

# Structural Optimization: From Education To Research To Application

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## Survey from Abstracts

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### ▶ Investigated Abstracts

#### ▶ Topics

- ▶ Structural Optimization: 55 presentations
- ▶ Shape and Topology Optimization: 152 presentations
- ▶ Optimization in Emerging Areas: 15 presentations
- ▶ Multidisciplinary and Multiphysics Design Optimization: 43 presentations
- ▶ Applications in Industry: 28 presentations
- ▶ Optimization (Education): 8 presentations

## Details concerning applications

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1. **Stress, impact, crashworthiness and buckling issues**
  - ▶ Stress : **14**, Impact: 3, Crashworthiness: 7, Buckling: 1
  - ▶ Consideration of stress constraints in the optimization is interesting for academia, and vital for industries.
2. **Consideration of constraints for practical industries**
  - ▶ Casting and milling constraint (No. 5490)
  - ▶ Buildability constraint (No. 5364)
  - ▶ Manufacturing constraint (No. 5233)
  - ▶ Casting constraint (No. 4873)
  - ▶ Casting manufacturability constraints (No. 5632)
  - ▶ Manufacturing cost (No. 5626)
  - ▶ Fatigue (No. 5150, 5232, 5472, 5605, and 5533)
  - ▶ Aeroelasticity constraints (No. 5437)
  - ▶ Modularity (No. 4943)

## Details concerning applications (cont.)

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3. **Target-driven optimization issues**
  - ▶ Aircraft: **12**
  - ▶ Turbines: **6**
  - ▶ Supersonic transportation (No. 5289)
  - ▶ Brake squeal (No. 5325), Tesla valve (No. 5412)
  - ▶ Reinforced concrete (No. 5487)
  - ▶ Deployable structure (No. 5380, 5547, 5580)
  - ▶ Robots (No. 5341), Unmanned aerial vehicles (No. 5597)
  - ▶ Woven materials (No. 5495)
  - ▶ Plastic spring seat (No. 5303)
  - ▶ Nanosecond pulsed laser ablation process (No. 5119)
  - ▶ Real-time location system (No. 5104)
  - ▶ Drawing process (No. 5331)
  - ▶ Injection molding process (No. 5071)

## Details concerning applications (cont.)

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### 4. Composite structure and microstructure issues

- ▶ **16** presentations
  - ▶ Hierarchical optimization (No. 4939, 5299, 5459, 5532)
  - ▶ Heat control using composite structures (No. 5097)

### 5. Physics problems other than structural problems

- ▶ Fluid mechanics problems: 7
  - ▶ Use of lattice Boltzmann method (No. 5171, 5354)
  - ▶ Solid-fluid interaction problem (No. 5103, 5585)
- ▶ Acoustic problems: 5
- ▶ Thermal problems: 3

## Details concerning applications (cont.)

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### 6. Design of actuators and sensors

- ▶ Use of piezoelectric materials: 7
- ▶ Electrostatic capacitive sensors (No. 5039, 5197)
- ▶ Polymer based vibration energy harvester (No. 5246)

### 7. Electromagnetic problems, solar cells, nano applications, etc.

- ▶ Magnetic design (No. 5095, 5138, 5575)
- ▶ Electromagnetic wave propagation problems:
  - ▶ Plasmonic composites (No. 5329), Photomask (No. 6227), Optical Cloak (No. 5283), Far-infrared lens (No. 5326)
- ▶ Solar cells (No. 5081, 5113, 5305, 5465)
- ▶ Solid fuel cell (No. 5236)
- ▶ Nano applications
  - ▶ Nano-Aperture design (No.5142), Micro/nano lithography (No. 5407), Nanoparticle growth (No. 5558), Nanoscale geometry (No. 5578)
- ▶ Super-repellent surface (No. 5145)
- ▶ Phononic crystal (No. 5088), Acoustic metamaterials (No. 5142)

## Details concerning applications (cont.)

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### 8. Biomechanical applications

- ▶ Hip replacement implant (No. 5267)
- ▶ Coronary stents (No. 5317, No. 5593)
- ▶ Coronary refractive surgery (No. 5400)
- ▶ Cementless hip joints (No. 5316)
- ▶ Light-eye technology (LeyT) (No. 5549)

## Education

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1. **PowerPoint-based teaching modules**
  - ▶ University of Florida (No. 4914)
2. **Online Engineering Education: Bringing Technical Courses to Industry and Students Worldwide**
  - ▶ University of Florida (No. 5493)
3. **Innovative Engineering Curricula and University Design Competition Applications of Altair OptiStruct and HyperStudy Structural Optimization CAE Tools**
  - ▶ Northwestern University (No. 5596)
4. **A Design Optimisation Course with a Focus on Industrial Applications**
  - ▶ University of Leeds (No. 5610)
5. **Teaching Multidisciplinary Design Optimization (MDO) in a Reconfigurable Interactive Classroom**
  - ▶ Iowa State University (No. 5629)
6. **The Role of MDO in a Corporate Education Program Aimed at the Design of Complex and Highly Integrated Systems**
  - ▶ Embraer - Empresa Brasileira de Aeronautica S.A. (No. 5603)

## Education (cont.)

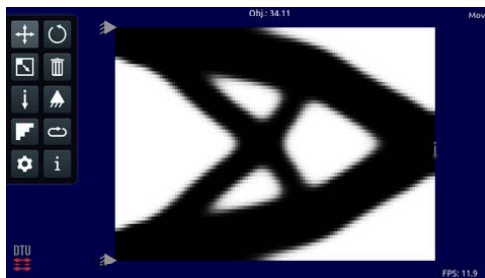
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### ▶ Game Applications

#### ▶ Improving Topology Optimization using Games (No. 5106)

- ▶ TopOpt App is an interactive topology optimization tool that solves minimum compliance problems. The App allows the user to change loads, supports and the volume fraction on the fly, and watch the design evolve to a new optimum in real-time.

<http://www.topopt.dtu.dk/?q=node/781>



## Remarks

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### ▶ Research and Applications

1. Consideration of stress constraints in structural optimization is an important issue from both academic and industrial viewpoints.
2. Many reports considering manufacturing constraints for practical industry demands were presented.
3. Design of aircraft and turbines are a major target for structural optimization.
4. Application of fluid mechanics problems is an ongoing research issue. Numerical problems remain concerning application to industrial problems.
5. Applications for actuator and sensor designs are mainstream.
6. Applications for electromagnetic problems, electromagnetic wave propagation problems, nano technology, solar cells, metamaterials, and biomechanics problems are being established as new structural optimization fields.

## Remarks (cont.)

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### ▶ Education

1. Several reports concerning education in universities and companies were presented.
2. Game applications are very attractive, stimulate student interest, and help students develop an intuitive understanding of structural optimization systems.