 2013 to find a possible design for such a craft that can take off vertically like a rocket and fly like an aircraft. BY ALPER UNSAN

Although TERN is currently kept confidential in military terms, according to the information obtained from the

publicly-available sources, GE Aviation has managed to modify the T700 engine for the UAV equipped with the Vertical Take-Off and Landing (VTOL) capability developed for the US Navy, under the sponsorship of the US Defence Advanced Research Projects Agency (DARPA) in less than 18 months jointly with Northrop Grumman.

For propulsion, Northrop Grumman, developing the TERN UAV platform, chose to modify the General Electric T700 turboshaft engine, the same kind of engine that powers the US Navy's MH-60 Seahawk helicopters, because T700 had the right power and the US Navy knew the engine well. But some changes had to be made for the TERN application as the T700 is positioned horizontally when supplying power to the vertical shaft of the Seahawk, but on TERN it will be tilted vertically during takeoff and landing. Therefore, GE had to modify the engine to ensure that both engine and gearbox would be lubricated in this vertical position, and that the new gearbox would fit into demonstrators' wings.





The subsystems such as new and relocated accessory gear box, engine air inlet, directional exhaust and especially engine lubricating system had to be modified and the special-purpose Full Authority Digital Engine Control (FEDAC) unit had to be installed on the T700 engine in order to fulfill the operations and control requirements for vertical landing-take-off (VTOL) from the ship helicopter platforms.

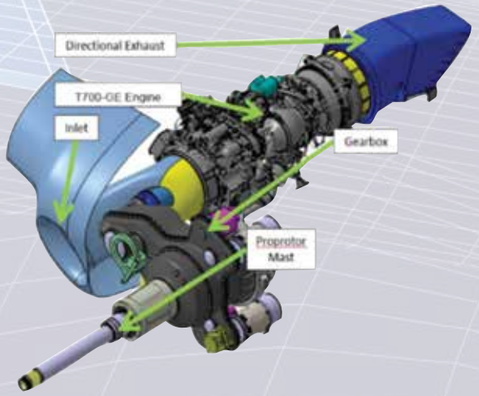
Thus, following change of around 210 parts in subsystems, a T700-Powered Tern Integrated Propulsion System Test (IPST) completed sustained vertical operations for the first time during testing in the Mojave Desert, California in January 2018.

A special-configuration swirl frame module, manufactured by TEI, is used in this newly-developed version of T700 engine.

Although the T700 engine was first released in 1970s, the "young at heart" engine has always updated itself in time and met the final user needs beyond expectations with its ownership cost, maintainability, reliability and performance aspects, and it doesn't seem to be willing to retire in the long run.

In our country, the turboshaft engines with the nameplate of T700-TEI-701D, to be manufactured by TEI under the GE License as part of the Utility Helicopter Program (UHP) under the sponsorship of the Presidency of Defence Industries of the Presidency of the Republic of Turkey, will be started to be delivered to Turkish Aerospace Industries, Inc. as of September 2018 in order to be used in the domestic T70 Turkish Blackhawk Helicopters.

Considering availability of the R&D, manufacturing, assembly and test centers such as TEI for the technologically-leading turboshaft and UAV engines, and




inevitable use of the UAVs for military and intelligence purposes under these harsh geopolitical geographical conditions prevailing in our country, it's highly likely that it will be an inevitable necessity for our country to realize the similar kind of innovative projects in future.

And the good news is that the qualified manpower and technological opportunities are increasing day by day in Turkey.

## REFERENCES


- https://www.darpa.mil/program/tern
- https://www.youtube.com/watch?v=XKj21xsVCmM
- https://bikeshop.geaviation.com/product/terning-the-t700-vertical-ges-t700-completes-a-key-test-as-powerplant-for-unmanned-air-system/



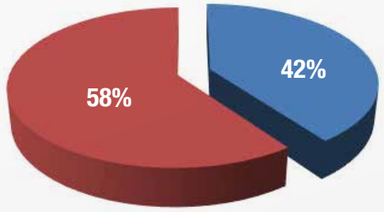
**ABOUT ALPER UNSAN**

He was born in 1975 in Istanbul. Graduating from the Department of Aerospace Engineering, Istanbul Technical University in 1998, he completed his Master of Business Administration at Koc University in 2001. He has been serving at TEI Programs Management as Senior Technical Leader since 2012.

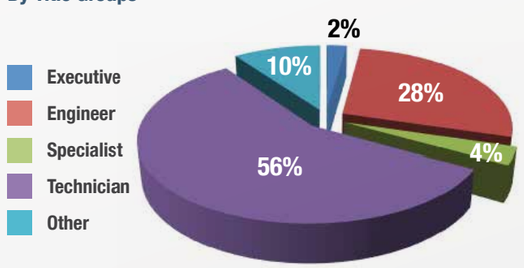

## STATISTICS ON TEI'S EMPLOYEES

**In respect of our 2124 employees as of June 30, 2018;**

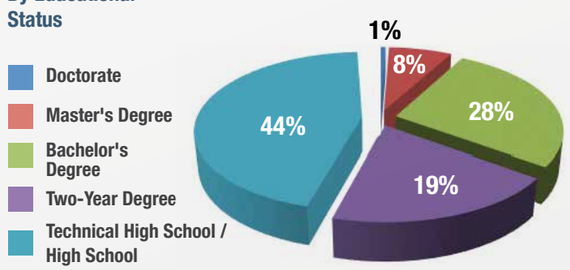
**Breakdown of White-Collar and Blue-Collar Employees**



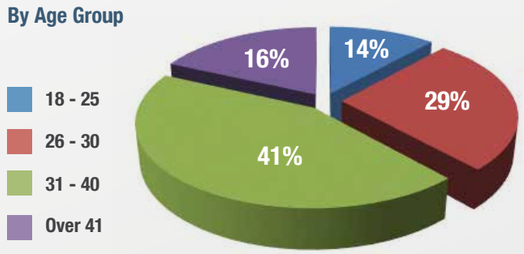

**By Title Groups**



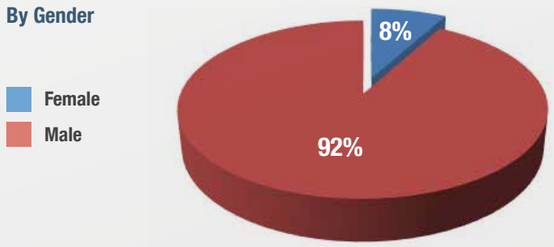

**By Educational Status**




**By Age Group**




**By Gender**








# NEW ASSIGNMENTS IN OUR COMPANY BETWEEN JANUARY 01, 2018 – JUNE 30, 2018

**Mehmet Demiroglu**
was assigned to serve as Turboshaft Project Director at Head Office on May 18,2018;

**Yeliz Cetinkaya**
was assigned to serve as Human Resources Director at Head Office on June 06, 2018;

**Ahmet Kain**
was assigned to serve as Programs Director at Head Office on June 28, 2018;

**Yasemin Ozkan**
was assigned to serve as NDT and Special Process Quality Leader at NDT and Special Process Quality Management on January 24, 2018;

**Seda Tuzemen**
was assigned to serve as Special Process Leader at Special Process Management on January 24, 2018;

**Emre Yavuz**
was assigned to serve as NDT and Special Process Quality Leader at NDT and Special Process Quality Management on January 24, 2018;

**Murat Eksi**
was assigned to serve as Special Process Leader at Special Process Management on January 24, 2018;

**Selahaddin Kinyas**
was assigned to serve as Special Process Leader at Special Process Management on January 24, 2018;

**Aysin Aras**
was assigned to serve as Quality Leader at Quality Management on February 14, 2018;

**Yuksel Akbay**
was assigned to serve as Security Leader at Facilities and Logistics Services Management on March 05, 2018;

**Mehmet Ali Aktas**
was assigned to serve as Construction and Specifications Leader at Construction Team Leadership on March 05, 2018;

**Gizem Ezgi Tatar**
was assigned to serve as Technical Leader at Senior Design Integrity and Airworthiness Team Leadership on April 09, 2018;

**Sibel Piskin**
was assigned to serve as Technical Leader at Senior Design Integrity and Airworthiness Team Leadership on April 09, 2018;

**Goktug Kara**
was assigned to serve as Material and Process Development Leader at Material and Process Development Management on April 09, 2018;

**Burak Balci**
was assigned to serve as Compressor Leader at Compressor Management on May 16, 2018.

## DEPARTMENTS ESTABLISHED AT TEI BETWEEN JANUARY - JUNE 2018

- **Turboshaft Project Directorate**

**We wish them success in their new positions.**

# VISITORS

**Visits to our company by various institutions and organizations continued at full steam in the first half of 2018.**

22.01.2018

Visit by Fadi Trabzuni, Vice President of AMIC, and His Delegation

31.01.2018

Visit by Major General Knife Dagnew, President of the Ethiopian METEC, and His Delegation

07.02.2018

Visit by Mechanical Engineering Department of Yeditepe University

15.02.2018

Visit by Research and Development Society of Sakarya University

22.02.2018

Visit by Industrial Engineering Society of Students of Eskisehir Osmangazi University

28.02.2018

Visit by the Executive Committee of the Presidency of Defence Industries, and the Accompanying Delegation



# TEI POST

07.03.2018

Visit by Randall Hobbs, Member of the Board of Directors of TEI, and Senior Executives of GE

23.03.2018

Visit by Turkey Air Technical Schools Command

27.03.2018

Visit by Materials Science Club of Yildiz Technical University

19.04.2018

Visit by Celal Sami Tufekci, Vice President of Defence Industries, and Delegation from the Presidency of Defence Industries

04.04.2018

Visit by Serdar Demirel, Vice President of Defence Industries, and Air Marshal Julian Alexander Young, Member of Executive and Steering Board of JSF, and His Delegation

03.05.2018

Visit by Daniel Fri, Director of F-35 Product Support Manager and Delegation from the Presidency of Defence Industries

11.05.2018

Visit by the Students of the Faculty of Engineering of the Middle East Technical University

17.05.2018

Visit by the Mechatronics Club of Kocaeli University

# EXHIBITIONS ATTENDED BY TEI

## EURASIA AIRSHOW


TEI attended and opened a booth at the Eurasia Airshow, held initially at Antalya International Airport between April 25 - 29. PD170 turbodiesel aircraft engine, TS1400 turboshaft engine mock-up, TJ90 turbojet engine, and 5 stage blisk manufactured for LEAP engine, and TS1400 engine parts manufactured by means of additive manufacturing method were exhibited at the Airshow. Prof. Ismail Demir, the President of Defence Industries, visited TEI's booth, and obtained information from Prof. Mahmut F. Aksit, President & CEO, TEI, about the national projects during the event. Meetings were set with senior executives of Turkish procurement authorities, international delegations and our client OEMs during the fair.


## AUVSI XPONENTIAL 2018

TEI attended and ran a booth at the AUVSI XPONENTIAL Fair, organized on May 1 - 3 in the city of Denver of the United States of America. TEI exhibited the PD170 turbodiesel aircraft engine and TJ90 turbojet engine section view during the fair which is the most important organization held for UAVs.





# EVENTS AND ORGANIZATIONS ATTENDED BY TEI

### DEFENCE INDUSTRIES R&D PERSONNEL TRAINING PROGRAM

Erinc Erdem, serving as Chief Engineer at TEI Chief Engineering Office, delivered a presentation titled "Turboshaft Engines and Indigenous Turboshaft Engine Development Project at TEI" as part of the Defence Industries R&D Personnel Training Program held on February 2, 2018 at Uludag University.


### AVIATION DAYS AT MIDDLE EAST TECHNICAL UNIVERSITY

Gokhan Aran, serving as Chief Engineer at TEI Chief Engineering Office, delivered a presentation in Aviation Days held on February 16, 2018 at Middle East Technical University.

### HEZARFEN AVIATION DAYS AT ESKISEHIR OSMANGAZI UNIVERSITY

Hakan Afsar, serving as Chief Engineer at TEI Turbojet/Turboprop Engine Management, delivered a presentation in Hezarfen Aviation Days held on March 3, 2018 at Eskisehir Osmangazi University.


### NATIONAL DEFENCE INDUSTRY AND SUBSYSTEMS TECHNOLOGIES SUMMIT AT FIRAT UNIVERSITY

Gokhan Bursoy, served as Turbojet/Turboprop Engines Manager between 2002-2018, vdelivered a presentation in the National Defence Industry and Subsystems Summit held on March 7, 2018 at Firat University.

### 13TH NATIONAL MECHANICAL ENGINERING CAREER SUMMIT

Salih Emrah Turan, serving as Power Turbine Manager at TEI, delivered a presentation in the 13th National Mechanical Engineering Career Summit held on March 7, 2018 at Istanbul Technical University.

## ESKISEHIR OSMANGAZI UNIVERSITY "2 GUNDE SIRKET-I ALEM" EVENT

Ercan Arican, serving as Combustion Chamber Manager at TEI, delivered a presentation in "2 Gunde Sirket-i Alem" event held on March 9, 2018 at Eskisehir Osmangazi University.

## YILDIZ TECHNICAL UNIVERSITY MATERIALS DAYS

Salih Emrah Turan, serving as Power Turbine Manager and Ozgur Poyraz, serving as Chief Engineer at TEI Chief Engineering Office at TEI, delivered a presentation in Materials Days held on March 13, 2018 at Yildiz Technical University.


## "KUMMPAS" EVENT AT KOCAELI UNIVERSITY

Mustafa Tuksal, serving as Compressor Manager at TEI, delivered a presentation in "KUMMPAS" event held on March 15, 2018 at Kocaeli University.

## UNIVERSITY OF TURKISH AERONAUTICAL ASSOCIATION NATIONAL UAV WORKSHOP

Turgay Karakus, serving as Flight Platform Integration and Pilotage Expert at TEI, attended the National UAV Workshop held on April 11 - 12, 2018 by the University of Turkish Aeronautical Association.

## MECHANICAL ENGINEERING SPRING CONFERENCES AT KIRKLARELI UNIVERSITY

Ozgur Alpan, serving as Advanced Lead Engineer in Piston Engines Management at TEI, delivered a presentation titled "Propulsion Systems in Unmanned Aerial Vehicles" during Mechanical Engineering Spring Conferences held on April 10, 2018 at Kirklareli University.

## DEFENCE INDUSTRY WORKSHOP IN KAYSERI

During the Defence Industry Workshop held in Kayseri on April 11, 2018 Erhan Bilgic, served as Piston Engines Manager between 2008 - 2018, and Selcuk Kilicarslan, serving as Special Process Manager at TEI, delivered presentations at the Unmanned Aerial Vehicles Vision Panel and the Military Advanced Materials Vision Panel, respectively.

## SUSTAINABLE AVIATION RESEARCHES WORKSHOP

Ahmet Findik, serving as Design Engineering Director at TEI, delivered a presentation in Sustainable Aviation Researches (SARES) Workshop held on April 19 - 20, 2018 at Atilim University.


## MIDDLE EAST TECHNICAL UNIVERSITY STUDENTS MEETING

Erinc Erdem, serving as Chief Engineer at TEI Chief Engineering Office, met students and delivered a presentation titled "Turboshaft Engine Development Project" on April 12, 2018 at Middle East Technical University.


## INDUSTRY AND TECHNOLOGY SUMMIT AT GEBZE TECHNICAL UNIVERSITY

TEI attended and ran a booth in Industry and Technology Summit at Gebze Technical University on April 11 - 12. The PD170 turbodiesel aircraft engine model, TS1400 turboshaft engine mock-up and TJ90 turbojet engine were displayed during the event. Fatos Bahar Cekyay, Turboshaft System Design and Integration Manager at TEI, also delivered a presentation titled "Turboshaft Engine Development Project and Cooperation Opportunities" in the summit.


### CAREER DAYS AT BATMAN UNIVERSITY

Salih Emrah Turan, serving as Power Turbine Manager at TEI, delivered a presentation in Career Days held on April 19, 2018 at Batman University.

### ISTANBUL TECHNICAL UNIVERSITY AVIATION DAYS

Ercan Arican, serving as Combustion Chamber Manager at TEI, delivered a presentation in Aviation Days held on April 19, 2018 at Istanbul Technical University.

### DEFENCE INDUSTRY PROGRAM AT INONU UNIVERSITY

Mustafa Tuksal, serving as Compressor Manager at TEI, delivered a presentation in the Defence Industry Program held on May 3, 2018 at Inonu University.

### YILDIZ TECHNICAL UNIVERSITY 8TH DEFENCE INDUSTRY DAYS

Emin Tuzlu, Piston Engines Manager at TEI, delivered a presentation in Unmanned Aerial Vehicles Panel as part of the 8th Defence Industry Days held on May 3, 2018 at Yildiz Technical University.

### LAGARI DEFENCE AND AVIATION DAYS AT BURSA TECHNICAL UNIVERSITY

Mustafa Tuksal, serving as Compressor Manager at TEI, delivered a presentation in Lagari Defence and Aviation Days held on May 8, 2018 at Bursa Technical University.

### ASME TURBO EXPO 2018

Advanced Lead Engineer Volkan Tatar and Engineer Firat Kiyici, who both serve in Design Engineering Directorate at TEI, presented their articles at ASME Turbo Expo, which was held on June 11 - 15 this year in Oslo, Norway.





# EMERGENCY MANAGEMENT

**The emergency means any contingency or chain of contingencies, which may negatively result in one or more death, injury, material damage, ecocide, etc..**


The emergencies are determined by taking into account the human and environmental factors. The emergencies may vary based on each institution or organization. In general, the fire, earthquake, deluge or flood, lightning, occupational accidents, environmental accidents, heavy snow, and food poisoning constitute the common emergencies, and the technological disasters, sabotage, terrorism, chemical-biological-radiological-nuclear (CBRN) factors are also considered as the emergency based on the content of the good and services.

Determination of the emergencies constitute the keystone with respect to determination of the works to be carried out in order to minimize the potentially negative consequences and to prevent occurrence of any emergency, as well as to response management, and to the emergency management, in brief. The planning constitutes one of the most critical stages with respect to the emergency management. The trainings, drills and coordination of the activities also constitute the other important factors.

The natural disaster is the first thing coming to mind with respect to determination of the emergencies. In respect of the natural disasters, the primary subjects consist of geographical location, meteorological threats (hurricane, storm, lightning, flood, snowstorm, and wave of hot and cold air, etc.), topographical characteristics (avalanche, landslide, etc.), tectonic movements (earthquake, volcanic eruption, etc.), and biological threats (epidemics, disease-spreading animals, etc.).

Technological  disasters occurs due to human activities or induction by the natural disasters. Such disasters generally consist of the chemical, nuclear and radiological accidents in the field of industry, mining, transport and transportation, and the conflagrations, biological incidents, sabotage and wars, critical infrastructures and cyber threats, as well as of any disaster or emergency resulting in the environmental threats, the loss of lives, the diseases, the social deterioration, the economic disruption and the environmental degradation.

The number and frequency of the technological disasters have recently increased in our country, as in throughout the world, based on the development of the technology, the rapid population growth, level of development, environmental pollution and irregular urbanization. Therefore, it is required to be prepared against the technological disasters as much as the natural disasters.

The emergency management should be a dynamic process in order to ensure compliance with the ever-changing and -developing conditions, and to take into account the risks, which may arise from the conditions, and also to be prepared against any and all kinds of conditions, and it should be applicable not only to the institutions and organizations but also any and all relevant parties. In respect of the relevant parties of the emergencies affecting the business continuity as much as the safety of life and property, the elements of the supply chain and the public and local administrations should also be available.

The trainings and drills should be carried out with respect to the events, determined, in order to be prepared totally against any and all kinds of emergencies, and the level of awareness of the employees and people should be raised, and also it should be cooperated in order not to be damaged materially and immaterially in case of any potential event.


**Technological Disasters Inducted By The Natural Disasters**

- Major Industrial Accidents
- Mining Accident
- Radiological and Nuclear Accidents
- Climate Change
- Environmental Effects
- Environmental Release of the Genetically Modified Organisms
- Accidents Resulting in the Marine Pollution
- Accidents Resulting from the Dangerous Goods Transportation
- Critical Infrastructures and Cyber Security etc.

**Natural Disasters Inducted By The Technological Disasters**

- Earthquake
- Flood
- Landslide
- Rock Fall
- Avalanche, etc.





# DESIGN ENGINEERING DIRECTORATE ASSESSMENT MEETING FOR 2017

Design Engineering Directorate held the Year-End Assessment Meeting at TEI Social Facilities Building on January 12. Prof. Mahmut F. Aksit, President & CEO, TEI, attended the meeting, held under the leadership of Ahmet Findik, Design Engineering Director, besides all employees serving at the directorate.

During the meeting, where the activities carried out within the organization of the Design Engineering Directorate in 2017 were assessed, the targets and plans set for 2018 were unveiled. The meeting, during which treats were served, ended with the quiz show and award ceremony.

# DINNER EVENT ORGANIZED FOR THE INTERNATIONAL WOMEN'S DAY - MARCH 8

Prof. Mahmut F. Aksit, President & CEO, TEI, organized a dinner event at TEI Guesthouse for female employees on the occasion of the International Women's Day - March 8. During the event attended by Randall Hobbs, Member of the Board of Directors of TEI, Mr. Aksit, President & CEO, gave his ear to the suggestions of female employees.

# 32ND TRADITIONAL TEI SPRING TOURNAMENT

32nd Traditional TEI Spring Tournament started on April 1, 2018. During the six-week tournament participated by TEI's 1023 employees; competitions were held in the branches of football, basketball, volleyball, tennis, table tennis, bowling, badminton, dart and billiards. Also, the bouncy castle set up for our employees' children was one of the most attracting activities during the tournament.

The qualifying employees were granted with the cups by Prof. Temel Kotil, Chairman of the Board of Directors, Prof. Rafet Bozdogan, Prof. Osman Saim Dinc and Melih Abis, Members of the Board of Directors, Prof. Mahmut F. Aksit, President & CEO, TEI, and the Senior Management of TEI at the cup ceremony held on June 6, 2018.






## Qualifying Employees

**DART TOURNAMENT**
1. Hakan Mutluay
2. Mehmet Emre Kurt
3. Orkun Kekec

**TENNIS TOURNAMENT**
1. Ahmet Ozsahin
2. Murat Deha Deger
3. Guray Akbulut

**TABLE TENNIS**
**Men's Singles**
1. Kivanc Akcesme
2. Murat Ozcan
3. Mustafa Babacan

**Women's Singles**
1. Aysin Aras
2. Aylin Enginsoy
3. Elif Yenigun

**Doubles**
1. Kivanc Akcesme – Mustafa Budun
2. Murat Ozcan – Murat Kasap
3. Turgut Alptekin – Ahmet Ozsahin

**BADMINTON**
**Singles**
1. Murat Kesmeli
2. Ibrahim Calikusu
3. Ozgur Yaman

**Doubles**
1. Hale Nur Kuzgun – Gurhan Kuzgun
2. Ibrahim Calikusu – Murat Kesmeli
3. Gokcen Tuzturk Yilmaz – Sercan Yilmaz

**BILLIARDS**
1. Ilayda Ugurlu
2. Abdullah Sonayaz
3. Turgut Avci

**BOWLING**
**1. Testciler:** Coskun Tunca, Ersin Basaran, Ercan Eken, Cetin Enser, Mehmet Emre Kurt, Kamil Kivrak, Hakan Dinc
**2. Bir Ton:** Gurcan Duran, Soner Korpe, Ugur Ozer, Levent Sarsilmaz, Sabri Yilmaz, Onur Gunal, Ercan Ercanlar
**3. Blue Stamp:** Bulent Ferli, Ismail Kurt, Murat Uzbilir, Ozgur Tunaboyu, Mustafa Saka, Cihan Sahin, Ozgur Kilic

**VOLLEYBALL**
**1. HoopHey:** Onur Aydogan, Ecem Altintas, Merve Cikla, Nafiz Cagri Sahin, Ilayda Ugurlu, Ozgur Alpan, Muzaffer Bilinmis, Bertu Birkan Gul
**2. Voleymibol:** Aylin Enginsoy, Muzaffer Kaya, Serkan Yavuz, Firat Arslan, Omer Burak Unsal, Ali Can Budak, Mehmet Emin Bal, Fatih Ceylan
**3. Anti-Kor:** Oyman Kurban, Sedat Akdogan, Hande Akbas, Deniz Asiklar, Faruk Cincor, Yakup Duran, Ersin Kayaarasi, Ugur Aksay

**BASKETBALL**
**1. Luftwaffe:** Himmet Emre Aktas, Yigit Cetinkaya, Erinc Erdem, Ozgur Alpan, Omer Burak Unsal, Mertcan Mut
**2. Ramp – up:** Yusuf Kemal Demiray, Fatih Tektas, Onur Ariyurek, Furkan Bilgic, Samet Tasyurek
**3. High Towers:** Ercan Arican, Ozan Ayhan, Necip Peker, Atacan Kilic, Emin Tuzlu, Serdar Kayhan






**FOOTBALL**

**1. Kalite Birligi:** Ahmet Benli, Alican Ergen, Ender Yurtsever, Mustafa Zeki Salkin, Resul Dumlukaya, Burak Var, Mehmet Can Kuru, Engin Kusan, Eray Can Mutlu, Kadir Goksel, Niyazi Metin, Volkan Tepekaya, Necati Erdal, Osman Ozyurt, Melih Karamalaklar, Serkan Yavuz, Mithat Sunecli, Serhat Goz, Yusuf Karali

**2. AR-GE:** Serdar Kayhan, Sinan Guresci, Mustafa Kadir, Hakan Afsar, Hakan Emiralioglu, Serkan Kinden, Ilhan Gorgulu, Murat Deha Deger, Yusuf Sancak, Muzaffer Bilinmis, Enes Cakmak, Semih Avcun, Yucel Beki, Necip Peker, Sevket Ertekin, Mehmet Kesbic, Mustafa Cem Sertcakan, Ozan Ayhan, Mertcan Mut, Coskun Tunca

**3. Genc Freze:** Hakan Gundogan, Ali Demir, Birol Saracik, Cafer Karaca, Omer Emre Karaduman, Erdal Ozbel, Erhan Eker, Erman Gunaydin, Fuat Donmez, Gurcan Sert, Halil Karabulut, Harun Mevlut Sari, Ismail Ciftci, Metin Cetin, Ridvan Bilir, Serdar Ayhan, Serkan Kaya, Aykut Cavdar, Gurkan Gur








**THE MOST GENTLEMAN TEAM**

**Tool Crip FC:** Samet Duru, Fatih Kalay, Serkan Cimen, Cuneyt Kilic, Orcun Koseoglu, Kadir Baydar, Gokhan Sarikinaci, Baris Akin, M. Emin Buyruk, Bugra Akgun, Atila Bulut, Erbay Erturk, Kemal Dogan, Sefa Yasar, Yilmaz Girgin, Fatih Kaynarcalioglu, Can Ertunalilar, Serdar Tavlar, Onder Duzgun

**TOP SCORER**

Burak Var – Kalite Birligi

**THE BEST GOALKEEPER**

Serdar Kayhan – AR-GE


# EVENTS FOR APRIL 23 ORGANIZED

Organized every year since 2009 as part of Events for April 23 dedicated to the children of our employees, the contest was held under the theme of "Recycling". The works, participating in the contest, were displayed at TEI Guesthouse in Children's Event for April 23. 98 participating children had an enjoyable time with the animation team. The organization ended with presentation of gifts to the qualifying and participating children.

# TEI'S TRADITIONAL IFTAR DINNER ORGANIZED

TEI's Traditional Iftar Dinner was held with attendance of Prof. Temel Kotil, Chairman of the Board of Directors of TEI, Prof. Rafet Bozdogan, Prof. Osman Saim Dinc and Melih Abis, Members of the Board of Directors, Prof. Mahmut F. Aksit, President & CEO, TEI, and our 1300 employees on June 6, 2018. Mr. Aksit, President & CEO, shared his mid-year assessment after the dinner, which drew a great deal attention from the employees.

# LET'S MAKE OCCUPATIONAL SAFETY YOUR BEST FRIEND

Every year, the week of May 4-10 is celebrated as Occupational Health and Safety Week in Turkey in order to emphasize the importance and priority of occupational health and safety in work life. Accordingly; the Occupational Safety Slogan Contest, open for participation of TEI's employees, was held for the 2nd time this year, thus becoming a tradition across TEI. The slogans proposed by TEI employees were assessed by the jury based on the criteria of being concise, striking and original. The slogan proposed by Ceyhan Ozdamar, serving as Technician in Manufacturing Fabrication Management, titled as "Let's Make Occupational Safety Your Best Friend!" was selected, and he received his prize from Prof. Temel Kotil, Chairman of the Board of Directors of TEI, during the TEI's Traditional Iftar Dinner held on June 6 ,2018.





# TEI VISITS MOTHERS ON THE 33RD ANNIVERSARY OF ITS INCORPORATION


As part of this traditional organization held for the first time on January 25, 2016, the anniversary of incorporation of TEI, by the members of TEI's Social Responsibility Group, the volunteer female employees and members of TEI's Social Responsibility Group visited 50 mothers, giving birth to their children on that day, and shared their excitement with their gifts of new-born sets.


# ITU HEDEF TEAM CROWNED WITH CHAMPIONSHIP

ITU Hedef Team, supported by TEI as the gold sponsor, ranked first among 26 teams in Imeche UAS Challenge, and was crowned with the "Overall Grand Champion" award.

# **TEI CONTINUES TO** SUPPORT EDUCATION

As part of the traditional Intelligence Workshop Project organized for the first time in 2016, TEI set up its fifth workshop at Sehit Osman Gazi Altinoluk Primary School in the district of Han, Eskisehir on January 15, 2018.

The opening ceremony of the Intelligence Workshop, set up with the contributions of TEI's volunteers, was attended by Alay Yazici, District Governor of Han, Ozden Akkaya, Deputy Provincial Director of National Education in Eskisehir, Mehmet Ertas, Deputy District Director of National Education in Han, TEI's volunteers and the teachers of the school.





The sixth Intelligence Workshop of TEI was set up at Metin Sonmez Primary School in the district of Odunpazari, Eskisehir on May 28, 2018.

The opening ceremony of the Intelligence Workshop was attended by Necmi Ozen, Provincial Director of National Education in Eskisehir, Kursad Onder Ceylan, District Director of National Education in Odunpazari, Ozden Akkaya, Deputy Provincial Director of National Education in Eskisehir, Ejder Yurttas, Department Head of the Provincial Directorate of National Education, Murat Colaker, Head of Internal Auditing and Evaluation Committee, Selma Oguz, School Principal, and the teachers of the school.



# CONTEST OF MAKING AND FLYING A MODEL AIRCRAFT HELD BY TEI FOR WOMEN OF **AVIATION** WORLDWIDE WEEK

The week covering the date March 8th has been celebrated as "Women of Aviation Worldwide Week" since 2010 with a different and meaningful theme in the memory of March 8th, 1910 when the first woman pilot was licensed across the world. Accordingly; TEI organized the Contest of Making and Flying a Model Aircraft with participation of 36 female students from 18 different schools on March 8 at Sabiha Gokcen Vocational and Technical Anatolian High School, with the support of the Provincial Directorate of National Education in Eskisehir. During the organization, members of the Institute of Electrical and Electronics Engineers of Eskisehir Osmangazi University (IEEE) guided the contestants in making of a model aircraft. Beyhan Rifat Cikilioglu Anatolian High School won the first place in the category of making the best aircraft while Sabiha Gokcen Vocational and Technical Anatolian High School ranked first in the category of flying the model aircraft made for a maximum period of time. Thanks to this organization, Prof. Mahmut F. Aksit, President & CEO, TEI, received the "Organizer of the Most Acclaimed Organization of the World for the Women of Aviation Worldwide Week" award.


# **BLOOD DONATION CAMPAIGN** ORGANIZED

TEI organizes blood donation campaign two times a year as part of the Blood Donation Protocol signed with Blood Donation Center of Turkish Red Crescent in Eskisehir. As part of this campaign, a Red Crescent bus visited TEI's facilities in Eskişehir, and more than 50 volunteers from TEI supported the campaign by donating their blood on March 28.


# **WORLD AUTISM AWARENESS DAY** ORGANIZATION

TEI's volunteer employees hosted 15 students, receiving training at Eskisehir Tepebasi Municipality Center for the Disabled, and three teachers, serving at this center, in TEI Guesthouse on April 2 World Autism Awareness Day. The organization was ended with presentation of the gifts to the guests following the breakfast.





# **CHILDREN WITH AUTISM SUPPORTED** BY TEI


TEI added a new project to the ones carried out with the support of the Provincial Directorate of National Education in Eskisehir, and the opening ceremony for the panic room, needed at Special Education Application Center in Vadisehir, was held by TEI on May 24. Delivering a speech during the opening ceremony, Ozden Akkaya, Deputy Provincial Director of National Education in Eskisehir, thanked TEI for its social responsibility projects realized in the field of education across Eskisehir. The organization, attended also by the Department Head of the District Directorate of National Education in Odunpazari, ended with ribbon cutting and plaque presentation ceremonies.

BY EZGI TATAR

# AIRWORTHINESS AND CERTIFICATION WITH EASA

Today, “Certification” and “Airworthiness”, which have become an integral part of the civil aviation, arise as non-ignorable requirements in development processes of aircraft and related systems. The purpose of this article is to explain the process carried out by the European Aviation Safety Agency (EASA), which constitutes an European Union organization, with respect to satisfaction of such requirements.

**Airworthiness - Certification**

• Based on the definition as provided under the MIL - HDBK - 516B, the airworthiness means the property of a particular air system configuration to safely attain, sustain and terminate the flight in accordance with the approved usage and limits . The certification is a systematic process, which is applied in order to determine that any air system is airworthy under the operational conditions, and results in any resolution documented by the authority as the definition given by European Council (2008).

• Aviation authorities have been authorized to certificate any and all kinds of aircraft and relevant products thereof, so by ensure the airworthiness in the field of civil aviation. The Federal Aviation Administration (FAA) and EASA, established in accordance with the principles of the International Civil Aviation Organization (ICAO), principally check the compliance with such specification through establishment of the procedures and specifications. They also certificate the aircraft and relevant products thereof as well as the organizations designing and manufacturing such aircraft and products.

The reason behind the design and production organization approvals given by the authority in addition to the product certificates is the growth of the authorities cannot reach the number of the people working in the industry and the number of the products industry produces.

• Due to the nature of the certification process; the certification requirements applicable for the product to be certified are determined and the certificate of such products must be issued after the compliance of the product with tese certification specification is checked independently and the compliance is confirmed accordingly by the aviation authorities. Due to the rapid development of the aviation business over time, the staff members, who will check each product particularly, have been required to be available within the organization of the aviation authority; however, it has not been deemed appropriate to include such a large number of staff members within the organization of the aviation authority, because of financial and administrative issues. It has been decided that it is more appropriate to establish a systematic, through which the relevant aircraft products will be checked independently based on the certification specifications of such products, within the organization of the companies designing and manufacturing the aircraft. The requirements of such systematic with respect to the aircraft design are described in the following section.

**Certification by EASA**

• EASA carries out the certification processes in accordance with the Commission Regulation Nr. 748/2012, which is also known as the Part 21. The organizations, designing such aircraft or relevant product, are required to obtain a Design Organization Approval (certificate) in order for certification of the aircraft and relevant products in accordance with the Part 21.

• Any organization, designing the aircraft or relevant products, must firstly file an application for the Design Organization Approval (DOA). Any application for certificate is also required to be filed with respect to the aviation product, to be designed, in a manner to be parallel with the application for DOA.

A Design Assurance System (DAS) is required to be established in a manner to be integrated with the quality system (ISO9001, AS9100 or similar) defined within the company in order for obtainment of the DOA by applicant organization.

**There should be three functions in the DAS in accordance with the requirements prescribed under the Part 21 (Figure 1). These are as follows:**

i. Design function, which performs the design of the product, to be certified, in accordance with the procedures of quality and design assurance system of the company, and demonstrates its compliance with the relevant standards;

ii. Airworthiness function, which performs the independent check and compliance verification with respect to the product to be certified;

iii. Independent monitoring function, which monitors the operation of the design assurance system within the organization.

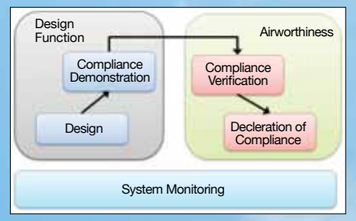



*Figure 1. Design Assurance System*

• The relevant aviation authority (e.g. EASA) checks the compliance of the product with the relevant certification specifications in a manner to be parallel with the airworthiness function (compliance verification) until the applicant company for the certificates, completes the DOA process and obtains the certificate. After the organization obtains the certificate of DOA, it may utilize the privileges, as defined under the Part 21, and it may perform compliance verification activities within the company, under the airworthiness function. Once such certificate is obtained, EASA might only review the documents, they deems necessary for compliance verification, or it may not require such review.

• In the Part 21, the definition of Compliance Verification Engineer (CVE) is given for the personnel who perform the airworthiness function, and the points to be considered for selection of such personnel are provided together with the airworthiness signatories.

• Airworthiness signatories of CVEs are used to represent the authority under the DOA certificate. The certificate of DOA establishes a framework of trust between EASA and the design organization obtaining such certificate. Once the requirements prescribed under the Part 21 are proved to be satisfied with the internal procedures, the signature of the CVEs means verification of the compliance of the aviation product with the applicable airworthiness specification.

• The type certification process of a product and the airworthiness function activities, for which CVEs are responsible, are illustrated in the diagram below:

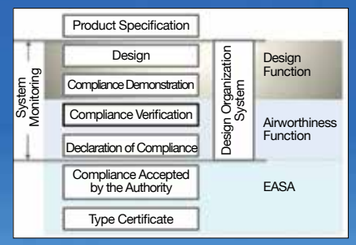



*Figure 2. Type Certification Process and CVE Activities*

**Conclusion**

In conclusion, the process described in order to be able to design a airworthy product for the aviation industry in the European Union region, is required to be satisfied by the relevant companies. Once such requirements are satisfied, it may be ensured that the accidents are reduced in the Civil Aviation, and that the safe travels are provided.

**ABOUT EZGI TATAR**

She was born in 1987 in Ankara. She graduated from the Astronautics Engineering of Istanbul Technical University in 2010. Tatar, who joined TEI in 2011, continues to serve as the Technical Leader in the Design Integrity and Airworthiness Senior Team Leadership.

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# TRADITIONAL CONFIGURATION MANAGEMENT APPROACH, INTEGRATED PROCESS EXCELLENCE AND CMII (CONFIGURATION MANAGEMENT 2) METHODOLOGY

BY SIBEL PISKIN

### Traditional Configuration Management Approach

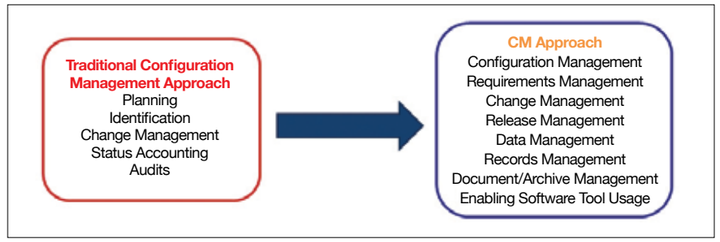
Configuration management constitutes the whole of the systematic activities carried out during the entire life cycle of the product as of creation of the project, including the design, manufacturing, service processes, with respect to the "product" oriented engineering studies in order to perform the product and any and all of its relevant documents and data flow, defining the product, between any and all relevant units in an integrated and concurrent manner, and to guarantee that the need for change arising is reflected in the product and any and all of its documents, and to ensure that the final product obtained corresponds to any and all documents defining the product, and also to be able to guarantee that the product, satisfying the requirements, has been performed.

Configuration management should be considered as monitoring and checking both physical and functional configuration throughout the life cycle of the product. The primary objectives of configuration management can be listed as follows:

• To guarantee that the product, delivered to the customer has the functional and physical requirements described in specification and drawings specified in in the contract;
• To allow the product to be remanufactured;
• To provide full, current and accurate information to Project Management;
• To minimize the restructuring process of the product;
• To document the product in a manner to satisfy the needs for operation, repair - maintenance and change.

### Why Configuration Management?

• To support the objective to have the globally original power systems, as covered by the vision of TEI.




• To guarantee the clarity, conciseness and validity of data transferred from design to manufacturing;
• To provide retroactive traceability with respect to the repair, maintenance and overhaul activities performed during the service process;
• To prevent the same data from being kept in more than one area repetitively and without revision check;
• To create know-how by providing reuse of the design data;
• To guarantee that the change has been reflected in the product and the documents defining the product;
• To guarantee that the manufacturing manufactures the final revision design product;
• To notify the supplier timely of any change planned;
• To be able to manage the product BOM (Bill of Material);
• Configuration management is essential in order to increase the employee satisfaction.

Traditional configuration management approach consists of five fundamental components which are as follows:

• Configuration Management Planning;
• Configuration Management Identification;
• Configuration Management Change Management;
• Configuration Management Status Accounting;
• Configuration Management Audits.

Configuration management planning constitutes the planning of resource, training, organization and performance monitoring of the configuration management discipline, and also planning of the activities for standard configuration management practices specific to the project, if and when required, in order to develop and monitor configuration management processes.

Identification of the configuration management is intended to provide a descriptive basis in order to be able to carry out the control and status accounting activities throughout the life of the configuration unit. Accordingly, the product configuration structure is created, and the configuration units are identified, and the flows are fictionalized in order to publish the documents of the configuration unit, and the configuration baseline which will provide the configuration information of the product at certain times, are defined, and also the configuration units and documents are numbered.

Configuration change management constitutes a systematic process, in which any change is suggested, justified, assessed, coordinated and approved, and also in which the implementation plan of the change is presented, in case of any need for change after the configuration unit documents are published.

The "Configuration Control Board" (CCB) structure is operated in order to review the changes to be performed in the documents of the configuration unit, and to determine the dates of implementation, and also to identify the other documents impacted.

Configuration status accounting constitutes demonstration, recording and reporting of the status of any and all changes, which have been performed in the baseline documents, periodically in order to be able to manage the configuration system effectively. Its purpose is to create records for the other configuration management activities.

Configuration management audits seek an answer for two questions which are as follows: "Have we designed the right product?" and "Have we correctly manufactured the product we have designed?" Two types of configuration audit, constituting the functional and physical audit, are performed in order to answer such questions. The audits are performed by ensuring the customer coordination in order to ensure that the product design satisfies the requirements agreed under the contract, and to validate the integrity of the configuration documents, and also to verify the consistency between the product and the product documentation.

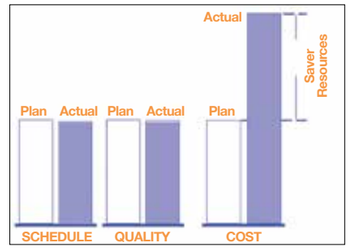


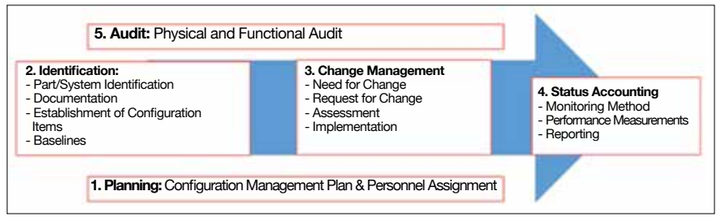


limitations. In respect of a "product" based approach, the CMII intends to achieve process excellence by controlling a range from configuration management to the change and data management through utilization of an effective PLM (Product Lifecycle Management).

In general, achievement of the quality and calendar objectives with respect to the projects conducted by the enterprises is just possible by allocating extra resources, and such resources are over-costing. Usually, utilization of extra resources is performed at 40% to 60% of those planned in any project.

The standard configuration management principles do not involve an approach that covers any and all of the main business fields of the organization. CMII Methodology leads to such objective by implementing the




### Integrated Process Excellence and CMII Methodology

CMII constitutes an industrial standard and business methodology, which constitutes a prerequisite in order to achieve the Integrated Process Excellence, and which has been designed in order to keep the requirements clear concise and valid and to manage the changes. CMII stands for Configuration Management 2, and it constitutes a model designed in order to provide solutions for the traditional configuration management original Configuration Management approach on an incorporate scale. Configuration management has been re-fictionalized in a manner to assemble any and all of the main business fields of the enterprises under the same roof. The integrated process excellence is achieved when the enterprise processes are fully integrated and automated, and accordingly when the "Zero Source" is allocated for the error correction activities with respect to the "Quality" and "Calendar". The CMII approach


addresses the following corporate processes, one of which constitutes the configuration management, as a whole.

• Configuration management ensures that the configurations are in compliance with the requirements.
• Requirements management ensures that the requirements documented are clear, concise and valid.
• Change management ensures that the documents and data published are managed through the closed-loop process.
• Release management ensures that the documents have been authorized and released before use.
• Data management ensures that the database is accurate and secure.
• Records management maintains the traceability of any and all documents, and it proves that the results are appropriate.
• Document and library management protects the information assets and prevents the unauthorized changes.
• The active use of PLM software enables the capability and efficiency of the processes to be increased.

### When is the CMII essential?

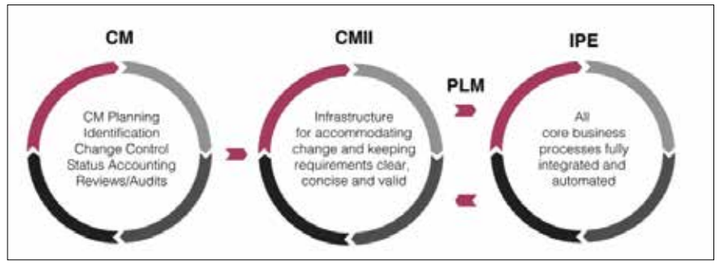
• When the processes are repeated and implemented;
• When the processes are tracked through the paper copies;
• When the processes require intensive labor;
• When the processes are highly affected by human error;
• When the processes are performed using Excel, MS Access, post-it notes and e-mails;
• When the processes cause the problems with respect to the after-sales services.

When the differences between the traditional configuration management approach and CMII are reviewed, it is observed that the CMII does not use

conventional configuration management outlines, and that it does not define any configuration unit, and that the outline are not fixed but movable, and also that not only the change management of the product but also the change management of any and all processes are addressed.

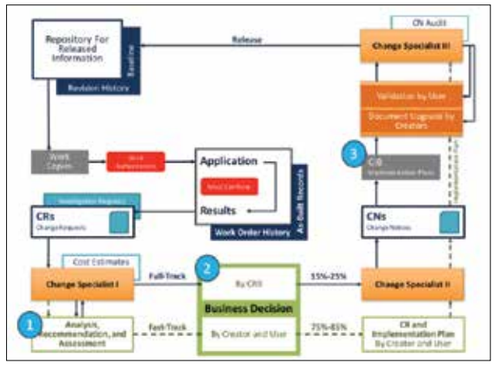
While the scope of the traditional configuration management is limited to the design definitions, the CMII establishes a structure that assembles any and all activities with respect to the configuration management under the same roof.

While the conventional configuration management approach proposes the Configuration Control Board (CCB) structure under the change management, it proposes separation of the technical assessment, resolution and implementation functions of the change under the CMII approach. Accordingly, it also recommends the Change Implementation Board structure, in addition to the Configuration Control Board structure, in order to ensure the planning and follow-up of the activities required by the change. When the need for change occurs, the preliminary assessment is performed; and it suggests that




the "Fast – Track" or "Full – Track" is decided, and that the 75 - 85% of the changes can be monitored in a manner to be subject to less approval by means of such method and in a structure, in which any decision is made faster.

The trainings for CMII approach within the organization of TEI were initiated in 2016. In the sector, the companies such as Turkish Aerospace, ASELSAN, SSM, STM, TUBITAK - SAGE, FNSS, TUMSAN, Vestel Savunma and Nurol Makina also receive the advanced modules of CMII trainings as collective training groups, and they continue their studies for adoption of the CMII methodology as a company culture and reflection thereof in the applications they have performed. Similarly, TEI also continues to carry out its studies in order to transit the product life cycle in real terms, and to ensure the necessary integrations, including ERP primarily, and also to achieve the Integrated Process Excellence by implementing the CMII methodology, after the PLM tool becomes widespread in the other activity fields within the organization of TEI. Accordingly, any and all relevant departments available within the organization of TEI, primarily Design Engineering Directorate, continue to carry out the detail-analysis studies in order to fictionalize their processes in a manner to manage them on the PLM tool under the coordination of Information Technologies Directorate.




**ABOUT SIBEL PISKIN**

She was born in 1981 in Antalya. She graduated from the Department of Industrial Engineering of Yildiz Technical University in 2003. She served as Material Planning Engineer in 2006 - 2010 and as Configuration Engineer in 2015 - 2018 within the organization of TEI.
She continues to serve as the Technical Leader in the Configuration Management Team Leadership under the Design Engineering Directorate.

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# SOFTWARE IS A LIFE SAVER

BY MUJDAT ASLAN

***Ariane 5 Flight 501***
***Date: June 1996***

**We're encountering software in every field of our life, and surrounded by a gradually-extending software network each passing day. We're involved in a universal world ranging from simple software solutions, used to monitor our entries/exits to/from the workplace every day, to virtual money networks.**

Ariane 5 spacecraft, under the financial and technical management of CNES (Centre national d'études spatiales - National Centre for Space Studies) acting under the supervision of the French Department of Defence and Research, was launched by means of the same software as the one used in Ariane 4 flight. And the result? It resulted in a loss of US$370 million due to an explosion occurring approximately 40 seconds after it was launched! As it was launched in a controlled area and designed for unmanned mission, it caused no loss of life or injury. Is it a relief? Considering that 4 A320 aircraft can be purchased with US$370 million based on the price list of Airbus for 2017, it can be clearly understood that we need much more to deem it as a relief.

2 million lines of codes for Lockheed's F-22... 7 million lines of codes for B787 Dreamliner... 150 million lines of codes for the brand-new F150 of Ford... 2 billion lines of codes used by Google to provide Internet... I think all these figures suggest how giant the scope of what we mention here is.

Just a few examples: an automobile you ride with 220 km/h, an aircraft carrying nearly 300 persons on board, and Internet providers on which you save all your private life... So, what do you think about in what kind of a perspective they are developed and made available for us? Are they developed by means of random codes by a few software teams without any control mechanism? How can the authorities ensure safety and security of all these products in this new world that cannot be dissociated from software? And the answer here reveals how critical the software is. This concept of criticality is formed based on the safety risk of the system under the software. An aircraft... A high-speed train... A nuclear reactor... An X-Ray... They are all considered as a safety-critical system. And the software installed on these systems are developed in line with the safety criticality assignment depending on the criteria such as whether they constitute any risk to cause to loss of life and property or to damage environment.

**Software Criticality Assignment (Development Assurance Level)**
Although there are several methods to be used to determine the safety criticality level of software depending on the areas of use, "SAE ARP4754A - Guidelines for Development of Civil Aircraft and Systems", the guideline recognized as the "best practice" example, is used. Software is assigned with a criticality level using the Safety Assessment process and methods provided thereunder. To summarize; first of all, hazard assessment of the software-related functions of the system / subsystem into which the software will be integrated, is conducted, and then, functional and part-based criticality assignments are performed using the fault trees drawn for each function.

Here, software is considered as a part, and developed at an appropriate development assurance level in line with the criticality level assigned, and thereby, it is integrated into the respective system along with the acceptable safety risk. Internal criticality of the software units is assessed separately by means of FMECA (Failure Mode, Effects and Criticality Analysis), and the special fields to focus on during development are determined. This process is followed by the software design / development phase. In fact; the standards, used for the development phase, are not safety standards. They aim to ensure that the software delivers the expectations in harmony with the concepts such as quality, reliability and security, etc. in line with the criticality level assigned to the software from the system level. Which means that in case you assign any wrong safety target or functionality following the analyses conducted at the system level, you might well guarantee an accident in fact with any software designed in line with these standards!

Development standards/guidelines vary depending on the areas of use. While EN50128, IEC62138 and IEC62304 are used in rail systems, nuclear power plants, and medical devices, respectively, DO178C guideline is used for avionic equipment software development. The contents of all these development standards/ guidelines are created to make the software free from systematic errors as much as possible, and to prevent such potential errors to cause any unsafe condition at system level.

Although software development errors cover a highly extensive cluster, errors are predominantly development process-related errors called as "systematic errors". We can classify such errors generally as logical, syntax and running errors. We can say that the logical errors, which can be defined as the failure by the software to act in line with the expectations, and the "run-time errors", which arise due to emergence of conditions beyond our projections during utilization of any function, are the most dangerous ones among the above-mentioned errors. Because, these two errors might not be determined by any means other than special analyses while the syntax errors can be determined and corrected by means of coding and compiling tools.

Common methods are offered in all safe software development standards/ guidelines in order to make the software free from errors. The method continues with the process of "Code just what is requested, test what you have coded, and take notes of the outputs of the test". While the process is maintained, the detailed questions of "What did the client request, and what did I do? To which extent did my work satisfy the client's request?" are asked. Answers to these questions are recorded by means of reviews and tests.

Thereby any extra, missing and insufficient code will have been determined and eliminated in the software during this process among the trio of Requirement - Code - Test, and the software will have been analyzed to see that whether it can go through all these potential processes for minimum once, as well as the relation inside the modular structure leading to functions / independency status. In cases where such debugging processes are not carried out, any error that doesn't arise during the tests might arise in a critical operational point, making the entire system unsafe.

An unknown cluster, which reach up to million and even billion lines, become a part of a known world thanks to all these reviews, tests and records.

System Safety doesn't like anything unknown; because, acceptability of any unknown thing cannot be commented. On the other hand, anything known can be assessed in the acceptance process. In case the software made known is at the acceptable risk level as stipulated by the safety requirements, it will be integrated into the system, and made functional. If it's now at such level, it may not be a part of any safety-critical system. Developers of such kind of software will end up with billions of code lines, and it would be hard for them to put themselves in for any other billions of lines due to loss of time, money and motivation.

Upon the Ariane 5 flight 501 accident in 1996, the developers squared the circle and completed Flight 502 successfully.  Are you asking how? By attaching value as deserved to the acquired disciplines. The engine of the system, to which the software used in the former model of Ariane 5 was integrated, was equipped with a lower level of acceleration compared to Ariane 5. The effect of such acceleration difference at software level occurred as such: the result found after converting the 64-bit decimal to the marked 16-bit integer was greater than what was expected. And this resulted in the failure in the inertial reference system, and the spacecraft exploded. CNES team addressed this accident as a lesson, and conducted the-then most extensive research in the field of software with respect to Ariane 502 flight.

Ariane 5 accident is just one of the examples. There are many more software-related accidents and efforts by the organizations which accepted their errors and generated solutions to prevent reoccurrence of such errors. For example;

• Toyota had to recall its 160.000 Prius Hybrid cars, which was the biggest





of all times, due to the software error which stopped its engine, in 2014.

• The US$125 million-Mars Climate Orbiter approached Mars much closer than it should have been, and exploded due to the conversion error since the NASA team utilized the imperial system while another team under the project utilized the metric system.

• Due to a failure on the incoming network line of the L.A. Airport, take-offs/landings from/to the airport were suspended for 8 hours in 2007. Can you imagine that such an error occurs at Ataturk Airport where, according to the data for 2017, 120 passengers are involved in the air traffic per minute, and the loss of potential accidents in such a case?

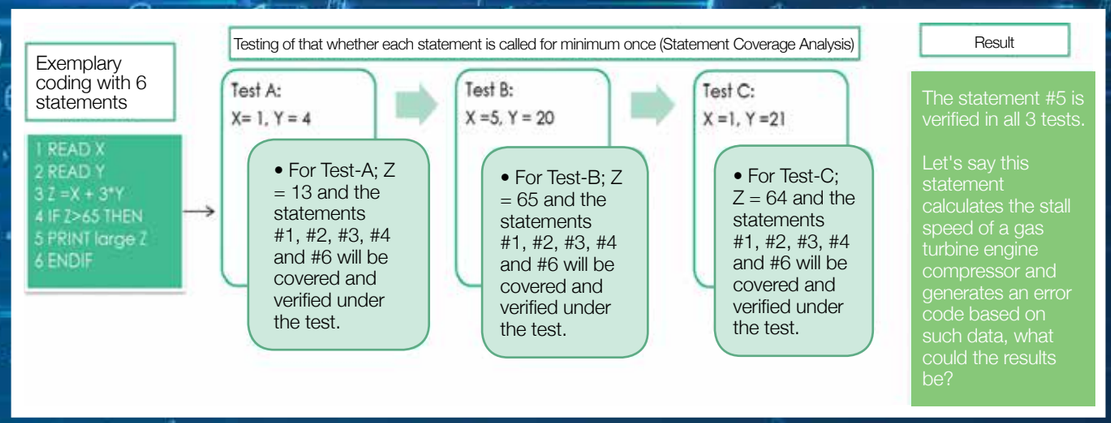
Systems including software have become a part of our lives. They have some safety risks, which does not necessarily mean that they have some components to be afraid of. What matters is to which extent you can measure your risk, and keep it under your control. We need to employ the quality processes and reliability approach, which serves directly for safety, in order to make any unknown thing known. Although the processes are tough and costly, they become pale in comparison with the costs I have mentioned above. First of all; when human life is at issue, it should not be relied on any unknown thing without any technical base.

Unfortunately; it's impossible to develop any software for safety-critical systems by abstaining from the reporting and procedural operational workload introduced by the evidence generation processes (Requirements - Code - Test - Review), an essential component of software development process. Someone had already paid for, and shared their mistakes with severe penalties. Considering the limited project deadlines and budgets in Turkey, we should listen to the quote by Hyman G. Rickover said, in order to maintain our existence: "It is necessary for you to learn from others' mistakes. You will not live long enough to make them all yourself."

While artificially-intelligent humans, flying automobiles, autonomous vehicles in all fields, and many more push the limits of our imagination about the future, if we fail to attach the value as deserved to the acquired disciplines, we might be required to acquire them by losing all the things we value.


## ABOUT MUJDAT ASLAN

Born in 1990 in Ayancik, Sinop, Mujdat graduated from Department of Aeronautical Engineering Faculty, Istanbul Technical University in 2013. He has been serving as an Engineer at the Design Integrity and Airworthiness Team Leadership since 2014.

# SUCCESSOR?

**When talking about European basketball, there's nothing to discuss about the top-ranking figure. The most influential figure of basketball across the old continent: Zeljko Obradovic - the current head coach of Fenerbahce Dogus -**

BY BURAK BALCI

In statistical terms; achievements of Obradovic, he attained in both different teams and long years, are far beyond his competitors. But the persons, who know him, are well aware of that he is something more than just numbers and statistics; he is different in terms of other factors. Regardless of a pre-season practice match or a Final Four match, we always see him in the same concentration status on the bench. He is always demanding. He expects his players to reach their 100% performance during both trainings and matches. If a player makes a wrong shot choice, he cannot escape from being called on the carpet by him even if the shot is successful . A momentary absent-mindedness or negligence is the major fault in either defence or offense. He wants to see the reflection of the fire he lights from the bench. Independently from being stars of the team, he always prefers to give the jersey to players who deserve it; he never shows favor, just believes in hard working. He always reminds his players of what it means to play basketball at professional level in front of thousands of spectators who have come to watch them live, and wants them to know that they should act with the responsibility, imposed thereby, in their minds. He blows up to see that young players are not aware of the chance granted to them, and believes that they should be engaged in personal trainings, care for personal development, and remain on the gym longer than anyone else. He severely criticizes the ones who fail to act so. He values commitment. He has always been recognized and received a high level of respect by the fans and society of each club he has worked for so far. To summarize this list that can be extended further, Obradovic went through the proper channels to climb up to the top and remain there, and achievement is a default feature of him. After such a long and fascinating introduction, let's make a pause here (but, we'll mention about the legend of Obradovic again later).

### A success story: Zalgiris Kaunas

Real Madrid hit the peak in the Final Four held in Belgrade this year. They were, in fact, not considered as the favorite team at all, but the Spanish representative took the cup to its museum following the Final Four, consisting of just two matches which suggest a contradiction with the long season. Unlike the common case of winners' putting their stamps on history only, we congratulate Real Madrid, and focus on the team which went beyond the expectations. Zalgiris Kaunas is, beyond doubt, the major story of this year in the European basketball world. Despite being one of the few lowest-budget teams in EuroLeague, Zalgiris Kaunas made it to the Final Four, marking the most surprising event we have ever witnessed since 2010 when Partizan achieved the same. In this kind of surprises by the teams without any star player, generally head coaches take the lion's share, which is also true for Zalgiris this year.

Sarunas Jasikevicius (aka Saras), who stormed through Europe while playing actively, got off to a great start in his career as the head coach. Basketball lovers remember his playing career from many legendary moments . He would

have become the man to defeat the USA on his own in 2000 Sydney if he had also scored the last shot, and he was also selected as the MVP of the tournament in 2003 EuroBasket as the player who led the top-ranking Lithuanian team on the court. He won the championship of EuroLeague with three different teams for four times, and especially, in the first years of his career, he played a unique leading role in all teams he played. His winner character was always on the top level, and his court-view was as high as the one in few players around the world. When he was on the court either in the club or national team jersey, he led all players around him like a maestro, and guided all his teammates with both his mimics and words regardless of where he is - on the court or the bench. Starting to act as the court coach during the years when he was playing, Saras became the head coach of Zalgiris Kaunas, the symbol team of his country, in 2016 summer following two years when he served as the assistant coach of the team. In fact, he achieved some surprising victories, and remained only two matches below the play-off places with its performance going beyond the team capacity, and drew a great deal of attraction during the last season; but, this year's achievement is something that can be witnessed rarely in history. It was already a great achievement for Zalgiris to finish the season in sixth place. But, they weren't contented with this achievement, and destroyed an old-stager team like Olympiakos, which always resists and hardly never throws the match, in both performance and score table, and achieved an extraordinary performance in real terms. Saras has hardly ever any player that can be said to provide a substantial contribution in the outstanding teams of the EuroLeague.


But with this team, Saras showed and proved that what matters is just to be a team, share the ball, and do what's right during the course of the match. Going beyond the expectations, the representative of Lithuania made the spectators enjoy its matches, like its head coach made in old days. Through fast passing games, they created the desired positions and attacked, always delivered a great energy on the court, and never take a step back, as we all saw in the Final Four semi-final match. Jasikevicius, the architect of this team, is now just at the heart of a different discussion following this achievement. Now, we should return to the matter of Obradovic we made a pause in the first paragraph.

**Is he the successor of Obradovic?**

The question of "Can Jasikevicius be the successor of Obradovic?" is commonly circulated around nowadays. Both of them are always energetic and keep saying something and shouting on the bench, give the same kind of reactions to even minor errors / lazy behaviors of players, always demand 100% effort and exhibit a perfectionist attitude, which shows that they are in the same ballpark. And that's the reason why this question is raised and circulated around. Furthermore; it's not an outside chance for Saras to be nominated as the "unquestionable best head coach of Europe" after Obradovic. But, the term of "successor of Obradovic" is completely different. Throughout his 27-year career with the title of head coach, Obra has always tried to attain the top-ranking point in both national and international competitions. There is hardly ever any season when he has not been competitive. He gets ready specifically for big matches and series, and he is unique in turning any weak point of the opposing team into advantage for himself.

During the matches requiring going beyond the plan A, he implemented the trials that many coaches cannot dare to engage, and attained achievements in most of them. Throughout his career with the title of head coach, he has always adapted himself to changing games, and the point to which basketball is evolved. On these lands where we aren't used to the term of stability, the achievements he attained with Fenerbahce in the last four seasons are sufficient alone to show us what kind of a perspective he has, and that there is nothing like satisfaction with achievements in his wordbook. It's really a heavy claim to be the new version of such a man equipped with all these characteristics.

Yes; Saras got off to a good start in his career, and the level of performance, exhibited by his available players, is highly promising for future. What he has achieved so far might be a guarantee of what he can achieve in future; but, we should still observe him for long years or what he can achieve in other teams he will (likely) manage. Besides, the matters of how long his satisfaction and motivation will continue upon all likely future achievements, and how he could adapt himself to the changes of the game will put this comparison on a more sound foundation.

Sports lovers generally love the predecessor - successor relationship. It has always been and will always be discussed that whether any equivalent of Maradona has ever come to the global football world, or that to what extent Lebron James has caught up with Michael Jordan, or that a successor of Federer or Schumacher will ever take the stage in future, or not. Time will tell us that whether he will be able to become the successor of Obradovic, or not; but, I think nomination of him for this title is just sufficient to express the light burnt by Saras. We're on the lucky side of this discussion, 'cause we'll continue to watch the careers of these two legendary figures of the European basketball, independent from the answer of this question. Let's see what are the new surprises that Saras and Obra prepare for us ?

**ABOUT BURAK BALCI**

Born in 1984 in Ankara, Burak Balci graduated from the Department of Mechanical Engineering, Middle East Technical University in 2006 and received his master's degree in Computational Mechanics from Munich Technical University in 2008. He started to work at Turkey Technology Center in 2009. He has been serving at Compressor Management as Technical Leader since 2015.





# SOCIAL ACTIVITY GROUP A TRIP TO CANAKKALE


A day-trip was organized to Canakkale with attendance of 169 employees on May 12-13 by TEI's Social Activity Group. Eceabat, Kabatepe, Ariburnu, Anzac Cove, Canakkale Martyrs Memorial, Bloody Ridge, 57. Infantry Regiment Cemetery, Chunuk Bair, Kemalyeri Memorial, Turkish Martyrs' Cemetery, Seddulbahir Castle, Yahya Cavus, Seyid Onbasi Memorials and Kilitbahir Castle were visited.

## PHOTOGRAPH EXHIBITION THEMED WORLD ENVIRONMENT DAY HELD

As part of TEI's environment policy and values, TEI Photography Club held a photograph exhibition themed World Environment Day on June 5 in order to enhance the level of awareness on environmental protection and our impact on environment.

# INTERINSTITUTIONAL TABLE TENNIS TOURNAMENT 2018 IN ESKISEHIR

TEI Table Tennis Club took part in the Interinstitutional Table Tennis Tournament 2018 in Eskisehir, held in February, with five teams. TEI Turbojet Team ranked second and TEI Power Team ranked fourth in the tournament participated by 21 teams. Thanks to this ranking, TEI was entitled to compete in the Turkey Institutions Championship to be held in July in Samsun. TEI Women Table Tennis teams also took part in the interinstitutional tournaments for the first time this year.

# TEI PARTICIPATES IN BUSINESS LEAGUE BASKETBALL TOURNAMENT WITH TWO TEAMS



TEI participated in Surel in Sports Business League Basketball Tournament with TEI Turboshaft and TEI Turbojet teams. TEI Turboshaft team finished the tournament in the 3rd place.





# THE FIRST OUT-OF-TOWN TRIP OF THE YEAR BY "BLISKET"

TEI Blisket Club held the first out-of-town bike tour of this year to Lake Iznik on April 15, 2018. Participants set off at 06:30 after disassembly of the bicycles at the point of meeting. After having breakfast at Cennet Vadisi, they arrived in Iznik and assembled their bicycles and started the bike tour at 11:30. Following completion of the 40 km track in the direction of Orhangazi by the unique natural views, the participants had enjoyable times during the egg-and-spoon race, gunny sack race and standing in balance on bicycles.


# TEI VOLLEYBALL TEAM TAKES PART IN TOURNAMENTS

TEI volleyball team took part in two different tournaments during 2017 - 2018 season. The first one was the well-known Surel in Sports Volleyball Tournament held every year in various branches by TED College in Eskisehir. In the tournament attended by 8 teams in 2 groups consisting of four teams each, TEI qualified out of the group as the leader, and finished the tournament in the 3rd place.
Then, TEI took park in the Interinstitutional Volleyball Tournament, held by the Provincial Directorate of Youth and Sports in Eskisehir and attended by 20 teams this year, qualified out of the group as the leader, and competed in the quarter-finals.

# A MIND EXERCISE:

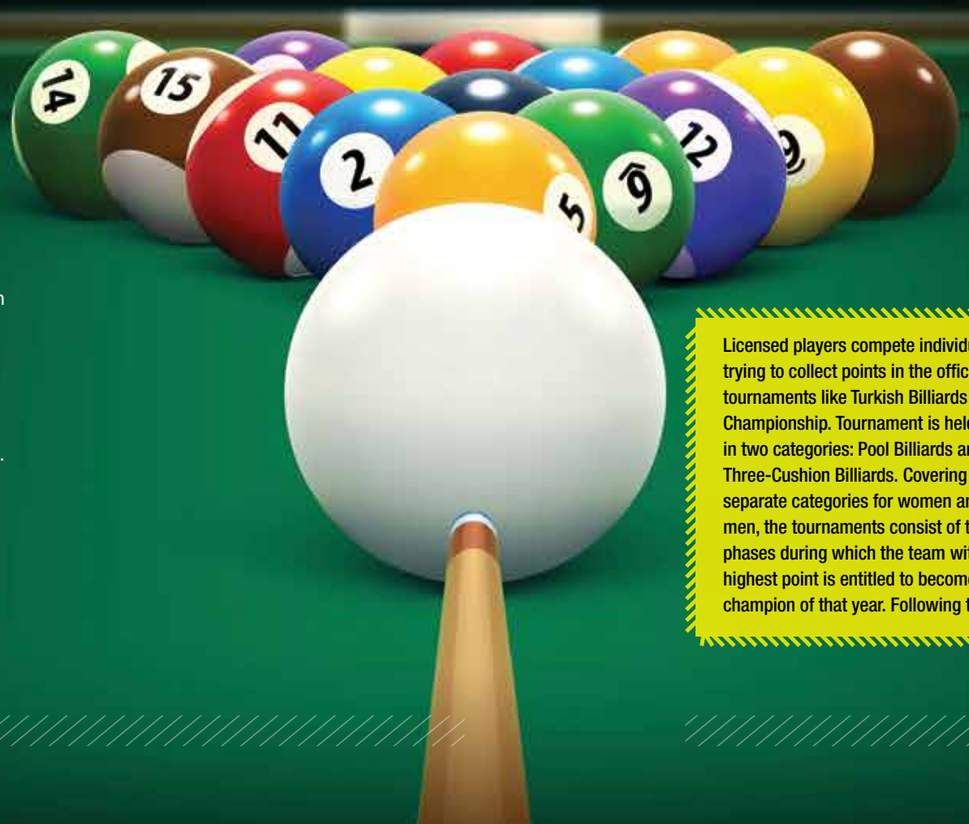
# BILLIARDS

**Billiards is a lifestyle for Ilayda Ugurlu who is serving as Engineer at TEI Programs Management. Stating that she was engaged actively in the physically demanding sports in each phase of her life, Ms. Ugurlu continued her words: "I couldn't have imagined that billiards, I used to play just to have some fun, would one day be the sports branch that I would spend most of my time".**

I frequently visited the billiards hall, located in the campus, during the first years of my university life. I took up billiards when the coach of the billiards team watched me playing billiards, and invited me to the exercises. I spent almost two years in exercises and unprofessional tournaments. I finally took part in the team, and started to participate in the Turkish championships at US Billiards, thereby, stepping into the professional career in billiards.

I have played in the final game and come off second-best in the Turkish Championship, the first professional tournament I have ever taken part in, and this is the highest rank I have received so far. I also became the champion, among 64 participants, in the Billiards Tournament, staged for the first time this year across our company as part of the Spring Tournaments. I became the champion as the only female participant of the tournament, which made this achievement more meaningful for me.

I think billiards is not a man-thing sports branch, instead, it enables both women and men to compete under equal conditions. Because right strategy, concentration and ability come to the forefront, rather than physical force, to achieve in billiards. Therefore, I think sportswomen should leave their bias aside, and show their abilities in billiards, like the other sports branches. I hope we'll see the number of our women billiards players to increase.



**According to the researches by the Copenhagen University, the benefits of playing billiards are as follows:**

- It enhances concentration ability.
- It is an essential requirement to concentrate on something to achieve a purpose. While playing billiards, players should choose their targets (cue ball and object ball) well, and look at their targets from an appropriate perspective, which enhances the concentration ability of players.
- It teaches how to keep calm. According to the research, billiard players can keep calm and think more relaxed without losing their control in a stressful case, when compared to the ones who don't play billiards.
- It strengthens mind. Trying to make geometrical references and make imaginary plans without stopping during the game, players both have fun and make a mind exercise. This makes them to have a more powerful and precise mind.


Licensed players compete individually, trying to collect points in the official tournaments like Turkish Billiards Championship. Tournament is held in two categories: Pool Billiards and Three-Cushion Billiards. Covering separate categories for women and men, the tournaments consist of three phases during which the team with the highest point is entitled to become the champion of that year. Following the recent global achievements by the Turkish billiard players, the level of interest in billiards has increased in our country, and billiards, which was once played in coffee houses as an entertainment game, has started to be perceived as a sports branch. Thanks to the initiatives by the Federation, billiards is now considered as a sports branch which supports personal development at early ages, and is instructed at schools.

## ABOUT ILAYDA UGURLU

Born in 1992 in Istanbul, Ilayda Ugurlu graduated from Metallurgical and Materials Engineering department, Middle East Technical University in 2016. She has been serving as Engineer at Programs Management since August 2017.

# FOOTBALL
# IS NOT JUST FOOTBALL

**It's not possible for any child, who was born in Eskisehir, to keep herself/himself away from the magic of football. We can call it either faith or genetics.**

When I was studying at the secondary school, a district bazaar was opened in each neighborhood. My mom gave me a jug of water, and made me sell water at the district bazaar as she wanted me to learn how to earn money. In one of these days, I read on the glass of the local football team's building, situated on the corner of the bazaar, that football player selection would be held. So, I stepped into the football world in Adanirspor which was founded in 1958 and named after the then-well-known outside-right of Besiktas Recep Adanir although it appeared as a local club. Adanirspor is a distinguished value of us in football which served in amateur football for many years, became champion for many times, raised several players and managers such as Onder Ozen, and which made us feel the amateur spirit deeply.

As such, would it be possible to start playing football immediately after passing through that door? First, you should be well-behaved, and then receive team and locality discipline. You should be trained by the elders of the team, and learn not only football, but also life so that you can sweat over the jersey. Matches played on the soil field, being a team-mate, long-lasting friendships, joy of victory, sorrow of loss, championships, injuries, jerseys dried over the stoves during half-time are the memories I still remember from my football career.

When I started to work after dropping amateur football career following the military service, I never left the sports and football despite my busy business schedule. In the course of time, I started to be interested in teaching what I know about football, and developing myself in this field. So, I applied for the coaching training, opened in 2013 by the Turkish Football Federation, and I was accepted for the training opened in that year in Eskisehir. Following completion of the coaching training with a camping period of 15 days, I was entitled to obtain the diploma.

It was an indefinable feeling for me to return to the red-white colored club I sweated for many years. It gave me the opportunity to pay the duty of loyalty to Adanirspor which gave me many good memories. I have raised tens of responsible players in various age groups for five years.





The eight players, included in the team I formed in the initial years, continue to study at the university, and move forward to be qualified individuals, besides being well-performing players. Additionally; we also sometimes organize trainings and seminars in our club's building about the hazards of drugs for our players, in cooperation with some NGOs. We, as the club, have been opening summer football school for the last two years for many children in various age groups, enabling them to exercise and be social individuals without addiction to Internet and telephone.

I have a busy business schedule, as required by my position at TEI. But, I mostly participate in the exercises following the work, before going home. It's a great feeling to be the coach of them on-the-field, and brother of them off-the-field. As I love being a coach, I somehow find the force required to tolerate the challenges introduced by it. While I keep forming the metals at TEI, I also enjoy forming the young brains on the green field.

I hope your life will be full of sports, and your heart will be full of love.

**ABOUT OZKAN ERKOCA**

Born in 1972 in Eskisehir, Ozkan Erkoca started to serve at TEI in 1996, and currently holds the position of Shop Supervisor at Tool Manufacturing Leadership.

# TRAVEL TO THE PAST AND FUTURE: JAPAN


**In Japan, one of the most unique countries of the world, past and future, technology and tradition coexist. Our colleague Zeynep Unluer, served as Senior Technical Leader at Human Resources Directorate of TEI, shared with us her journey to Japan, which still remains a mystery.**

When I was in the university and having difficulty even in learning Hiragana alphabet at the Japanese course, which I could hardly attend for a few weeks (even though I want to mean a few classes), our teacher Akiko said "We need to finish at least secondary school to be able to read a newspaper. Because we use three different alphabets (Hiragana, Katakana and Kanji) in writing , and Hiragana is the simplest one.", and at that moment, I knew that getting Japanese lesson, where I looked forward to the first break and ran away without a backward glance, would be useful one day. I was going to greet my Japanese friends in their country by saying "Hajimemashite. Douzo yoroshiku onegaishimasu" (its meaning in English is "Hello, nice to meet you"), which was the only thing I remember of those days and which I kept on saying).

A long journey was waiting for us. Due to transfers between Ankara - Istanbul, Istanbul - Seoul (South Korea) and Seoul - Osaka (Japan), the waiting times and time difference zone, we spent about a full day on transportation. If we had known that it would be that difficult, we could have preferred direct flight with a higher price. According to our travel plan; we were going to visit the cities of Osaka, Nara, Kobe, Kyoto and Tokyo, which play an important role in the history and culture of Japan, and we had only ten days for this travel, except the round-trip time. We quickly left ourselves to the history, culture and nature of Japan, one of the countries ideal to travel past and future.

Japanese tell their history with surreal events, and they believe that the first Emperor Jimmu Tenno was born from the left eye of the sun goddess, thus Japanese emperors have divine powers. The dynasty of Emperor Jimmu (Yamato) is known as the best-established family of the world with 125 emperors. Akihito, 125th Emperor of Japan, is the first emperor who ascended to throne not under the title of "god".

*Todai-ji Temple*





### NARA

The imperial palace was built in Nara in the 6th century AD, and it was declared as the first permanent capital. During this period, Buddhism, spread over Asia, began to influence Japan, where national religion was Shintoism, and Buddhist temples were built in Nara. Horyu-ji, the oldest wooden Buddhist temple of the world, is the largest and tallest wooden construction of the world, and Todai-ji Temple, which includes the world's largest bronze Buddha statue, is also located in Nara.

It is a great pleasure to be together with hundreds of deer roaming freely, which are regarded as messengers of the gods, in Nara Park, which is located in the center of many temples and historical constructions.
Even though we had to share the crackers and snacks, which we took with us in case that we could stay hungry, with the deer chasing us and asking for food, the silence, greens and communication with animal takes away daily stresses of people.

### CAPITAL OF CAPITALS: KYOTO

In Japan, where society is divided into classes, Buddhism has become a political force with the increasing interest of the noblesse. When the divine powers of the emperor in Shintoism were not recognized in Buddhism, Emperor Kanmu carried the capital to Kyoto in 864 to take the public away from this influence. Kyoto, which was established as the city of peace and tranquility by taking into account the direction of the flow of rivers and mountains, means the capital of capitals. Today, Kyoto, the capital for nearly a thousand years, still reflects the tranquility and peace imbedded in the texture of the city. In Kyoto, there are many places with historical, religious and natural beauties.

*Deer in Nara Park*

### Kyoto Imperial Palace

Previous reservation is required to visit the palace, which hosted imperial dynasties until 1868. As we were not informed about it, we had to content ourselves with visiting the unique yard.

### Fushimi Inari Temple

The most distinct characteristic of the Shinto temple, located on the outskirts of Mountain Inari, is the thousands of orange gates called as torii. If you make a wish here and it comes true, you donate to this temple, and they set up an orange colored gate with your name on it.

### Bamboo Forest and Monkey Park

Segano Bamboo Forest and Monkey Park, located in Arashiyama, 10 km west of Kyoto, bring us together with plants and animals, which we are not familiar with.

### OSAKA

With the increase of Japanese population in the 11th century, the scarce arable lands became even more important, and thus resulted in the emergence of feudalism. The most important problem that the empire had to deal with other than Buddhism in this period was feudalism.
Civil wars were experienced for many years since the Samurais fed by feudal lords as guardians gained power and requested to take part in the administration of the country with military management.

*Big Buddha Statue*

By the feudal lord Toyotomi Hideyoshi, who ended the civil wars that lasted until the beginning of the 17th century and unified the country, Osaka became the center, and a was built here.

Today, the castle is a museum which tells the history by use of all audio-visual elements.
Osaka, the second biggest city of Japan, is also regarded as the heart of Japanese cuisine.

The prominent dishes of the Japanese cuisine are rice and seafood products, and the number of sushi restaurants, which are the first to spring to mind when it comes to Japanese cuisine, is also high. Beside these, you may prefer a delicious, yet not a filling dish with vegetables and beefsteaks in the restaurants with self-catering concept. It is not filling you up because the beefsteak, as thin as pastrami, is very expensive.
Even though the non-standard working hours of the restaurants, the "hashi" chopsticks used instead of knives and the sauces used make it difficult for tourists, you can also find dishes

*Fushimi Inari Temple*


*Castle and Samurais*

suitable to your taste bud and get forks and knives if you lose the battle with hashi chopsticks.

Vegetable noodles, corn soup, crepes served with the toppings you wish, “gyoza", which is similar to our manti (Turkish type ravioli), fried fish and chicken called "tempura" are among the dishes that you can eat with peace of mind.
When you are shopping for packaged food, mobile phone applications that allow visual translation are very useful, and when you cannot find out the content of the product, these enable you to determine it easily.

## KOBE

Another world-famous hero of the Japanese cuisine is Kobe beef. Even the fact that only a single serving size costs hundreds of dollars does not stop people to prefer it. Kobe, where the beef of cattle that are made to listen classical music, massaged regularly and fed in a dark and narrow place in order to avoid marbling has become famous, is at a distance of 1 hour by train from Osaka.


*Kobe Earthquake Memorial*

Beside the beef, the name of Kobe has been imprinted on people's minds also with earthquakes. About 6500 people lost their lives because of the earthquake and fires subsequently broke out in "Great Hanshin" earthquake occurred on January 17, 1995 in Kobe with a magnitude of 7.2.

The buildings built after 1995 are designed and constructed so as to ensure living with the earthquake in the safest manner possible, and the memorial (monument) allows keep in mind the material and moral losses encountered in Kobe.

## TOKYO

After Toyotomi, who chose Osaka as the base, died, Edo, the region where Tokugawa tribe, who ruled the country for almost 265 years, lived, became the symbolic capital of the empire. The name of the region was then changed to "Eastern Capital", and then called Tokyo.
Edo period begins with Tokugawa.
In this period, Japan closed its doors to the outside world; civil wars ended; nationalism grew stronger; art developed. Since there was no war in this period, samurai of feudal lords, who were held in the center, were used in state affairs, and they were directed to art and philosophy. Poetry called as “Haiku”, which tell about life and nature with three lines, became so popular among samurai in this period.
We left to Tokyo just like a witness of one the three-lined poems of Matsuo Basho, the most important "haiuku" master in Japanese poetry.
"The wind from Mt. Fuji
I put it on the fan.
Here, the souvenir from Edo"
We spent the night on road, and went to Tokyo from Kyoto by bus in 8.5 hours. It is possible to travel comfortably by buses, where you fully recline your seat to sleep, and draw the curtain between next seat.

When the first lights of the morning were shining through the gaps, I opened the curtain to see where we were, and Mountain Fuji behind the fog cloud was just like the souvenir in the haiuku. Daily tours to Mountain Fuji from Tokyo are organized. We couldn't visit the volcano, which is the biggest mountain of Japan with a height of 3766 meters and gains admiration of Japanese and tourists with its characteristic cone shape, but watched from afar, since we didn't include it in the program.
After our journey, which ended in Tokyo Shinjuku Bus Terminal, we set out to explore the history, culture and nature of Tokyo.

### Japanese Gardens

In Shinjuku Gyoen National Park, which is caught between skyscrapers and where you can hear the birds singing, rather than traffic or city noise, you can see examples to landscaping of different nations (Japanese, British, etc.).
In Japanese gardens, each element represents an events or an object. The essential elements of these gardens such as the stone lanterns, the stone towers that stand as if they are placed one on the top of another, the streams that represent human life (from birth to death), ponds, pike and turtles that are believed to bring good luck, are placed carefully in accordance with the message to be given.

### Meiji Shrine

Japan, which has closed its doors to the outside world under the management of the Tokugawa tribe, was obliged to sign an agreement in 1854 and accepted the articles such as opening its ports to trade and allowing USA to keep a consulate in the country.


*Mountain Fuji*





During the period when Japanese introverted, they realized that they were far behind other countries in terms of life and military aspects, and feudal rule ended with the revolt initiated by nationalist young samurai, and Emperor Meiji ascended the throne. Emperor Meiji focused on modernization, and the country gained both economic and military power while the country was rapidly industrializing. In this period, the state structure was also improved and caste system was abolished.
Meiji Shrine, built for the Emperor Meiji who died in 1912, draws a great of attention from the public and tourists.

### Tokyo National Museum

You can spend a whole day at Tokyo National Museum displaying each and every detail about the Japanese culture. The first masks, puppets and costumed about traditional Japanese theatre Noh and Kabuki, as well as exhibitions about the Japanese writing, development of painting and sculpting, clothes of Samurai families are all displayed here.

### Shibuya

You can find the skyscrapers extending up to the skies with colors, globally-known brands, and restaurants serving all kinds of foods and meals in Shibuya, one of the busiest centers in Tokyo. While you can access everything easily here, it's not surprising for us to see here more crowded than the other regions.


*Samurai Armors*

*Shibuya Crossing*

Crowd turns into an art, and you'll find yourself watching the movements on Shibuya Crossing in Tokyo which is highly orderly despite being known for its all-time crowded population, and where everyone acts each other respectfully.
It's speculated that when the green light is turned on for pedestrians during rush hours, thousands of people cross in different directions at the same time but without creating any chaos. First, you'll just stand rooted to the spot and watch these movements in a few color changes, and then find yourself among the crowd. Without colliding and with the enthusiasm to cross again and again as if you were on a gaming platform.
We had a moment that gripe our soul in this colorful, developed, lively and crowded place. This was when we encountered the bronze dog statute after we took the Hachiko exit from the Shibuya station. Some of you might know Hachiko which was also filmed before. "Hachiko", the Akita dog breed which was adopted by Professor Ueno when he was a baby, would accompany the professor to the university in the mornings, and come to the Shibuya station to welcome him in the evening. And one day, the professor didn't return at his usual time. Days, months and years passed, but he didn't return. But Hachiko would wait for his deceased master at the station in every evening. Waiting for his master to return for ten years, Hachiko died at the Shibuya station when he was 12 years old, and his bronze statute was erected at this station in the memory of Hachiko This statute rises at the very heart of this fast-flowing life to remind all people of fidelity, loyalty and love.


*Hachiko Statute*

There are some other unique topics to address and places to visit in Japan. "Respect" (towards environment, human, history, culture, etc.) was the most important message of our trip to this praiseworthy country which has some unique characteristics with its nature, history, cuisine, arts, sports, technology and local people and which always aims to achieve continuous development, and I wish to see the other parts of Japan we couldn't see in our ten-day trip.

**ABOUT ZEYNEP UNLUER**

Born in 1987, Zeynep Unluer graduated from the Department of Industrial Engineering, Baskent University in 2009. She served as Senior Technical Leader at TEI Human Resources Directorate between 2013 - 2018.

# AIZONAI ANCIENT CITY


**Taking advantage of the fine weather with the initial spring fever, I took my wife and two little daughters and visited the Aizonai Ancient City that I heard from the promotional brochures at Kutahya Museum of Archaeology during my military service at the Air Force Enlisted Airmen Training Brigade Command in Kutahya but couldn't find any opportunity to visit thoroughly.**

Located in the Village of Cavdarhisar, Kutahya 134 km away from Eskisehir, Aizanoi Ancient City takes 1 hour and 45 minutes to arrive by car. As its name suggests, the Village of Cavdarhisar is named after Cavdar Tatars who settled here in ancient years. The Phrygians, one of the ancient civilizations of this geography, were the first known residents of this region. Aizanoi is derived from a mythological hero named "Azan". Although it's not a well-known fact, Aizanoi is as impressive as Ephesus with the greatest Temple of Zeus which still remains rising across the Anatolia. The area covering the Temple is well-preserved. I think this is why the newly-married couples came here to take a souvenir photo during our visit.

With its ionic load-bearing columns, the Temple is a product of breath-taking stonemasonry works. Seeing that all these structures, which were built only with human efforts and animal power, stood out against numerous earthquakes and environmental conditions for thousands of years evoke admiration in real terms. The statute Medusa, rising at the entrance of the Temple, somehow reminded me of the statute of Medusa exhibited in the Basilica Cistern in my hometown Istanbul. Aizanoi continued to be an important trade center during the Roman period after the Phrygians. It is even speculated that the first known stock exchange market of the world was established here. Hence; the Turkish baths, theatres and bridges over the rivers feature the characteristics of the-then developed Roman cities.


### Ancient Exchange Market (Macellum)

Speaking of exchange market, I read a highly interesting piece of information on one of the informative signboards. Cost of living and inflation was a problem people tried to deal with throughout the history. Therefore, the Roman Emperor Diocletianus adopted edict titled "Edictum de Pretiis Rerum Venalium" (Edict Concerning the Sale Price of Goods) to determine the price caps across the Roman Empire in 301 A.D. with the aim of finding a solution for this situation. Although this edict aimed to determine the maximum prices and fees for various goods and services, the emperor could keep this edict in force for just a few years, and then, he was overwhelmed by inflation. It is seen on these prices that the purple silk chlamys, worn by the king and his family, was the most expensive commercial product with its value of exactly 150,000 Denarii which means that it amounted nearly to 27-year salary of a palace guard who was paid with 5500 denarii in a year.





As a matter of fact, if you weren't a noble in ancient times, you couldn't have worn purple silk; so, no need to worry. All kidding aside; although some figures seem highly logical when compared to the fees specified in this list, I cannot understand the logic of some of them. But; of course, we should assess each era in line with the-then prevailing conditions. Our country is, really, situated on a highly critical geographical location for the world history. I'm ending my article recommending all nature and history lovers to spend one day to visit this Cavdarhisar Aizanoi ancient city which is located so near to us.

Finally; when you go down the Vaulted Room under the Temple of Zeus, you'll immediately feel that the temperature varies between above and under the ground. While the weather is sunny above the ground, the underground stone vault is like a cold storage. I think people would put their perishable foods in such kind of places in ancient times. Nowadays, various headstones and stelas are exhibited in the vault accessed by climbing down the wooded stairs.
Can you imagine any Roman city where no Gladiator games were not played?

So, one of the headstones exhibited in the Vaulted Room belongs to a gladiator who look like Rhetiarius, the gladiator who salutes with his well-known quotes of "Ave Caesar! Morituri Salutamus!" (Hail, Emperor, those who are about to die salute you!), and fights with his trident and net.

**ABOUT ALPER UNSAN**
He was born in 1975 in Istanbul. Graduating from the Department of Aerospace Engineering, Istanbul Technical University in 1998, he completed his Master of Business Administration at Koc University in 2001. He has been serving at TEI Programs Management as Senior Technical Leader since 2012.

**Aizanoi**

"Described as the oldest tribe of the world by Herodotus, the Phrygians is the first community encountered in Kutahya. Phrygia was divided in two administrative groups; namely Greater Phrygia and Hellespontine Phrygia, and Aizanoi is one of the important cities of Hellespontine Phrygia. After the Phrygia, the region fell under the rule of the Cimmerians, Lydians, Persian, Alexander's Empire, Kingdom of Pergamon, and the Roman Empire in 133 B.C., respectively. The city maintained its importance as the center of episcopacy in the Roman period.
Suleiman ibn Qutulmish, the son of Kutalmis, who founded the Sultanate of Rum in 1078, occupied Kutahya in the same year. It was passed into the hands of Turks and Byzantines until the Anatolian beylik of Germiyan was founded in the region. It was occupied by the crusaders during the first Crusade in 1097. After Kilij Arslan II defeated the Byzantine in 1176 during the Battle of Myriokephalon, it turkified the regions of Kutahya and Eskisehir permanently in 1177 and 1182.
During settlement of the Anatolian beylik Osmanogullari in the Western Anatolia, Cavdar Tatars used the Aizanoi as their base. It is known that the district of Cavdarhisar was named after this tribe."
* Obtained from the website of the Municipality of Cavdarhisar.

# HOW DO WE MAKE OUR CHILDREN UNHAPPY?

*"Childhood is like sky, it never goes anywhere."*
Edip Cansever

I'm not a child development specialist. But, I raised two children. Meanwhile, I made several mistakes. As part of my occupation, I read and share what I read either verbally or in writing. I listen to the problems of reputable persons, and observe the problems between my circle and their children at various ages. I have made a remark recently on this matter in a TV program, and it was shared for more than five million times, which shows that how strongly people need to receive appropriate guidance while raising their children.

During the meetings held with parents at various educational institutions, I ask them "what kinds of children they would like to raise". I frequently receive the answer of "successful". Then I request them to define "being successful", and when I inquire this question in detail, it's understood that what they want in fact are "money, status and reputation". When I ask them "what they wish" for their children, I generally receive the answer of "We wish them to be happy away from difficulties." I also well know that a great majority of such parents at the upper-middle income level of the society push their budgetary limits and sacrifice their interest substantially in their living standards to send their children to the schools providing a high level of education and training. Our talks with such parents reveal that their children don't have any responsibility at home other than studying.  Children are made to share the well-being, not the life of their family, they're provided with all kinds of opportunities to enjoy their lives easily. A great majority of such parents say that they don't want their children to suffer from the difficulties which were experienced by them in their childhood.

Parents observe what specialists say about the warning to not to say any unfavorable thing to their children even if their report card includes bad marks, they stand by the opinions of the Ministry which support that children shouldn't be assigned with homework during holidays, and they try to give everything their children want in an endless good faith. But, good faith doesn't yield good fruits at all times. Supporting and encouraging children is of course good; but, giving everything they want is harm for them, indeed. Because, such an approach paves the way for raising individuals who "believe that they have a right to do anything they want without any just cause, and feel themselves claimant from the world at all times". The current biggest problem encountered by executives in business life is the young employees who don't like their jobs and entities, criticize everything but come up with no new solution.

**Struggle makes you develop**

The common and absolute opinion of the families from the middle and upper income groups is that their children have hard times. In fact, the ones who have really hard times are the children who live in the poverty conditions across the country. The ones who cannot find a school to study in their villages or towns, and the ones who walk for kilometers long to their schools in icy cold conditions of winter. The ones who provide a contribution to the lives of their families, besides their responsibilities towards studying. The ones who secretly know that despite all their self-sacrificing efforts, they will never be able to attain the opportunities to make their dreams come true, due to the inequality of opportunity across the country. These children have the right to complain about the difficulty of living.

In our talks with the parents from the middle and upper income groups about their own lives, they say they had to overcome all difficulties they encountered for many times, to work while studying, and to provide a contribution to their families' living from early ages. I frequently hear such kinds of examples especially from the ones who came from the rural areas or who were raised in the regions with limited opportunities across the country. Such parents cannot see that what carried them forward to their current level of welfare was the struggles they exerted in previous years, or even if they see this fact, they try to keep their children away from such kind of struggles while raising them.

Children are sent to summer schools, which adds a new burden to the budget of families. The frequently-seen reason of this: "I want my child to learn a foreign language, to gain independence. I don't want my child to feel herself/himself loser as her/his friends all go to the summer school." Indeed, children just extend their slang word vocabulary in their mother tongue, and gain some bad habits in the three- or five-week summer schools. If they are encouraged to work for 4 - 6 weeks instead of summer schools, they can gain some capabilities that can make them win throughout their lives. A teenager in adolescence period, who works in such manner, learns the adult language, makes her/his own decisions, assumes responsibility, becomes close to the lives of people from various socio - cultural backgrounds, and gets to know where the borders of human relations run.
The above-listed things are much more important gains than "understanding the value of money" which comes to the minds of many people in the first place.

Parents, who believe that their children deserve a three-month summer vacation, complain of their children who spend gradually much more time on social media, who are glued to their cell phones, and who are always busy with computer.  Researches show that the time spent on social media not only affects the educational achievements unfavorably, but also makes them unhappy. Looking at their friends' happy moments on social media and thinking about why they are so unhappy lead them to end up with unhappiness. Unfortunately, there's nothing that can be done by parents to prevent such situation.

**Unveil the potential**

Potential is unveiled under pressure. It doesn't seem realistic to expect children, who have not assumed any responsibility other than studying and encountered any pressure, to overcome the difficulties and deal with the life when they grow.
And the children raised by the parents, who are convinced to fulfill the requirement of saying that their children are "unique, one-and-only, and great", believe that "they can be everything, and they're entitled to the right to do anything they want." And this entitlement turns into a tangible reward when the children, coming from the middle and upper income groups, crown it with a new toy they made their parents buy during a family walk. The time spent together as a family is no longer a reward for them. When this situation is not provided with the mutual and sincere attention of family members, a mandatory togetherness that can be tolerated for the sake of a toy emerges. The excitement of rewards, which become gradually usual at a home filled with toys, increases the expectations like a flash in the pan when the packaging is opened. These children with their level of expectations increased so much have difficulty in understanding why their line managers push them after stepping into business life. They expect to become a CEO before they turn thirty, and become unhappy when they realize that this is impossible to come true. Starting to work, and climbing up the career steps like a regular person sound tough and meaningless for them. They have difficulties in accepting that promotion can only happen by striving, struggling, pushing one's own limits, and waiving from some delightful and pleasant things if and when so required; so, they develop an agonized and critical attitude against life. When they get married to a person who was conceived that s/he was "unique, one-and-only, and great" like them, they have difficulty in understanding that they have to be attuned to each other. Starting with the excitement of a new house, new furniture and appliances, as well as a new life, marriage life timely starts to suffer the same fate as a new toy which is unpacked with excitement, and put aside after a while. This is the reason why most marriages end up with divorce when the emotions fade away.

The adulthood stage of girls have some different features in terms of their relationships with their fathers. Nowadays, women make their presence gradually felt in both business life and social activities. Because, researches show that the ones attributed to women are predominant among the necessary characteristics of an executive in the matters such as leadership, achievement, happiness and conduct, etc. However; especially the women, who will be promoted to the position to leader, should have been both encouraged and forced, if and when so required, by their fathers during their childhood and adulthood periods, which reduces the chance of girls who are the "princess of their fathers".  Supporting them with confidence instilled while forcing them doesn't seem an easy task to overcome for many fathers.
And here's what I have deducted from all my own personal experiences, clinical experiences and business observations: The effect of having a high level of welfare on raising children who can reflect their own potential to life is less than expected. It's a well-known fact that many children, who have been raised with some level of force under more limited conditions, turn into successful individuals who can reflect their own potential to life. I think there are two critical advantages introduced by raising children who can reflect their own potential to life: patience and affection. I deliberately abstained from using the word "love"; because many families give damage to their children with their unhealthy love.
When the recent address forms of "mommy", "daddy", "grannie", and even "sweetheart" and "darling", which become apparent pathologically, are included, children are forced to emotional dilemmas and unhealthy dependency.

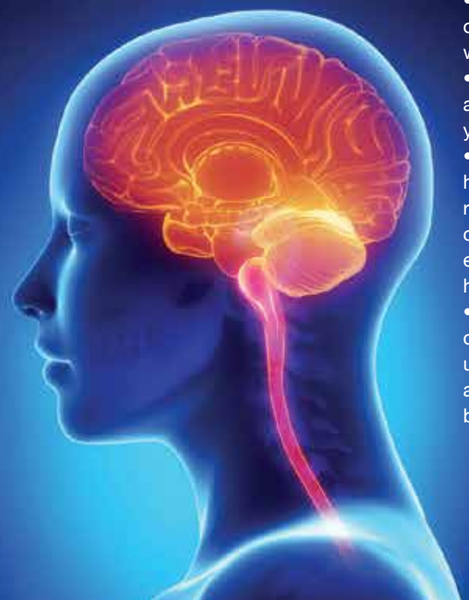
**Conclusion**

If a life is lack of hurts, sufferings, sorrows, failures and disappointments, such life is meaningless and purposeless. As we draw our children closer to the easy side of life and convince them to have a right to do anything they want, we don't do good for them; on the contrary, we prevent them from reflecting their own potential to life, and make them unhappy in the long run, even if we don't mean to cause it.

*Prof. Acar Baltas*
*Psychologist*

# KEYS TO KEEP OUR BRAIN IN SHAPE

**With increasing age, brain gets exhausted like every organ. Researches have proved that some certain simple brain exercises are beneficial to delay the wearing period and to keep our brain in shape. Saying that "Simple exercises create shortcuts in our brains. And creating shortcuts is highly important for a practical life", Dr. Umit Gedikoglu Kurtar, Neurologist at Acibadem Hospital in Eskisehir, shared the keys to keep our brain in shape with us.**



Emphasizing that puzzles are quite helpful for brain development of children, Dr. Umit Gedikoglu Kurtar said that doing crossword puzzles, keeping passwords and numbers with many digits in mind, memorizing telephone numbers, and mental arithmetic of some simple mathematical calculations at increased ages are beneficial, and the ones who cannot do these exercises should frequently read, and provided the below-listed recommendations to keep our brain in shape:

• Well sleeping and adequate nutrition is the simplest and most important way to keep our brain in shape.
• Sleeping for 10 minutes during daytime boosts productivity, and does good for brain.
• Keeping your blood glucose level fixed and high enables your brain to work in full capacity. Having 6 meals a day is beneficial.
• Worries tires and wears your brain out. Keep your brain away from worries.
• Consuming caffeine - i.e. coffee, tea and cola - in small quantities makes your brain to function more clearly.
• Such foods as chocolate, banana, hazelnut, peanut and fish, etc. releases happiness hormone as they contain serotonin. Such foods have an effect to keep your brain in shape and happy.
• Nicotine narrows your body vessels down, and deteriorates blood build-up in your brain. This means a less amount of blood is pumped to your brain, resulting in a low level of functional capacity in your brain. Therefore, keep away from smoking to keep your brain in shape.
• Brain shrinkages can arise in frequent-drinkers. Use of drugs might make your brain as small as a walnut. Alcohol and drugs are the enemy of brain, like they are for the entire body.
• Taking up a hobby is highly important to have a refreshed mind. Even a simple hobby such as knitting makes a person, and thereby her/his brain, happy.
• Physical exercise is helpful for brain health. The hormone of endorphin is released in the brain during physical exercise. Thereby, exhausted brain cells find the opportunity to renew themselves. Physical exercises ensure brain development.
• Being happy and smiling is the most influential way to keep your brain in shape.

*Dr. Umit Gedikoglu Kurtar*
*Neurologist*





## OUR EMPLOYEES WHO RETIRED BETWEEN JANUARY 1, 2018 - JUNE 30, 2018

# OUR NEW RETIREES FOR THE PERIOD

- K. Levent Tufekci retired as Human Resources Director on February 28, 2018,
- Bulent Dinc retired as Chief Technician on March 12, 2018,
- Ugur Gorgulu retired as Expert Storekeeper on March 28, 2018,
- Ismail Kaya retired as Expert Storekeeper on March 30, 2018,
- Mesut Erol retired as Chief Technician on April 25, 2018,
- Ayhan Yavuz retired as Chief Technician on April 27, 2018

**WE WISH THEM ALL THE BEST IN THEIR LIVES AFTER RETIREMENT.**

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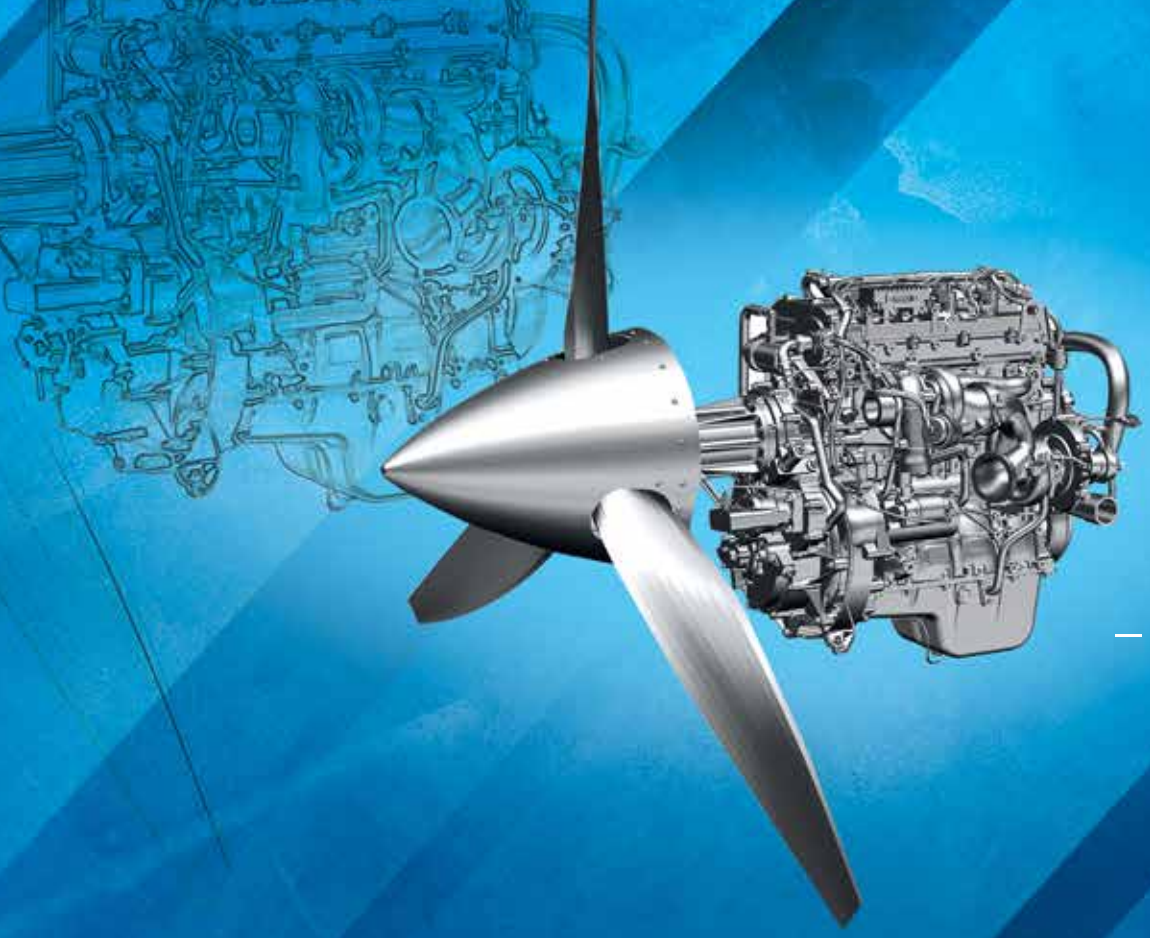

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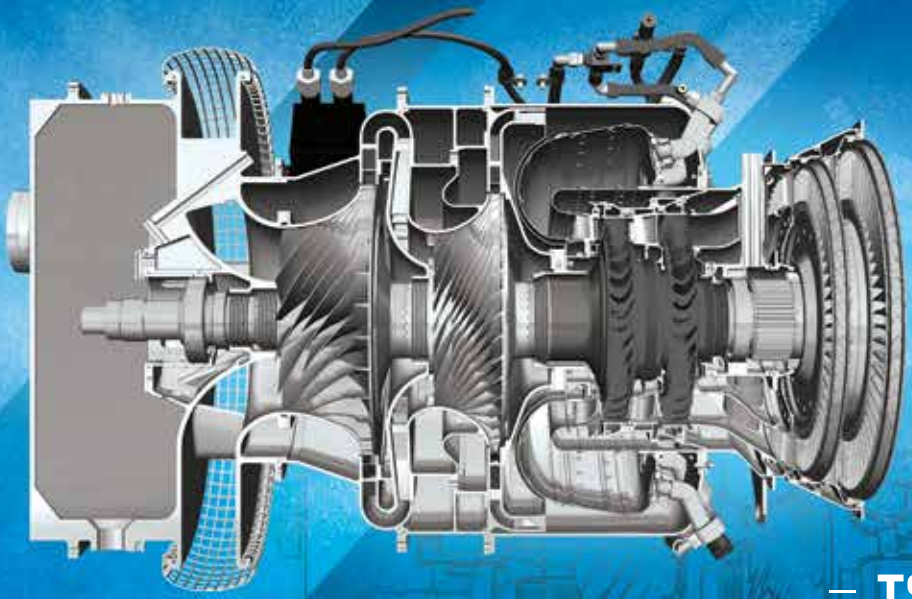

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