DIMACS

Series in Discrete Mathematics and Theoretical Computer Science

Volume 67

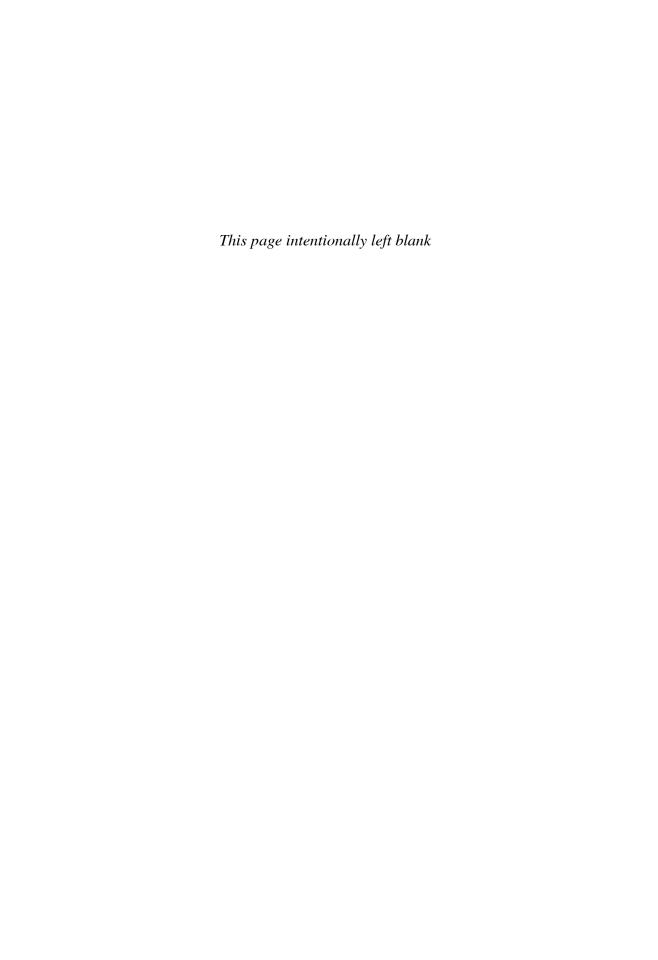# Geometric and Algorithmic Aspects of Computer–Aided Design and Manufacturing

DIMACS Workshop
Computer Aided Design and Manufacturing
October 7–9, 2003
Piscataway, New Jersey

Ravi Janardan
Michiel Smid
Debasish Dutta
Editors

American Mathematical Society

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Center for Discrete Mathematics
and Theoretical Computer Science
A consortium of Rutgers University, Princeton University,
AT&T Labs–Research, Bell Labs (Lucent Technologies),
NEC Laboratories America, and Telcordia Technologies
(with partners at Avaya Labs, HP Labs, IBM Research,
Microsoft Research, and Stevens Institute of Technology)

American Mathematical Society

This DIMACS volume presents the proceedings from the workshop Computer Aided Design and Manufacturing held at the DIMACS Center, Rutgers University, October 7–9, 2003.

Contents

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Foreword

A workshop on Computer-Aided Design and Manufacturing was held on October 7-9, 2003 at Rutgers University. We would like to express our appreciation to Debasish Dutta, Ravi Janardan and Michiel Smid for their efforts to organize and plan this successful conference.

The workshop was part of the 2002-2005 Special Focus on Computational Geometry and Applications. We extend our thanks to Steven Fortune, Bernard Chazelle and Bill Steiger for their work as special focus organizers.
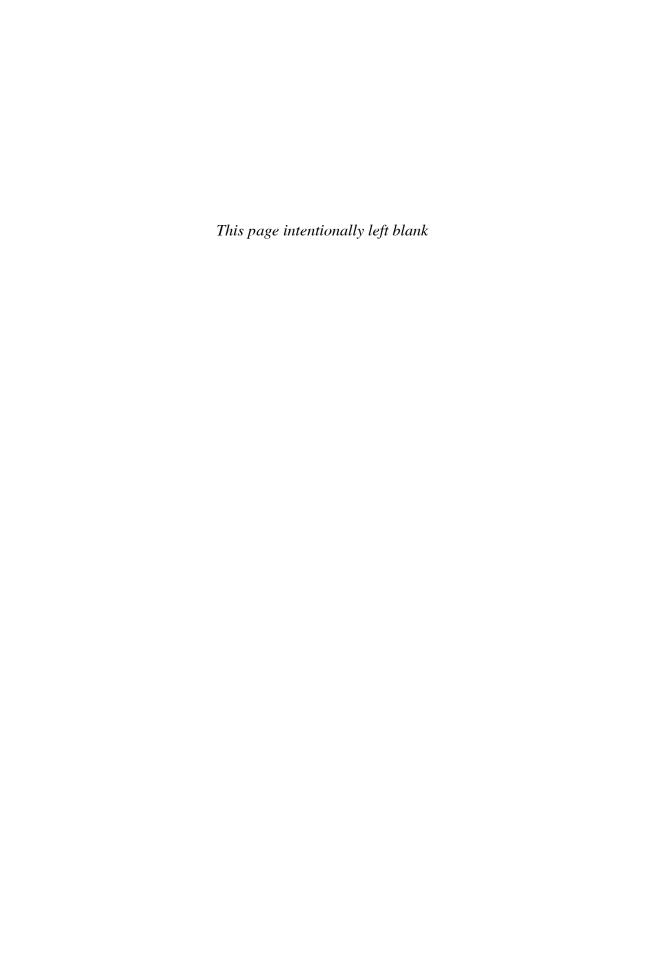
The workshop brought together theoreticians and practitioners working in the field of Computer-Aided Design and Manufacturing (CAD/CAM) and those working in Computational Geometry (CG), for the purpose of promoting and exploring links between these areas.

Topics addressed by the workshop included computational metrology and tolerancing, geometric constraint solving, geometric modeling related to manufacturing, numerically-controlled machining, part immobilization, rapid prototyping and layered manufacturing, and surface modeling and reconstruction. These and many other topics are all major themes of current interest in both CAD/CAM and CG.

DIMACS gratefully acknowledges the generous support that makes these programs possible. Special thanks go to the National Science Foundation, the New Jersey Commission on Science and Technology, and to DIMACS partners at Rutgers, Princeton, AT&T Labs - Research, Bell Labs, NEC Laboratories America, and Telcordia Technologies, and affiliate partners Avaya Labs, HP Labs, IBM Research, Microsoft Research, and Stevens Institute of Technology.

Fred S. Roberts
Director

Robert Tarjan
Co-Director for Princeton

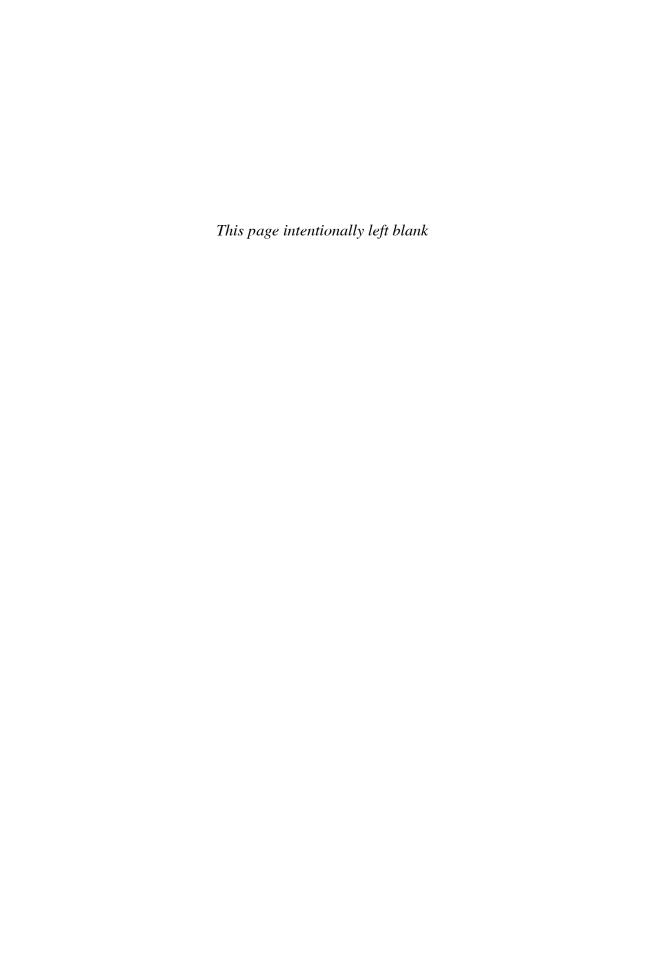*This page intentionally left blank*

Preface

Computer-Aided Design and Manufacturing (CAD/CAM) is concerned with all aspects of the process of designing, prototyping, manufacturing, inspecting, and maintaining complex geometric objects under computer control. As such, there is a natural synergy between this field and Computational Geometry (CG), which involves the design, analysis, implementation, and testing of efficient algorithms and data representation techniques for geometric entities such as points, polygons, polyhedra, curves, and surfaces. On the one hand, CG can bring about significant performance improvements in CAD/CAM, while, on the other hand, CAD/CAM can be a rich source of interesting problems that can spur new research in CG. Indeed, such two-way interaction has already been witnessed in recent years in areas such as numerically-controlled machining, casting and injection molding, rapid prototyping and layered manufacturing, metrology, and mechanism/linkage design, to name just a few.
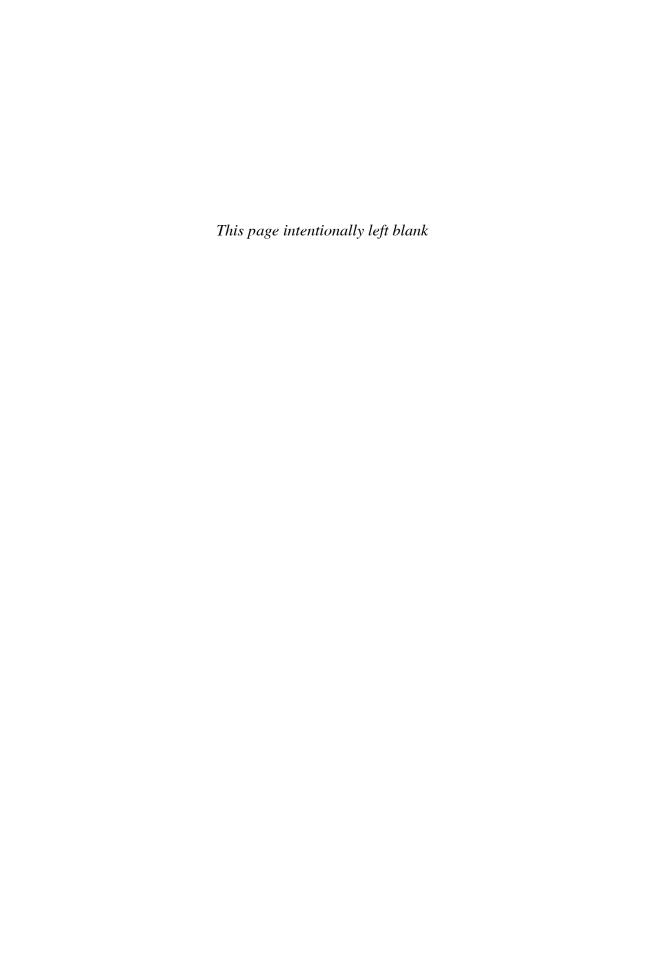
To further promote the interaction between the two fields, we organized a Workshop on *"Computer-Aided Design and Manufacturing"* at the DIMACS Center in Piscataway, NJ, from Oct. 7-9, 2003. The Workshop, which was attended by about fifty-five individuals from academia, research laboratories, and industry, was organized around a series of invited talks, contributed presentations, and informal discussions geared towards fostering collaborative research. Details about the Workshop can be found at `http://dimacs.rutgers.edu/Workshops/CompAided/`.

Subsequently, authors of papers presented at the Workshop were invited to submit expanded and polished versions of their research to this Volume. The intent was to provide, in one place, a set of self-contained papers that could serve as the starting point for further research. All submissions were refereed. The papers in this Volume are an outgrowth of this process and cover topics such as geometric modeling, computational topology, computational metrology, geometric constraint solving, part immobilization, geometric aspects of machining, layered manufacturing, and algebraic methods.

We thank Fred Roberts (DIMACS Director) and Steve Fortune (Member, DIMACS Council and Chair of the DIMACS Special Focus on Computational Geometry and Applications) for their support and encouragement, DIMACS and AMS staff members for organizational help, the referees for their help with the reviews, and, of course, the authors for their research contributions. We are grateful to the National Science Foundation for financial support for the Workshop.

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Ravi Janardan (Minneapolis, MN)
Michiel Smid (Ottawa, Canada)
Debasish Dutta (Ann Arbor, MI)
July 2004

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Topics covered in this volume include geometric modeling, computational topology, computational metrology, geometric constraint solving, part immobilization, geometric aspects of machining, layered manufacturing, and algebraic methods.

The book is suitable for graduate students and researchers interested in geometric and algorithmic aspects of computer-aided design and manufacturing.