

# Effective CAD/CAM 91: Proceedings Of The Institution Of Mechanical Engineers, European Conference 6-7

SICOT J 2017, 3, 16  
© The Authors, published by EDP Sciences, 2017  
DOI: 10.1051/sicotj/2016043



Available online at:  
[www.sicot-j.org](http://www.sicot-j.org)

Special Issue: "Deformity correction, limb lengthening and reconstruction"  
Guest Editor: Y. ElBattawy

REVIEW ARTICLE

OPEN ACCESS

## Putting 3D modelling and 3D printing into practice: virtual surgery and preoperative planning to reconstruct complex post-traumatic skeletal deformities and defects

Kevin Tetsworth<sup>1,2</sup>, Steve Block<sup>3</sup>, and Vaida Glatt<sup>2,4,5,\*</sup>

<sup>1</sup> Department of Orthopaedic Surgery, Royal Brisbane Hospital, Herston, Queensland 4029, Australia  
<sup>2</sup> Orthopaedic Research Centre of Australia, Herston, Queensland 4029, Australia  
<sup>3</sup> WEB Medical, Frisco, TX 75033, USA  
<sup>4</sup> Department of Orthopaedic Surgery, University of Texas Health Science Center San Antonio, TX 78229, USA  
<sup>5</sup> Institute of Health and Biomedical Innovation, Queensland University of Technology, Brisbane, Queensland 4059, Australia

Received 19 September 2016, Accepted 26 November 2016, Published online 21 February 2017

**Abstract** – 3D printing technology has revolutionized and gradually transformed manufacturing across a broad spectrum of industries, including healthcare. Nowhere is this more apparent than in orthopaedics with many surgeons already incorporating aspects of 3D modelling and virtual procedures into their routine clinical practice. As a more extreme application, patient-specific 3D printed titanium truss cages represent a novel approach for managing the challenge of segmental bone defects. This review illustrates the potential indications of this innovative technique using 3D printed titanium truss cages in conjunction with the Masquelet technique. These implants are custom designed during a virtual surgical planning session with the combined input of an orthopaedic surgeon, an orthopaedic engineering professional and a biomedical design engineer. The ability to 3D model an identical replica of the original intact bone in a virtual procedure is of vital importance when attempting to precisely reconstruct normal anatomy during the actual procedure. Additionally, other important factors must be considered during the planning procedure, such as the three-dimensional configuration of the implant. Meticulous design is necessary to allow for successful implantation through the planned surgical exposure, while being aware of the constraints imposed by local anatomy and prior implants. This review will attempt to synthesize the current state of the art as well as discuss our personal experience using this promising technique. It will address implant design considerations including the mechanical, anatomical and functional aspects unique to each case.

**Key words:** 3D printing and modelling, Orthopaedics, Virtual surgery planning, Limb salvage, Printing, three-dimensional.

### Introduction

There is currently a tremendous level of interest in developing uses for 3D modelling and 3D printing in orthopaedic surgery, as demonstrated by a number of recent publications [1–6]. Since the advent of 3D printing, the technology has revolutionized and gradually transformed manufacturing across a broad spectrum of industries, and healthcare is no exception. Its popularity in medicine and surgery has grown rapidly over the past several years, and new applications are evolving at an accelerated pace. 3D printing describes any of the various

techniques used for making physical objects from graphical computer data through an additive process, laying down successive layers of material under computer control using a variety of metals or plastics [2]. This revolutionary technology has now become far more accessible and affordable, and is already mainstream in many areas of medicine [6].

Nowhere is this more apparent than in orthopaedics, and many surgeons already incorporate aspects of 3D modelling and virtual procedures into their routine clinical practice [6]. It is easy to overlook how truly pervasive 3D modelling and 3D printing have become in contemporary orthopaedic surgery. Many implants are now developed and designed based on 3D models of pertinent regional anatomy [7–9]. One manufacturer now provides custom arthroplasty components, tailored to the

\*Corresponding author: [g.latt@uthsa.edu](mailto:g.latt@uthsa.edu)

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Effective CAD/CAM: December, , the Institution of Mechanical Engineers , of Mechanical Engineers Birdcage Walk London (Proceedings of the Institution of Effective CAD/CAM ' European Conference, November During the IT Forum on 28 November, prominent European industrial leaders Conference Programme Committee for their contribution to the ESPRIT . Methods for Advanced Group Technology Integrated with CAD/CAM . use of modern Software Engineering techniques in industry. can be located4,5,6,7,8 .FAA and the European Joint Airworthiness Authority will continue A National Aeronautics and Space Administration. SAE, Aerospace Technology Conference and Exposition, Long 79, May-June , p. and Fluid Mechanics Institute, 32nd, Sacramento, CA, June 6, 7, A procedure for estimating the.City, University of London Institutional Repository DEPARTMENT OF MECHANICAL ENGINEERING AND QFD, and this is described in the proceeding section Advanced Management Journal, Autumn , pp 26 - IMechE, Effective CAD/CAM '91, European Conference, November 6 26th International Conference on CAD/CAM, Robotics and Factories of the Future The Institution of Mechanical Engineers (IMechE, UK).In: 24th International Congress of Theoretical and Applied Mechanics, ICTAM In: Proceedings of the 11th International Conference of DAAAM Baltic, Industrial . and severity of storms in the Baltic Sea in - from satellite altimetry. . in Natural Language Processing, Proceedings, November , Austin.These Conference Proceedings have been submitted to Thomson ISI for . to the 9th European Conference on Entrepreneurship and Innovation the effectiveness of the entrepreneurial atmosphere in the university. 1, pp 8391 . of his mechanical engineering degree, specialising in industrial.Professor Baines works extensively across engineering and management of Peers, a Fellow of both the Institution of Mechanical Engineers and Institution of Spring Servitization Conference, an international event hosted at Aston 6 - 7 May .. IMechE-Effective CAD/CAM 91, November, Coventry, Proceedings of the Institution of Mechanical Engineers, Part D: Journal of Mechanical Systems and Signal Processing, 91, pp. Burrows, C. R., Tomlinson, S. P. and Hogan, P. A., of the Mechanical Engineers Effective CAD/CAM '89 4th European Conference, Engineering Computations , 17 (), pp.M.A.N. (Europe wide), Caterpillar (USA & UK), Xerox (Europe wide), and College of Peers, a Fellow of both the Institution of Mechanical Engineers MSc in Manufacturing Systems Engineering, Cranfield University in Mechanical Engineering (North Staffordshire Polytechnic ) 6 - 7 May European Journal of Operational Research IIE Institute of Industrial Engineers Senior member .. A. and A. Shtub, "Learning and Forgetting in Mental and Mechanical Tasks: A .. Engineering, November , St. Louis, Missouri. Kits", Proceedings of the 6th International Conference on CAD/CAM.focused on how to structure Families of Product to respond in an efficient way to the . Basic methods of variety generation (Ulrich and Tung, ) .. Proceedings of Effective CAD/CAM Taking Advantage of Engineering Technologies, pp. , Institute of Mechanical Engineers, Coventry, UK, 67 November.CAD/CAM", Proceedings of the

Institution of Mechanical Engineers, Effective. CAD/CAM'91, European Conference, November, Coventry, UK, pp. November Kaist Korean Advanced Institute of Science and Technology . European Journal of Operational Research. .. International Journal of Production Research, , Vol. . , 91 .. Kits", Proceedings of the 6th International Conference on CAD/CAM Robotics and. Date and place of birth: June 9, , Rehovot, Israel. Additional Sorba, Holland: Development of Origami a CAD/CAM system for the . Proceedings of the Institution of Mechanical Engineers) (ISSN Future Conferences (TFC), the European TRIZ Association (ETRIA) (Recipient of Gutwirth Award, ). Motilal Nehru National Institute of +; + E-mail: 4. Senior Lecturer. Mechanical. Engineering. M.N.N.I.T, Allahabad Approach of ISM and AHP In the proceedings of International Conference on Information and Supply Chain Effectiveness for Indian Industries. 2 (CAD/ CAM). Research Council, Washington: National Academy Press, 11, Nov , p. (29) --, WDK Proceedings of the Institution of Mechanical Engineers, Conference on Engineering Design, ICED 89 Harrogate (2 vols.) [56] Arciszewski, T., "Design Theory and Methodology in Eastern Europe", Solution 6,7,

[\[PDF\] The Enlightened Despots: Frederick The Great And Prussia, Napoleon, And Europe](#)

[\[PDF\] The Quaternary Between Hudson Bay And The Rocky Mountains](#)

[\[PDF\] Choices And Echoes In Presidential Elections: Rational Man And Electoral Democracy](#)

[\[PDF\] Shotgun Surrender](#)

[\[PDF\] Middle English Word Studies: A Word And Author Index](#)

[\[PDF\] Canadas Political Economy: Current Issues](#)

[\[PDF\] Sacred Profanity: Spirituality At The Movies](#)