

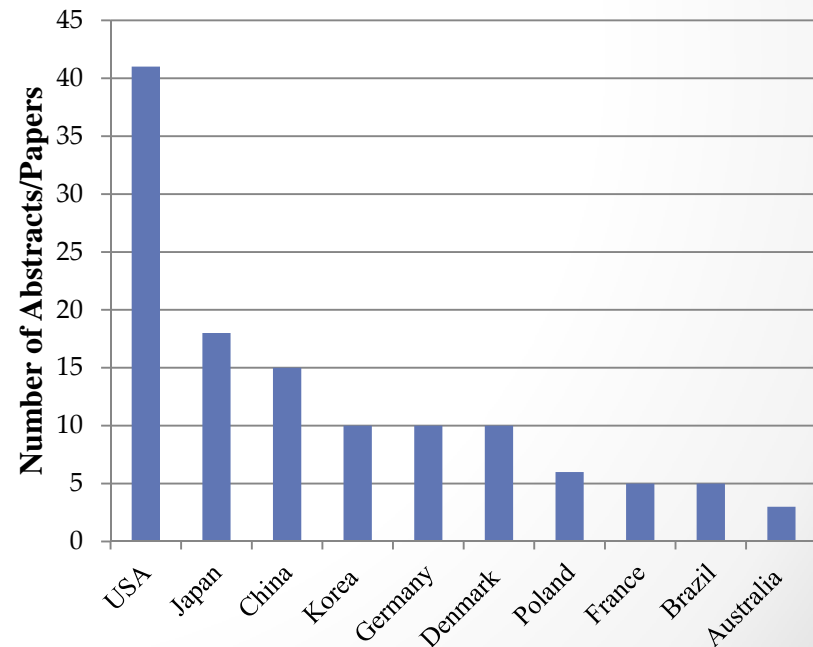
Glaucio H. Paulino

Donald and Biggar Willett Professor of Engineering

University of Illinois at
Urbana-Champaign

Where are we in topology optimization?

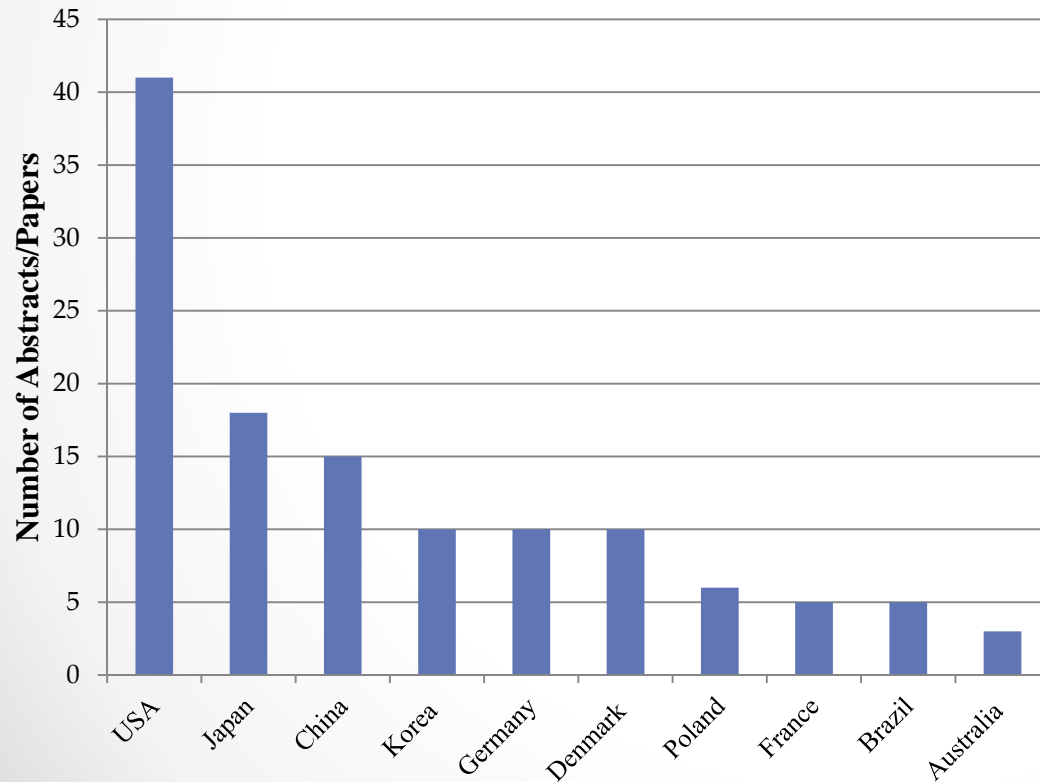
10th World Congress on Structural
and Multidisciplinary Optimization
Orlando, Florida. May 23, 2013



Disclaimers and Credit

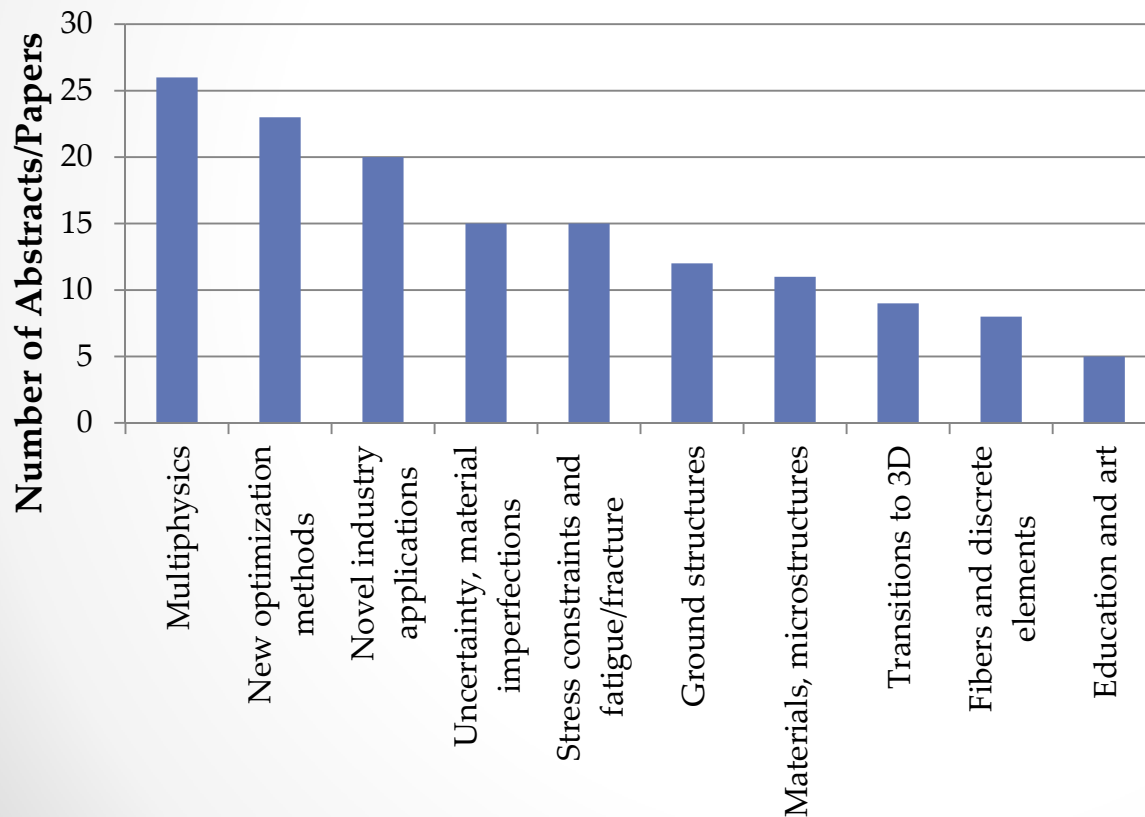
- “Where are we in topology optimization?”
 - Well-posed question, ill-posed solution
- “The Apprentice”
- Figures were used as a means to illustrate the topics
- Apologize in advance for any omission
- Credit: Evgueni Filipov and Xiaojia (Shelly) Zhang, Tomas Zegard

- Over 144 papers related to topology optimization
- 22 countries with papers in topology optimization



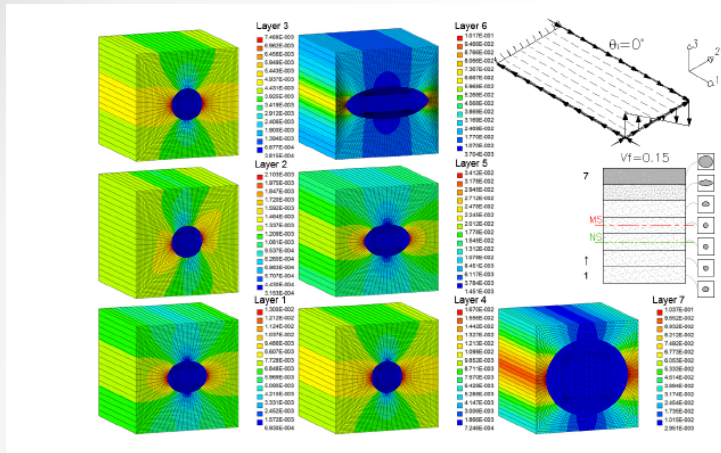
USA	41	Sweden	3
Japan	18	Spain	3
China	15	Portugal	2
Korea	10	Italy	2
Germany	10	Belgium	2
Denmark	10	Russia	1
Poland	6	Netherlands	1
France	5	Israel	1
Brazil	5	Iran	1
Australia	3	Hungary	1
UK	3	Finland	1

- Over 144 papers related to topology optimization
- 10 categories of papers in topology optimization



Multiphysics	26
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Stress constraints and fatigue/fracture	15
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Materials, microstructures	11
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Fibers and discrete elements

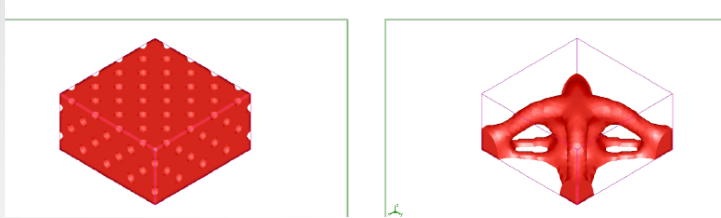


Hierarchical optimization of laminated fiber reinforced composites

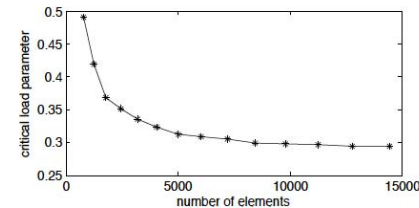
Rafael T.L. Ferreira , Helder C. Rodrigues , Jose M. Guedes , Jose A. Hernandez

Topology optimization of discrete structures and lattices considering manufacturing cost	A. Asadpoure; J.K. Guest; L. Valdevit	Univ of California Irvine	USA
Topology Optimization for Reinforced Concrete Design using Bilinear Truss-Continuum Material Models	Yang Yang, Andrew T. Gaynor, James K. Guest, Cris Moen	Johns Hopkins University	USA
Estimating Material Cross-Property Bounds with Topology Optimization	Seung-Hyun Ha; Vivien J. Challis; James K. Guest; Joseph F. Grotowski; Anthony P. Roberts	Johns Hopkins University	USA
Discrete Topology Optimization Based on Truss-Like Continuum	Kemin Zhou, Hae Chang Gea	Rutgers University; Huaqiao University	China
Hierarchical optimization of laminated fiber reinforced composites	R.T.L. Ferreira; H.C. Rodrigues; J.M. Guedes; J.A. Hernandez	Instituto Tecnológico de Aeronáutica	Brazil
Topology and lay-up optimization of multi-layered composite materials	Gabriel Delgado, Grégoire Allaire	Ecole Polytechnique	France
A Design Method for Optimal Redundant Truss Structures with Certain Redundancy Based on Combinatorial Rigidity Theory	Rie Kohta; Makoto Yamakawa; Naoki Katoh; Yoshikazu Araki; Makoto Ohsaki	Kyoto University	Japan
A New Accelerated Multi-objective Particle Swarm Algorithm. Applications to Truss Topology Optimization	R. Elliaia / A. Habbam / E. Pagnacco	Engineering Mohammadia School	France

Uncertainty, manufacturing constraints, geometric and material imperfections (1/2)



Casting constraints in structural optimization via a level-set method. Gregoire Allaire, Francois Jouve, Georgios Michailidis



(a) Convergence study for buckling load

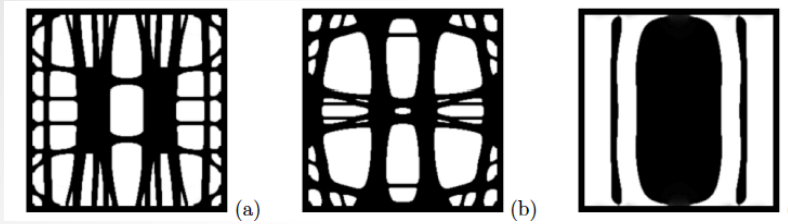


(b) Mode B1, 800 el. (c) Mode B1, 6050 el.

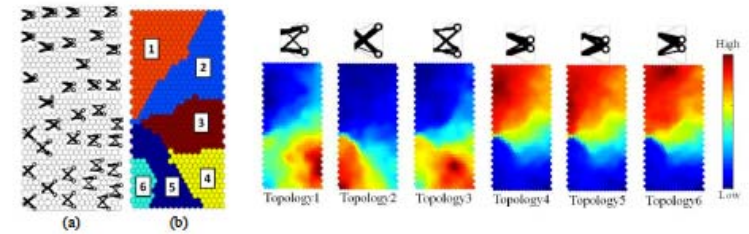
Variational design sensitivity analysis of a non-linear solid shell with applications to buckling analysis. N. Gerzen, F. J. Barthold

Robust topology optimization of slender structures with geometric imperfections	Miche Jansen, Geert Lombaert, Mattias Schevenels, Boyan S. Lazarov, Ole Sigmund	DTU	Denmark
Topology Optimization under Fabrication Uncertainties	M. Tootkaboni, A. Asadpoure, J.K. Guest	University of Massachusetts Dartmouth	USA
Topology optimization under casting and milling constraints	Mu Zhu, James Guest	Johns Hopkins University	USA
Topology optimization of structures under stochastic excitations	Junho Chun; Junho Song; Glaucio H. Paulino	University of Illinois at Urbana-Champaign	USA
Casting constraints in structural optimization via a level-set method	Gregoire Allaire; Francois Jouve; Georgios Michailidis	Ecole Polytechnique of Paris	France
Variational design sensitivity analysis of a non-linear solid shell with applications to buckling analysis	Nikolai Gerzen; Franz-Joseph Barthold	TU Dortmund	Germany
Topology optimization of masonry blocks with enhanced thermomechanical performances	Matteo Bruggi; Carlo Cinquini; Alberto Taliervo	Dept. of Civil Engineering and Architecture, University of Pavia, Italy	Italy

Uncertainty, manufacturing constraints, geometric and material imperfections (2/2)



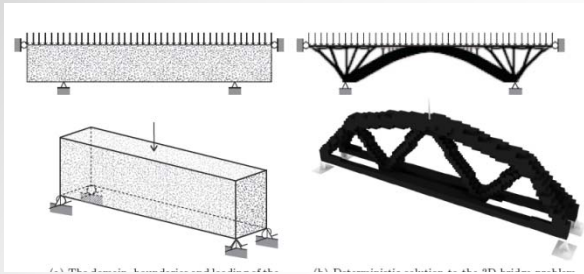
Topology optimization of masonry blocks with enhanced thermomechanical performances.
Matteo Bruggi, Carlo Cinquini, Alberto Taliercio



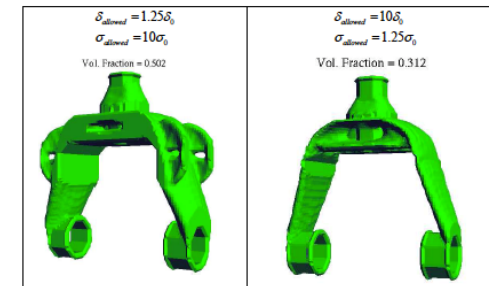
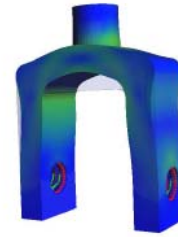
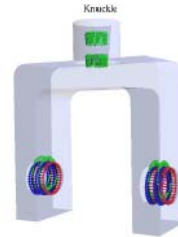
Design Exploration of Robust Topologies under the Loading Uncertainty for the Lug Structure of Super Sonic Transportation . H.Shin, Y. Hirano A. Todoroki

Advances in Multiscale Concurrent Topology Optimization of Lattice Materials	Yan Jun;Hu Wenbo; Duan Zunyi	State Key Laboratory for Structural Analysis of Industrial Equipment	China
Topology optimization of compliant mechanisms designed with multiple materials	Cristina Alonso; Ruben Ansola; Osvaldo M. Querin	University of The Basque Country	Spain
Adaptive topology optimization based on fully error control for separated fields	Yiqiang Wang, Zhen Luo, Zhan Kang	The University of Technology, Sydney (UTS)	Australia
Shape optimization of cold-formed steel beams and columns with manufacturing constraints	Jiazhen Leng; Zhanjie Li; James K. Guest; Benjamin W. Schafer	Dept. of Civil Engineering, Johns Hopkins University	USA
Comparison between reliability based and robust topology optimization considering uncertainties in the geometry	Boyan S. Lazarov and Ole Sigmund	Department of Mechanical Engineering	Denmark
A simplified approach to the topology optimization of structures in case of unilateral material/supports	Matteo Bruggi; Pierre Duysinx	Politecnico di Milano	Italy
Compliance based column topologies generated for maximal buckling load	Bogdan Bochenek, Katarzyna Tajs-Zielinska	Cracow University of Technology	Poland
Design Exploration of Robust Topologies under the Loading Uncertainty for the Lug Structure of Super Sonic Transportation	HYUNJIN SHIN; YOSHIYASU HIRANO; AKIRA TODOROKI	Tokyo Institute of Technology	Japan

Transitions to 3D



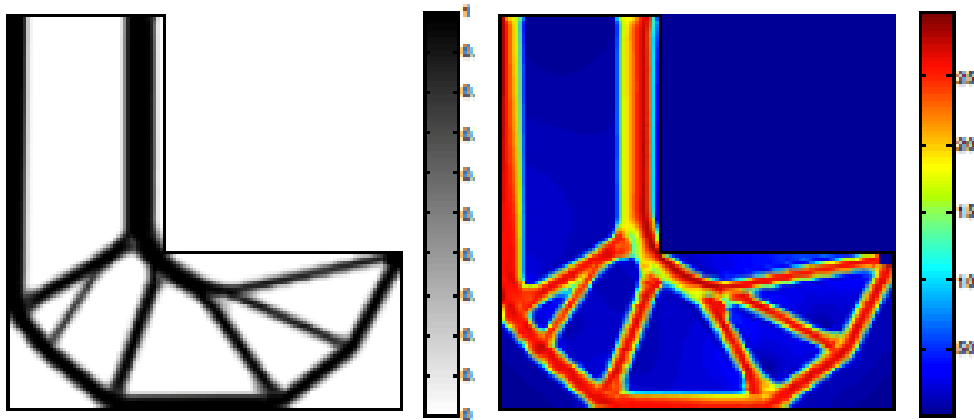
Robust topology optimization of 2D and 3D continuum and truss structures using a spectral stochastic finite element method
 JNRichardson, R.FCoelho and S. Adriaenssens



Generating 3D Topologies with Multiple Constraints on the GPU
 Krishnan Suresh

Topology Optimization using Polytopes	Arun L. Gain, Glaucio H. Paulino, Leonardo Duarte, Ivan F.M. Menezes	University of Illinois at Urbana-Champaign	USA
Discrete Object Projection – New Restriction Capabilities in Topology Optimization	James K. Guest	Johns Hopkins University	USA
Robust topology optimization of 2D and 3D continuum and truss structures using a spectral stochastic finite element method	James N Richardson; Rajan Filomeno Coelho; Sigrid Adriaenssens	Université libre de Bruxelles	Belgium
Generating 3D Topologies with Multiple Constraints on the GPU	Krishnan Suresh	Univ of Wisconsin, Madison	USA
Three-dimensional topology optimization via B-splines	Mingming Wang, Xiaoping Qian	Illinois Institute of Technology	USA
Photomask optimization of micromachined 3D structure using multistep projection targeting minimization of residual displacement	Tsuyoshi Nomura; Takashi Ozaki; Norio Fujitsuka; Keiichi Shimaoka	Toyota Research Institute of North America	USA
A 3D topology optimization model of the cathode air supply channel in planar solid oxide fuel cell	Xiankai Song Alejandro R Diaz Andre Benard	Michigan State University	USA
Application of X-FEM in Isoline/Isosurface Based Topology Optimization	Meisam Abdi; Ian Ashcroft; Ricky Wildman	University of Nottingham	UK
Three-dimensional topology optimization of microstructure for composites applying a decoupling multi-scale analysis	Junji Kato; Daishun Yachi; Kenjiro Terada; Takashi Kyoya	Tohoku University	Japan

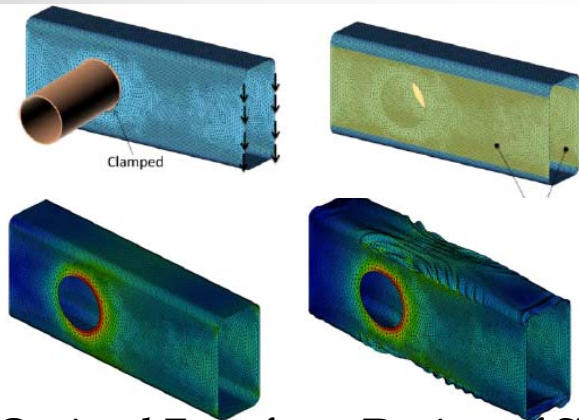
Stress constraints and fatigue/fracture optimization (1/2)



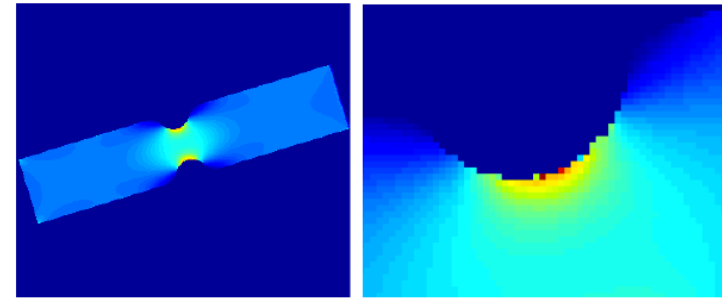
Global and clustered approaches for stress constrained topology optimization and deactivation of design variables. Erik Holmberg, Bo Torstenfelt, Anders Klarbring

A Method for Fatigue-Based Topology Optimization	Julian Norato; Chau Le	Caterpillar Inc.	USA
Optimal topology design of continuum structures with stress concentration alleviation via level set method	Wei Sheng Zhang; Xu Guo	Dalian University of Technology	China
Topology Optimization Method for Dynamic Fatigue Constraints Problem	Seung Hyun Jeong; Dong-Hoon Choi; Gil Ho Yoon	Hanyang University	Korea
Stress-based Topology Optimization of Thermal Structures	Joshua D. Deaton, Ramana V. Grandhi	Wright State University	USA
A new approach for stress-based topology optimization: internal stress penalization	Alexander Verbart; Matthijs Langelaar; Fred van Keulen	National Aerospace Laboratory (NLR)	Netherlands
An enhanced aggregation method for stress-constrained topology optimization problems	Michael Yu Wang; Yangjun Luo	The Chinese University of Hong Kong	China
Optimization of bolt stress	Niels Leergaard Pedersen	DTU	Denmark
Topology Optimization for Maximum Von-Mises Stress Constraint Problems Using the Level Set Method and the KS Function	Takayuki Yamada, Kazuhiro Izui, Shinji Nishiwaki	Kyoto University	Japan

Stress constraints and fatigue/fracture optimization (2/2)



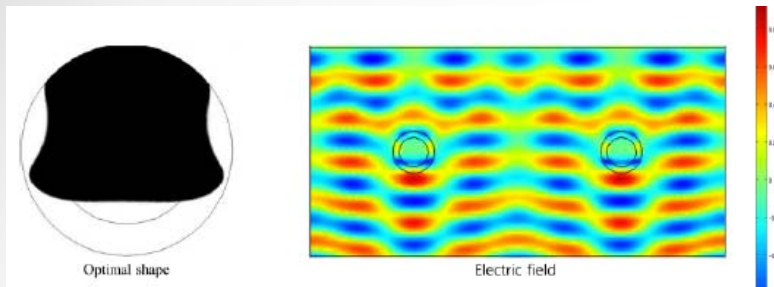
Optimal Free-form Design of Shell Structure for Stress Minimization M. Yonekura, M.Shimoda and Y. Liu



Interior Value Extrapolation - A new method for stress evaluation during topology optimization Henrik Svard

Global and Clustered approaches for Stress and Fatigue Constraints in Topology Optimization	Erik Holmberg;Bo Torstenfelt;Anders Klarbring	DTU	Sweden
Topology Optimization With Vanishing Constraints	W. Aichtziger	University of Erlangen-Nuremberg	Germany
Element connectivity parameterization method for the stress based topology optimization for geometrically nonlinear structure	Gil Ho Yoon	Hanyang University	Korea
IVE: A new method for stress evaluation during topology optimization	Henrik Svärd	KTH Royal Institute of Technology	Sweden
Using a binary material model for stress constraints and nonlinearities up to crash in topology optimization	Sierk Fiebig Joachim K. Axmann	Volkswagen Ag	Germany
A Comparison of Evolutionary Algorithms on Stress-constrained Multi-objective Topology Optimization of Truss Structures	Hao Hu Gang Li	Dalian University of Technology	China
Optimal Free-form Design of Shell Structure for Stress Minimization	Masato YONEKURA; Masatoshi SHIMODA; Yang LIU	Toyota Technological Institute	Japan

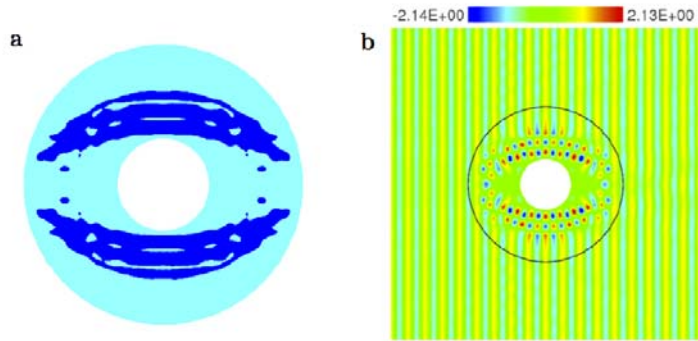
Fluids, dynamics and multiphysics (1/3)



Topology Optimization of silver nano-particles in thin film solar cells
 Soohwan Byun, Jeonghoon Yoo

Topology optimization for effective energy dissipation in elastoplastic systems	Praveen Nakshatrala; Daniel Tortorelli	University of Illinois	USA
A Level-set Method for Optimizing the Topology of Cooling/Heating Devices using Natural Convection	Peter Coffin; David Makhija; Kurt Maute	Univ of Colorado	USA
Topology Optimization of Fluid-Structure Interaction Problems using Levelset and Extended Finite Element Methods.	Jenkins, N.J., Maute, K.	University of Colorado, Boulder	USA
Topological optimization and control for reducing vibration in a beam using piezoelectric material	Jun Sérgio Ono Fonseca; Otávio Augusto Alves da Silveira; Odair Menuzzi	Universidade Federal do Rio Grande do Sul	Brazil
Polygonal multiresolution topology optimization for structural dynamics	Evgueni T. Filipov; Junho Chun; Glaucio H. Paulino; Junho Song	University of Illinois at Urbana Champaign	USA
Dynamic Topology Optimization of Continuum Structure by Using Independent Continuous Mapping Method	Hongling Ye; Yaoming Li; Yanming Zhang; Yunkang Sui	Beijing University of Technology	China
Invention for Fluid Characterization, based on Topology Optimization	Fridolin Okkels	DTU Nanotech	Denmark
Development of functionally graded flextensional piezoelectric devices designed by topology optimization	Ricardo C. R. Amigo, Emílio C. N. Silva	University of Sao Paulo	Brazil
Topological optimization of microstructure by means of bio-inspired methods	Tadeusz Burczynski Waclaw Kus Arkadiusz Poteralski	Silesian University of Technology	Poland
A fluid topology optimization method updating domain concurrently with solving unsteady Lattice Boltzmann method for low Reynolds number flow	Kazuo Yonekura	IHI Corporation	Japan

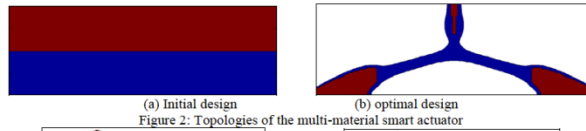
Fluids, dynamics and multiphysics (2/3)



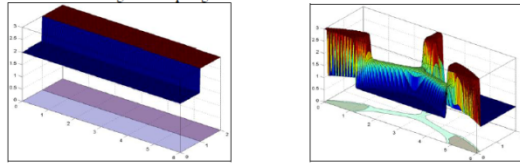
Level Set Based Topology Optimization for Optical Cloaks Containing a Large Scattering Object
 Garuda Fujii, Hayato Watanabe, Takayuki Yamada,
 Tsuyoshi Ueta, Mamoru Mizuno

A topology optimization framework of damping layer design for minimizing acoustic radiation in unbounded domain	Xiaopeng Zhang; Zhan Kang	Dalian University of Technology	China
A Topology Description Function Based Approach for Optimal Design of Piezoelectric Mass Sensors	Zheqi Lin; Xuansheng Wang	Sun Yat-sen University	China
Topology Optimization of Magnetic Vibration Energy Harvesters	Jaewook Lee; Sang Won Yoon	Korea Aerospace University	Korea
Topology optimisation for coupled convection problems	Joe Alexandersen, Casper Schousboe Andreasen, Niels Aage, Boyan Stefanov Lazarov, Ole Sigmund	Technical University of Denmark, DTU MEK	Denmark
Sensitivity Analysis in the Level Set Method for Electromagnetic Problems	S.M. Townsend; S.W. Zhou; Q. Li	University of Sydney	Australia
Topology Optimization with Design Domain Projection applicable to Permanent Magnet Design in Magnetic Fluid Heat Transfer System	Jaewook Lee; Tsuyoshi Nomura; Ercan M. Dede	Korea Aerospace University	Korea
Topology optimization of silver nano-particles in thin film solar cells	Soohwan Byun; Jeonghoon Yoo	Graduate School of Mechanical Engineering	Korea
Filter in topology optimization based on linear diffusion equation	Qinghai Zhao; Xiaokai Chen; Zheng-Dong Ma; Yi Lin	Beijing Institute of Technology	China
Vibro-Acoustic Microstructural Topology Optimization	Jianbin Du; Ruizhen Yang	Tsinghua University	China

Fluids, dynamics and multiphysics (3/3)



(a) Initial design
(b) optimal design
Figure 2: Topologies of the multi-material smart actuator



(a) Initial design
(b) optimal design
Figure 3: Level set surfaces of the multi-material smart actuator

Topological Shape Optimization of Multiphysics Actuators using Level Set Method
Zhen Luo, Yu Wang, Nong Zhang

Topology optimization with a mixed u/p finite element formulation for acoustic-porous-structure interaction system	Gil Ho Yoon	Hanyang University	Korea
Topological shape optimization of multiphysics actuators using level set methods	ZHEN LUO, YIQIANG WANG, YU WANG, NONG ZHANG	The University of Technology, Sydney (UTS)	Australia
Simultaneous optimization of structure and electrode layouts for in-plane piezoelectric sensors and actuators	D. Ruiz, J.C.Bellido, A. Donoso, J.L Sánchez-Rojas	University of Castilla la-Mancha	Spain
Shape optimization under vibroacoustic criteria in the mid-high frequency range	Troian Renata Besset Sebastien Gillot Frederic	Ecole Central de Lyon	France
Level set based topology optimization of directly bonded copper substrates targeting thermal stress minimization on die-substrate bonding line	Tsuyoshi Nomura, Sang Won Yoon, Jaewook Lee and Ercan M. Dede	Toyota Research Institute of North America	USA
Level set based topology optimization for optical cloaks containing a large scattering object	Garuda Fujii; Hayato Watanabe; Takayuki Yamada; Tsuyoshi Ueta; Mamoru Mizuno	Akita Prefectural University	Japan
On the Use of MPCCs Combined Topological and Parametric Design of Genetic Regulatory Circuits	Tinghao Guo; James T. Allison	University of Illinois at Urbana-Champaign	USA
Level Set Based Topology Optimization of Switching Fluidic Device for Incompressible Viscous Flow	Seiji Kubo; Kentaro Yaji; Takayuki Yamada; Kazuhiro Izui; Shinji Nishiwaki	IHI Corporation	Japan

Materials, cellular structures and microstructures (1/2)

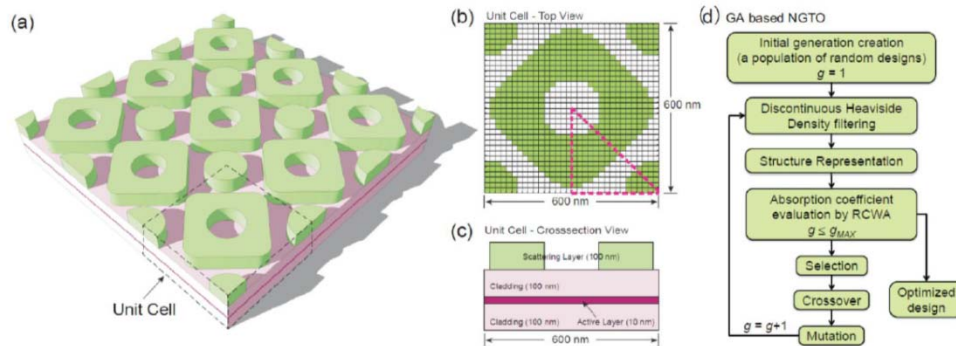


Figure 1: Nanophotonic light-trapping structure optimization model and GA based NGTO framework

Topology Optimization for Highly-efficient Light-trapping Structure in Solar Cell
 Shuangcheng Yu, Chen Wang, Cheng Sun, Wei Chen*

Highly Efficient Light-trapping Structure for Thin-film Solar Cells using Topology Optimization	Shuangcheng Yu;Chen Wang;Cheng Sun;Wei Chen	Northwestern University	USA
Topology optimization of phononic crystals for self-collimation of elastic waves	Jun Hyeong Park, Pyung Sik Ma, Yoon Young Kim	Seoul National University	Korea
Level set-based topology optimization of acoustic metamaterials	Masaki Otomori;Lirong Lu;Shinji Nishiwaki;Takayuki Yamada;Kazuhiro Izui;Takashi Yamamoto	Kyoto University	Japan
Multi-Criteria Multi-Material Topology Optimization of Laminated Composite Structures including Local Constraints (submitted to the session "Optimization of composite structures")	Erik Lund; Rene Sørensen; Søren Nørgaard Sørensen	Department of Mechanical and Manufacturing Engineering, Aalborg University	Denmark
Structural optimization of super-repellent surfaces	Andrea Cavalli; Peter Bøggild; Fridolin Okkels	Technical University of Denmark	Denmark

Materials, cellular structures and microstructures (2/2)

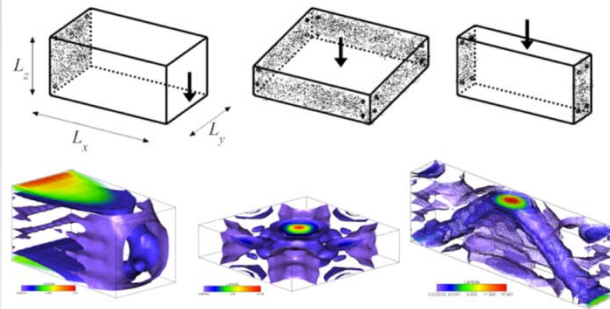
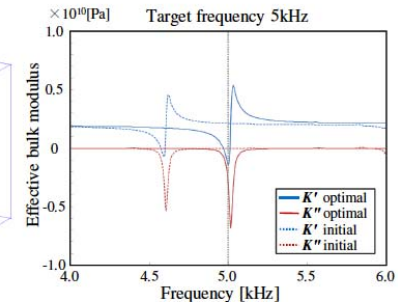
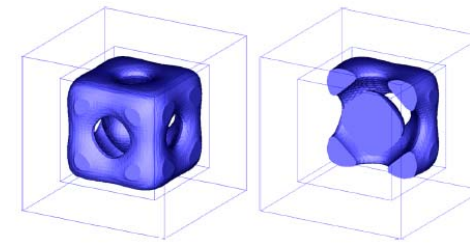


Figure 1: Selected isovalues of the optimal Kelvin modulus λ_1/E_0

Reduction of the Free Material Design problem to a locking material formulation
 Slawomir Czarnecki and Tomasz Lewiński



Level Set-based Topology Optimization of Acoustic Metamaterials Masaki Otomori, Lirong Lu, Shinji Nishiwaki, Takayuki Yamada, Kazuhiro Izui, Takashi Yamamoto

Tailoring Nonlinear Cellular Material Response through Topology Optimization	Reza Lotfi James Guest	The Johns Hopkins University	USA
Multiscale topology optimization of cellular sandwich and laminated structures	Coelho P.G.; Rodrigues H.C.	New University of Lisbon	Portugal
Multiscale topology optimization of structures and non-periodic cellular materials	Kai Liu; Kapil Khandelwal; Andrés Tovar	Indian University -Purdue University Indianapolis	USA
Topology optimization for the microstructure design of plasmonic composites	Masaki Otomori; Jacob Andkjær; Ole Sigmund; Takayuki Yamada; Kazuhiro	Kyoto University	Japan
Topology optimization of dielectric composite hyperelastic materials using level set boundary expressions	Y.Wakukawa; A.Kitagawa; T.Yamada; K.Fuchi; K.Izui; S.Nishiwaki; A.Diaz	Kyoto University	Japan
Reduction of the Free Material Design problem to a locking material formulation	Slawomir Czarnecki ; Tomasz Lewinski	Warsaw University of Technology, Faculty of Civil Engineering	Poland

Novel industry applications (1/2)

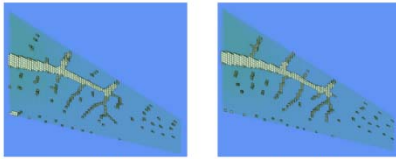


Figure 4: Wing optimum design obtained with combi filter.

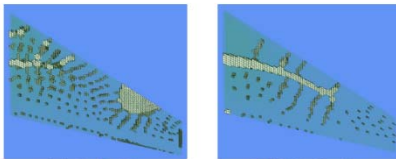
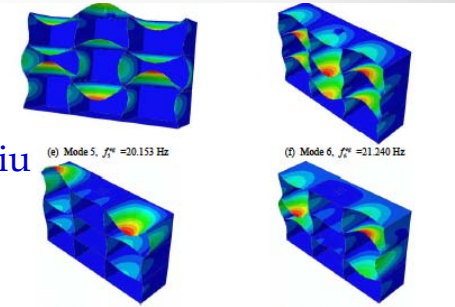


Figure 5: Flying wing optimum designs obtained with combi filter in (a) single load and (b) multiple load formulations.

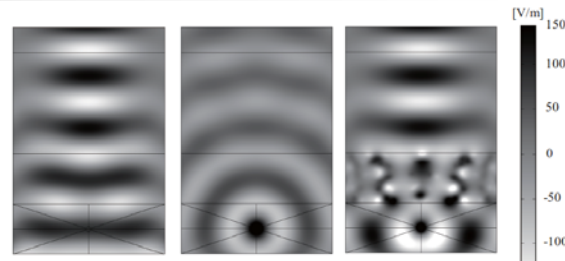
Wing Topology Optimization with Self-Weight Loading
Luis Félix1, Alexandra A. Gomes, Afzal Suleman

Minimizing Machinery Vibration Transmission in a Lightweight Building using Topology Optimization. Niels Olhoff, Bin Niu



Topology and Topometry Optimization of Crash Applications with the Equivalent Static Load Method	Heiner Müllerschön; Andrea Erhart; Peter Schumacher	DYNAmore GmbH	Germany
Design of deployable structures using topology optimization	Saranthip Rattanaserikiat; James K. Guest	Johns Hopkins University, Civil Engineering Department	USA
On Challenges and Solutions of Topology Optimization for Aerospace Structural Design	Wenjong Gu	United Technologies Research Center	USA
Re-design of Tesla valves using topology optimization	Sen Lin, James K. Guest, Yongbo Deng, Zhenyu Liu	Johns Hopkins University	USA
Wing Topology Optimization with Self-Weight Loading	Luis Félix; Alexandra A. Gomes; Afzal Suleman	Instituto Superior Técnico	Portugal
Multidisciplinary Level Set Topology Optimization of the Internal Structure of an Aircraft Wing	Mr Christopher J. Brampton; Dr Peter D. Dunning; Dr H. Alicia Kim	University of Bath	UK
An integrated structural topology optimization framework for the design of high-rise buildings	Lauren L. Beghini; William F. Baker; Alessandro Beghini; Glaucio H. Paulino	University of Illinois at Urbana-Champaign	USA
Minimizing machinery vibration transmission in a lightweight building using topology optimization	Niels Olhoff; Bin Niu	Dept. of Mechanical and Manufacturing Engineering, Aalborg University	Denmark
About Self-Penalization in Topology Optimization	Fabian Wein	University Erlangen-Nuremberg	Germany

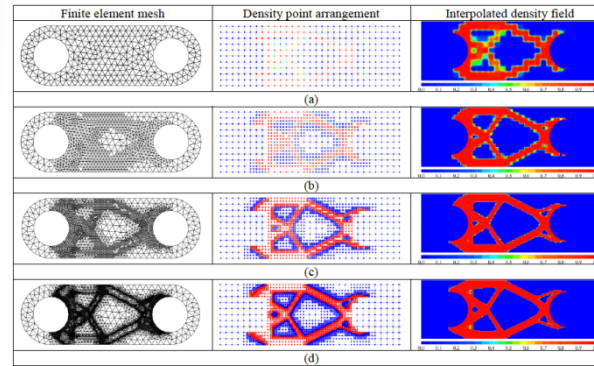
Novel industry applications (2/2)



Design of a far-infrared lens based on topology optimization Yuya Akatsuchi, Takayuki Yamada, Kazuhiro Izui, Shinji Nishiwaki, Makoto Ohkado, Tsuyoshi Nomura

Topology optimization of dielectric ring resonators in application on laser resonators and optical sensors	Akihiro Takezawa; Masanobu Haraguchi; Toshihiro Okamoto; Mitsuru Kitamura	Hiroshima university	Japan
A case study of multicriteria shape optimization of thin structures	A. Benki ; A. Habbal	INRIA	France
Bionic Growth Technique of Stiffener Layout for Plate and Shell Structures Based on Optimality Criteria Method	Xiaohong Ding; Jin Ji	university of Shanghai for Science and technology	China
A hybrid approach to structural topology optimization of vehicle for crashworthiness	Gengdong Cheng; Kun Yan	Dalian University of Technology	China
Isogeometric Layout Optimization of Shell Structures Using Trimmed NURBS Surfaces	Michael Breitenberger; Kai-Uwe Bletzinger	Chair of Structural Analysis, Technical University of Munich	Germany
The Novel Lattice Structure Design for the SL Investment Casting Patterns	Xiaojun Gu; Jihong Zhu; Weihong Zhang	Northwestern Polytechnical University	China
How to route a pipe - Discrete approaches for physically correct routing	Sonja Mars; Jakob Schelbert; Lars Schewe	FAU Erlangen-Nürnberg, Discrete Optimization	Germany
Combining the best of both worlds - shape optimization using a combination of homogenization and sensitivity based method	Peter M. Clausen	FE-DESIGN GmbH	Deutschland
Topology optimization of section for wind turbine blade	O-Kaung Lim; Eun-Ho Choi; Eung-Young Choi; Jin-Rae Cho	Pusan National University	Korea
Shape optimization for brake squeal	Kohei Shintani; Hideyuki Azegami	Nagoya University	Japan
Design of a far-infrared lens based on topology optimization	Yuya Akatsuchi; Takayuki Yamada; Kazuhiro Izui; Shinji Nishiwaki; Makoto Ohkado; Tsuyoshi Nomura	Kyoto University	Japan

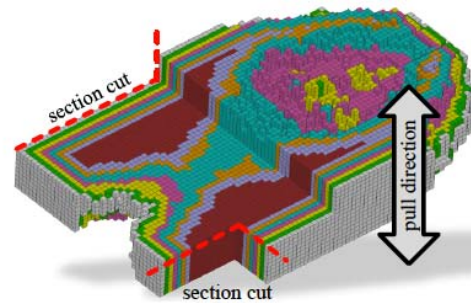
New optimization methods and theories (1/2)



An adaptive topology optimization approach based on mesh-independent density interpolation
 Zhan Kang*, Yiqiang Wang

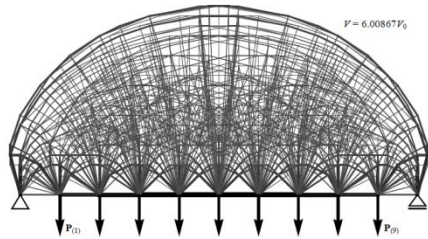
A general topology optimization framework for polygonal finite element meshes in arbitrary domains	I. Menezes; A. Pereira; C. Talischi; G.H. Paulino	Pontifical Catholic University of Rio de Janeiro (PUC-Rio)	Brazil
Stable topology optimization Using Polygonal Finite Elements	Glaucio H. Paulino Cameron Talischi	University of Illinois at Urbana-Champaign	USA
On Numerical Instabilities of the Extended Finite Element Method for Topology Optimization	Kurt Maute and David Makhija	University of Colorado	USA
Smooth topology optimization results using continuous density functions	Anand Parthasarathy and Ashok Kumar	University of Florida	USA
Topology optimization using the material density as a level set function	FERNANDEZ L. F.; GUARNERI P.; FADEL G.	CLEMSON UNIVERSITY	USA
Topological Optimization through Insertion and Configuration of Finite-sized Holes and Inclusions	Hung-Yun Lin; Ganesh Subbarayan	Purdue University	USA
An adaptive topology optimization approach based on mesh-independent density interpolation	Zhan Kang	Dalian University of Technology	China
Improved Two-Phase Projection Topology Optimization	Josephine V. Carstensen; James K. Guest	Department of Civil Engineering, Johns Hopkins University	USA
Topological Derivative Corresponding to Insertion of a Spherical Inclusion	Hung-Yun Lin; Ganesh Subbarayan	Purdue University	USA
Effect of different isogeometrical methodologies on topological structural optimization	B. Hassani S. M. Tavakkoli	Ferdowsi University of Mashhad	Iran
Topology optimization using the p-version of finite element method	Tam Nguyen	Northeastern University	USA
Phase field approach to topology optimization of contact problems	A. Myslinski	Systems Research Institute	Poland

New optimization methods and theories (2/2)



Maximum member sizes and multiple concurrent optimization paths within a binary material topology optimization method
C.Brecher, S. Schmidt, S. Fiebig

On the similarities between micro/nano lithography and topology optimization projection methods	Miche Jansen; Boyan S. Lazarov; Mattias Schevenels; Ole Sigmund	Technical University of Denmark	Denmark
An implementation of level set based topology optimization using GPU	David Herrero, Jesus Martínez, and Pascual Martí	Technical University of Cartagena (UPCT)	Spain
Numerical study of avoiding mechanism issues in structural topology optimization	Guilian Yi;Yunkang Sui	Univ of Florida	USA
Element energy based method for topology optimization	Vladimir Uskov	Central Aerohydrodynamic Institute (TsAGI)	Russia
Multiple concurrent optimization paths in evolutionary topology optimization considering maximum member sizes	Christian Brecher, Sierk Fiebig, Simo Schmidt	Werkzeugmaschinenlabor der RWTH Aachen	Germany
Sensitivity analysis with the eXtended Finite Element Method	Laurent Van Mieghroet; Lise Noël; Emmanuel Tromme; Pierre Duysinx;	University of Liège	Belgium
A Numerical Form Finding Method for Minimal Surface of Membrane Structure	Kouichi Yamane;Masatoshi Shimoda	Graduate School of Toyota Technological Institute	Japan
Topology Optimization using an Explicit Interface Representation	Asger Nyman Christiansen; Morten Nobel-Jørgensen; Niels Aage; Ole Sigmund; Jakob Andreas Bærentzen	Technical University of Denmark	Denmark
On multigrid-CG for efficient topology optimization	Oded Amir; Niels Aage; Boyan S. Lazarov	Technion - Israel Institute of Technology	Israel
Level-set and ALE based topology optimization using nonlinear programming	Shintaro Yamasaki; Atsushi Kawamoto; Tsuyoshi Nomura	Osaka University	Japan
h-Adaptive Extended Finite Element Method for Structural Optimization	Xuefeng Tian; Michael Yu Wang	The Chinese University of Hong Kong	China



On the adaptive ground structure approach for multi-load truss topology optimization. T. Sokół, G.I.N. Rozvany

Ground structures and Michell structures

Topology design of trusses using a Voronoi-based ground structure method	Sushant Maheshwari; Xiaojia Zhang; Adeildo Ramos Jr.; Glaucio H. Paulino	University of Illinois at Urbana-Champaign	USA
A Gradient-based Approach to Truss and Frame Topology Optimization with Integer Design Variable Constraints	Andrew T. Gaynor; James K. Guest	Johns Hopkins University Civil Engineering Department	USA
On the adaptive ground structure approach for multi-load truss topology optimization	Tomasz Sokół; Tomasz Lewinski, George I.N. Rozvany	Warsaw University of Technology	Poland
Structural Optimization of Timoshenko Beam Networks	KUFNER Tobias; STROHMEYER Christoph; STINGL Michael; LEUGERING Günter	Friedrich-Alexander-University Erlangen-Nuremberg	Germany
Topology and Configuration Optimization of Trusses Based on Virtual Bars Concept	Dariusz Bojczuk; Anna Rebosz-Kurdek	Kielce University of Technology	Poland
PZT layout optimization in semi-active vibration control systems of large space truss structures based on ground structure approach	Akihiro Takezawa; Kanjuro Makihara; Nozomu Kogiso; Mitsuru Kitamura	Hiroshima university	Japan
Extension of Michell's theory to exact stress-based multi-load truss optimization	G. I. N. Rozvany T. Sokol	Budapest University of Technology and Economics	Hungary
Ground structure based linkage mechanism topology optimization: new formulation and applications including automobile steering system design	Suh In Kim; Yoon Young Kim	Seoul National University, Korea	Korea
A ground structure approach for topology optimization of nonlinear trusses	Adeildo Ramos, Glaucio H. Paulino	Federal University of Alagoas (UFAL)	Brazil
Distributed loads in truss topology optimization	Kristo Mela; Juhani Koski	Tampere University of Technology	Finland
Density filters for topology optimization based on the geometric and harmonic means	Krister Svanberg; Henrik Svärd	KTH Royal Institute of Technology	Sweden
Free-form Optimization Method for Designing Spatial Framed Structure	Masatoshi Shimoda; Fuminori Hayashi; Naoki Umeda; Yang Liu	Toyota Technological Institute	Japan

Educational and artistic applications



The use of topology optimization for artistic image generation	Yoon Young Kim; Eun Il Kim; Byeongseong Ahn	Seoul National University	Korea
A design optimisation course with a focus on industrial applications	Vassili Toropov	University of Leeds	UK
Innovative Engineering Curricula and University Design Competition Applications of Altair OptiStruct and HyperStudy Structural Optimization CAE Tools	David Schmueser; Matthias Goelke	Altair Inc	USA
A discussion about choosing an objective function and constraints in structural topology optimization	Yunkang Sui; Guilian Yi	Univ of Florida	USA
Improving Topology Optimization using Games	Morten Nobel-Jørgensen; Asger Nyman Christiansen; Jakob Andreas Bærentzen; Niels Aage; Ole Sigmund	Technical University of Denmark	Denmark

Open Areas: Opportunities and Challenges

- Stress constraints
- Restriction Methods
- Integration with optimization theory, e.g. treatment of vanishing constraints (non-convex problem formulations)
- Algorithms – efficient algorithms specialized for both deterministic and non-deterministic topology optimization
- Verification: Understanding difference between benchmark and numerical solutions
- Computational Efficiency (HPC, CPUs, GPUs)
- Multiphysics: electromagnetics, antenna
- Multiscale topology optimization
- Interpolation schemes (micro/mesomechanics)
- Local Buckling; Low density areas (nonlinear TOP)
- RBTO
- Integration of topology optimization and fine arts

Questions?

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