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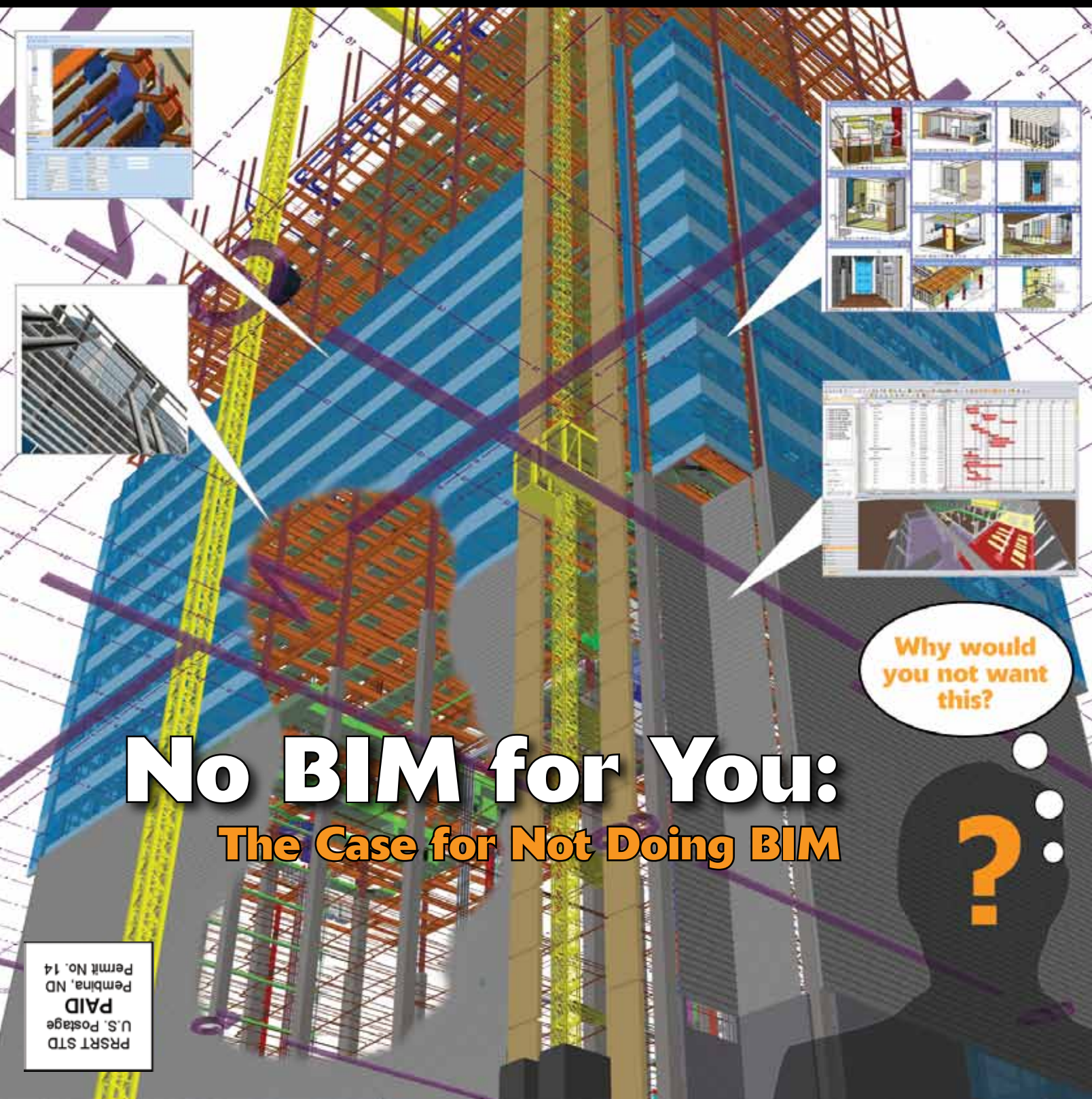

No BIM for You:

The Case for Not Doing BIM

BIM Return on Investment: A Case Study

By Brittany Giel and Raja R.A. Issa

THE EVOLUTION OF BUILDING information modeling (BIM) and virtual design and construction (VDC) are fundamentally changing the process by which buildings are designed and constructed. The perceived high initial cost of BIM has, however, deterred many industry professionals from implementing it. In some cases, an owner's willingness to pay for the BIM is crucial in the contractor's decision to use BIM.

This study presents data gathered from three case studies on three sets of two similar projects: one a recently constructed BIM-assisted project and the other an earlier project without BIM to show the return on investment (ROI). The potential savings to an owner choosing to invest in BIM as an additional service were estimated based on the measurable cost benefits associated with reduced schedule overruns and reduced change order costs.

Table 1. Project Description

	Project A (Pre-BIM)	Project B (BIM-Assisted)
Contract value	$7,128,000.00	$8,844,073.00
Schedule duration	12 months	12 months
Schedule delay	7 days	0 days
Delivery method	Negotiated Bid	Negotiated Bid
Contract type	GMP	GMP
Square footage	123,000 SF	(3) 81,000 SF bldgs.
Use	Com. warehouse w. leasable mixed-use space	Com. warehouse w. leasable office space
Construction Type	Tilt-up wall with steel framing	Tilt-up wall with steel framing

Table 2. Project A: BIM ROI

Cost Category	Amount
Total direct cost of subcontracting out panel shop drawings:	**$16,650**
Direct costs in preventable change orders:	
Embed fix change order	$928
Girder and joist seat fix change order	$8,499
Girder and door opening conflict change order	$5,664
Total:	$15,091
Indirect costs of 7-day BIM-preventable time overrun:	
Daily cost of contractor time overrun (general conditions) ($855/day)	$5,985
Daily cost of 5 percent interest on construction loan for time overrun ($976/day)	$6,832
Daily cost of developer administration for time overrun ($446/day)	$3,122
Estimated cost of architect's contract administration for time overrun ($149/day)	$1,043
Total	**$16,982**
Total estimated savings	**$48,723**
Cost of BIM (0.5 percent of contract value)	**$35,640**
Net BIM savings	**$13,083**
ROI	**36.7 percent**

BACKGROUND

Using past project data from a medium-sized commercial construction management firm, a study was conducted to determine BIM's ROI to building owners. In 2007, the subject company began offering VDC as an additional service to its clients. In the BIM-assisted projects described in these case studies, BIM was implemented at an additional cost to the owner after the design phase was completed when the contract was awarded to the contractor.

CASE STUDY ONE

First, two small tilt-up wall commercial warehouse projects were analyzed to determine the cost savings associated with BIM's implementation. The projects are labelled Projects A and B. A general description of both projects is shown in TABLE 1. The use of BIM resulted in a 34 percent reduction in requests for information (RFIs) and a 40 percent reduction in change orders. There also was an overall reduction in the total cost of change orders and a reduction in schedule delays on the BIM-assisted project.

Estimated ROI

The estimated ROI that could have been realized by the owner if BIM had been used on Project A was determined based on an analysis of what BIM-preventable conflicts occurred and the proportion of schedule overruns attributed to these issues. BIM was used to create a set of tilt-up panel shop drawings. Thus, a portion of the costs preventable by BIM included the cost of subcontracting out that task. In addition, three of Project A's change orders could have been completely eliminated had BIM been used.

The costs of schedule overruns associated with these BIM-preventable issues were estimated based on four major cost categories: the daily cost of the contractor's general conditions, the daily cost for the developer's administration,

the architect's construction administration time and the daily cost of interest on the owner's construction loan. For the purpose of this study, a 5 percent capitalization rate was assumed (TABLE 2).

The calculated ROI of Project A was used as a model rubric for BIM-assisted Project B. Due to a lack of recorded cost data, Project B's ROI was estimated based solely on the costs associated with its seven days of prevented schedule overrun and the exclusion of the cost to subcontract the panel shop drawings (TABLE 3).

CASE STUDY TWO

A similar case study was conducted on two three-story assisted living facility projects to determine the cost savings of implementing BIM. TABLE 4 summarizes some of the general information for Projects C and D.

Estimated ROI

There were four specific change orders on Project C which may have been prevented if BIM had been utilized. Due to inaccuracies in the construction drawings, numerous modifications were made to the balconies of two unit types on the second floor resulting in a shell over-estimate for the contractor. Another change order resulted from a clash between the roof scuppers and exterior walls that was uncovered late in the construction process. Additionally, inconsistencies in the construction drawings caused several doors in the mechanical rooms to be resized.

Lastly, during the inspection process it was found that two four-hour, fire-rated walls were missed by the designer in the original drawings. Because this mistake was uncovered so late, Project C's completion was delayed two months. The resulting change order included the cost of the demolition of the existing walls and ceilings and the material and labor costs associated with hanging, reframing and finishing the corrected walls. Most of these issues would likely have been uncovered during the 2D conversion process to BIM in preconstruction, if the technology had been available.

The estimated ROI of using BIM on Project C may have totalled 376 percent, if the technology had been available (TABLE 5).

Table 3. Project B: BIM ROI from Indirect Savings

Cost Category	Amount
Total direct cost of subcontracting out panel shop drawings: ($0.13/SF X 243,000 SF)	$31,590
Indirect costs of 7-day BIM-prevented time overrun:	
Daily cost of contractor time overrun (general conditions) ($888/day)	$6,216
Daily cost of 5 percent interest on construction loan for time overrun ($1212/day)	$8,484
Daily cost of developer administration for time overrun ($544/day)	$3,808
Daily cost to architect's contract administration for time overrun ($181/day)	$1,267
Total	**$19,775**
Total estimated savings	**$51,365**
Cost of BIM (0.5 percent of contract value)	**$44,220**
Net BIM savings	**$7,145**
ROI	**16.2 percent**

Table 4. Project Descriptions

	Project C (Pre-BIM)	Project D (BIM-Assisted)
Contract value	$10,701,967	$11,799,071
Original schedule duration	13 months	14.6 months
Schedule delay	2 months	0
Contract type	Design Assist	Design/Build
Delivery method	GMP	Stipulated Sum
Square footage	120,000 SF	66,926 SF
Use	Assisted Living Facility	Assisted Living Facility
Type of construction	Concrete Block	Conventional Framing
Stories	3	3
Units	131	80

Table 5. Project C: BIM ROI

Cost Category	Amount
Direct costs in preventable change orders:	
Unit 227 and 228 shell overages	$6,202
Roof scupper re-route	$6,515
Door re-size at closets/mech room	$833
4-hour wall rework and construction	$17,225
Total	**$30,775**
Indirect costs of 60-day BIM-preventable time overrun:	
Daily cost of contractor time overrun (general conditions) ($1410/day)	$84,600
Daily cost of 5 percent interest on construction loan for time overrun ($1466/day)	$87,960
Daily cost of developer administration for time overrun ($641/day)	$38,460
Estimated cost of architect's contract administration for time overrun ($214/day)	$12,840
Total	**$223,860**
Total estimated savings	**$254,635**
Cost of BIM (0.5 percent of contract value)	**$53,510**
Net BIM savings	**$201,125**
ROI	**376 percent**

Table 6. Project D: BIM ROI	
Cost Category	**Amount**
Indirect costs of 30-day BIM-prevented time overrun:	
Daily cost of contractor time overrun (general conditions) ($1554/day)	$46,620
Daily cost of 5 percent interest on construction loan for time overrun ($1616/day)	$48,480
Daily cost of developer administration for time overrun ($706/day)	$21,180
Estimated cost of architect's contract administration for time overrun ($235/day):	$7,050
Total estimated savings	**$123,330**
Cost of BIM (0.5 percent of contract value)	**$58,995**
Net BIM savings	**$64,335**
ROI	**109 percent**

Table 7. General Project Descriptions		
	Project E (Pre-BIM)	**Project F (BIM-Assisted)**
Contract value	$41,757,618.00	$44,400,000.00
Original schedule duration	601 Days	652 Days
Schedule delay	426 Days	0 (60 Days Early)
Contract type	GMP	GMP
Delivery method	Negotiated Bid	Negotiated Bid
Square footage	439,760 SF	456,594 SF
Use	Mixed use- res. condo/ garage	Mixed use- res. condo/ garage
Number of stories	14 Stories	7 Stories
Number of units	311	218
Type of construction	Conv. formwork w. Conv. Reinf.	Conv. formwork w. cast in place tables

The ROI of using BIM on Project D was estimated based on a number of clashes that were uncovered using BIM during preconstruction. Numerous conflicts were resolved between the mechanical and structural disciplines, most of which were the result of discrepancies between the shaft detail drawings and the interior dimensions referenced in the architectural drawings. Using traditional methods, it is presumed most of these discrepancies would not have been uncovered until at least one month into the project schedule. On Project D there were also significant conflicts between the ceiling heights of several units and the mechanical and structural disciplines that were revealed during preconstruction using BIM.

Through analysis of these major conflicts, it was estimated that using BIM for coordination saved at least one month of schedule overrun time on Project D (TABLE 6).

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CASE STUDY THREE

The final case study compared two mid-rise commercial condominium projects to determine the value of BIM to an owner on a project of greater scale and complexity. TABLE 7 shows a summary of some of the projects details.

In this study, BIM resulted in a 43 percent reduction in the total number

of RFIs and a 37 percent reduction in change orders. The total cost of change orders on the BIM-assisted project totalled roughly 10 percent of that of a similar project constructed without BIM. Additionally, Project E experienced almost two years of schedule overruns that resulted in several legal disputes. In contrast, BIM-assisted Project F finished roughly two months ahead of schedule.

ESTIMATED ROI

Multiple BIM-preventable issues occurred on Project E. Perhaps the most noteworthy was a major drafting error in the site plan that left the original building's footprint falling outside the existing property lines. This resulted in a substantial change order. There were also several change orders that resulted from 2D errors and discrepancies between drawings.

In addition to the BIM-preventable change order costs on Project E, its schedule was delayed 426 days past its original 601-day duration. Analysis revealed that 221-delay days were attributed to BIM-preventable issues, including the drafting error in the building's boundary survey, major structural dimension conflicts, conflicts between the foundation and sidewalks, the relocation of columns due to grid misalignment and limited plenum space in the ceilings of most units. Had BIM been used, the projected BIM ROI for Project E was estimated at 1,654 percent (TABLE 8).

The ROI for Project F was estimated at roughly 300 percent based solely on the savings in reference to its 60-day early completion (TABLE 9).

CONCLUSION

The results of this research confirm the overall high return on investment of BIM to an owner, suggesting that regardless of the size and scope of a project, the implementation of BIM can be a vital tool that results in significant cost savings for all stakeholders. ■

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Table 8. Project E: BIM ROI

Cost Category	Amount
Direct costs in preventable change orders:	
Revised boundary survey	$24,862
Added beam in shear wall	$787
Shear wall # 1 revision	$3,396
Movement of (2) columns due to grid mis-alignment	$419
Addition of (16) 3" deck drains	$19,158
Readjustment of fire sprinkler heads for ceiling height changes	$1,777
Window reorder/install due to conflict with exterior columns	$2,632
Sliding glass doors mislabelled as window type	$2,208
Revised ceiling heights to conceal drop panels	$13,062
Additional framing of roof drains	$19,081
Re-routing of mechanical ductwork around electrical panels	$2,722
Additional soffits to accommodate return air ductwork	$14,115
Additional fire sprinkler heads adjustment for dropped ceiling	$1,285
Demolition and repair of elevator door beams	$66,812
Materials escalation due to 221-day delay based on survey and structural plan errors	$300,000
Total	**$472,316**
Indirect costs for 221-day BIM-preventable time overrun:	
Daily cost of contractor time overrun (general conditions)) ($5,425/day)	$1,198,925
Daily cost of 5 percent interest on construction loan for time overrun ($5720/day)	$1,264,120
Daily cost of developer administration for time overrun ($2466/day)	$544,986
Daily cost to architect's contract administration for time overrun ($822/day)	$181,662
Total	**$3,189,693**
Total estimated savings	**$3,662,009**
Cost of BIM (0.5 percent of contract value)	**$208,788**
Net BIM savings	**$3,453,221**
ROI	**1653.9 percent**

TABLE 9: Project F: BIM ROI of Indirect Time Savings

Cost Category	Amount
Indirect costs saved by 60-day early completion:	
Daily cost of contractor (general conditions) ($5,425/day)	$325,500
Daily cost saved in interest (5 percent) on construction loan ($6,082/day)	$364,920
Daily cost of developer administration ($2,466/day)	$147,960
Daily cost to architect's contract administration for time overrun ($822/day)	$49,320
Total	**$887,700**
Total estimated savings	**$887,700**
Cost of BIM (0.5 percent of contract value)	**$222,000**
Net BIM savings	**$665,700**
ROI	**299.9 percent**