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2014/2016 Global activities summary:

I was on a one-year sabbatical leave to Istanbul Technical University, ITU, Turkey between 10-June-2014 and 15-August-2015. I completed an intensive period of "computational fluid dynamics research", some teaching and many productive interactions with other academic institutions in the region and in Europe. A good portion of my time during my sabbatical leave also went into working on my upcoming book on "Thermographic Liquid Crystals in Aero-thermal Research". I allocated significant amount of time with my research assistants who were continuing our PSU based research efforts in 2014-2015 academic year. These communications were helpful since they provided a healthy continuation of our existing research efforts at Penn State. My communications with Dr.Jason Town, Michael Averbach, Sowmya Raghu, and Christopher Axten were extremely useful in making progress in their thesis efforts. I also had a good amount of interactions with Drs. O.Turgut and A.Akturk on the technical papers we are now publishing in archival journals. I attended many doctoral level comprehensive exams and defenses via teleconferences for our department, ME&Nuclear Engineering and Petroleum&Natural Gas Engineering during my stay abroad.

The research project I was involved with dealt with the "multi-dimensional optimization of HP turbine tip platform shapes used in modern gas turbine engines". I helped developing a multi-year proposal for this effort and I acted as a consultant to this project. Although this turbine tip aero-thermal optimization problem is of great importance for aircraft turbo-fan engine research and development, the turbine tip region aerodynamic losses and heat transfer performance is especially important for small engines designed for helicopter turbo-shaft engines, UAV/RPV propulsion systems.

My research efforts held at Istanbul Technical University were enhanced by the outstanding support of DKTM/TUSAS. Before the start of my sabbatical research program at ITU, I submitted a multi year research proposal to DKTM (Rotorcraft Center of Excellence/TUSAS). The principal investigators of this proposed study were Professors Levent Kavurmacioglu and Erkan Ayder from Istanbul Technical University. Prof. Emre Alpman of Marmara University also participated in the optimization related aspects of the research project. It should be noted that Prof. Kavurmacioglu spent two sabbatical leaves at Penn State in the past. Prof. Alpman is also a doctoral graduate of Penn State University. The multi-year project was fully funded in late summer 2014. I acted as a formal advisor to the project between August 2014 and August 2015. Three doctoral candidates were hired and trained throughout this project that is directly supporting the helicopter turbo-shaft engine design mission of DKTM. Close interaction with the principal investigators of the project and frequent technical meetings with the doctoral candidates were highly productive.

The research team made up of Profs. Camci, Ayder, Kavurmacioglu and Alpman established an effective and engine realistic computational aerodynamics system for the detailed analysis and optimization of turbine tip clearance flows with heat transfer. The project clearly satisfied the immediate needs of the local turbo-shaft engine development efforts of DKTM/TUSAS. In the meantime three doctoral candidates started their training and research in a highly strategic area of applied aero-thermal science. Cengiz Camci plans to continue his interactions with the research team after his return to the US after August 2015. Many technical publications from this effort is under consideration.

I was able to produce many publications for archival journal publication during 2014 and 2015. I attended 2014 ASME International Gas Turbine Conference held in Dusseldorf, Germany in June 2014. I chaired two technical sessions in this conference and I presented a technical paper in the area of applied aerodynamics of ducted-fans. I prepared a technical paper for 2015 AIAC Ankara International Aerospace Conference. The paper was entitled "A Brief Description of Ducted Fan Inlet Flow Distortion Reduction Concept Double-Ducted-Fan (DDF)". I also organized a technical session in the same conference. Finally, I worked on three technical papers for archival journal publication during my sabbatical leave at Istanbul Technical University. These three papers are currently accepted for publication in the International Journal of Rotating Machinery, ASME Journal of Fluids Engineering and Journal of Aerospace Science and Technology, Elsevier.

A list of the technical papers written, seminars presented, conferences and lectures participated and/or organized are as follows:

1. Research paper presented at the 2014 ASME International Gas Turbine Conference, Dusseldorf, Germany, June 2014
"LIP SEPARATION AND INLET FLOW DISTORTION CONTROL IN DUCTED FANS USED IN VTOL SYSTEMS," presenter : (C.Camci & A.Akturk)

2. Technical session chaired at the 2014 ASME International Gas Turbine Conference, Dusseldorf, Germany, June 2014
14-1 Gas Path Heat Transfer I *(Technical Session)*
Session Chair: Cengiz Camci, *Penn State University* & Istanbul Technical University

3. Technical session co-chaired at the 2014 ASME International Gas Turbine Conference, Dusseldorf, Germany, June 2014
14-5 Gas Path Heat Transfer II *(Technical Session)*
Session Co-Chair: Cengiz Camci, , *Penn State University* & Istanbul Technical University

4. Invited Lecture at graduate level "Turbomachinery Design and Theory" course at **ITU**, Istanbul Technical University, November 2014, **"RECENT TRENDS IN TURBOMACHINERY AERO-THERMAL RESEARCH,"**
Presenter: (C.Camci)
Course Leader: Prof. Erkan Ayder, ITU

5. Invited Lecture at graduate level "Gas Turbine Design Fundamentals" course at **METU**, Middle East Technical University , Dept. of Aerospace Engineering **"AERODYNAMIC AND THERMAL CHALLENGES IN TURBO-SHAFT ENGINE RESEARCH & DEVELOPMENT,"**
Presenter: (C.Camci)
Course Leader: Dr. Taylan Ercan, METU/TUSAS/TAI/DKTM

6. Scientific Advisory Committee Member, **FAN 2015, INTERNATIONAL CONFERENCE ON FAN NOISE, TECHNOLOGY AND NUMERICAL METHODS**, Lyon, France. (http://www.fan2015.org/gb/support-committee.html)

7. Invited Lecture at "R&D in Aeronautics and the National Aircraft Development Project", **"RESEARCH AND DESIGN ISSUES IN CONTEMPORARY AIRCRAFT ENGINE DESIGN,"** XIX. Bilgisayar Destekli Sistem Modelleme Konferansi, April 2015, Ankara, sponsored by FIGES Inc. (http://www.figes.com.tr/konferans/2015/index.php)

8. Scientific Advisory Committee Member, **AIAC**, 8 th Ankara International Aerospace Conference, September 2015, **METU**, Middle East Technical University , Dept. of Aerospace Engineering. (http://aiac.ae.metu.edu.tr/)

9. Research Paper prepared for the 8 th **AIAC**, Ankara International Aerospace Conference, Ankara, **METU**, Middle East Technical University, Dept. of Aerospace Engineering. "**A BRIEF DESCRIPTION OF THE DUCTED FAN INLET FLOW DISTORTION REDUCTION CONCEPT, DOUBLE-DUCTED-FAN (DDF),**" **(C.Camci & A.Akturk)** session : UAV Design and Technologies-1. (paper prepared and accepted but not presented).

10. Technical session organized for the 16th **ISROMAC** International Symposium on Transport Phenomenon and Dynamics of Rotating Machinery, to be held in Hawaii, April 2016. Forum F-35 " AXIAL FLOW FANS & INLET FLOW DISTORTION MITIGATION AS APPLIED TO VTOL UAV SYSTEMS,"

11. Research paper prepared for the 16th **ISROMAC** International Symposium on Transport Phenomenon and Dynamics of Rotating Machinery, to be held in Hawaii, April 2016. **"A VTOL-UAV INLET FLOW DISTORTION REDUCTION CONCEPT USING A NEW FLOW CONTROL APPROACH: DOUBLE-DUCTED-FAN (DDF)," (C.Camci & A.Akturk)**

12. Research paper prepared for the 16th **ISROMAC** International Symposium on Transport Phenomenon and Dynamics of Rotating Machinery, to be held in Hawaii, April 2016. **"INLET FLOW SEPARATION CONTROL VIA NOVEL LIP-SPOILERS FOR DUCTED FAN BASED VTOL UNINHABITED AERIAL VEHİCLES," : (C.Camci, N.Herwig & A.Akturk)**

13. Acted as a consultant for the specific research and technical paper entitled **"A PARAMETRIC APPROACH TO TURBINE TIP LEAKAGE AERODYNAMIC INVESTIGATION FOR AXIAL FLOW TURBINE ,"** authored by Levent Kavurmacioglu, Hidir Maral, Cem Berk Senel, Istanbul Technical University ITU, June 2015.

14. Acted as a consultant for the specific research and technical paper entitled **"IMPROVING AERODYNAMIC PERFORMANCE AND NOISE LEVEL OF AXIAL FLOW FANS USING CASING TREATMENTS,"** authored by Levent Kavurmacioglu and Hidir Maral, Istanbul Technical University ITU, July 2015.

15. Attended many weekly research meetings with ITU faculty and graduate students for the DKTM/TUSAS/TAI research project dealing with the parametric aero-heat transfer computations performed in 2014 and 2015. The project will continue in 2016. C. Camci plans to participate as a consultant in the remaining part of 2015 and 2016.

I helped initiating/chairing a special technical forum at the 16 th ISROMAC International International Symposium on Transport Phenomenon and Dynamics of Rotating Machinery, to be held in Hawaii, U.S.. Prof Erkan Ayder from ITU will co- chair this session to be held in the Spring of 2016. Five papers from the local research&development domain in 2014/2015 were reviewed and accepted for the session. Prof. Kavurmacioglu and his students are involved in preparing a few of the technical papers to be disseminated in the 16 th ISROMAC conference.

I had the opportunity to submit three significant technical papers to reputed archival journals in my field. A list of the three archival publications and other conference papers accepted for publication and presentation in 2014/2015 time frame are as follows:

1. "A Time Efficient Adaptive Gridding Approach and Improved Calibrations in Five_Hole Probe Measurements,"(with Town) accepted for publication in the Special Issue on, "Advances in Measurement Techniques for Turbomachinery Flow, Heat Transfer, and Acoustics (AMTT)" by IJRM International Journal of Rotating Machinery, 376967, Vol. (2015) DOWNLOAD

2. "Factors Influencing Computational Predictibility of Aerodynamic Losses in a Turbine Nozzle Guide Vane Flow," (with Turgut) reviewed and accepted for publication in ASME Journal of Fluids Engineering, ISSN: 0021-9223, July 2015. DOWNLOAD

3. "A Nonaxisymmetric Endwall Design Approach and Its Computational Assessment in the NGV of an HP Turbine Stage," (with Turgut) reviewed and accepted for publication in Aerospace Science and Technology, August 2015, Elsevier B.V., ISSN: 1270-9638. DOWNLOAD

4. "Lip Separation And Inlet Flow Distortion Control in Ducted Fans Used in VTOL Systems,"(with Akturk) GT2014-26249, Presented at 2014 ASME IGTI International Gas Turbine Conference, June 2014, Dusseldorf, Germany DOWNLOAD

5. "A Brief Description of the Ducted Fan Inlet Flow Distortion Reduction Concept, Double-Ducted-Fan (DDF),"paper prepared for the 8 th AIAC, Ankara International Aerospace Conference, Ankara, METU, Middle East Technical University, (with A.Akturk) session : UAV Design and Technologies-1. DOWNLOAD

6. Research paper prepared for the 16th **ISROMAC** International Symposium on Transport Phenomenon and Dynamics of Rotating Machinery, to be held in Hawaii, April 2016. **"**A VTOL-UAV Inlet Flow

Distortion Reduction Concept Using A New Flow Control Approach: Double-Ducted-Fan (Ddf)**,"** (C.Camci & A.Akturk)

7. Research paper prepared for the 16th **ISROMAC** International Symposium on Transport Phenomenon and Dynamics of Rotating Machinery, to be held in Hawaii, April 2016. "Inlet Flow Separation Control via Novel Lip-Spoilers For Ducted Fan Based VTOL Uninhabited Aerial Vehicles," **:** (C.Camci, N.Herwig & A.Akturk)

My sabbatical leave at Istanbul Technical University was a productive one in terms of the research efforts and publications. I acted as an academic advisor to a new research program that coincided with my stay at the Faculty of Mechanical Engineering, ITU. I participated in almost twice weekly research meetings with the three graduate students involved with this project.

My one year sabbatical leave from the Pennsylvania State University certainly improved my capacity to serve Penn State University in the future, in the areas of teaching, research, graduate student recruiting and international collaboration. It is our hope and intention to grow this already well established academic relationship between Penn State University and Faculty of Mechanical Engineering at ITU, Turkey.

I am grateful to Penn State University for allowing me to take this one-year sabbatical leave .

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