

## TABLE OF CONTENTS

	Pág.
DEDICATORIA.....	ii
ACKNOWLEDGMENTS.....	iii
LIST OF TABLES .....	vii
LIST OF FIGURES.....	ix
ABSTRACT .....	xi
RESUMEN.....	xii
RESUM	xiii
1. INTRODUCTION .....	1
1.1. Background .....	2
1.1.1. The design phase of construction projects .....	2
1.1.2. Interaction in the design phase of construction projects .....	3
1.1.3. Building Information Modeling uses .....	5
1.1.4. Lean design .....	6
1.2. Research context .....	8
1.2.1. Research problem .....	8
1.2.2. Research questions.....	9
1.2.3. Research goals .....	9
1.3. Research methods.....	10
1.4. Dissertation outline .....	14
2. BIM USE ASSESSMENT (BUA) TOOL FOR CHARACTERIZING THE APPLICATION LEVELS OF BIM USES FOR THE PLANNING AND DESIGN OF CONSTRUCTION PROJECTS .....	17
2.1. Introduction .....	17
2.2. Research methodology .....	19
2.3. Identification, selection, and definition of BIM uses .....	23
2.4. Proposal of a BUA tool for measuring the level of BIM application .....	27

2.5.	Validation of the BUA tool via the evaluation of the projects in the planning and design phases .....	30
2.6.	Conclusions .....	35
3.	AN ASSESSMENT OF LEAN DESIGN MANAGEMENT PRACTICES IN CONSTRUCTION PROJECTS .....	37
3.1.	Introduction .....	37
3.2.	Research methodology .....	40
3.2.1.	Stage 1: Lean design management practices – a literature review	41
3.2.2.	Stage 2: Validation of Lean design management practices: practices-principles relationship.....	42
3.2.3.	Stage 3: Assessment of Lean design management practices .....	46
3.3.	Results and Discussion.....	48
3.3.1.	Identification of Lean design management practices from the literature	48
3.3.2.	The relationship between Lean design management practices and Lean principles.....	54
3.3.3.	Assessment of Lean design management practices in construction projects.....	60
3.4.	Conclusions .....	65
4.	UNDERSTANDING INTERACTIONS BETWEEN DESIGN TEAM MEMBERS OF CONSTRUCTION PROJECTS USING SOCIAL NETWORK ANALYSIS	69
4.1.	Introduction .....	69
4.2.	Research methodology .....	73
4.3.	Literature review of interaction networks .....	76
4.3.1.	Dimensions of interaction in a work team .....	76
4.3.2.	SNA experiences in the AEC industry .....	81
4.3.3.	Gaps in SNA in the AEC industry .....	85
4.4.	Proposal for a network evaluation method: metrics and sociograms .....	86
4.5.	Pilot project: evaluation and analysis.....	94
4.6.	Conclusions .....	104
5.	ANALYZING THE ASSOCIATION BETWEEN LEAN DESIGN MANAGEMENT PRACTICES AND BIM USES IN THE DESIGN OF CONSTRUCTION PROJECTS .....	106
5.1.	Introduction .....	106

5.2. Background .....	111
5.3. Research method .....	115
5.4. Results and discussion.....	123
5.5. Conclusions .....	133
6. COMPARING TEAM INTERACTIONS IN TRADITIONAL AND BIM-LEAN DESIGN MANAGEMENT.....	137
6.1. Introduction .....	137
6.2. Background .....	140
6.3. Research method .....	145
6.4. Results and discussions .....	151
6.5. Conclusions .....	165
7. OVERALL DISCUSSION OF RESULTS.....	167
7.1. Phase 1: the creation of assessment tools.....	168
7.2. Phase 2: relationship analysis.....	177
8. CONCLUSIONS .....	186
8.1. Contributions to knowledge .....	186
8.2. Practical value .....	189
8.3. Limitations .....	191
8.4. Futures lines of research.....	194
9. CONCLUSIONES.....	196
9.1. Contribuciones de la investigación .....	196
9.2. Valor práctico .....	199
9.3. Limitaciones .....	202
9.4. Futuras líneas de trabajo.....	205
REFERENCES.....	208
A P P E N D I X E S .....	229
APPENDIX A: PUBLISHED PAPERS FIRST PAGE .....	230
APPENDIX B: BUA TOOL .....	233
APPENDIX C: LPS QUESTIONNAIRE .....	235