# 4. TITLE AND SUBTITLE
Seminar on Stress-Turbine and Compressor Blades

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# 13. ABSTRACT (Maximum 200 words)
Prof. Ostachowicz presented a seminar to the Aeropropulsion Laboratory, Dayton, Ohio on 5 May 1992 concerning: stress-strain analysis of a turbine blade root, vibrations of turbine and compressor blades, stiffness matrices of cracked finite elements, and vibrations of a cracked rotor and a cracked turbine blade.

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REPORT  
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Date of the visit: 5-7 May 1992  
Date of the Seminar: 5 May 1992 (Main Conference Room)  
45 min. + 25 min. discussion  
Place of the Seminar: Wright-Patterson Air Force Base  
Aeropropulsion Laboratory  
WL/POTC Dayton OH 45433-6563  
Persons who listened the Seminar: Capt. Richard Heim and ca 16  
persons (between others Capts. Driver and Murawski)  
Also I met Dr. J. S. Przemieniecki, Senior Dean of the  
Air Force Institute of Technology.

In the first part of the seminar I briefly described activity  
of the Institute of Fluid Flow Machinery, Polish Academy of  
Sciences. In particular I presented the activity fields of its 10  
departments.

In the second part I presented the following topics:

- Stress-strain analysis of a turbine blade root  
The object of analysis is stress-strain problem in turbine and  
compressor blade roots including contact problems. A blade root  
and a fragment of disk are modelled by 3-dimensional finite  
elements. We used the finite element with 20 nodes (60 d.o.f).  
The discrete model contains superelements. On a surface between a  
blade root and a cut of a disk we introduced special point finite  
elements which model sliding and broken properties of a joint.  
Using this model we can calculate stresses including adhesion,  
sliding (Coulomb forces) and broken contact. The calculations  
were provided for elastic and elasto-plastic properties of a  
material. During the seminar I presented results of calculations  
for the real system.
- Vibrations of turbine and compressor blades
  The object of analysis are vibrations of blades. Blades were
  modelled by finite elements. We used 3-dimensional finite
  elements (8-node, 16-node or 20-node), thick shell finite
  elements and transition finite elements. We formulated four
  models of a blade. Each model contained the combination of
  described above finite elements. We considered separately short
  and long blades and also special blades (for example the blades
  of Baumann stage). During the seminar I presented results of
  calculations for three first natural frequencies. Numerical
  calculations were compared to experimental results. The best
  results we obtained for the model which contained both
  3-dimensional FE (20-node), thick shell FE and transition FE.

- Stiffness matrices of cracked finite elements
  A crack in a structure causes local changes in stiffness. These
  changes, in turn, affect the dynamics of the system. Both
  frequencies of the natural vibrations and the amplitudes of
  forced vibrations are changed. During the seminar I presented the
  method which we used to formulation of stiffness matrices for few
  cracked elements. I described these matrices for the following
  finite elements: bar, beam, disk, plate, solid. The examples
  illustrated the possibilities of calculations and also their
  accuracy. We compared the results of numerical calculations to
  analytical results and also to experimental data.

- Vibrations of a cracked rotor and a cracked turbine blade
  Using described above stiffness matrices we analyzed the
  influence of cracks on the natural frequencies of torsional and
  bending vibrations of rotor shaft and turbine blades. Also
  dynamic instability of cracked beams were considered. During the
  seminar I presented the results of calculations which illustrated
  changes of dynamic properties of cracked structures. Natural
  frequencies decrease their values when the depth of a crack
  increases. These frequencies also depend on location of cracks. I
  discussed the results of forced vibrations. In particular I
  explained the dependence between crack's properties and
  amplitudes of vibrations. Also the dependence between the regions
  of dynamic instabilities and crack parameters were discussed.