יום העיון השמונה עשר
במנועי סילון וטורבינות גז

18th Israeli Symposium on Jet Engines and Gas Turbines

November 28 2019,

Faculty of Aerospace Engineering,

Technion, Haifa, Israel

BOOK OF ABSTRACTS

יום ה', ל' חשון ה'תש"פ, 28/11/2019 אודיטוריום 235, בניין הפקולטה להנדסת אוירונוטיקה וחלל, טכניון, חיפה.

הטכניון, מכון טכנולוגי לישראל

הפקולטה להנדסת אוירונוטיקה וחלל הטכניון

ענף הנעה מפא"ת

חיל האוויר ענף הנעה מחלקת מטוסים

תעשייה אווירית

רפא"ל, הרשות לפתוח אמצעי לחימה

מפעל מנועי בית שמש

THE 18TH ISRAELI SYMPOSIUM ON JET ENGINES AND GAS TURBINES
Thursday, November 28 ,2019 (9:00-17:00),

Auditorium (235), Faculty of Aerospace Engineering, Technion, Haifa

This year, as in the previous 17 years, we plan to hold the Israeli Symposium on Jet Engines and Gas Turbines. There is a steady expansion of activities in Israel in jet propulsion. This includes the serial production of small engines, increased electricity generation using gas turbines fueled with Natural Gas (NG) as well as production of engines parts and maintenance work. Many companies and organizations are active in jet propulsion and gas turbine, including: MAFAT (MoD), IAF, Israel Navy, EL-AL, IAI, Bet Shemesh Engines, RAFAEL, TAAS, ORMAT, Israel Electric Corporation, R-Jet & Turbogen, the Technion and more.

Applied research, Improved engineering & technological innovations and new projects in Israel calls for continued professional meetings' for the exchange of information, for cross-pollination and for creating a fertile seedbed for cooperation. During the previous 17 symposia, in every one, more than hundred scientists and propulsion engineers met and presented their work from the various industries, the MoD and Academia. These symposia were a success, wetting the appetite for more such meetings.

The 18th symposium will include few invited lectures on selected subjects (from the US Air Force Research Laboratory and Purdue University) as well as 20 more lectures on large variety of topics, distributed over 6 sessions. The presentations are concerned with activities in different Israeli industrial firms, organizations and academia. A tour to the newly renovated Turbomachinery and Heat Transfer Laboratory will be conducted during the long lunch break.

The first half of the symposia (until lunchtime) will be held in English as well as most of the afternoon presentations.

Please note that the presentation from the 17th symposium can be seen in the following website: *https://jet-engine-lab.technion.ac.il/* . We shall upload the presentations (in full, or as a "censored" version), after the conference on the jet engine laboratory website (see below). Selected presentations will be published as archive publications in the "*INTERNATIONAL JOURNAL OF TURBO & JET ENGINES*":(https://www.degruyter.com/view/j/tjj)

Looking forward for a fruitful and enjoyable symposium!

Professor Emeritus Yeshayahou Levy
Chairman of the symposium
Technion, Faculty of Aerospace Engineering,

e-mail: levyy@technion.ac.il,
http://jet-engine-lab.technion.ac.il





18th ISRAELI SYMPOSIUM ON JET ENGINES & GAS TURBINES

TECHNICAL PROGRAM

	18th ISRAELI SYMPOSIUM ON JET ENGINES & GAS TURBINES, NOVEMBER 28 2019 Auditorium (room 235), Faculty of Aerospace Building
08:30	(Registration) הרשמה
09:30	Opening: Professor Emeritus Yeshayahou Levy, Chairman, Turbo and Jet Engine Laboratory, Faculty of Aerospace Engineering, Technion.
	Professor Itzchak Frankel, Dean, Faculty of Aerospace Engineering, Technion.
	Major Yigal Ben-Shabat, Head, Propulsion Systems Branch, Aeronautical Division, MOD.
09:50	(Session First) מושב ראשון
	Session Chairman: Lt.Col. Avi Yosfan, Head of Propulsion Branch
A1	Prof. Guillermo Paniagua, Purdue Univ., USA, Turbine Research at Purdue from Innovation to Maturity
A2	Dr. John Clark, Air Force Research Laboratory, USA, Development of Cooled Vanes for the High Impact Technologies Research Turbine
	(and refreshments Break) הפסקה וביבוד קל
A3	Prof. Levy Yeshayahou, Technion, Conversion of Jet Engine Combustor from Jet Fuel to Natural Gas
A4	Prof. Beni Cukurel, Technion, Development of Ultra-Compact Micro Gas Turbines with 400W Electric Power Output as a Battery Replacement in Drones
A5	Dr. David Lior, RJET & TURBOGEN, Small Recuperated Turbo-Fan conceptual design
13:10 - 14:40	(Lunch) ארוחת צהריים Student Building – Transparent (Glass) Hall and tour at the laboratory

14:40 – 15:40	(Second Session) מושב שני		מושב שלישי (Third Session)		מושב רביעי (Forth Session)
	Auditorium – Room 235		Room 161		Room 241
	Session: Rotor dynamics and Vibrations		Session: Turbomachinery Optimization		Session: Production Technologies
	Session Chairman: Dr. Amiram Leitner, Rafael		Session Chairman: Dr. Shaul Eliahu Niv, IAI		Session Chairman: Ariel Cohen, Bet Shemesh Engines
B1	XU Dong and Yanfeng Zhang, University of Chinese Academy of Sciences, China, Numerical Investigation of Flutter Stability of a High-Speed Transonic Fan	C1	Shachar Balas, RAFAEL, Adjoint-Based CFD Optimization Method Demonstrated on a Test Bench Design	D1	Dr. Bernhard Bringmann, Starrag AG, Switzerland, Blisk Milling - From Component to Machine Design
B2	Afik Lifshitz, Eyal Setter, Shachar Tresser, RAFAEL, Estimation of Jet Engine Rotor Bearings Stiffness by Modal Testing	C2	Dr. Alexander Khrulev and Prof. Sergey Dmitriev, Ukraine, ICE Turbochargers Failures and Some Features of the Study of Their Causes Using the Fault Tree Analysis	D2	Yochanan Nachmana, Bet Shemesh Engine Ltd, Abradable coating in turbomachinery and plasma technology, Performance improvement
B3	Ori Kam, Bet Shemesh Engine Ltd., Spline-Coupling – Effective Stiffness Effect on Rotating System Dynamics	C3	Dvir Mendler, ORMAT, Unusual Challenges in Mixed-Flow Pump Design	D3	Shir Avrahami and Ori Kam, Bet Shemesh Engine Ltd, Single Crystal Casting Simulation
15:40 - 15:55	(Break and refreshments) הפסקה וכיבוד קל				

תודתנו נתונה לגופים ומוסדות אשר תמכו ביום העיון:

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IAI התעשייה האווירית לישראל	תעשיה אווירית
RAFAEL	רפא"ל
מנועי בית שמש	מנועי בית שמש
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INTERNATIONAL JOURNAL OF TURBO AND JET ENGINES DE G DE GRUYTER	De Gruyter Publishing House

C2

ICE Turbochargers Failures and Some Features of the Study of Their Causes Using the Fault Tree Analysis

Alexander Khrulev and Sergey Dmitriev
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Despite significant advances in research and design of turbochargers for internal combustion engines, there is a large number of them failing in operation, the failures being caused both by operation and by errors in engine maintenance, and occasionally by manufacturing defects.

As the studies show, there are few sources that contain data on determining the causes of faults in turbochargers, and the information in them is not always helpful to the consumer. Existing methods for identifying the causes of faults give dozens of possible causes, as a result of which their use in practice requires so much laboriousness that it is actually inefficient - in a large amount of cases, in operation, consumers find it difficult to determine the cause of failures and therefore prefer to simply replace the turbocharger with a new one. However, this approach often leads to the repeated failure if the cause of it was not related to the turbocharger itself, but was triggered by external causes, for example, a malfunction of the engine and its systems. As a result, the cost of repairing a vehicle significantly increases, sometimes even multiplies, and this problem becomes more and more acute as turbocharging becomes more widespread in engines of various vehicles, and its complexity and costs are increasing.

On the other hand, when assessing the reliability of aggregates, logical-probabilistic models are widely used, describing the causal relationships of failures of the entire system with failures of individual elements and other events (impacts), including the well-known method of the fault tree analysis (FTA). However, this method, which is used in practice for calculating probabilistic characteristics and risks of failures, does not quite correspond to the problems of finding the causes of the faults.

In the present study, an attempt has been made to develop a relatively simple logical method for determining the causes of failures of turbochargers, relying on existing experience in their operation and maintenance, on the one hand, and on the fault tree analysis, on the other. For this purpose the turbocharger was presented as a simple unit that consists of four blocks (fig.1) with the links between them and the engine.

In this case the determination of the cause of the turbocharger failure can be made based on the analysis of the modified (reversed) fault tree, which allows the analysis to be performed in the direction opposite to the generally accepted direction - from the failure of the system up to the basic events that initiate the failures in its individual elements (fig.2).

Verification of the proposed method built on the specified principles using the experience of the studying faults of turbochargers in the real cases of failures showed that determining the cause of failure can be done with sufficient accuracy for practice as well as minimal time consumption.

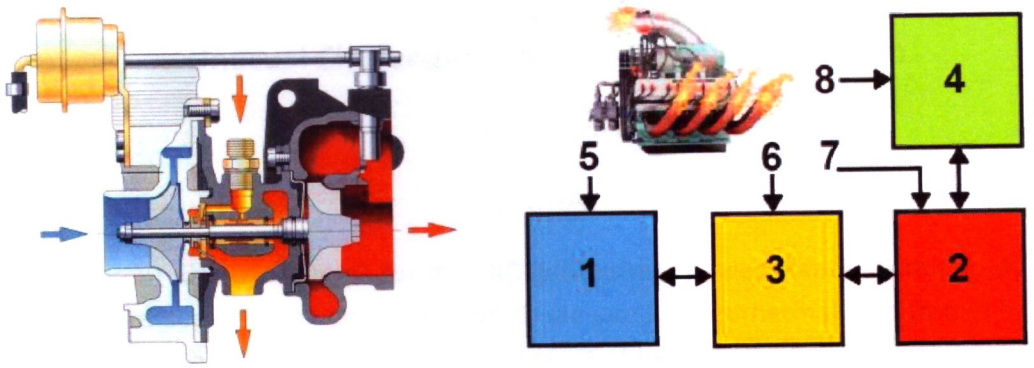
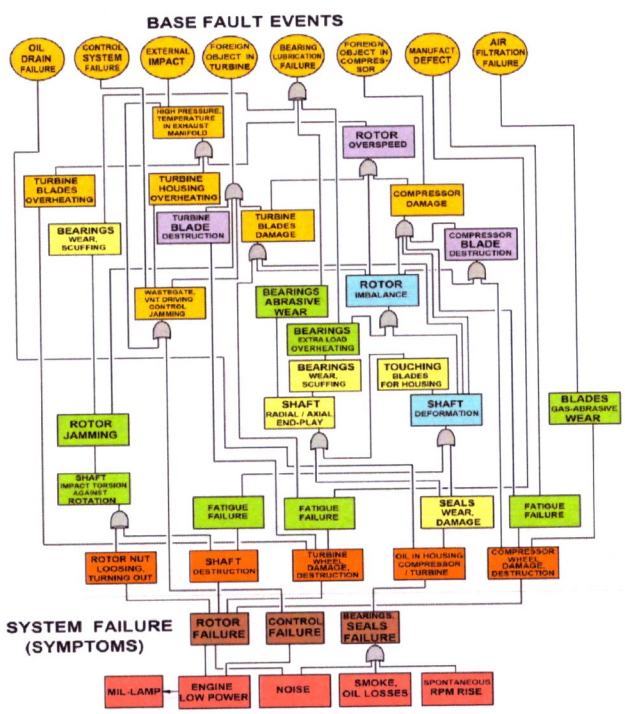


Fig.1. Turbocharger (left) and its block diagram (right):
1- compressor, 2- turbine, 3- bearing unit, 4- control system (Wastegate valve, variable nozzle turbine or other, with driving mechanism and control unit), external impacts on the turbocharger (from the internal combustion engine), including: 5- intake system of ICE, 6- ICE oil system and crankcase, 7- ICE cylinder and exhaust manifold, 8- engine control system.



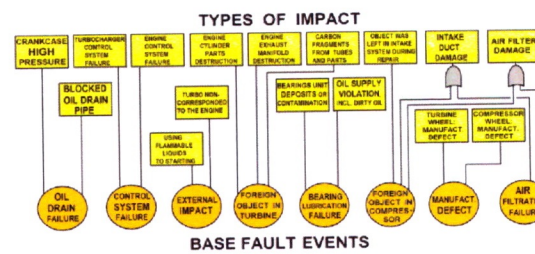


Fig.2. A general view of modified (reversed) fault tree of turbocharger presented as a diagram with the links between basic events causing failures and fault symptoms (left). On the right - the diagram with the link between basic events and types of impacts as causes of failures.

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