International Society for Structural and Multidisciplinary Optimization

ISSMO NEWSLETTER

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Editors

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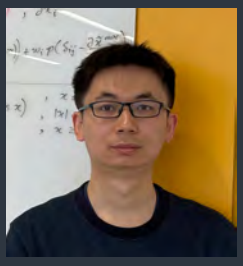

Professor Hongyi Xu
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This issue

Message from the President, Dr. Qing Li

I wish everyone well and hope you continue to make great progress in your work throughout the year. As many of you may already know, we have selected Kobe in Japan as the venue for our next World Congress on Structural and Multidisciplinary Optimization (WCSMO-16). Please allow me to warmly congratulate our Japanese colleagues from Kyoto, Nagoya, and Waseda Universities, led by Professor Kazuhiro Izui, for organizing this major event in our society. I would also like to take this opportunity to extend my heartfelt appreciation to several other dedicated teams from Australia, Hungary, Korea, and USA, who invested significant effort in planning and submitting high-quality proposals to host this prestigious conference. Their outstanding contributions certainly posed a challenge for the committee in making the final decision. We look forward to welcoming you all to Kobe for WCSMO-16 from 18 to 23 May 2025.

While the biennial WCSMO is held in each odd year, our ISSMO members remain actively engaged through participation in the other major conferences throughout 2024. From May19-23, 2024, Asian Congress of Structural and Multidisciplinary Optimization (ACSMO-2024) was held in Zhengzhou (China) (https://www.acsmo2024.cn/) chaired by Prof Gang Li (Dalian University of Technology) as well as co-chaired by Professors Yoshihiro Kanno (University of Tokyo) and Jae Woo Lee (Konkuk University). ACSMO-2024 attracted about 400 participants from different countries/regions. This regional conference series can be traced back to China-Japan-Korea Joint Symposium on Optimization of Structural and Mechanical Systems (CJK-OSM), first held in Xi'an (China) Oct 1999, which was renamed ACSMO since 2016 conference in Nagasaki (Japan) and has since been organized in different countries each even-numbered year.

Many ISSMO members actively participated in 2024 IUTAM Congress in Korea. In particular, Profs. Wei Chen and Ole Sigmund organized a compelling mini symposium entitled "Metamaterials architectured materials and topology optimization", which garnered significant attention and interests from the broader applied mechanics community.

I also observed that a large number of ISSMO members were actively engaged in the 16th World Congress of Computational Mechanics (WCCM-2024), held in Vancouver (Canada) in July 2024, by organizing a series of highly successful mini-symposia. These sessions covered a wide range of SMO topics, from emerging algorithms for topology and shape optimization, machine learning, inverse and nondeterministic design, to innovative applications in metamaterials, multiphysics, additive manufacturing, biomedicine, green engineering, and complex systems across different length/temporal scales. These sessions generated remarkable impacts in the research community.

I would like to express my great appreciation to the colleagues at Technical University of Denmark (DTU) and TU Delft for their ongoing organization of this year's Top Webinars, which have featured some cutting-edge topics from data-driven multiscale design to soft robots, additive manufacturing, lattice structures and fluidic systems. I see that these online Webinars play a role to not only showcase the latest advancements in research, but also foster collaboration and innovation within our community.

I would like to take this opportunity to express my sincere gratitude to Professor Gengdong Cheng and Dr. Ming Zhou for their exceptional leadership as Editors-in-Chief, as well as to about 40 dedicated Review Editors and many other editorial board members for their outstanding contributions in maintaining the prestige and high standards of our official journal, *Structural and Multidisciplinary Optimization* (SMO). SMO has served as a vital platform for many of our members to share novel ideas, research breakthroughs, and impactful applications.

One of the key missions of ISSMO is to promote excellence in research, education, service, and translation among our members by establishing esteemed awards for various career stages. Following extensive discussion and consultations, the Executive Committee has decided to introduce a new ISSMO Fellowship program starting in 2025, aimed to recognize the outstanding contributions and service to ISSMO.

I would also like to thank the current members of the ISSMO Executive Committee for their invaluable leadership, dedication and contributions, often through numerous emails and online meetings across the multiple time zones over the year. It has been a true pleasure working with this vigorous team, and I deeply appreciate their wisdom, commitment, and innovative thinking. I would also like to extend my earnest appreciation to Drs. Ahmad Najafi and Hongyi Xu, our ISSMO Newsletter editors, for their enthusiasm and dedication.

Together, we are wholeheartedly committed to continuously enhancing our service to the ISSMO members with great enthusiasm. We warmly welcome you to share with us your new ideas and suggestions, helping to make ISSMO even stronger and more vibrant.

May I look forward to meeting you all in Kobe (Japan) May 2025.

Prepared by Qing Li

Professor in School of Aerospace, Mechanical and Mechatronics Engineering, The University of Sydney

WCSMO-16 Announcement, Kobe, Japan, May 18th-23rd, 2025

The 16th World Congress on Structural and Multidisciplinary Optimization (WCSMO-16) is scheduled to take place from May 18th through May 23rd, 2025, in the vibrant city of Kobe, Japan.

WCSMO stands as a prestigious biennial gathering, serving as a longstanding catalyst for innovation and collaboration in the field of optimization. Over the years, it has evolved into a renowned international event, uniting experts and researchers from around the world to advance the domains of computational design and structural optimization.

Kobe, with its rich maritime heritage dating back to the 9th century, has historically been a focal point for shipping, trade, and the nurturing of diverse industries and cultures. Through its port, Kobe has cultivated a distinctive cultural identity, influenced by various international sources, which continues to imbue the city with a unique global flavor. This cultural richness is epitomized by Kobe's multicultural population, as well as its architectural and culinary landscape, which seamlessly blend European, traditional Japanese, and modern elements. Moreover, Kobe has placed significant emphasis on global business expansion, particularly in the realm of research and development of cutting-edge technologies, positioning itself as a premier hub for advanced technologies and innovation.

We cordially invite you to join us in Kobe for WCSMO-16, where academic excellence converges with cultural splendor. We eagerly anticipate your participation in this momentous congress as we continue our exploration and advancements in structural and multidisciplinary optimization.

The congress will feature a diverse range of sessions covering topics regarding various fields of computational design methods and novel structural optimization techniques. Attendees will have the opportunity to engage with world-renowned experts, participate in thought-provoking discussions, and explore the latest developments in the field.

In addition to the rich academic program, participants will have the chance to experience the unique charm of Kobe. The city's blend of traditional Japanese culture and modern innovation provides an ideal backdrop for this international gathering of minds. From its scenic harbor to its cutting-edge research facilities, Kobe offers a stimulating environment that complements the congress's focus on advanced technologies and optimization.

The abstract submission site opened on October 15th, 2024, with a submission deadline of January 15th, 2025. We look forward to receiving your contributions and welcoming you to Kobe for an enriching scientific and cultural experience at WCSMO-16.

For more information on the congress, please visit our official website: https://www.wcsmo2025.com/

Prepared by Kazuhiro Izui,

Chair, Local Organizing Committee,
Professor, Kyoto University

Interview with Dr. Glaucio H. Paulino

Professor Glaucio H. Paulino

Princeton University

Dr. Glaucio H. Paulino is the Margareta Engman Augustine Professor of Engineering at Princeton University, Professor of Civil and Environmental Engineering and the Princeton Materials Institute (PMI). His interests are in topology optimization, multiscale optimization, and computational mechanics. His work has been employed by industry, academia and national labs.

Question: Can you share the journey that led to your remarkable achievement of being awarded the 2020 Drucker Medal from ASME?

Answer: I was quite surprised and humbled to receive that medal, especially because Professor Drucker was someone I studied extensively during my student years. At the time of receiving the award, I was working on a paper dedicated to Professor Drucker, which was later published in *Proceedings of the Royal Society A* (476:2019861). I mentioned this paper in my acceptance speech and was thrilled because it bears Drucker's name in the title!

The paper presents a unified approach for topology optimization with local stress constraints, considering various failure criteria. The ideation of this paper is deeply motivated by the pioneering contributions of Professor Daniel C. Drucker to the field of applied mechanics, particularly his key contributions to the theory of plasticity. His seminal work paved the way for the development of a realistic theory of plasticity, widely used in engineering applications. Our formulation for topology optimization draws significant inspiration from his fundamental work, especially the well-established Drucker-Prager yield criterion.

Q: Can you highlight some of your other notable scientific accomplishments and their impact on the field?

A: My group has made significant contributions across various fields, including computational mechanics, reconfigurable structures, origami engineering, applied math, and variational methods. Focusing on optimization, we developed one of the first stable formulations of topology optimization using polygonal finite elements, leading to the creation of the PolyTech family of computer codes and methods. We were also pioneers in applying topology optimization within the virtual element method framework and worked extensively on multi-resolution and multi-scale approaches, particularly relevant to additive manufacturing processes.

In the medical field, we conducted early research on topology optimization to aid cancer patients, proposing patient-specific craniofacial segmental bone replacements. This work, published in PNAS over a decade ago, was a collaboration with cancer surgeon Dr. Michael Miller and remains a project I'm particularly proud of due to its potential to help people.

We also contributed to local stress constraints in topology optimization. In addition, we collaborated with industry and national labs. For instance, some of our design update schemes have been implemented in PLATO, the optimization software at Sandia National Labs, in collaboration with Miguel Aguilo and his team.

Education is another crucial aspect of my career. I believe in positively impacting young minds, and I've dedicated significant time to writing educational papers, many of which were published in our flagship SMO (*Structural and Multidisciplinary Optimization*) journal. We have released numerous open-access computer codes, including PolyMesher, PolyTop, PolyFluid, PolyMat, PolyStress, PolyDyna, and the upcoming PolyPlas (stay tuned). These computer codes, which are freely available, together with their associated journal papers, have contributed to the research and education of a large number of students and engineers worldwide.

Q: How do you see the field of structural and multidisciplinary optimization

A: There are many exciting ideas in the field of topology optimization, and I'd like to highlight a few that I'm currently working on. One notable project is multi-scale, multi-functional, and multi-physics topology optimization. For instance, we published a paper in *Advanced Materials* (Senhora et al., 2022), which was featured on the cover. This work focused on multi-scale topology optimization, where we developed optimally tailored spinodal architected materials for multi-scale design and manufacturing. These architectures, made from a single material, allow for clever control of porosity, resulting in remarkable material functionality.

Another example is the Ph.D. thesis of my former student, Emily Sanders, now a professor at Georgia Tech. Her research embedded lattices within the topology optimization framework, creating manufacturable architectures. Using a voxel-based approach, we could functionally grade and transition various microstructures, enabling multiscale 3D printing. This work was published in *Science Advances* (2021). These examples, and works from other researchers, demonstrate the significant impact topology optimization has had, is having, and will continue to have on materials science, involving the creation of metamaterials.

From a theoretical perspective, nonlinear topology optimization is another crucial area. Nonlinear problems, especially those associated with dissipation, often present challenges in terms of cost and feasibility, requiring innovative solutions for path-dependent sensitivities and coupling nonlinear mechanics.

Topology optimization holds great potential in the biomedical field, though its full impact is yet to be realized. Future interdisciplinary advancements will likely enhance its influence significantly.

Additionally, advances in manufacturing techniques are required to better integrate topology optimization with various manufacturing processes including, but not limited, to additive manufacturing on earth and in outer-space exploration (on-demand printing of what is needed when it is needed where it is needed).

Lastly, the integration of machine learning and AI with topology optimization is a dominant global trend. While prevalent in literature, we need to find more synergistic ways to combine these technologies effectively (e.g., connecting with the physics of the problems), facilitating its transition from academia to industry.

Q: What advice would you give to Ph.D. students and young investigators who are just starting their careers in this field?

A: I recommend emphasizing the fundamentals. In a pervasive design field like optimization, applicable to many areas, fundamentals can sometimes be overlooked. This isn't beneficial. My advice is to always remember the fundamentals, as they are crucial.

Interview With Dr. Glaucio H. Paulino (Continued)

Q: What role do professional societies like the International Society for Structural and Multidisciplinary Optimization play in advancing the field?

A: I believe ISSMO is an outstanding organization. I'd like to start by mentioning Professor Rozvany, the Founder-President of ISSMO. I appreciate the opportunity to mention his name, and I am moved to do so. And if you allow me to connect this with the previous question when I referred to "fundamentals," I would like to mention that his emphasis on fundamentals greatly inspired me. In 2014, just before Professor Rozvany passed away, we organized a CISM event on "Topology Optimization of Structures and Continua – Computational Aspects and Background" in Udine, Italy. This event featured lectures from notable experts like Ole Sigmund, Kurt Maute, Krister Svanberg, and Pierre Duysinx. Unfortunately, it was the last time I saw Professor Rozvany.

ISSMO has significantly advanced the field of optimization, not just topology optimization. The Society's foundation by Professor Rozvany is particularly meaningful. And even today, the shape of the conference is very much in the way that it started, and I appreciate that. ISSMO has been crucial in the development of the field and has done some great things, for example, initiatives like recent webinars that address new topics and visions. I recently participated in a webinar on machine learning for topology optimization, and discussed online learning. I also appreciate the involvement of young researchers, such as Prof. Shelly Zhang (University of Illinois at Urbana-Champaign) – she was given the opportunity to deliver the State-of-the-Art-Talk on topology optimization during the WCSMO in Ireland (2023) and she did a remarkable job. In summary, ISSMO truly is a remarkable organization.

One recommendation would be to have more awards for the community, for the young researchers, the mid-career, and the senior ones. For example, something similar to what we do in the Applied Mechanics Division (AMD) of the American Society of Mechanical Engineers (ASME), we have the Hughes Award for young researchers, we have a mid-career award like the Belytschko Award, and we have very senior awards like the Drucker Medal. And then maybe in the future, this range of awards could be considered by ISSMO.

Q: What are the next steps in your research, and what are you most excited about?

A: I'd like to share a couple of exciting projects we're currently working on, both in collaboration with Dr. Fernando Senhora and Dr. Emily Sanders. A recent project that I'm deeply interested in is using topology optimization to create new materials. Specifically, we introduced a new set of materials named HELMets (High Entropy Lattice Metamaterials). When simple elements combine in specific ways, they form complex systems with emergent properties not inherent to the individual elements. By controlling the connectivity within lattice structures, using percolation theory, we can manipulate the randomness of connections, enhancing the structure's mechanical properties. In this work, we investigate various distinct architectures, each tailored to optimize different aspects of mechanical performance as it loops into a significantly richer design space. Using advanced computational models, we optimize multi-scale structures to achieve maximum stiffness with minimal weight. Our findings confirm that high microstructural complexity leads to superior mechanical properties in low density materials. I hope to see a lot of HELMets in the near future.

Another relevant area of much interest involves cloaking. There is a seminal paper by Mansfield in 1953 ("Neutral holes in plane sheet: reinforced holes which are elastically equivalent to the uncut sheet" Q. J. Mech. Appl. Math.) that introduced the concept of a neutral hole in a plate where reinforcing around the hole eliminates stress concentration. This idea has influenced the field in different ways, both in positive and also in undesirable ways. For instance, many papers have attempted to implement cloaking in topology optimization, but I believe cloaking for either a specific load case or a limited set of load cases is not sufficient. What about if you have a load that is not in your set of design loads? This motivated us to develop a new framework that considers cloaking for arbitrary elastic disturbances. This work is still in progress, but it is very promising, and I hope that it will be published soon.

Q: Can you share any personal anecdotes or experiences that have shaped your career?

A: The anecdote I want to share goes back to meeting Professor Martin Philip Bendsøe during the WCSMO 10 in Orlando, Florida, in 2013. I was inspired to work on stress constraints because of Professor Bendsøe's work, and we had many discussions on this topic during the conference. I admire him and have learned so much from him. His contributions have significantly impacted our community and the field of topology optimization.

In the acknowledgment section of one of our papers published in the SMO journal (2021, 63:2065-2097), I mentioned this anecdote. The acknowledgment reads: "This paper is dedicated to Martin Bendsøe. He motivated our interest in the research reported in the present paper and in other recent ones, such as Senhora et al. (2020) and Giraldo-Londoño and Paulino (2020). More specifically, our intellectual curiosity in the topic was sparked by an early discussion between Paulino and Bendsøe during the WCSMO 10, held in Orlando, Florida, in 2013." Additionally, the editor in charge of the aforementioned paper was Professor Ole Sigmund, another giant in the field.

Professor Bendsøe has been a source of inspiration and an intellectual mentor for me. I have studied all his papers, and his work has always inspired me and my research group.

Q: Is there anything else you would like to add?

A: Yes, I would like to mention that the major impact on my career has come from my former graduate students. I've learned a great deal from them and continue to do so. Often, professors receive credit, but it's the dedication and hard work of these amazing students that make everything possible. I'm incredibly grateful for their contributions and consider them instrumental people in the field (they are the future!).

Q: Thank you for this insightful conversation. It was a pleasure discussing your work and experiences. Wishing you continued success in all your endeavors!

A: Thank you, Ahmad. Thank you, Hongyi. This was a pleasure. You did a great job in the interview, and I was very happy to talk to both of you.

Prepared by

Glaucio H. Paulino, Margareta Engman Augustine Professor, Princeton University, USA,

Ahmad Najafi, Associate Professor, Drexel University, USA,

Hongyi Xu, Assistant Professor, University of Connecticut, USA.

SMO Journal Status Update

We encountered significant challenges beginning in July 2023 when Springer transitioned our editorial system from Editorial Manager (EM) to SNAPP. The new platform's design and functionality were drastically different from EM, creating substantial difficulties for our team, presenting an existential threat to our operations. In response, the team worked cohesively to advocate for a return to EM, and by February 2024, we successfully convinced Springer to revert to the original system. This disruption led to a decline in both submissions and publications. As we work to recover from this challenging period, *we need your advocacy and support now more than ever*.

Despite these challenges, our journal's performance in 2023 remained strong. Our Journal Citation Reports (JCR) ranking improved, even though our score slightly decreased to 3.6 (Figure 1). SMO now ranks in the top quartile (Q1) for 'Mechanics' (#34 out of 170 journals vs. 32/137 in 2022) and 'Multidisciplinary Engineering' (31/180 vs 27/90 in 2022). Additionally, we remain in the second quartile (Q2) for 'Computer Science Interdisciplinary Applications' (56/169 vs. 52/110 in 2022), maintaining a solid standing across key categories.

Another important measure of journal quality is the Elsevier CiteScore, which calculates citations over a four-year period (citations from 2020–2023 divided by articles published during 2020–2023), which has increased compared to 2022. This score reflects a continued overall upward trend in the journal's performance (Figure 2).

The journal operates with a distinctive editorial process in which approximately 40 Review Editors (REs) volunteer to manage the peer-review process. This system was originally developed by founding Editor-in-Chief George Rozvany and later enhanced by his successor, Rafi Hafka, who formally credited the Handling Editor in each published paper. The RE team benefits from a natural renewal mechanism, with new REs replacing those who take sabbaticals. Over the past year, we have welcomed new Review Editors to our team: Vikant C. Aute, Souma Chowdhury, and Qing Quan (Stephen) Liang. Additionally, Qing Li and Daniel Tortorelli have joined as Senior Advisors.

We want to extend our congratulations to authors whose papers were most cited, according to the 2023 IF citation data (see Table 1).

Prepared by

Ming Zhou, Chief Engineer – Computational Mechanics and Design Optimization, Altair Engineering, USA,

Gengdong Cheng, Professor, Dalian University of Technology, China,

Silvia Schilgerius, Senior Publishing Editor at Springer.

Figure 1. Impact factor in the latest 5 years

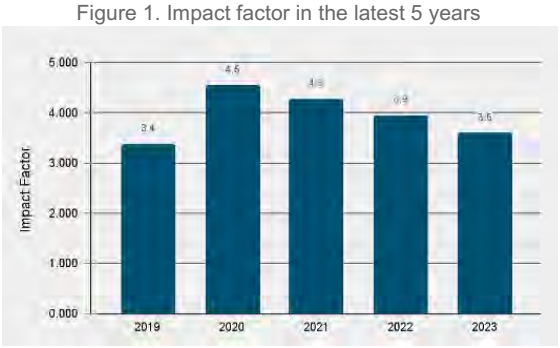

Figure 2. CiteScore in the latest 4 years

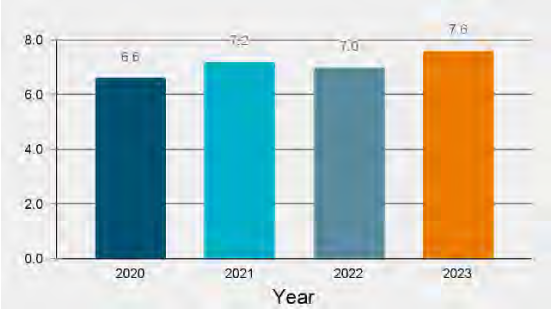

Table 1. The List of Most Cited Articles According to the 2023 Impact Factor Citation Data.

Title	Author	Publication Type	Publication Date	DOI	Total Citations *	Citations For IF 2023
Topology optimization of multi -scale structures: a review	Wu, Jun; Sigmund, Ole; Groen, Jeroen P.	Review	2021	10.1007/s00158-021-02881-8	255	92
Evidence theory -based reliability optimization for cross-scale topological structures with global stress, local displacement, and micro -manufacturing constraints	Wang, Lei; Zhao, Xingyu; Wu, Zhangming; Chen, Wenpin	Article	2022	10.1007/s00158-021-03112-w	82	43
TOuNN: Topology Optimization using Neural Networks	Chandrasekhar, Aaditya; Suresh, Krishnan	Article	2021	10.1007/s00158-020-02748-4	113	42
A comprehensive review of educational articles on structural and multidisciplinary optimization	Wang, Chao; Zhao, Zhi; Zhou, Ming; Sigmund, Ole; Zhang, Xiaojia Shelly	Review	2021	10.1007/s00158-021-03050-7	65	36
A comprehensive review of digital twin - part 1: modeling and twinning enabling technologies TC Digital Twin Technology	Thelen, Adam; Zhang, Xiaoge; Fink, Olga; Lu, Yan; Ghosh, Sayan; Youn, Byeng D.; Todd, Michael D.; Mahadevan, Sankaran; Hu, Chao; Hu, Zhen	Review	2022	10.1007/s00158-022-03425-4	80	32
On the use of artificial neural networks in topology optimisation	Woldseth, Rebekka V.; Aage, Niels; Baerentzen, J. Andreas; Sigmund, Ole	Review	2022	10.1007/s00158-022-03347-1	60	31
PolyStress: a Matlab implementation for local stress-constrained topology optimization using the augmented Lagrangian method	Giraldo-Londono, Oliver; Paulino, Glaucio H.	Article	2021	10.1007/s00158-020-02760-8	58	26
Topology optimization with linearized buckling criteria in 250 lines of Matlab	Ferrari, Federico; Sigmund, Ole; Guest, James K.	Article	2021	10.1007/s00158-021-02854-x	44	24
Crashworthiness design and multi -objective optimization of a novel auxetic hierarchical honeycomb crash box	Tan, Hailun; He, Zhicheng; Li, Eric; Cheng, Aiguo; Chen, Tao; Tan, Xiwen; Li, Qiqi; Xu, Bing	Article	2021	10.1007/s00158-021-02961-9	64	21
Integrating deep learning into CAD/CAE system: generative design and evaluation of 3D conceptual wheel	Yoo, Soyoung; Lee, Sunghee; Kim, Seongsin; Hwang, Kwang Hyeon; Park, Jong Ho; Kang, Namwoo	Article	2021	10.1007/s00158-021-02953-9	58	20
An efficient multi -objective optimization method based on the adaptive approximation model of the radial basis function	Liu, Xin; Liu, Xiang; Zhou, Zhenhua; Hu, Lin	Article	2021	10.1007/s00158-020-02766-2	55	20
Modeling, analysis, and optimization under uncertainties: a review	Acar, Erdem; Bayrak, Gamze; Jung, Yongsu; Lee, Ikjin; Ramu, Palaniappan; Ravichandran, Suja Shree	Review	2021	10.1007/s00158-021-03026-7	40	20

TOP Webinar

Launched in 2020, the Topology Optimization Webinar (TOP Webinar) is now celebrating its fifth year. Earlier this year, we revised the webinar format to better align with the current landscape where in-person conferences have returned, offering much needed opportunities for scientific exchange and social interaction. However, through surveys and conversations with colleagues and students, we recognized the continued demand for an online platform. The flexibility of virtual events, which can accommodate PhD talks, panel discussions, tutorials, and talks of latest research, remains valuable. The online format also allows for global connection without the need for travel.

In the new format, each webinar centers around specific themes, featuring one educational/review presentation (20 minutes) and two research talks (10 minutes each), all related to the same topic.

So far, we have successfully hosted five sessions using this format, and it has been very well received. Attendance via Zoom averages 60-100 participants, with an additional 10-20 viewers joining the YouTube livestream. We've also noticed an increase in discussions following the talks, often needing to wrap up conversations due to time constraints.

The five sessions are: Fluid topology optimization (organized by Joe Alexandersen, University of Southern Denmark), Topology optimization for additive manufacturing (Matthijs Langelaar and Can Ayas, TU Delft), Data-driven multiscale design (Wei Chen, Northwestern University), Multiscale topology optimization (Jun Wu, TU Delft), and Topology optimization of soft robots (Josh Pinskier, CSIRO Robotics).

Building on the success of this format, we will continue with thematic sessions. We are also looking to expand the format with panel discussions, PhD presentations, and more. We encourage colleagues interested in organizing sessions to reach out to us. Suggestions and questions are always welcome.

The new season of the TOP Webinar kicked off in September 2024, with the first session scheduled for Sep. 26th. This session focused on *Truss Optimization*, organized by Dr. Helen Fairclough from the University of Sheffield, UK. A session on Topology Optimization in Industry followed in October. For more details and updates, please visit our website at http://top-webinar.org.

If you missed a session, you can always watch the recording on our YouTube (https://youtu.be/gulbiqG21fk) channel.

Note: If you would like to receive announcement emails, please register via this form, https://forms.gle/RqzMxM4FW7jPYnBCA or send a message to topwebinar.org@gmail.com

www.top-webinar.org

TU Delft

Delft University of Technology

DTU Denmark Technical University

Organizers:

Jun Wu, Associate Professor, Delft University of Technology, Netherlands,

Matthijs Langelaar, Professor, Delft University of Technology, Netherlands,

Fred van Keulen, Professor, Delft University of Technology, Netherlands,

Niels Aage, Associate Professor, Technical University of Denmark, Denmark,

Ole Sigmund, Professor, Technical University of Denmark, Denmark.

JMD Webinar

The Journal of Mechanical Design Webinar is a series of webinars organized quarterly to feature interesting research work being published in the ***Journal of Mechanical Design*** **(JMD)**. The goal is to share the latest research and development in the field, and by doing so, to keep our community connected.

The webinar takes place online quarterly and features invited presentations of recently published/accepted articles in JMD. So far, the webinar has covered a diverse range of thematic topics, such as artificial intelligence, design for additive manufacturing, robot and robotic system design, early-stage product design, and more. Each JMD webinar includes a ***90-minute Zoom webinar session*** and a ***30-minute gather.town session*** for further discussion/networking. Register and watch past recordings at https://asmejmd.org/webinar-2/.

Upcoming ISSMO Endorsed Events

AIAA AVIATION Forum: 21–25 July 2025, Las Vegas, NV, USA

AIAA SciTech Forum: 6–10 January 2025, Orlando, FL, USA

18th U.S. National Congress on Computational Mechanics: 20–24 July 2025, Chicago, Illinois, USA

https://usnccm18.usacm.org

Call for Volunteers – New Initiatives

ISSMO is determined to increase diversity and inclusion among its community and create opportunities for young researchers to develop their career. We welcome enthusiastic volunteers to work on different new initiatives and provide us with their unique perspectives and capabilities in various capacities. If you are interested, please send a one-page CV along with a one-paragraph description of what you would like to achieve by serving the ISSMO community to Dr. Oded Amir.

ISSMO Website

Our website is available at https://www.issmo.net/. You can find information on membership, events including WCSMO and indorsed events, news including announcements and job openings, ISSMO newsletters, awards, and publications.

Becoming a Member

For membership listing and approval, please visit https://www.issmo.net/membership/join-issmo/ and submit your information. If you have any difficulty, please email a resume with a list of publications to Secretary General. Associate membership is granted upon recommendation of one of the members of the executive committee based on record of activity in the field of Structural or Multidisciplinary Optimization. Full membership requires attendance of at least one of the World Congresses of Structural and Multidisciplinary Optimization.

ISSMO/Springer Prize

Dr. Changyoung Yuhn

"4D topology optimization: Integrated optimization of the structure and self-actuation of soft bodies for dynamic motions"

Changyoung Yuhn is a researcher at Toyota Central R&D Labs., Inc., Japan. He received his Ph.D. from the University of Tokyo in 2021, focusing on computational hemodynamics using reduced-order models for disease prediction and surgical planning. Since joining his current position, he has been working on topology optimization under the supervision of Dr. Nomura and Dr. Kawamoto. His research interests include the co-design of structure and motion in self-actuated soft materials, such as soft robots.

Soft robots, made from materials like rubber, have attracted growing interest due to their ability to deform flexibly and adapt to changing environments. However, designing both their structure and motion is challenging because of their high degrees of freedom. This process often relies on trial and error, intuition, expert knowledge, or inspiration from biological organisms.

In this paper, we propose a "4D topology optimization" framework that extends classical topology optimization to incorporate both spatial and temporal design domains (Fig. 1). This approach optimizes not only the robot's structure but also its deformation strategy (self-actuation) over time, enabling the robot to perform desired dynamic tasks. The optimization determines the structure, actuator placement, and time-dependent actuation by representing these elements as densities across space (3D) and time (1D). Our results demonstrate that the optimized robots can move, rotate, and control their posture by skillfully manipulating complex structures, resembling the motion of living organisms.

The key contributions of this study are twofold. First, the framework addresses the design of highly deformable materials interacting with their environment through complex contact dynamics. It utilizes the material point method to handle large deformations and intricate contact interactions, while automatic differentiation enables efficient gradient-based optimization in these dynamic scenarios.

Second, the design space is extended into the time domain through novel design representations. We model actuation as a sequence of pulses over time:

$$\hat{u}(t) = A_{\mathrm{act}} \tanh\left[\int_0^T \chi_{\mathrm{pul}}(t)\left\{A_{\mathrm{pul}} \exp\left(-\frac{(t'-t)^2}{2\sigma_{\mathrm{pul}}^2}\right)\right\} dt'\right],$$

where $\chi_{\mathrm{pul}}(t)$ is a characteristic function that takes values from {−1, 0, 1} and is optimized. A_{pul} and σ_{pul} are the peak amplitude and standard deviation of a Gaussian pulse, respectively, while A_{act} represents the actuation strength. The resulting actuation signal $\hat{u}(t)$ can exhibit complex shapes with a high degree of expressive freedom.

A potential direction for future exploration is to extend the proposed method to real-world fabrication. 4D topology optimization holds promise for designing soft robots actuated by air pressure, magnetic forces, or muscle cell contractions, with potential applications in medical and diverse industrial fields.

Prepared by

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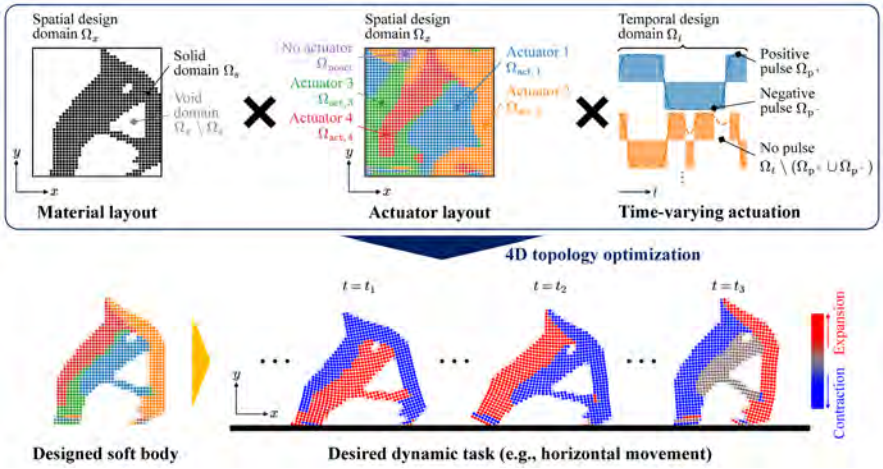

Fig. 1. Schematic illustration of the 4D topology optimization.

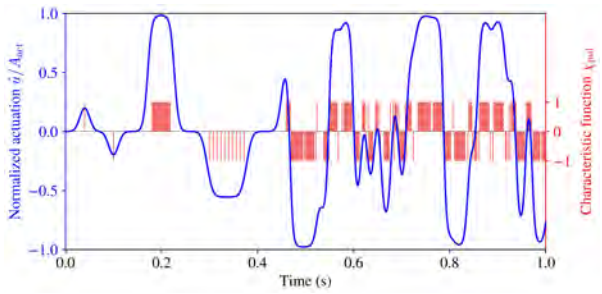

Fig. 2. Example of the actuation signal given as the convolution of characteristic function and Gaussian pulses.

Symposium on “Metamaterials, Architectured Materials and Topology Optimization” in ICTAM2024

Professor Wei Chen (Northwestern University, USA) and Professor Ole Sigmund (Technical University of Denmark, Denmark) co-organized the symposium on “Metamaterials Architectured Materials and Topology Optimization” at the 26th International Congress of Theoretical and Applied Mechanics (ICTAM 2024), August 26-30, 2024, Daegu, Korea. The symposium featured 4 invited talks, 80 regular talks, and 24 posters, and was the 2nd largest symposium among the 53 symposiums held. ISSMO EC member Professor Gilho Yoon (Hanyang University) served on the Local Organizing Committee of ICTAM 2024.

Prepared by

Wei Chen, Wilson-Cook Professor and Chair of Department of Mechanical Engineering, Northwestern University, USA.

Announcing Call for ISSMO Fellow Nominations

The ISSMO Executive Committee is pleased to announce the introduction of the ISSMO Fellowship, starting in 2025.The status of **Fellow of ISSMO**, the International Society for Structural and Multidisciplinary Optimization, is awarded to eminent members of ISSMO with distinguished records, who have contributed significantly to the advancement of structural and multidisciplinary optimization. This may be through their original research and impactful publications, the translation of research into practice, their leadership and excellence in pedagogy, mentoring, as well as professional service in the society. Nominees should be currently active in making both technical contributions to ISSMO and participating in ISSMO activities.

All ISSMO Members may be nominated by an ISSMO Member (self-nominations are not permitted; only one nomination is allowed per member). To be considered for the ISSMO Fellowship, the following materials must be received by the Executive Committee through the ISSMO Secretary General by the nomination deadline of February 15, 2025. Please note that members of the current ISSMO Executive Committee cannot be nominated, nor act as nominators or referees.

From the Nominator: A Letter of Nomination and the Candidate’s Curriculum Vitae (CV). The Letter of Nomination (maximum 2 pages) should confirm the candidate’s eligibility and provide a justification for recommending the candidate for the award. The letter should include a suggested citation to appear on the Fellowship certificate to highlight the nominee’s eminent status and exceptional contribution (maximum 30 words). The candidate’s CV should be no more than 4 pages in length.

From Two Other Referees: Letters of Recommendation (maximum 2 pages) should provide a justification to recommend the candidate for the fellowship. A referee can recommend only one candidate.

The Nominator should properly combine all the materials required into a single pdf and send the pdf directly to the Secretary General at odedamir@technion.ac.il with the candidate’s name in the subject line. All materials must be received by the nomination deadline of February 15, 2025.

The ISSMO Fellows will be selected from the eligible nominees by the ISSMO Executive Committee. The new ISSMO Fellows will be recognized at the General Assembly of the WCSMO-16. The ISSMO fellowships will be awarded every two years during the WCSMO.

Questions regarding the nomination procedure may be sent to the ISSMO Secretary General, Professor Oded Amir at odedamir@technion.ac.il

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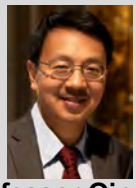

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