RESUME

Rafael Sacks

Israel ID: 015739477, Male.
Born July 7th 1962, in Johannesburg, South Africa.
Resident in Israel since January 1984.
Married with two daughters and a son.

Registered Engineer (Israel), No. 34051, 1984.

ACADEMIC DEGREES

1998, D.Sc. Civil Engineering, Faculty of Civil Engineering, Technion - Israel Institute of Technology, Haifa, Israel

1985, M.S. Civil Engineering, Faculty of Civil and Environmental Eng., MIT - Massachusetts Institute of Technology, Cambridge, Mass. USA

1983, B.Sc. Civil Engineering, Faculty of Civil Engineering, University of the Witwatersrand, Johannesburg, South Africa

ACADEMIC APPOINTMENTS

2015 Visiting Professor, School of Built Environment, Faculty of Humanities, Curtin University, Perth, Australia.

2012 Visiting Professor, School of Construction Management and Engineering, University of Reading, UK.

2012-2015, Head, Structural Engineering and Construction Management Unit, Technion – Israel Institute of Technology.

2009, Acting Head, Israel National Building Research Institute, Technion – Israel Institute of Technology.

2008, Visiting Research Fellow, School of Construction Management and Engineering, University of Reading, UK.

2007, Associate Professor, Faculty of Civil and Environmental Engineering, Technion – Israel Institute of Technology.

2003, Senior Lecturer, Faculty of Civil and Environmental Engineering, Technion – Israel Institute of Technology.

2001, Research Scientist, PhD Program, College of Architecture, Georgia Institute of Technology, Atlanta GA, USA.

2000, <u>Lecturer</u>, Faculty of Civil Engineering, Technion – Israel Institute of Technology.

1998, <u>Adjunct Lecturer</u>, Faculty of Civil Engineering, Technion – Israel Institute of Technology.

1994, <u>Teaching Assistant</u>, Faculty of Civil Engineering, Technion – Israel Institute of Technology.

1985, <u>Teaching Assistant</u>, Faculty of Civil and Environmental Eng., MIT - Massachusetts Institute of Technology, Cambridge, Mass., USA.

PROFESSIONAL EXPERIENCE

October 1997 to September 2000, <u>Managing Partner</u>, Shahaf Sacks Property Development and Construction Management Ltd. Management of housing projects.

March 1989 to February 1994, <u>Senior Engineer</u> - Shacham Computerized Engineering Ltd. Responsible for establishment of CAD stations, management of software projects in the fields of infrastructure, town planning, GIS, architecture and construction. Consultant to large account clients (e.g. Israel Aircraft Industries, INTEL, Ministry of Construction and Housing).

March 1988 to March 1989, <u>Military Service</u>. Construction Unit IDF. Responsibility for setup of CADAM system on IBM Mainframe 4381.

September 1985 to February 1988, <u>Structural Engineer</u> at Ben-El Consulting Eng. Jerusalem. Design of Steel and Concrete structures, Site Supervision and responsibility for computers in design office, including CAD.

June 1984 to September 1984, <u>Structural Engineer</u> at Ben-El Consulting Eng. Jerusalem.

December 1982 to February 1983, <u>Engineering Intern</u>, WLPU Consulting Eng. in Johannesburg South Africa. Design of industrial reinforced concrete structures and computer programming.

RESEARCH INTERESTS

- Information Technology (IT) in Construction: Building Information Modeling (BIM), Building Product Models and IT enabled process change in civil engineering design and construction.
- Lean Construction and Lean Design: Theory, production system design, project management, construction safety.

TEACHING EXPERIENCE

<u>Strategies for IT Adoption in the Building Industry</u>, **Graduate**, College of Architecture & Dept. of Civil Engineering (Construction Management) (in collaboration with Prof. C.M. Eastman), Georgia Institute of Technology, Spring 2002.

Advanced Seminar in Construction Management, **Graduate**, Faculty of Civil and Env. Engineering, Technion, 2000-present.

Computer Methods in Construction Management, **Graduate**, Faculty of Civil and Env. Engineering, Technion, 1997-2001.

Special Topics in Construction Management, **Graduate**, Faculty of Civil and Env. Engineering, Technion, 2002-2003.

Lean Construction, **Graduate**, Faculty of Civil and Env. Engineering, Technion, 2004-present.

International Collaboration in Construction Management, **Graduate**, Faculty of Civil and Env. Engineering, Technion, in collaboration with Dept. of Civil and Env. Engineering, Carnegie-Mellon University, METU (Turkey), Universidade Nova de Lisboa (Portugal) and UFRGS (Brazil); 2006-present.

Advanced Building Information Modeling, **Graduate**, Faculty of Civil and Env. Engineering, Technion, 2012-present.

Construction Planning and Control / Introduction to Computing in Construction Management, **Undergraduate**, Faculty of Civil and Env. Engineering, Technion, 2003-present.

Construction Equipment and Automation, **Undergraduate**, Faculty of Civil and Env. Engineering, Technion, 2003-2007.

Introduction to Construction Management, **Undergraduate**, Faculty of Civil and Env. Engineering, Technion, 2000-2001, 2003

Final Project in Construction Management, **Undergraduate**, Faculty of Civil and Env. Engineering, Technion, 2000-2001.

Engineering Economics, **Undergraduate**, Faculty of Civil and Env. Engineering, Technion, 2003.

Construction Methods, **Undergraduate**, Faculty of Civil and Env. Engineering, Technion, 2004.

Engineering Information, **Undergraduate**, Faculty of Civil and Env. Engineering, Technion, 2006-present.

PUBLIC PROFESSIONAL ACTIVITIES

International Panel of Experts

2015-2018, Member, Second International Panel of Experts on Building Information Modeling (BIM), Building and Construction Authority, Govt. of Singapore

Journal Editor/Advisory Board/Editorial Board

2007 to present, Advisory Board member, Lean Construction Journal, Lean Construction Institute

2008 to present, Associate Editor, Journal of Computing in Civil Engineering, American Society of Civil Engineers

2011 to present, Editorial Board member, Construction Management and Economics, Taylor and Francis

2011 to present, Scientific Advisory Board member, School of Engineering, Aalto University

2012 to present, Academic Advisory Board member, Design Innovation Research Centre, University of Reading

2013 to present, Editorial Board member, Automation in Construction, Elsevier

Membership in International Committees

1995 to present, Member, CIB W-78 Commission – Computer Integrated Construction.

2002 to 2007, Member, International Association for Automation and Robotics in Construction.

2003 to present, Member, International Group for Lean Construction

2006 to present, Member, Construction Research Council of the Construction Institute of the ASCE (American Society of Civil Engineers)

Referee for Journals

2001 to present, ASCE Journal of Management in Engineering

2002 to present, Computer-aided Civil and Infrastructure Engineering

2002 to present, ASCE Journal of Construction Engineering and Management

2003 to present, Journal of Lean Construction, Lean Construction Institute

2004 to present, ASCE Journal of Computing in Civil Engineering

2005 to present, ITcon, International Journal of Information Technology in Construction

2006 to present, Construction Management and Economics

2009 to present, ASCE Journal of Professional Issues and Education in Engineering Practice

2009 to present, Research in Engineering Design

Conference Organization

2011, Workshop Chair, International BIM Education Workshop, Technion, Haifa, 13th-15th June 2011.

2010, Conference Chair, 18th Annual Conference of the International Group for Lean Construction, Technion, Haifa, 14th -16th July 2010.

2006, Scientific Chair (Editor), 14th Annual Conference of the International Group for Lean Construction, Santiago, Chile, 25th-27th July, 2006.

Membership of Conference Scientific Committees

2002, CISEMIC, 1st International Conference on Information Standardisation, Exchanges and Management in the Construction Industry, University of Salford, Salford UK, 22nd-23rd November 2002.

2005, ICCC2005, ASCE Conference in Computing in Civil Engineering, Cancun, Mexico, 15th-17th July, 2005.

2005, IGLC 13, Annual Conference of the International Group for Lean Construction, Sydney, Australia, 19th-21st July, 2005.

2006, ICCCBE XI, Joint International Conference on Computing and Decision Making in Civil and Building Engineering, Montreal, Canada, 14th-16th June, 2006.

2007, IGLC 15, Annual Conference of the International Group for Lean Construction, East Lansing, Michigan, US, 17th-20th July, 2007.

2007, ICCC2007, ASCE International Workshop on Computing in Civil Engineering, Pittsburgh, PA, US, 25th-28th July, 2007.

2008, IGLC 16, Annual Conference of the International Group for Lean Construction, Manchester, UK, 18th-20th July, 2008.

2009, CITC-V, Fifth International Conference on Construction in the 21st Century, Istanbul, Turkey 20th-22nd May, 2009.

2009, IGLC 17, Annual Conference of the International Group for Lean Construction, Taipei, Taiwan, 15th-17th July, 2009.

2009, CIB W78, Managing IT in Construction, Istanbul, Turkey, 1st-3rd October, 2009.

2010, IGLC 18, Annual Conference of the International Group for Lean Construction, Haifa, Israel, 14th-6th July, 2010.

2010, CIB W78, Application of IT in the AEC Industry, Cairo, Egypt, 16th-18th November, 2010.

2011, IGLC 19, Annual Conference of the International Group for Lean Construction, Lima, Peru, 13th-15th July, 2011.

2012, IGLC 20, Annual Conference of the International Group for Lean Construction, San Diego, California, US, 13th-15th July, 2012.

2013, IGLC 21, Annual Conference of the International Group for Lean Construction, Fortaleza, Brazil, 30th July – 1st August, 2013.

2013, CONVR, International Conference on Construction Applications of Virtual Reality, London, UK, 30th–31st October, 2013.

2014, IGLC 22, Annual Conference of the International Group for Lean Construction, Oslo, Norway, 27th-30th June, 2014.

2015, IPC Innovative Practices in Construction and IGLC 23, Annual Conference of the International Group for Lean Construction, Perth, Australia, 28th-31st July, 2015.

2015, CIB W78 conference, Eindhoven, Netherlands, 27th-29th October, 2015.

2016, ISARC, 33rd International Symposium on Automation and Robotics in Construction, Auburn, Alabama, USA, 18th –21st July, 2016.

2016, IGLC, 24th Annual Conference of the International Group for Lean Construction, Boston, Massachusetts, USA, 20th-22nd July, 2016.

2016, CONVR, 16th International Conference on Construction Applications of Virtual Reality, Hong Kong, 12th-13th December, 2016

Other

2014, Civil Engineering Advisory Board Member, Registrar of Architects and Engineers, Israel Ministry of the Economy.

2004, Israel National Association of Construction Contractors and Builders, Judge for the 'Excellence in Construction' competition.

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Member, American Society of Civil Engineers and the ASCE Construction Institute

Member, Israel Engineers Association

Professional Member, Post-Tensioning Institute (North America).

Professional Member, Precast/Prestressed Concrete Institute (North America).

HONORS

1983, Jere Jennings Medal and Postgraduate scholarship, Faculty of Engineering, University of the Witwatersrand, Johannesburg, South Africa

1995, Prize for Excellent Teaching, Faculty of Civil Eng., Technion

1996, Esther and Mordechai Rubinstein Research Grant, Faculty of Civil Eng., Technion

1997, Prize for Consistently Excellent Teaching, Technion

2001, Jacob and Ethel Feld Academic Lectureship, Technion

2002, Research Achievement Award, College of Architecture, Georgia Institute of Technology

2005, Arenson Prize for Excellence in Lecturing, Faculty of Civil and Env. Eng., Technion; Technion Excellence in Lecturing Award.

2008, Best Paper Award, ASCE Journal of Construction Engineering and Management.

2013, Technion Excellence in Lecturing Award.

2016, Thomas Fitch Rowland Prize, Construction Institute of the ASCE, for "valuable contributions to construction management and construction engineering."

GRADUATE STUDENTS

Post-Doctoral Supervision Completed

1. Dr. Amotz Perlman, 2011-2012

Post-Doctoral Supervision in Progress

2. Dr. Ling Ma, 2013-2016

PhD Completed

1. 2005, Esin Ergen, PhD, "Formalization of Life-Cycle Data Management of Engineered-to-order Components Using Advanced Tracking Technologies" (Asst. Prof. Burcu Akinci – primary supervisor) Civil and Env. Eng., Carnegie-Mellon University.

2. 2008, Ophir Rozenfeld, PhD, "Lean Scheduling for Safety: Development of a Time-Dependent Risk Level Model", (Assoc. Prof. Yehiel Rosenfeld – primary supervisor), Civil and Env. Eng., Technion.

3. 2008, Efraim Tribelsky, PhD, "Lean Design of Civil Engineering Projects: Development of Measures of Information Flow", Civil and Env. Eng., Technion.

4. 2008, Micha Harel, PhD, "A Lean Model for Two-dimensional Optimization of Process Flow in Construction Projects with Sub-contractors", Civil and Env. Eng., Technion.

5. 2011, Irina Brodetskaia, PhD, "Computer-Aided Implementation of Lean Principles for Real-Time Optimization of Flow in Construction Operations", (Assoc. Prof. Aviad Shapira – secondary supervisor), Civil and Env. Eng., Technion.

6. 2014, Shiva Aram, PhD, "A Knowledge-Based System Framework for Semantic Enrichment and Automated Detailed Design in the AEC Projects" (Prof. Chuck Eastman – primary supervisor), College of Architecture, Georgia Tech.

7. 2015, Michael Belsky, PhD, "Toward Intelligent Semantic Enrichment of Building Information Models", Civil and Env. Eng., Technion.

8. 2015, Vitaliy Priven, PhD, "The 'Social Subcontract': A Social Network Pact for Stable, Reliable and Continuous Workflow in Construction at the Operation Level", Civil and Env. Eng., Technion.

PhD in Progress

9. 2016, Reem Zeibak-Shini, PhD, "Generation of a building information model (BIM) representing the deformed state of a structure using laser scanning and prior information", (Assoc. Prof. Sagi Filin – secondary supervisor), Civil and Env. Eng., Technion.

10. 2018, Ury Gurevich, PhD, "Management, Design and Economic Implications of Implementing BIM Standards in a Major Construction Client Organization", Civil and Env. Eng., Technion.

11. 2018, Shmuel Korb, PhD, "Looking Beyond the Project to Local Industry Networks: Opportunities and Barriers to Lean Implementation in the AEC Industry", Civil and Env. Eng., Technion.

MSc Completed

1. 2004, Irina Brodetskaia, M.Sc., "An Examination of the Potential for Monitoring Construction Project Performance using an Equipment Mounted 'Black Box'" (Assoc. Prof. Ronie Navon – primary supervisor), Civil and Env. Eng., Technion.

2. 2006, Alberto Esqenazi, M.Sc., "Evaluation of Lean Construction Improvements using Computer Simulation", Civil and Env. Eng., Technion.

3. 2007, Arieh Yurovsky, M.Sc., "The Current State of Private Construction in Israel based on Lean Principles", (Dr. Amnon Katz – secondary supervisor), Civil and Env. Eng., Technion.

4. 2007, Maxim Goldin, M.Sc., "A Lean Approach to Managing Housing Construction subject to Design Changes," Civil and Env. Eng., Technion.

5. 2008, Ronen Barak, M.Sc., "Specification and Development of an Object Model for Building Information Modeling of Cast-in-place Reinforced Concrete Structures", Civil and Env. Eng., Technion.

6. 2008, Israel Kaner, M.Sc., "Interoperability and Building Information Model Exchange between Architects and Engineers for Precast Facades", Civil and Env. Eng., Technion.

7. 2009, Rebecca Partouche, M.Sc., "A Lean Model for Construction of Tall Office/Commercial Buildings", Civil and Env. Eng., Technion.

8. 2012, Gabi Raviv, M.Sc., "Identification and Analysis of Mechanisms for Constructability Knowledge Transfer from Contractors to Designers", (Assoc. Prof. Aviad Shapira – primary supervisor), Civil and Env. Eng., Technion.

9. 2012, Ergo Pikas, M.Sc., "Evaluation of University-level BIM Education in Construction Engineering and Management", Civil and Env. Eng., Technion.

10. 2012, Ury Gurevich, M.Sc., "Examination of the Effects of a KanBIM system on Subcontractor Task Choice in Finishing Works", Civil and Env. Eng., Technion.

11. 2013, Tomer Lutaty, M.Sc., "Construction Labor Productivity Trends in Light of Developments in Industrialization and Technology", Civil and Env. Eng., Technion.

12. 2014, Dana Swissa, M.Sc., "Safe construction by Design: Virtual Assessment of Construction Hazards in Design", Civil and Env. Eng., Technion.

13. 2014, Tanya Bloch, M.Sc., "Towards Building Information Modeling of Damaged Buildings to Guide Search and Rescue", (Prof. Oded Rabinovitch – secondary supervisor), Civil and Env. Eng., Technion.

14. 2015, Lola Ben Alon, M.Sc., "Simulating and Visualizing the Flow of Trade Crews using Agents and Building Information Models", Civil and Env. Eng., Technion.

15. 2016, Yasuer Shachaf, M.Sc., "The Flow of Process Information and its Impact on the Workflow of Construction Crews", Civil and Env. Eng., Technion.

MSc in Progress

16. 2016, Amit Dayan, M.Sc., "3D Visualizations as Cognition Enhancers for Apartment Customization", Civil and Env. Eng., Technion.

17. 2016, Eran Haronian, M.Sc., "Understanding 'Production Process Status Information' in Terms of Product Flow and Value Creation", Civil and Env. Eng., Technion.

18. 2017, Mordechai Shachaf, M.Sc., "Interoperability between BIM and GIS in a Campus Environment", Civil and Env. Eng., Technion.

ME Completed

1. Michael Shem-Tov, M.E., "The impact of delays in off-site manufacturing processes on construction projects," February 2001.

2. Maskit Pe'er, M.E., "Depth of adoption of information technology in construction in Israel," March 2001.

3. Irit Gendler, M.E., "Electronic commerce in construction companies," May 2001.

4. Avi Bachar, M.E., "Lessons learned from implementation of lean design principles in design management of a military project," July 2001.

5. Eran Mualem, M.E., "Examination of the design process of building 'B' in the Kirya from the perspective of Lean Design," July 2001.

6. Miki Frenklach, M.E., "Examination of design process improvements through adoption of the Last Planner lean construction technique," July 2001.

7. Abraham Haber, M.E., "Lean construction in the design of a 28 story office tower above an existing underground structure – analysis of applicability and benefit," July 2001.

8. Emanuel Atiya, M.E., "Adoption and integration of information technology tools in structural design," July 2001.

9. Buddy Halabi, M.E., "Characterization and estimation of economic risk for residential property developers," December 2001.

10. Eitan Benisti, M.E., "Examination of the viability of use of web-based project collaboration services," July 2003.

11. Yossi Hadad, M.E., "The impact of intensifying factors on the probability of accident scenarios in construction," December 2006.

RESEARCH GRANTS

1. 2003, PCSC (North American Precast Concrete Software Consortium), $32,000, "Precast Concrete Software Consortium Project - Phase Two", Rafael Sacks (Technion PI), Charles Eastman (Project leader at Georgia Tech under separate grant).

2. 2003, PITA ICES (Institute for Complex Engineered Systems) Research Seed Fund (Carnegie-Mellon University – Lehigh University, Pennsylvania State Govt.), $37,043, "Real-Time Tracking and Monitoring of Precast Concrete Pieces During Production, Erection, and Maintenance Phases in Support of Lean Supply-Chain Management", Rafael Sacks (Technion PI), Burcu Akinci (Carnegie-Mellon PI).

3. 2004, TEKLA Corporation, Espoo Finland, € 29,877 ($38,500)"Qualitative and Quantitative Assessment of the Impact of 3D Modeling of Building Structures on Engineering Productivity", Rafael Sacks (PI).

4. 2004, Danya Cebus Construction Ltd., NIS 77,000 ($17,900) "Procedures for Late Change Orders - Development of a Management Model Based on Lean Construction Principles", Rafael Sacks (PI).

5. 2004, PCSC (North American Precast Concrete Software Consortium), $15,000 "Precast Concrete Software Consortium Project - Phase Three", Rafael Sacks (Technion PI), Charles Eastman (Project leader at Georgia Tech under separate grant).

6. 2005, Israel Ministry of Industry, Trade and Employment, NIS 598,000 ($133,000) "A Lean Dynamic Quantitative Method for Planning Safety Enhancement Operations in Construction", Rafael Sacks and Yehiel Rosenfeld (PIs).

7. 2006, Israel Ministry of Housing and Construction, NIS 190,000 ($41,300) "Enhancing the competitiveness of prefabricated components for construction by shortening lead times using computer modeling", Rafael Sacks (PI).

8. 2006, TEKLA Corporation, Espoo Finland, $51,975, "Building Information Modeling of Cast-in-place Reinforced Concrete Structures - Data Model Definition to Support Design and Construction Management", Rafael Sacks (Technion PI), Charles Eastman (Georgia Tech PI under separate grant).

9. 2006, Charles Pankow Foundation, Ontario, California, USA, $58,588, "Building Information Model (BIM) For Precast Concrete", in collaboration with Dr. Earle Kennett, National Institute of Building Science (NIBS), Dr. Richard H. J. Jackson, FIATECH, and Prof. Charles Eastman, Georgia Institute of Technology. Total grant award $159,804.

10. 2007, Israel Ministry of Housing and Construction, NIS 185,000 ($44,000) "The Potential to Enhance Productivity in Construction through Industrialization using Lean Principles ", Rafael Sacks (PI), Aviad Shapira (co-PI).

11. 2008, Innovative Construction Research Centre, School of Construction Management and Engineering, University of Reading, UK, £46,830 and Tekla Ltd., Finland, £45,600, "The Value of Building Information Modelling Interfaces for Construction Management", Rafael Sacks and Milan Radosavljevic (PIs)

12. 2009, Institute for Occupational Safety and Health, UK, £93,684 "Building Safely by Design: Appraising safety hazards virtually before construction", Dr. Jennifer Whyte (University of Reading, UK, PI), Rafael Sacks (co-PI).

13. 2010, Israel Ministry of Industry, Trade and Employment, NIS 598,000 ($161,000) "Training Workers for Construction Safety using Virtual Reality", Rafael Sacks (PI).

14. 2010, Israel Ministry of Housing and Construction, NIS 290,000 ($76,316) "Impact of the 'KanBIM' system on the productivity, safety and quality of work of trade teams and team leaders", Rafael Sacks (PI).

15. 2010, European Union 7th Framework Program, FP7-PEOPLE-2009-IRSES grant for researcher mobility (Marie Curie), €102,600, "BIM Auto GEN Project", in collaboration with University of Cambridge (UK), University of Cyprus, FORTH (Greece), Georgia Tech (USA) and University of Michigan (USA).

16. 2011, Tidhar Construction Ltd., NIS 168,000 ($44,600), "Integrated Implementation of Lean and BIM in a Construction Company Case Study: Development of the 'Tidhar Way' "Rafael Sacks (PI).

17. 2012, Research Fund of the Israel Association of Insurance Companies, NIS 622,000 ($165,000), "Evaluation of Earthquake Damage to Buildings using Building Information Modeling and Laser Scanning", Rafael Sacks (PI), Sagi Filin (co-PI).

18. 2012, Israel Ministry of Housing and Construction, NIS 193,965 ($51,725) "Construction Safety by Design: Virtual evaluation of construction hazards and risk at the design stage", Rafael Sacks (PI).

19. 2012, Charles Pankow Foundation, $51,533, "Phase 3 of the Precast Concrete National Building Modeling Standard Project", in collaboration with Prof. Charles Eastman, Georgia Institute of Technology. Total grant award $195,021.

20. 2013, Tidhar Construction Ltd., NIS 228,000 ($64,700), "Integrated Implementation of Lean and BIM in a Construction Company Case Study: Development of the 'Tidhar Way' – Phase II", Rafael Sacks (PI).

21. 2014, Israel Ministry of Housing and Construction, NIS 201,780 ($51,396) "The Flow of Process Information and its Impact on the Workflow of Construction Crews", Rafael Sacks (PI).

22. 2015, Netivei Israel (Israel National Transport Infrastructure Company), NIS 324,528 ($85,922) "Investigation of the Suitability of Integrated Project Delivery for Transport Infrastructure Projects", Rafael Sacks (PI).

23. 2015, EU Infravation ERA-NET, €570,000 "SeeBridge - Automated Compilation of Semantically Rich BIM Models of Bridges", Rafael Sacks (PI, Coordinator), with University of Cambridge, Munich University of Technology, Georgia Tech, Trimble Navigation Inc., Kedmor Engineers, Pointivo Inc. and Georgia DOT.

24. 2015, Construction Division, Israel Ministry of Defense, NIS 287,527 ($74,394) "Implementation of a BIM Standard in the Construction Division of the Ministry of Defense: Management, Design and Economic Implications", Rafael Sacks (PI).

25. 2016, NHRP New Zealand, NZ$1,044,661 ($683,135) "Building Quake and People – A Serious Game Platform for Informing Life Saving Strategies using Virtual Reality, Building Information Modelling, Agent-Based Modelling and Damage Models", Asst. Prof Vicente Gonzalez (PI), Auckland University with University of Canterbury and Opus Ltd.

SIGNIFICANT PROFESSIONAL PROJECTS

1990, CAD policies for Jerusalem Municipality Civic Center Project, Shacham Computerized Engineering Ltd., Yossi Trigoda (project manager).

1991, CAD policies for Ministry of Housing, Shacham Computerized Engineering Ltd., Rafael Sacks (project manager).

1991 to 1994, Construction CAD software products 2BARS, TABA and others, Shacham Computerized Engineering Ltd., within the Autodesk Registered Developer Program. Rafael Sacks (project manager).

1992 to 1993, Jerusalem Highway 4 Visualization Project, Shacham Computerized Engineering Ltd., Rafael Sacks (project manager).

2011, Construction scheduling expert opinion report, Jerusalem Light Rail Project, Emy Matom Ltd.

PUBLICATIONS

*(Names of my graduate students and post-docs shown in **bold**)*

Theses

Computer Integrated Construction: Project Data Model Representation and Use
Doctoral Thesis, Technion – Israel Institute of Technology, 1997.

EIDOCC - Expert Interactive Design of Concrete Columns
Master's Thesis, MIT – Massachusetts Institute of Technology, 1985.

Refereed papers in professional journals

1. Sacks, R., and Buyukozturk, O., (1987), 'Expert Interactive Design of Concrete Columns under Bi-axial Bending', Journal of Computing in Civil Engineering, Vol. 1 No. 2 pp. 69-81.

2. Sacks, R., and Warszawski, A., (1997), 'A Project Model for an Automated Building System; Design and Planning Phases', Automation in Construction, Elsevier Science B.V., Vol. 7 No. 1 pp. 21-34.

3. Sacks, R., (1998), 'Issues in the Development and Implementation of a Building Project Model for an Automated Building System', International Journal of Construction Information Technology, Salford University, Salford UK Vol. 5 No. 2 pp. 75-101.

4. Sacks, R., Warszawski, A., and Kirsch, U., (2000), 'Structural Design in an Automated Building System', Automation in Construction, Elsevier Science B.V., Vol. 10 No. 1 pp. 181-197.

5. Sacks, R., (2002), 'Integrated AEC Information Services using Object Methods and a Central Project Model', Computer-Aided Civil and Infrastructure Engineering, Blackwell Publishers, Boston USA & Oxford UK, Vol. 17 No.6 pp. 449–456.

6. Sacks, R., Navon, R., and Goldschmidt, E., (2003), 'Building Project Model Support for Automated Labor Monitoring', Journal of Computing in Civil Engineering, Vol.17 No.1 pp. 19-27.

7. Sacks, R., Eastman, C.M., and Lee, G., (2003) 'Process Improvements in Precast Concrete Construction Using Top-Down Parametric 3-D Computer-Modeling', Journal of the Precast/Prestressed Concrete Institute, Vol. 48 No. 3 pp. 46-55.

8. Eastman, C.M., Sacks, R., and Lee, G., (2003), 'Development and Implementation of Advanced IT in the North American Precast Concrete Industry', ITCON - Electronic Journal of Information Technology in Construction, Vol. 8, pp. 247-262.

9. Sacks, R., Eastman, C.M., and Lee, G., (2004) 'Process Model Perspectives On Management and Engineering Procedures in the Precast/Prestressed Concrete

Industry', <u>Journal of Construction Engineering and Management</u>, Vol. 130 No. 2 pp. 206-215.

10. Sacks, R., Eastman, C.M., and Lee, G., (2004), 'Parametric 3D Modeling in Building Construction with Examples from Precast Concrete', <u>Automation in Construction</u>, Elsevier Science B.V., Vol. 13 No. 3 pp. 291-312.

11. Warszawski, A., and Sacks, R., (2004), 'A Practical Multi-Factor Approach to Evaluating the Risk of Investment in Engineering Projects', <u>ASCE</u> <u>Journal of Construction Engineering and Management</u>, Vol. 130 No. 3 pp. 357-367.

12. Sacks, R., (2004), 'Evaluation of the economic impact of computer-integration in precast concrete construction', <u>Journal of Computing in Civil Engineering</u>, Vol. 18 No. 4. pp. 301-312.

13. Sacks, R., Navon, R., **Brodetskaia, I.,** and Shapira, A. (2005). 'Feasibility of Automated Monitoring of Lifting Equipment in Support of Construction Project Control', <u>Journal of Construction Engineering and Management</u>, Vol. 131 No. 5 pp. 604-614.

14. Sacks, R., Eastman, C.M., Lee, G. and Orndorff, D. (2005). 'A Target Benchmark of the Impact of Three-Dimensional Parametric Modeling in Precast Construction', <u>Journal of the Precast/Prestressed Concrete Institute</u>, Vol. 50 No. 4 pp. 126-139.

15. Sacks, R., Navon, R., and **Brodetskaia, I.,** (2006). 'Interpretation of Automatically Monitored Equipment Data for Project Control', <u>Journal of Computing in Civil Engineering</u>, Vol. 20 No. 2 pp. 111-120.

16. Lee, G., Eastman, C.M., Sacks, R., and Navathe, S.B., (2006). 'Grammatical Rules for Specifying Information for Automated Product Data Modeling', <u>Advanced Engineering Informatics</u>, Vol. 20 No. 2 pp. 155-170.

17. Sacks, R., and **Harel, M.,** (2006). 'An Economic Game Theory Model of Subcontractor Resource Allocation Behavior', <u>Construction Management & Economics</u>, Vol. 24 No. 8 pp. 869-881.

18. Lee, G., Sacks, R., and Eastman, C.M., (2006). 'Specifying Parametric Building Object Behavior (BOB) for a Building Information Modeling System', <u>Automation in Construction</u>, Vol. 15 No. 6 pp. 758-776.

19. **Ergen, E.,** Akinci, B., and Sacks, R., (2007). 'Tracking and Locating Components in a Precast Storage Yard Utilizing Radio Frequency Identification Technology and GPS', <u>Automation in Construction</u>, Vol. 16 No. 3 pp. 354–367.

20. Navon, R., and Sacks, R., (2007). 'Assessing Research in Automated Project Performance Control (APPC)', <u>Automation in Construction</u>, Vol. 16 No. 4 pp. 474-484.

21. Lee, G., Eastman, C.M., and Sacks, R., (2007). 'Twelve Design Patterns for Integrating and Normalizing Product Model Schemas', <u>Computer-Aided Civil and Infrastructure Engineering</u>, Vol. 22 No. 3 pp. 163-181.

22. Sacks, R., and **Goldin, M.,** (2007). 'Lean Management Model for Construction of High-rise Apartment Buildings', <u>Journal of Construction Engineering and Management</u>, Vol. 133 No. 5 pp. 374-384.

23. Lee, G., Sacks, R., and Eastman, C.M., (2007). 'Product Data Modeling using GTPPM - A Case Study', <u>Automation in Construction</u>, Vol. 16 No.3 pp. 392-407.

24. Sacks, R., **Esquenazi, A.,** and **Goldin, M.,** (2007). 'LEAPCON: Simulation of Lean Construction of High-rise Apartment Buildings', <u>Journal of Construction Engineering and Management</u>, Vol. 133 No. 7 pp. 529-539.

25. Lee, G., Eastman, C.M., and Sacks, R., (2007) 'Eliciting Information for Product Modeling using Process Modeling', <u>Data & Knowledge Engineering</u>, Elsevier Science B.V., Vol. 62 No. 2 pp. 292-307.

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This book has been translated into Korean, Portuguese and Italian. Two Chinese editions are being prepared (Beijing and Taipei). The first English edition was published April 2008, ISBN: 978-0-470-18528-5, John Wiley and Sons, Hoboken NJ, 495 pages.

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2. Sacks, R., Warszawski, A., Kirsch, U., '<u>An Automated Building System - the Structural Aspect</u>', Israel National Building Research Institute Report #803, Haifa, 1998, 80 pages.

3. Eastman, C.M., Sacks, R., and Lee, G., '<u>Specification for a Precast Concrete Design and Engineering Software Platform</u>', Georgia Institute of Technology, Atlanta, 2001.

4. Eastman, C.M., Sacks, R., Lee, G., and Orndorff, D., '<u>PCSC Inform Task Report in Support of Development of Precast Concrete Design and Engineering Software</u>', Georgia Institute of Technology, Atlanta, 2003.

5. Sacks, R., and **Goldin, M.,** '<u>Management Procedures for Client Changes – Development of a Management Model based on Lean Construction Principles</u>', Research Report #1005158, Technion Research and Development Foundation, Haifa, 2005.

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9. Sacks, R., Rosenfeld, Y., Baum, H., and **Rozenfeld, O.,** '<u>A Lean Dynamic Quantitative Method for Planning Safety Enhancement Operations in Construction</u>', Israel National Building Research Institute Report #2005902, Haifa, 2007, 121 pages.

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15. Eastman, C., Panushev, I., Sacks, R., Venugopal, M., Aram, S., and See, R., 'A Guide for Development and Preparation of a National BIM Exchange Standard' Technical Report, buildingSMART, Atlanta 2011.

16. Whyte, J., Sacks, R., Zhou, W., and Haffegee, A., 'Building Safely by Design: Using Digital Design Models to Improve Planning for Safe Construction', Report 13.2, Institution of Occupational Safety and Health (IOSH), Wigston, Leicestershire, UK, 2014, 49 pages.

17. Sacks, R., Barak, R., Perlman, A., and Belaciano, B., 'Construction Safety Training using Immersive Virtual Reality', Israel National Building Research Institute Report #2014032, Haifa, 2012, 176 pages.

18. Sacks, R., Raviv, G., **Swissa, D.,** and Shapira, A., 'Safe Construction by Design: Virtual Assessment of Construction Hazards in Design', Israel National Building Research Institute Report #2016106, Haifa, 2013, 111 pages.

19. Sacks, R., **Zeibak-Shini, R., Ma, L.,** and Filin, S., 'Assessment of Earthquake Damage to Buildings Using a Building Information Model and Laser Scanning', The Research Fund of the Association of Insurance Companies in Israel and Israel National Building Research Institute, Haifa, 2014, 168 pages.

20. Sacks, R., **Shachaf, Y.,** and **Ma, L.,** 'The Flow of Process Information at the Construction Site and its Impact on the Work Flow of Trade Crews', Israel National Building Research Institute Report #2020714, Haifa, 2016, 140 pages.

Conferences and other contributed lectures

1. *Technical University of Berlin, Guest Lecture,* Berlin, West Germany, July 1985. "EIDOCC - Expert Interactive Design of Concrete Columns."

2. *Modeling of Buildings Through their Life Cycle, CIB W78 Workshop*, Stanford, CA, USA, August 1995. "The Project Model of an Automated Building System."

3. *Information Support for Building Economics, CIB W55 Workshop*, Salford, UK September 1997. "The Development of Knowledge Modules for Automated Structural Design."

4. *IT in Construction in Africa, CIB W78 Workshop,* White River, South Africa, May 2001. "Adding Function and Behavior to Project Model Objects to Integrate AEC Information."

5. *ASCE Specialty Conference on Fully Integrated and Automated Project Processes (FIAPP) in Civil Engineering*, Blacksburg, VA, USA, January 2002. "An Automated Building System - Development, Difficulties and New Directions."

6. *Polytechnic University, guest lecture,* Brooklyn, New York, USA, April 2002. "Computer Integrated Construction Research: An Overview".

7. *CEC02 Concurrent Engineering Conference,* Berkeley, CA, USA, July 2002. "Information and Process Flow in Models of Precast Concrete Design and Construction."

8. *ISARC - Nineteenth International Symposium on Automation and Robotics in Construction*, NIST, Gaithersburg, MD, USA, September 2002. "Monitoring Construction Equipment for Automated Project Performance Control."

9. *PCI – National Convention of the Precast/Prestressed Concrete Institute,* Nashville, TN, USA, October 2002. "Can parametric 3-D computer-modeling prevent errors in Precast Construction?"*IGLC – Eleventh Meeting of the International Group for Lean Construction,* Virginia Polytechnic Institute and State University, Blacksburg, VA, USA, July 2003. "3D Modeling and Real-time Monitoring in Support of Lean Production of Engineered-to-order Precast Concrete Buildings."

11. *ISARC - Twentieth International Symposium on Automation and Robotics in Construction*, Technical University Eindhoven, Netherlands, September 2003. "Monitoring Lifting Equipment for Automated Progress Control: A Feasibility Study."

12. *Third National Conference on Construction and Infrastructure*, Tel Aviv, November 2003. "Management Reporting in Construction Projects based on Computerized Monitoring of Lifting Equipment." (in Hebrew).

13. *Grupo Dragados and Drace 3D Modeling Seminar,* Madrid, Spain, March 2004. "Background to the PCSC Project – Precast Concrete Software Consortium"; "The Benefits of 3D modeling for the Precast Concrete Industry" (invited lecture).

14. *Tekla Global Business Forum*, Prague, Czech Republic, June 2004. "The PCSC Project and Evaluating Economic Benefits" (invited lecture).

15. *IGLC – Twelfth Meeting of the International Group for Lean Construction,* Elsinore, Denmark, August 2004. "Towards a lean understanding of resource allocation in a multi-project sub-contracting environment."

16. *Tekla Structures Seminar,* Leeds, UK, August 2004. "3D parametric modeling of precast concrete structures: Motivation, technical specifications and productivity measures."

17. *BIBM* – Amsterdam, Netherlands, May 2005, "3D parametric modelling of precast structures - a revolutionary change."

18. *IGLC – Thirteenth Meeting of the International Group for Lean Construction,* Sydney, Australia, July 2005. "Pull-driven construction of high-rise apartment buildings."

19. *IGLC – Thirteenth Meeting of the International Group for Lean Construction,* Sydney, Australia, July 2005. "Lean scheduling for safety: development of a time-dependent risk level model."

20. *Carnegie-Mellon University ICCM Meeting*, Pittsburgh PA, US, April 2006. "A Game Theory Analysis of Subcontractor Resource Allocation" (invited lecture).

21. *ICCCBE-XI - 11th Int'l Conference on Computing in Civil and Building Engineering,* Montreal, Canada, June 2006. " 'WORKMANAGER' - an Online Interface for Lean Flow Control in Apartment Building Construction."

22. *ICCCBE-XI - 11th Int'l Conference on Computing in Civil and Building Engineering,* Montreal, Canada, June 2006. "Quantitative Assessment of the Impact of 3D Modelling of Building Structures on Engineering Productivity."

23. *IGLC - 14th Conference of the International Group for Lean Construction,* Santiago, Chile, July 2006. "Subcontractor Resource Allocation in a Multi- project Environment – Field Study."

24. *IGLC - 14th Conference of the International Group for Lean Construction,* Santiago, Chile, July 2006. "Evaluation of Lean Improvements in Residential Construction using Computer Simulation."

25. *IGLC - 14th Conference of the International Group for Lean Construction,* Santiago, Chile, July 2006. "How Last Planner Motivates Subcontractors to Improve Plan Reliability – a Game Theory Model."

26. *Conference on Preventive Action and Research for Occupational Health and Safety*, Jerusalem, Israel, June 2007. "Lean Scheduling for Safety in Construction by Predicting Risk Levels." (in Hebrew).

27. *CME25 - Construction Management and Economics: Past, Present and Future,* University of Reading, UK, July 2007. "Measures of Information Flow for Lean Design in Civil Engineering."

28. *IGLC – 15th Conference of the International Group for Lean Construction*, East Lansing, Michigan, USA, July 2007. "Understanding Flow and Micro-variability in Construction: Theory and Practice."

29. *Statsbygg Lean Construction Seminar*, Oslo, Norway, December 2007. "Linking BIM to Lean – Lean Construction and Building Information Modelling" (invited lecture).

30. *Georgia Tech College of Architecture Symposium "Adopting Building Information Modeling and Integrated Practice"*, Atlanta, GA, USA, March 2008. "Synergy: Lean Construction and Building Information Modeling" (invited lecture).

31. *Carnegie-Mellon University, Civil and Environmental Engineering Seminar*, Pittsburgh PA, US, March 2008. "Information Flows, Resource Allocations and Safety Risks: Lean Construction Research at the Technion" (invited lecture).

32. *IGLC – 16th Conference of the International Group for Lean Construction*, Manchester, UK, July 2008. "Partial remuneration for capacity to stabilize subcontractor resource allocations."

33. *Yonsei University, Dept. of Architectural Engineering Seminar,* Seoul, Korea, October 2008. "KanBIM - Lean and BIM Research at the Technion" (invited lecture).

34. *ICCCBE-XII 12th Int'l Conference on Computing in Civil and Building Engineering & INCITE 2008*, Beijing, China, October 2008. "R&D of BIM Exchange Standards for IFCs: A Case Study of Architectural Precast Facades."

35. *Salford University Research Institute for the Built and Human Environment (BuHu),* Salford, UK, November 2008. "Synergies of Building Information Modelling (BIM) and Lean Construction" (invited lecture).

36. *AEC-ST and Ecobuild Fall – buildingSMART Alliance National Conference,* Washington DC, US, December 2008. "National BIM Exchange Standards for Precast Concrete."

37. *ASCE Construction Research Congress,* Seattle, Washington, US, April 2009. "Production Flow in the Construction of Tall Buildings."

38. *EGLC European Group for Lean Construction Industry Day*, Schaffhausen, Switzerland, April 2009. "Lean Management im Bauwesen - Building Information

Modeling die Revolution der Planung" together with Prof. Manfred Breit (invited lecture).

39. *5th International Conference on Construction in the 21st Century (CITC-V)*, Istanbul, Turkey, May 2009. "Teaching Globalization Issues to Civil Engineering Students – The International Collaborative Construction Management Course."

40. *Design Management and Information Modelling (BIM),* Chartered Institute of Builders (CIOB) and Association of Researchers in Construction Management (ARCOM), Ascot, UK, June 2009. "Parametric 3D Modelling: Implications for Management of Design Professionals."

41. *Aalborg University, Dept. of Civil Engineering,* Aalborg, Denmark, November 2009. "KanBIM and the Interaction of Lean and Building Information Modeling in Construction" (invited lecture).

42. *CIB World Congress 2010, Meeting of CIB W78,* Salford, UK, May 2010. "A Building Information Modelling based Production Control System for Construction."

43. *IGLC - 18th Conference of the International Group for Lean Construction*, Haifa, Israel, July 2010. "Implementation of Pull Control in Finishing Works with Re-Entrant Flow."

44. *GEPUC 10th Annual Workshop,* Pontifica Universidade Catolica de Chile, Santiago, Chile, September 2010. "The Synergy of Building Information Modeling and Lean Construction" (invited lecture).

45. *Universidade Federal do Rio Grande do Sul,* NORIE, Department of Civil Engineering, Porto Alegre, Brazil, September 2010. "BIM and Lean Research at the Technion Virtual Construction Lab" (invited seminar).

46. *II Project Manager's Day,* Tallin Technical University & Tallinn University of Applied Sciences, Tallinn, Estonia, November 2010. "Introduction to Building Information Modeling- process rather than software" (invited keynote lecture).

47. *CIB W78 Workshop,* Cairo, Egypt, November 2010. "Development of the National BIM Standard (NBIMS) For Precast/Prestressed Concrete."

48. *CIB W78 Workshop,* Cairo, Egypt, November 2010. "Engineering Semantics of Model Views for Building Information Model Exchanges Using IFC."

49. *CIB W78 Workshop,* Cairo, Egypt, November 2010. "Introducing a New Methodology to Develop the Information Delivery Manual for AEC Projects."

50. *Institution of Civil Engineers (UK) Workshop - Engineering Management in a Digital Economy: Research and Practice,* London, UK, December 2010. "Lean construction and information management in the supply chain" (invited lecture).

51. *IGLC - 19th Conference of the International Group for Lean Construction*, Lima, Peru, July 2011. "Field Tests of the KanBIM Lean Production Management System."

52. *BIM Inter-institutional Group Advanced BIM Workshop — Building Information Modeling: needs and ways to implementation*, Sao Paulo, Brazil, July 2011. "Building Information Modeling Support for Production Control on Site" (invited lecture).

53. University of Sao Paulo, Dept. of Civil Engineering, Sao Paulo, Brazil, July 2011. "Building Information Modeling (BIM) Education" (invited lecture).

54. University of Campinas, Department of Architecture and Civil Eng., Campinas, Brazil, July 2011, "BIM and Virtual Reality Research at the Technion VC Lab" (invited lecture).

55. *TIC 2011 Conference on IT in Construction in Brazil*, Salvador, Brazil, August 2011. "Construction Management Research using BIM, Virtual Reality and Discrete Event Simulation" (invited keynote lecture).

56. *IGLC - 20th Conference of the International Group for Lean Construction,* San Diego, US, July 2012. "A brief history of the concept *'waste'* in production".

57. *BIMCON Workshop*, VTT Research Centre, Espoo, Finland, September 2012. "Building Information Modeling Support for Production Control on Site."

58. *Dean's Lecture Series 2012,* University of Melbourne, Melbourne School of Design, Melbourne, Australia, October 2012. "Processes and Products: The Synergies of Building Information Modeling and Lean Construction in a Changing Construction Industry" (invited lecture).

59. *ITC 2012 – Australasian Conference on Innovative Technologies in Construction*, Wuhan, China, December 2012. "From BIM to Beyond: The BIM and Lean Construction Paradigm Shifts" (invited keynote lecture).

60. *IGLC – 21st Conference of the International Group for Lean Construction,* Fortaleza, Brazil, August 2013. "Integrated adoption of Lean and BIM - The Tidhar Way" (invited lecture).

61. *IGLC – 21st Conference of the International Group for Lean Construction,* Fortaleza, Brazil, August 2013. "Social Network Development in Last Planner System™ Implementations".

62. *GEPUC Construction and Mining Workshop*, Santiago, Chile, August 2013. "Productivity Improvement through Lean and BIM - The Tidhar Way" (invited lecture).

63. *CIB W-78 30th International Conference*, Beijing, China, October 2013. "A Framework for Semantic Enrichment of IFC Building Models".

64. *CONVR 13th Conference on Virtual Reality in Construction*, London, UK, October 2013. "Integrated Virtual Reality and Discrete Event Simulation Methods for Production System Research in Construction".

65. *Tekla European BIM Forum*, Berlin, Germany, February 2014. "BIM and Lean Construction: Can BIM remove waste from construction processes?" (invited keynote lecture).

66. *Sinduscon SP 5th International Seminar on Building Information Modeling (BIM)*, Sao Paulo, Brazil, October 2014. "The Tidhar Way - A story of integrated Lean and BIM adoption" (invited lecture).

67. *CITA Smart Collaboration Challenge*, Dublin, Ireland, November 2014. "BIM and Virtual Construction: Lean or Waste?" (invited lecture).

68. *Lake Constance 5D Conference 2015,* Konstanz University of Applied Sciences, 5D Initiative, "BIM and Lean Construction" (invited lecture).

69. *IGLC – 23rd Conference of the International Group for Lean Construction,* Perth, Australia, July 2015. "Constructible BIM Elements: A root cause analysis of work plan failures".

70. *IGLC – 23rd Conference of the International Group for Lean Construction*, Perth, Australia, July 2015. "Simulating and Visualizing the Flow of Construction Trade Crews Using Agents and Building Information Models".

71. *University of Auckland Faculty of Engineering Lecture,* Auckland, New Zealand, August 2015. "Synergies of BIM and Lean Construction in a Changing Construction Industry" (invited lecture).

72. Nanyang Technological University, Centre for Infrastructure Systems, School of Civil and Environmental Engineering, Singapore, October 2015. "Recent BIM Research at the Virtual Construction Lab: Compilation of Semantically Rich BIM Models".

73. *BuildSmart Conference 2015*, Singapore, October 2015. "Semantic Enrichment of Building Models: A New Approach to Interoperability" (invited lecture).

74. *VII PJP Modern Construction Management Methods*, Tallinn, Estonia, November 2015. "Tidhar Way: Implementing Lean and BIM Practices" (invited lecture).

75. *Leonhard Obermeyer Center Lecture*, Technical University of Munich (TUM), Munich, June 2016. "Adopting Lean and BIM in the Construction Industry" (invited lecture).

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