ROUTLEDGE

Implementing

Virtual Design & Construction Using BIM

Current & future practices

Lennart Andersson

Kyla Farrell

Oleg Moshkovich

Cheryle Cranbourne

Implementing Virtual Design and Construction using BIM

Current and future practices

Lennart Andersson, Kyla Farrell,
Oleg Moshkovich, and
Cheryle Cranbourne

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

First published 2016
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
A catalog record for this book has been requested

ISBN: 978-1-138-01994-2 (hbk)
ISBN: 978-1-315-65707-3 (ebk)

Typeset in Myriad Pro
by Florence Production Ltd, Stoodleigh, Devon, UK

Printed and bound in the United States of America by Sheridan

Preface

Information technology is rapidly connecting all corners of the world, dissolving physical barriers and enabling previously impossible global interactions. As per Moore's Law,[1] computer hardware is evolving at a breathtaking pace; a mobile phone today is in some ways more powerful than a building-sized supercomputer was some 30 years ago. Furthermore, cloud computing has opened up new forms of communication and channels for sharing information around the globe. Cloud computing provides an abundance of available processing power, which has an enormous impact on processes and workflows across all areas of human endeavor.

We are entering the era of the Third Industrial Revolution. Technological innovations in manufacturing such as robotics are radically changing how products are made. Manufacturing techniques such as 3-D printing make it possible to create products locally and on demand, rather than stockpiling or shipping them across the world. Social networks and the interconnectedness of information technology are fostering new ways of thinking and working collaboratively. Crowdsourcing is making it possible for groups of physically disparate people to team up and work on projects and collectively arrive at solutions. It is more beneficial for individuals to share rather than "own" information, as the expiration date for some knowledge is drastically shorter now than in the past. Continuous learning must be incorporated into everyday workflows to stay on track with current progress.

GLOBAL PERSPECTIVE

As we enter an age in which many more people can produce drastically more product than was previously possible, we face enormous challenges in tending to the limited resources of this planet. Around the world, we are already depleting the resources we depend on.

The Industrial Revolution grew out of a view that we have infinite resources at our disposal, so the process of design focused solely on manufacture and usage. Very little thought was given to the impact of production on the environment, or what happens to something once it has served its purpose. Today, a different way of thinking must prevail; we need to put what we do into context and realize the interconnectedness of the systems in which we operate.

BUILDING INDUSTRY

The global building industry is one of the largest industries in the world and will grow from approximately an $8 trillion industry in 2013 to a $12 trillion industry by 2020.[2] Yet, building construction is still quite often a low-tech environment that can be extremely inefficient and wasteful. Indeed, it may be the only industry that has actually declined in efficiency over the past 20 years.

As building requires an enormous amount of resources, the industry has substantial effects on the environment. This book addresses the rapidly evolving technological tools that will make it possible to understand and change how things are built, and to streamline construction processes and minimize waste. The tools themselves will not solve our environmental quandary, but they enable us to visualize and solve complex problems. These tools bring transparency to the industry and expose the myriad interconnected issues involved in the building process. The industry can dramatically reduce its amount of waste by efficiently utilizing virtual building technologies.

BUILDING VIRTUAL

This book illustrates how technology can be successfully applied on a range of projects from an academic and theoretic perspective, and demonstrates how Virtual Design and Construction (VDC) actually interfaces and functions in the real world through case studies in New York City. The case studies included here are supported by reference chapters, which describe the tools and settings that help ensure the success of a VDC project.

As we are constantly developing VDC tools and workflows, please refer to our website for the most up-to-date examples and files at www.buildingvirtual.net.

ACKNOWLEDGMENTS

We would like to thank everyone who helped us on the projects described in this book, especially LiRo's CEO Luis Tormenta for believing in our department from the very beginning. Additionally, our colleagues Michael Bailey, Michael Burton, Vikas Wagh, and Vincent Valdemira who provided us with valuable industry knowledge, time, and resources. Our clients also deserve a big thanks, including Mark DeBernardo at MTA Capital Construction, for being our advocate when we started at East Side Access. Many thanks go out to Arta Yazdanseta and Harriet Markis for giving valuable feedback on early book concepts. An additional thanks to Brian

Guerin and Matthew Turpie at Routledge; our editor, Naveen Kumar; and our friends and family who read drafts and put up with our absence as we put this book together: Suzanne Bennett, Matt O'Neill, Vijay Pandurangan, Tan Shin Bin, and Andrea Lausevic.

Last but not least, we would like to thank everyone on the LiRo VDC team integral to the success of these amazing projects: Fernando Vazquez, Scott Blond, David Deiss, Izzet Keskintas, Aditi Patel, Jorge Berdecia, David Wu, and Brian Szeto.

NOTES

1 Moore's Law is named after Intel co-founder Gordon Moore, who predicted in 1975 that every two years the number of transistors in chip elements will double. So far, this prediction has proved to be true. Stephen Shankland, "Moore's Law: The Rule That Really Matters in Tech." CNET, October 15, 2012. Web. December 23, 2014.

2 David R. Schilling, "Global Construction Expected to Increase by $4.8 Trillion by 2020." Industry Tap. March 08, 2013. Web. November 10, 2014.

Contents

Illustrations

1 Introduction

Disruptive new technologies are transforming all facets of the built environment. Virtual Design and Construction (VDC) is the implementation of these technologies and processes. Understanding this emerging field is essential for all professionals working in Architecture, Engineering, and Construction (AEC).

The success of VDC depends not only on technology, but on the skills and knowledge of people who initiate, design, construct, and operate projects using a wide variety of professional tools. The ambition of this book is to communicate how powerful new tools significantly improve the process of building, as well as the quality of resulting buildings.

The AEC industry refers to much of what we discuss here simply as Building Information Modeling, or BIM. We find "BIM" to be an inadequate description of the workflows we are developing as VDC professionals. For the purposes of this book, the result of BIM or "BIM model" will be referred to simply as an "information model." For activities incorporating use of an information model, we use the terms VDC process (or methodology), VDC service, or VDC product. VDC processes are workflows that incorporate the information model and integrate previously disconnected aspects of design and construction. VDC processes seek to apply new technologies to the AEC industry and link all the work being done by the project team into the information model. The information model acts as a hub. VDC services are specific services unique to VDC, such as clash detection, 3-D scanning, tracking, or information model authoring. A VDC product is the deliverable resulting from a VDC service, such as a point cloud, a systems coordination model, database, or a constructability logistics animation.

While the concept of BIM has its roots in the early beginnings of computer technology, it was not until the personal computer became powerful enough to drive the data and graphics in real time that 3-D models became a useful tool. An information model simulates the geometry and data of an environment, unlike Computer Aided Drafting (CAD), which is merely a representation, like a drawing on paper. The information model is a virtual, geometrical, spatial relational database. It keeps track of data as it relates to specific geometry and location. Many types of data can be linked to a virtual object, and there are many possible ways to use and analyze the data contained in the model.

An information model is powerful because it allows all of the data surrounding a building project to be centralized into one ecosystem that all participants can share. This centralization mitigates problems associated with the fragmentation of data inherent in the traditional design and construction process. For example, someone viewing color-coded 3-D models instead of black-and-white line drawings gains a much better understanding of the project at hand, as relationships between different components are more clearly visible. Using information models thus minimizes the risk of misunderstandings and subsequent conflicts.

The case studies in this book are written from the perspective of our experience working in the VDC department within the LiRo Group, a Construction Management, Architecture, and Engineering firm headquartered in Syosset, NY. LiRo is a professional, full-service design and construction management firm ranked among the nation's Top 20 CM firms by Engineering News Record in 2014. The VDC department operates out of its own office in Manhattan. In addition to the VDC group, LiRo's current workforce of over 650 personnel includes licensed professional engineers, architects and field staff experienced in design, pre-construction, construction inspection and supervision, CPM scheduling techniques and computerized logging and document control systems. The staff also includes experienced value engineers, certified cost estimators, and LEED accredited professionals. The construction management team enlists in-house environmental, structural, traffic, and civil engineers, hazardous material specialists, PLA consultants and database developers, among others, to respond to any technical need that may arise on a project. From our vantage point in the VDC department, working with LiRo's full spectrum of designers, engineers, and constructors, we have a deep understanding of how the various processes of a building project relate to each other.

The construction manager's (CM) main role is to ensure that the intended design is built in the best possible way, at the lowest cost and in the most time-efficient manner. The tools a CM uses apply mostly to means and methods, such as planning and tracking the construction of the project. A CM ensures that all parties understand their scope and responsibilities through contractual documents. Specific services rendered include specification authoring, sequencing and scheduling, cost estimating, constructability review of the intended design, creating staging plans, tracking and reporting progress, enforcing site safety, quality assurance and control as well as cost-related tasks, such as value engineering and administration. All these services can be greatly improved with VDC processes. The CM might actually be one of the greatest beneficiaries of VDC, as the transparency it affords helps the CM understand and monitor every aspect of the project.

VDC will only continue to expand as a discipline, becoming a further integrated part of the AEC process.[1] New technologies and innovations are constantly being devised to address the many inefficiencies in current professional practice. As VDC professionals, we are interested in the rapid advances being made in the development of new technologies that facilitate a bidirectional link between the real and the virtual, providing a platform for better decision making. 3-D scanning, 3-D printing, sensors, prefabrication, automation, and robotics are among the many exciting innovations being developed. At its core, VDC ultimately seeks to bridge the expertise gaps between design, construction, and operations; to realize facilities that are dramatically less wasteful both in assembly and usage; and to create buildings that function to serve their occupants throughout the complete usage lifecycle.

NOTE

1 Forty percent of US owners and 38 percent of UK owners expect that more than 75 percent of their projects will involve BIM in just two years. McGraw Hill Construction, Marketing Communications, "U.S. and U.K. Building Owners Expect to Increase Their Involvement with BIM in the Next Two Years," Market Watch. October 13, 2014. Web, October 24, 2014.

2 The Practice of VDC

VDC is an interdisciplinary practice in which data is centralized, typically within a 3-D information model, allowing for increased efficiencies and deeper project understanding and analysis. VDC is a shift from mere representation of project information as in a 2-D design process to detailed simulation, from a linear design and construction process to a concurrent process with live feedback loops. Implementing a functional VDC practice requires an understanding of the building process, structure and professional culture both at the project and enterprise level.

VDC processes are workflows that incorporate the information model and integrate previously disconnected aspects of design and construction. VDC processes seek to apply new technologies to the AEC industry and link the work done by the project team to the information model. The information model acts as a central hub in the VDC workflow. VDC services are specific services unique to VDC, such as clash detection, 3-D scanning, tracking or information model authoring. A VDC product is the deliverable resulting from a VDC service, such as a point cloud, a systems coordination model, database or a constructability logistics animation.

VDC services can be utilized throughout the entire design and construction process. If VDC services simply run parallel to traditional workflows, they don't provide the optimal benefit to a project. VDC services must be integrated into the traditional trades and everyday workflows to be effective. Every member of the team needs a certain level of understanding regarding VDC in order to innovate and improve existing practices. Successful VDC implementation requires a thorough understanding of how things are done in theory as well as practice. Understanding the team's existing structure of decision making is crucial to implement effective new practices.

A VDC department's success depends not only on the talent of its team and strong process awareness, but also on clear organization. The structure of the VDC practice should evolve with each project, simplifying initial deployment, and incorporating lessons learned from previous projects, which are captured as a set of pre-formatted templates, databases, and a clearly organized file tree. Clear naming conventions and correctly implemented interoperability standards are the conduits that connect VDC to traditional AEC workflows and are addressed further in Chapter 5 ("Reference Documents").