



Volume 34 Number 3
August 2020

AI EDAM

Artificial Intelligence for Engineering Design, Analysis and Manufacturing

Amaresh Chakrabarti, Editor

CAMBRIDGE
UNIVERSITY PRESS

ISSN 0890-0604

EDITOR

AMARESH CHAKRABARTI
Indian Institute of Science

ASSOCIATE EDITORS

Gaetano Cascini, *Politecnico di Milano, Italy*
Kristina Shea, *ETH Zurich, Zurich, Switzerland*

Ashutosh Tiwari, *University of Sheffield, UK*

EDITORIAL BOARD

Alice M. Agogino, *University of California, Berkeley, CA*
Frances M.T. Brazier, *Delft University of Technology,
The Netherlands*
David C. Brown, *Worcester Polytechnic Institute, Worcester, MA*
Jonathan Cagan, *Carnegie Mellon University, Pittsburgh, PA*
Matthew I. Campbell, *University of Texas, Austin, TX*
Per Christiansson, *Aalborg University, Denmark*
Ellen Yi-Luen Do, *Georgia Institute of Technology, Atlanta, GA*
Alex H.B. Duffy, *University of Strathclyde, Scotland*
Donal Finn, *University College, Dublin, Ireland*
John S. Gero, *George Mason University, Fairfax, VA*
Kazjon Grace, *The University of Sydney, Australia*
Roderick A. Grupen, *University of Massachusetts, Amherst, MA*
Sean Hanna, *University College London, United Kingdom*
Yan Jin, *University of Southern California, USA*
Mark Klein, *Massachusetts Institute of Technology, Cambridge, MA*
John C. Kunz, *Stanford University, Stanford, CA*
Chris McMahon, *Technical University of Denmark, Denmark*

Wolfgang Nejdl, *Institut für Verteilte Systeme, Germany*
Panos Papalambros, *University of Michigan, Ann Arbor, MI*
H. Van Dyke Parunak, *New Vectors LLC, Ann Arbor, MI*
William C. Regli, *Drexel University, Philadelphia, PA*
Warren Seering, *Massachusetts Institute of Technology,
Cambridge, MA*
L.H. Shu, *University of Toronto, Canada*
Tim Smithers, *Independent Research Practitioner/Donostia/San
Sebastián/The Basque Country*
Ian F.C. Smith, *Federal Institute of Technology, Lausanne,
Switzerland*
Robert B. Stone, *Oregon State University, Corvallis, OR*
Rudi Stouffs, *Delft University of Technology, The Netherlands*
Markus Stumpfner, *University of South Australia, Adelaide,
Australia*
Tetsuo Tomiyama, *Cranfield University, UK*
Kristin Wood, *Singapore University of Technology and Design,
Singapore*

**FOUNDING EDITOR EMERITUS
(1986–1996)**

CLIVE L. DYM, *Harvey Mudd College*

**EDITOR EMERITUS
(1997–2001)**

WILLIAM P. BIRMINGHAM, *Grove City College*

**EDITOR EMERITUS
(2001–2011)**

DAVID C. BROWN, *Worcester Polytechnic Institute*

**EDITOR EMERITUS
(2012–2016)**

YAN JIN, *University of Southern California*

AIEDAM: Artificial Intelligence for Engineering Design, Analysis and Manufacturing is a journal intended to reach two audiences: *engineers and designers* who see AI technologies as powerful means for solving difficult engineering problems; and *researchers in AI and Computer Science* who are interested in applications of AI and in the theoretical issues that arise from such applications (for detailed information refer to the Aims and Scope section at the inside back cover).

AIEDAM is also interested in original, major applications of state-of-the-art AI techniques to important engineering problems (practicum papers). In addition to the rapid publication and dissemination of unsolicited research papers, **AIEDAM** is committed to producing special issues on important, timely topics. **AIEDAM** is indexed in Compendex Plus, SciSearch, Research Alert, and CompuMath Citation Index.

Editorial Office: Prof. Amaresh Chakrabarti, Editor, **AIEDAM: Artificial Intelligence for Engineering Design, Analysis and Manufacturing**, Centre for Product Design and Manufacturing, Indian Institute of Science, Bangalore, India. E-mail: ac123@iisc.ac.in

Publishing, Subscription, and Advertising Offices: Cambridge University Press, One Liberty Plaza, New York, NY 10006, USA; and (outside the US and Canada) Cambridge University Press, University Printing House, Shaftesbury Road, Cambridge CB2 8BS, UK.

AIEDAM is part of the Cambridge Core service. Access to online tables of contents and article abstracts is available to all researchers at no additional costs for institutional subscribers. Access to full text articles online is currently included with the cost of the subscription. Subscription must be activated; see <http://journals.cambridge.org> for details.

Subscription Information: **AIEDAM: Artificial Intelligence for Engineering, Design, Analysis and Manufacturing** (ISSN 0890-0604) is published quarterly by Cambridge University Press, One Liberty Plaza, New York, NY 10006, USA / Cambridge University Press, University Printing House, Shaftesbury Road, Cambridge CB2 8BS, UK. Annual subscription rates for Volume 33, 2019: Institutions electronic only: US \$1139.00 in the US, Canada, and Mexico; UK £692.00 + VAT elsewhere. Individuals electronic only: US \$363.00 in the US, Canada, and Mexico; UK £201.00 + VAT elsewhere.

© **Cambridge University Press 2020**. All rights reserved. No part of this publication may be reproduced, in any form or by any means, electronic, photocopy, or otherwise, without permission in writing from Cambridge University Press. For further information see <http://us.cambridge.org/information/rights> or <http://cambridge.org/uk/information/rights>. *Photocopying information for users in the USA:* The Item-Fee Code for this publication (0890-0604/17) indicates that copying for internal or personal use beyond that permitted by Sec. 107 or 108 of the US Copyright Law is authorized for users duly registered with the Copyright Clearance Center (CCC), provided that the appropriate remittance per article is paid directly to: CCC, 222 Rosewood Drive, Danvers, MA 01923. Specific written permission must be obtained for all other copying.

AIEDAM: Artificial Intelligence for Engineering, Design, Analysis and Manufacturing (ISSN 0890-0604) is published quarterly by Cambridge University Press, One Liberty Plaza, New York, NY 10006, USA.