KANDULA SRINIVASA REDDY MEMORIAL COLLEGE OF ENGINEERING (AUTONOMOUS)

KADAPA-516003. AP

(Approved by AICTE, Affiliated to JNTUA, Ananthapuramu, Accredited by NAAC)

(An ISO 9001-2008 Certified Institution)

DEPARTMENT OF CIVIL ENGINEERING

VALUE ADDED COURSE

ON

"BUILDING INFORMATION MODELLING"

Resource Person:

V. Maddileti Rangadu, Assistant Professor, Dept. of CE, KSRMCE

Course Coordinator:

T. Prasanth, Assistant Professor, Dept. of CE, KSRMCE

Duration: 08/10/2018 to 27/10/2018

K.S.R.M. COLLEGE OF ENGINEERING

(UGC-AUTONOMOUS)

Kadapa, Andhra Pradesh, India– 516 003

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Lr./KSRMCE/CE/2018-19/ Date: 02-10-2018

To
The Principal,
KSRMCE,
Kadapa.

Sub: Permission to Conduct Value Added Course on "Building Information Modelling" from 08/10/2018 to 27/10/2018–Req- Reg.

Respected Sir,

The Department of Civil Engineering is planning to offer a Value Added Course on "Building Information Modelling" to B. Tech. students. The course will be conducted from 08/10/2018 to 27/10/2018. In this regard, I kindly request you to grant permission to conduct the value added course.

Thanking you,

Forwarded to Principal sir
02/10/18

Yours faithfully

T. Prasanth
(Asst. Professor, CED)

Permitted
V.S.S. Murthy

K.S.R.M. COLLEGE OF ENGINEERING

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Cr./KSRMCE/CE/2018-19/ Date: 03/10/2018

Circular

The Department of Civil Engineering is offering a Value Added Course on "Building Information Modelling" from 08/10/2018 to 27/10/2018 to B.Tech students. In this regard, interested students are requested to register their names for the Value Added Course with following registration link.

https://docs.google.com/forms/d/e/1FAIpQLSeQyWeHlMuH5e4_NeE8DpD7XmFICGFa-eVZH9yl7I1TZkaUBg/viewform

For further information, contact Course Coordinator.

Course Coordinator:
T. Prasanth,
Assistant Professor,
Department of Civil Engineering,
KSRMCE.

HOD

Dept. of Civil Engineering

Cc to:

IQAC-KSRMCE

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DEPARTMENT OF CIVIL ENGINEERING
List of students registered for Value Added Course on "Building Information Modelling" from 08/10/2018 to 27/10/2018

Sl. No.	Roll Number	Name of the student	Semester	Branch
1	159Y1A0101	A Vishnu	VII	Civil
2	159Y1A0102	Alam Vinod Kumar	VII	Civil
3	159Y1A0105	Arukatla Mounika	VII	Civil
4	159Y1A0106	Avula Phanindra	VII	Civil
5	159Y1A0108	Avula Sri Sai Uttej	VII	Civil
6	159Y1A0109	Bande Guru Shareef	VII	Civil
7	159Y1A0110	Bandi Balasubramanyam	VII	Civil
8	159Y1A0111	Bellam Jayanth	VII	Civil
9	159Y1A0112	Bhavigadda Manjunath	VII	Civil
10	159Y1A0113	Bhupathi Venkata Naga Viharika	VII	Civil
11	159Y1A0117	Budamagunta Venkata Sai Tharun Teja	VII	Civil
12	159Y1A0118	Bukke Krishna Naik	VII	Civil
13	159Y1A0119	Busam Divya Swarup	VII	Civil
14	159Y1A0121	Challa Sumanth Kumar Reddy	VII	Civil
15	159Y1A0122	Challa Venkata Prasad	VII	Civil
16	159Y1A0123	Cheemalapenta Sumanth	VII	Civil
17	159Y1A0124	Chennabusigalla Kesava	VII	Civil
18	159Y1A0125	Chinta Naveen Kumar	VII	Civil
19	159Y1A0132	Eerabbi Chandra Mohan	VII	Civil
20	159Y1A0133	G Venkatesh	VII	Civil
21	159Y1A0134	Gadde Deepak Suryathej	VII	Civil
22	159Y1A0135	Gandham Sravan Kumar	VII	Civil
23	159Y1A0136	Gangavaram Kondaka Keerthi	VII	Civil
24	159Y1A0137	Garudaiah Gari Shashidhar Reddy	VII	Civil
25	159Y1A0138	Gatipati Suresh	VII	Civil
26	159Y1A0139	Girigittala Mohammed Ayaz	VII	Civil
27	159Y1A0140	Gogula Krishna Vamsi	VII	Civil
28	159Y1A0144	Gopavaram Rajasekhar	VII	Civil
29	159Y1A0145	Gorla Rajapaul Moses	VII	Civil
30	159Y1A0146	Gorla Sunilkumar	VII	Civil
31	159Y1A0148	Guggulla Prakash Kumar Reddy	VII	Civil
32	159Y1A0150	Gurrampati Sai Kumar Reddy	VII	Civil
33	159Y1A0151	Guvvala Himabindu	VII	Civil
34	159Y1A0152	Jalagadugu Venkata Srikar Datta	VII	Civil
35	159Y1A0153	Jollu Nagendra	VII	Civil

36	159Y1A0154	Jyothi Paul Vinay Kumar	VII	Civil
37	159Y1A0156	Kamatham Anilkumar	VII	Civil
38	159Y1A0157	Kamatham Sai	VII	Civil
39	159Y1A0159	Kandukuri Bhavya	VII	Civil
40	159Y1A0160	Kandukuri Chandra Sekhar	VII	Civil
41	159Y1A0161	Karnati Basireddygari Phanindra Reddy	VII	Civil
42	159Y1A0162	Kasireddy Rajeshkumarreddy	VII	Civil
43	159Y1A0163	Katari Leelakrishna	VII	Civil
44	159Y1A0164	Katta Bhargavi	VII	Civil
45	159Y1A0165	Kaveti Syam Sai	VII	Civil
46	159Y1A0166	Killola Mahesh	VII	Civil
47	159Y1A0167	Kollu Guru Mohan	VII	Civil
48	159Y1A0177	Lingampalli Naveen Kumar	VII	Civil

Coordinator **HOD**

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
(Autonomous)
KADAPA - 516 003. (A.P.)

Registration for Value Added Course on "Building information modelling" From 08/10/2018 to 27/10/2018

prasanthce@ksrmce.ac.in (not shared) Switch account

* Required

Roll Number *

Your answer

Name of the Student *

Your answer

B.Tech Semester *

- I SEM
- II SEM
- III SEM
- IV SEM
- V SEM
- VI SEM
- VII SEM
- VIII SEM

Branch *

- CIVIL
- EEE
- MECHANICA
- LECE
- CSE

Email ID *

Your answer

Submit

Clear form

Syllabus of Value Added Course

Course Name: Building information modelling

Course Objectives:

- Define key BIM terminology and explain its significance in the construction industry.
- Demonstrate proficiency in using BIM software to create 3D models of buildings.
- Identify clashes and conflicts in BIM models and propose solutions for resolution.
- Utilize BIM data for construction planning, scheduling, and budgeting.

Course Outcomes: Upon completing the course students will be able to:

- Explain the fundamental concepts and benefits of Building Information Modeling (BIM).
- Create and manipulate BIM models using industry-standard software.
- Apply BIM for collaboration, coordination, and clash detection in construction projects.
- Utilize BIM for construction management tasks such as scheduling and quantity takeoff.

<u>Contents</u>

Module 1:

Introduction to BIM: Introduction to BIM concepts and history, Benefits of BIM in construction projects, BIM software and tools overview.

Module 2:

BIM Fundamentals: Building elements and components, BIM data exchange standards, BIM project life cycle stages

Module 3:

BIM Modeling and Software: Introduction to BIM modeling techniques, Hands-on training with BIM software, Creating basic building elements in BIM

Module 4:

BIM for Construction Management: BIM in construction scheduling, Quantity takeoff and cost estimation using BIM, BIM for construction documentation.

Module 5:

Advanced BIM Topics: BIM for facility management, BIM in sustainability and energy analysis, Industry case studies and future trends in BIM

Textbooks:

1. "Building Information Modeling: A Strategic Implementation Guide" by Michael Tardif and Sasha Reed (2015)
2. "BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors" by Chuck Eastman, Paul Teicholz, Rafael Sacks, and Kathleen Liston (2014)
3. "BIM in Small-Scale Sustainable Design" by François Lévy (2011)

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
KADAPA (A.P.)

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SCHEDULE

Department of Civil Engineering

Value Added Course on

"Building Information Modelling" from 08/10/2018 to 27/10/2018

Date	Timing	Resource Person	Topic to be covered
08/10/2018	4 PM to 6 PM	V. M. Rangadu	Introduction to BIM concepts and history
09/10/2018	4 PM to 6 PM	V. M. Rangadu	Benefits of BIM in construction projects
10/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM software and tools overview
11/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM software and tools overview
12/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM software and tools overview
13/10/2018	2 PM to 6 PM	V. M. Rangadu	Building elements and components
15/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM data exchange standards
16/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM project life cycle stages
17/10/2018	4 PM to 6 PM	V. M. Rangadu	Introduction to BIM modeling techniques
18/10/2018	4 PM to 6 PM	V. M. Rangadu	Hands-on training with BIM software
19/10/2018	4 PM to 6 PM	V. M. Rangadu	Creating basic building elements in BIM
20/10/2018	2 PM to 6 PM	V. M. Rangadu	BIM in construction scheduling
22/10/2018	4 PM to 6 PM	V. M. Rangadu	Quantity takeoff and cost estimation using BIM
23/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM for construction documentation
24/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM for facility management
25/10/2018	4 PM to 6 PM	V. M. Rangadu	BIM in sustainability and energy analysis
26/10/2018	4 PM to 6 PM	V. M. Rangadu	Industry case studies and future trends in BIM
27/10/2018	4 PM to 6 PM	V. M. Rangadu	Industry case studies and future trends in BIM

Resource Person(s) Coordinator(s) HOD

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
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LIGHTED TO LIGHTEN

ESTD: 1980

DEPARTMENT OF CIVIL ENGINEERING

Value Added Course
on
"Building Information Modelling"

Resource Person

Sri. V. Maddileti Rangadu
Assistant Professor
Department of Civil Engineering

Date

From 08/10/2018
to 27/10/2018

Coordinator

T. Prasanth
Department of Civil Engineering

Venue

CADD LAB,
Department of Civil Engg.

K.S.R.M. COLLEGE OF ENGINEERING
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Report of
Value Added Course on "Building Information Modelling"
From 08/10/2018 to 27/10/2018

Target Group	:	**B. Tech. Students**
Details of Participants	:	**48 Students**
Co-coordinator(s)	:	**T. Prasanth**
Resource Person(s)	:	**Sri. V. Maddileti Rangadu**
Organizing Department	:	**Civil Engineering**
Venue	:	**CADD Lab, Civil Department**

Description:

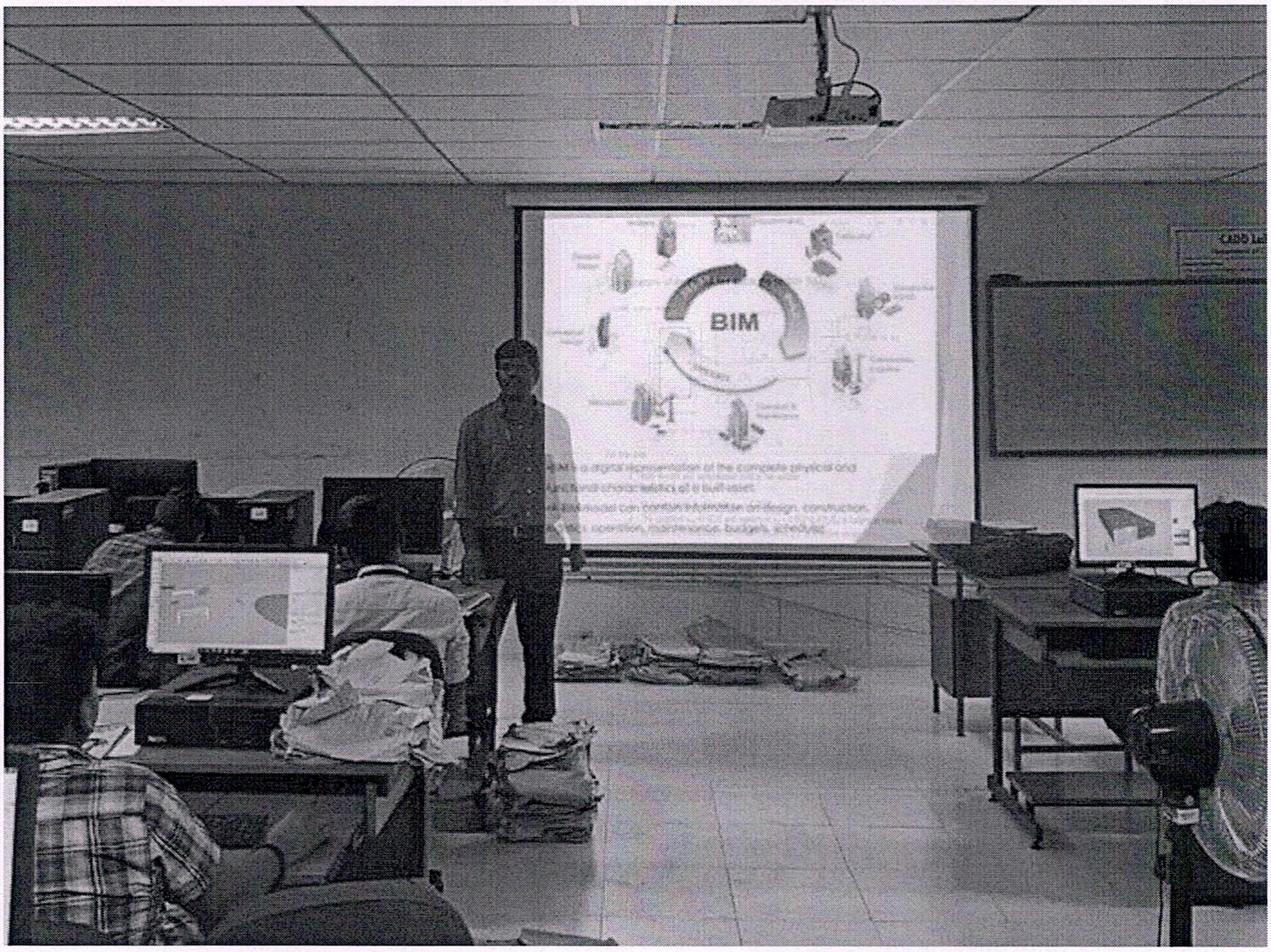
A Value Added Course on "Building Information Modelling" was offered by the Department of Civil Engineering from September 8 through September 27, 2018. T. Prasanth, Assistant Professor, Department of Civil Engineering, KSRMCE, served as the course coordinator. Sri. V. Maddileti Rangadu, Assistant Professor, Civil Engineering, taught the course.

Building Information Modeling (BIM) presents numerous advantages to the architecture, engineering, and construction (AEC) industry. It enhances collaboration by providing a centralized platform for data sharing, streamlines project timelines through better coordination, and reduces errors with automatic clash detection. BIM fosters sustainable design, improves cost estimation and quality control, and allows for efficient facility management. Its ability to integrate diverse data sources and ensure regulatory compliance makes it a powerful tool for modern construction projects. However, BIM also has its challenges, including initial implementation costs, a steep learning curve, and potential interoperability issues. Data security, software compatibility, and model maintenance can pose concerns, and over-reliance on technology may lead to a lack of traditional skills among professionals. To maximize the benefits of BIM, organizations must carefully plan and invest in training while addressing these challenges effectively.

In conclusion, BIM's advantages in terms of collaboration, visualization, and efficiency have revolutionized the AEC industry. Still, its successful implementation requires addressing issues related to cost, training, data management, and potential resistance to change. Ultimately, BIM's transformative potential can be harnessed by organizations committed to adapting to this technology-driven paradigm shift in the construction industry.

Photos:

The picture taken during the course is given below:



Introduction session of Building Information Modelling value added course

Coordinator(s)

HoD

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
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DEPARTMENT OF CIVIL ENGINEERING

Attendance sheet of Value Added Course on "Building Information Modelling"

Sl. No.	Roll No.	Name	08/10/2018	09/10/2018	10/10/2018	11/10/2018	12/10/2018	13/10/2018	15/10/2018	16/10/2018	17/10/2018	18/10/2018	19/10/2018	20/10/2018	22/10/2018	23/10/2018	24/10/2018	25/10/2018	26/10/2018	27/10/2018
1	159Y1A0101	A Vishnu																		
2	159Y1A0102	Alam Vinod Kumar							A											
3	159Y1A0105	Arukatla Mounika																		
4	159Y1A0106	Avula Phanindra																		
5	159Y1A0108	Avula Sri Sai Uttej				A														
6	159Y1A0109	Bande Guru Shareef																	A	
7	159Y1A0110	Bandi Balasubramanyam								A										
8	159Y1A0111	Bellam Jayanth																		

9	159Y1A0112	Bhavigadda Manjunath												A						
10	159Y1A0113	Bhupathi Venkata Naga Viharika																		
11	159Y1A0117	Budamagunta Venkata Sai Tharun Teja									A					A				
12	159Y1A0118	Bukke Krishna Naik																		
13	159Y1A0119	Busam Divya Swarup																		
14	159Y1A0121	Challa Sumanth Kumar Reddy																		
15	159Y1A0122	Challa Venkata Prasad																		
16	159Y1A0123	Cheemalapenta Sumanth			A														A	
17	159Y1A0124	Chennabusigall a Kesava																		
18	159Y1A0125	Chinta Naveen Kumar								A										
19	159Y1A0132	Eerabbi Chandra Mohan																		
20	159Y1A0133	G Venkatesh										A								
21	159Y1A0134	Gadde Deepak Suryathej																		
22	159Y1A0135	Gandham Sravan Kumar																		
23	159Y1A0136	Gangavaram Kondaka																		

		Keerthi																		
24	159Y1A0137	Garudaiah Gari Shashidhar Reddy	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	Shashi	A	Shashi	Shashi	Shashi
25	159Y1A0138	Gatipati Suresh	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A
26	159Y1A0139	Girigittala Mohammed Ayaz	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
27	159Y1A0140	Gogula Krishna Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamshi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi	G. Vamsi
28	159Y1A0144	Gopavaram Rajasekhar	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj	G.Raj
29	159Y1A0145	Gorla Rajapaul Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses	Moses
30	159Y1A0146	Gorla Sunilkumar	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	GSK	A	GSK	GSK
31	159Y1A0148	Guggulla Prakash Kumar Reddy	Prakash	Prakash	Prakash	Prakash	Prakash	A	Prakash	Prakash	Prakash	Prakash	Prakash	Prakash	Prakash	Prakash	Prakash	Prakash	Prakash	Prakash
32	159Y1A0150	Gurrampati Sai Kumar Reddy	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai	Sai
33	159Y1A0151	Guvvala Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu	A	Himabindu	Himabindu	Himabindu	Himabindu	Himabindu
34	159Y1A0152	Jalagadugu Venkata Srikar Datta	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]
35	159Y1A0153	Jollu Nagendra	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	A	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]	[signature]
36	159Y1A0154	Jyothi Paul Vinay Kumar	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay	Vinay

37	159Y1A0156	Kamatham Anilkumar																		
38	159Y1A0157	Kamatham Sai																		
39	159Y1A0159	Kandukuri Bhavya																		
40	159Y1A0160	Kandukuri Chandra Sekhar								A						A				
41	159Y1A0161	Karnati Basireddygari Phanindra Reddy						A												
42	159Y1A0162	Kasireddy Rajeshkumarreddy																		
43	159Y1A0163	Katari Leelakrishna					A													
44	159Y1A0164	Katta Bhargavi									A									
45	159Y1A0165	Kaveti Syam Sai																		
46	159Y1A0166	Killola Mahesh															A			
47	159Y1A0167	Kollu Guru Mohan										A								
48	159Y1A0177	Lingampalli Naveen Kumar																		

Coordinator(s)

HoD

Head
Department of Civil Engineering
K.S.R.M. College of Engineering
(Autonomous)
KADAPA - 516 003. (A.P.)

Feedback form on Value Added Course "Building information modelling" from 08/10/2018 to 27/10/2018

prasanthce@ksrmce.ac.in (not shared) Switch account

* Required

Roll Number *

Your answer

Name of the Student *

Your answer

The objectives of the Value Added Course were met*

- Excellent
- Good
- Satisfactory
- Poor

The content of the course was organized and easy to follow*

- ◯ Excellent
- ◯ Good
- ◯ Satisfactory
- ◯ Poor

The Resource Person was well prepared and able to answer any question *

- ◯ Excellent
- ◯ Good
- ◯ Satisfactory
- ◯ Poor

The exercises/role play were helpful and relevant *

- ◯ Excellent
- ◯ Good
- ◯ Satisfactory
- ◯ Poor

The Value Added Course satisfy my expectation as a value added Programme *

- Excellent
- Satisfactory
- Good
- Poor

Any other comments

Your answer

Submit

Clear form

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DEPARTMENT OF CIVIL ENGINEERING

Feedback of Value Added Course on "Building Information Modelling"

Sl. No.	Roll No.	Name	The objectives of the Value Added Course were met	The content of the course was organized and easy to follow	The Resource Person was well prepared and able to answer any question	The exercises/role play were helpful and relevant	The Value Added Course satisfy my expectation as a value added Programme
1	159Y1A0101	A Vishnu	Excellent	Excellent	Excellent	Satisfactory	Excellent
2	159Y1A0102	Alam Vinod Kumar	Excellent	Excellent	Good	Excellent	Excellent
3	159Y1A0105	Arukatla Mounika	Good	Good	Excellent	Excellent	Excellent
4	159Y1A0106	Avula Phanindra	Excellent	Excellent	Excellent	Excellent	Good
5	159Y1A0108	Avula Sri Sai Uttej	Excellent	Good	Good	Excellent	Excellent
6	159Y1A0109	Bande Guru Shareef	Good	Excellent	Excellent	Good	Good
7	159Y1A0110	Bandi Balasubramanyam	Good	Excellent	Good	Excellent	Excellent
8	159Y1A0111	Bellam Jayanth	Excellent	Excellent	Good	Excellent	Excellent

9	159Y1A0112	Bhavigadda Manjunath	Good	Good	Good	Excellent	Excellent
10	159Y1A0113	Bhupathi Venkata Naga Viharika	Excellent	Good	Good	Good	Excellent
11	159Y1A0117	Budamagunta Venkata Sai Tharun Teja	Excellent	Excellent	Excellent	Excellent	Satisfactory
12	159Y1A0118	Bukke Krishna Naik	Excellent	Excellent	Excellent	Good	Excellent
13	159Y1A0119	Busam Divya Swarup	Good	Good	Good	Excellent	Excellent
14	159Y1A0121	Challa Sumanth Kumar Reddy	Excellent	Excellent	Excellent	Excellent	Excellent
15	159Y1A0122	Challa Venkata Prasad	Excellent	Excellent	Good	Good	Excellent
16	159Y1A0123	Cheemalapenta Sumanth	Excellent	Good	Excellent	Excellent	Good
17	159Y1A0124	Chennabusigalla Kesava	Satisfactory	Good	Good	Excellent	Excellent
18	159Y1A0125	Chinta Naveen Kumar	Excellent	Excellent	Excellent	Excellent	Excellent
19	159Y1A0132	Eerabbi Chandra Mohan	Excellent	Excellent	Good	Good	Excellent
20	159Y1A0133	G Venkatesh	Excellent	Good	Excellent	Excellent	Good
21	159Y1A0134	Gadde Deepak Suryathej	Excellent	Excellent	Excellent	Satisfactory	Excellent
22	159Y1A0135	Gandham Sravan Kumar	Excellent	Excellent	Good	Excellent	Excellent
23	159Y1A0136	Gangavaram Kondaka Keerthi	Good	Good	Excellent	Excellent	Good

24	159Y1A0137	Garudaiah Gari Shashidhar Reddy	Excellent	Excellent	Excellent	Excellent	Excellent
25	159Y1A0138	Gatipati Suresh	Excellent	Good	Good	Excellent	Good
26	159Y1A0139	Girigittala Mohammed Ayaz	Good	Excellent	Excellent	Good	Excellent
27	159Y1A0140	Gogula Krishna Vamsi	Good	Good	Good	Excellent	Excellent
28	159Y1A0144	Gopavaram Rajasekhar	Excellent	Excellent	Good	Good	Excellent
29	159Y1A0145	Gorla Rajapaul Moses	Excellent	Excellent	Excellent	Excellent	Satisfactory
30	159Y1A0146	Gorla Sunilkumar	Good	Excellent	Excellent	Good	Excellent
31	159Y1A0148	Guggulla Prakash Kumar Reddy	Excellent	Good	Good	Excellent	Excellent
32	159Y1A0150	Gurrampati Sai Kumar Reddy	Good	Excellent	Excellent	Excellent	Excellent
33	159Y1A0151	Guvvala Himabindu	Excellent	Excellent	Good	Good	Excellent
34	159Y1A0152	Jalagadugu Venkata Srikar Datta	Good	Good	Excellent	Excellent	Good
35	159Y1A0153	Jollu Nagendra	Excellent	Excellent	Excellent	Excellent	Good
36	159Y1A0154	Jyothi Paul Vinay Kumar	Excellent	Excellent	Good	Good	Excellent
37	159Y1A0156	Kamatham Anilkumar	Excellent	Good	Excellent	Good	Excellent
38	159Y1A0157	Kamatham Sai	Excellent	Good	Excellent	Good	Excellent

39	159Y1A0159	Kandukuri Bhavya	Good	Excellent	Excellent	Excellent	Excellent
40	159Y1A0160	Kandukuri Chandra Sekhar	Excellent	Excellent	Excellent	Excellent	Good
41	159Y1A0161	Karnati Basireddygari Phanindra Reddy	Excellent	Excellent	Excellent	Good	Excellent
42	159Y1A0162	Kasireddy Rajeshkumarreddy	Good	Excellent	Excellent	Excellent	Excellent
43	159Y1A0163	Katari Leelakrishna	Excellent	Good	Good	Excellent	Good
44	159Y1A0164	Katta Bhargavi	Good	Good	Excellent	Excellent	Excellent
45	159Y1A0165	Kaveti Syam Sai	Good	Excellent	Excellent	Excellent	Good
46	159Y1A0166	Killola Mahesh	Excellent	Excellent	Excellent	Good	Good
47	159Y1A0167	Kollu Guru Mohan	Excellent	Excellent	Excellent	Good	Excellent
48	159Y1A0177	Lingampalli Naveen Kumar	Excellent	Good	Good	Excellent	Excellent

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From: 08/10/2018 to 27/10/2018

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Building Information Modeling

CHAPTER 2

BIM Implementation Strategies

Even if you're on the right track, you'll get run over if you just sit there.

—Will Rogers

Implementing building information modeling is much more of a business decision than a technical one. BIM is an enabling technology with the potential for improving communication among business partners, improving the quality of information available for decision making, improving the quality of services delivered, reducing cycle time, and reducing cost at every stage in the life cycle of a building. But while it opens the door to these possibilities, it does not make them happen. The technology must be deployed as part of a comprehensive business strategy in order to be successful. Many business processes and workflows must change to take full advantage of the technology.

Maintaining or enhancing one's competitiveness in the marketplace, or streamlining one's business operations, are among the reasons most commonly cited by business leaders for implementing BIM. These are perfectly valid business reasons, but when questioned, few business leaders can articulate a coherent strategy for how building information modeling will enhance their competitiveness or streamline their operations. Many fall back on a desire not to be perceived as lagging behind a growing and inevitable trend.

For many business owners and senior managers throughout the building industry, the key decision in their BIM implementation strategy is which software application to buy, and the key criterion for selection is "what everyone else is using." This is followed by decisions about the number of software licenses to purchase and the number of staff members to send to training. Too often, these three things define an organization's entire BIM implementation strategy. This is a legacy of the CAD era, in which a deep-seated aversion to risk and inexperience with the novel technology made following the herd appealing. In building design as in finance, no one ever got fired for following the market. But just as a conservative investment strategy yields only marginal returns, the conservative technology strategy of design firms in the CAD era yielded only marginal gains in innovation.

These are troubling business phenomena. In any realm of decision making other than technology, the same business leaders would consider the allocation of significant capital resources in the absence of a clearly defined business strategy highly irresponsible. They would not be likely to put the selection of a single product or service at the center of a comprehensive business strategy, nor would the popularity of a product among their competitors figure highly among their selection criteria. Successful business leaders develop business strategies to *distinguish* their companies from their competition. They examine their business needs and select products and services that meet those needs. They conduct cost/benefit analyses to assure themselves that the investment will result in increased revenue and profit. They establish performance metrics and closely monitor the return on their investment to determine whether it is yielding the forecasted results. They use the knowledge gained from measuring performance to adjust their strategy or to make better investment decisions in the future.

All too often in the building industry, investments in information technology seem to get a "pass" on this type of due diligence. This is a legacy of a business culture, now a generation old, that viewed technology in much the same way scientists view research in basic science—the pursuit of knowledge for its own sake, with no expectation of a practical result—but without the accompanying rigor of the scientific method, which requires that assumptions be documented and results compared to those assumptions.

LEAVING THE CAD ERA BEHIND

Because of our lack of due diligence and the absence of statistical data about the impact of technology on the building industry, we know frighteningly little about the impact that information technology has had on the industry over the last twenty or thirty years. This undisciplined approach to technology deployment in the building industry must change, if for no other reason than that we have failed to achieve the productivity gains realized in other industries over the same period. And it is becoming increasingly clear that the companies harvesting the most significant gains from their implementation of BIM are those that have exercised due diligence in their BIM implementation strategies. If the gains these firms have achieved are to be realized by the industry as a whole, companies throughout the industry will have to make decisions about BIM with the same rigor and discipline.

BIM is a technology that affects business processes beyond drafting and well beyond the organizational boundaries of design firms. The full potential of the technology cannot be realized with a narrow focus on the technology. The cost of software and training, while not insignificant, is incidental when compared to the potential impact on your organization's profitability resulting from other aspects of BIM.

Software is a consumable commodity, not a capital investment. It is of value only to the extent that it enables your organization to fulfill its mission. We can safely anticipate that software technology will change. The cost of training is an ongoing operational expense, not a strategic investment. Within the scope of a comprehensive BIM implementation strategy, software selection and training decisions must be made in the context of broader business objectives.

For a BIM implementation strategy to be fully effective, software training must be preceded by, or at least accompanied by, education. Training teaches people how to do. Education teaches people how to think. Employees trained to use a BIM application will learn how to perform tasks, not how to improve or change business processes, which only business leaders can do. An effective (and documented) BIM implementation strategy is necessary to provide the framework for an effective BIM training program.

A SYSTEMS APPROACH TO BIM IMPLEMENTATION

Business owners need to be able to perceive tangible benefits to changing internal business processes before they will make the investment to implement those changes. They also need to be able to recognize tangible benefits to changing the nature of their business relationships with business partners and clients. Whenever business owners are able to perceive such benefits clearly, BIM tends to foster rapid change, and institutional, legal, or cultural obstacles are easily overcome. On the other hand, when business owners are unable to connect BIM implementation to clear business goals, change tends to occur slowly or not at all, and the obstacles seem insurmountable. The most effective BIM implementation strategies are those based on a thoughtful review of an organization's business processes and workflow, both internally and externally. The focus is not on how to adapt the workflow to suit the technology, but rather on how to exploit the technology to improve the workflow.

The key to any successful BIM implementation is recognizing that an organization's internal business processes—whether it is a design, construction, or property ownership enterprise—are part of a *system,* and that building information created by anyone in the system is of potential value to anyone else in the system. This does not mean, as is so often asserted, that one party must assume the responsibility or bear the risk and cost of creating, compiling, or maintaining a comprehensive building information model for the benefit of someone else. In order for building information models to be sustainable throughout the life cycle of a building, they must be created and maintained on a sustainable business model, with a clear value proposition between the creators and hosts of the model and the beneficiaries of the information contained within it.

AVOIDING IDEOLOGICAL PITFALLS

A systems approach to building information modeling should not be confused with the notion of a single building information model. Implementing BIM does not mean that all of the information about a building must be compiled into a single data file, reside in a single physical location, or be maintained by a single business entity throughout the life cycle of a building. The notion of a comprehensive life cycle building information model—while conceptually appealing—is problematic from a business point of view. Often cited as one of the primary goals of a BIM implementation strategy, the single building model is beyond the reach of any end user today for the same reason that it has been out of reach for thirty years: neither the technology nor the market conditions needed to support it exist. To the best of our knowledge, not one viable comprehensive building information model residing within a single data file has ever been created.

No commercially available software application or technology platform is capable of containing all of the information created about a building throughout its useful life and making it accessible to appropriate stakeholders in real time on demand. More significantly, *none is in development.* The unmistakable trend in building information modeling software development is toward distributed building information models created by highly specialized software tools *that are designed to work together.* A number of factors may have contributed to this trend:

- The entire building life cycle of business processes and workflows is too complex to be modeled effectively within a single software application.
- Business processes and workflows vary too much across the industry and across the building life cycle to fit neatly within a single workflow paradigm.
- Working within a single building model environment requires too great a change of existing information-management infrastructure and business processes to support viable migration paths from existing workflows to new ones.
- The cost and technical challenges of developing a software application capable of meeting the needs of all users throughout the life cycle of a building are prohibitive.

Consider, for example, the specific use case of an architect and a structural engineer collaborating on the design of a building. A single software application that included all of the functionality needed for both architectural and structural design would be extremely unwieldy. Only a portion of the available functionality would be of use to either the architect or the engineer, but each would be burdened with a more complex user interface. Neither would be willing to pay for the functionality that neither is likely to use. An additional layer of complexity would have to be added to allow each party to maintain responsible control over the information that each party creates. The added complexity of the user interface and the increased IT burden of managing access to the data by multiple parties would likely erode any efficiency gained from the single building model environment. Complexity, cost, and functional inefficiency increase exponentially as other disciplines are added to the mix.

While statistical data about BIM implementation of any type is hard to come by, the case studies of "successful" BIM implementation that have emerged thus far reveal that the data for a typical BIM project is a compilation of distributed models created and analyzed using a suite of specialized BIM tools. The paradigm of "standardizing" on a particular BIM application or platform is becoming less and less important.

ALIGNING A BIM IMPLEMENTATION STRATEGY WITH TECHNOLOGY TRENDS

It is important for business leaders to understand and adapt their BIM implementation strategies with the evolving state of the available technology. In lieu of developing tools to create and sustain a single building information model, software developers are creating tools that allow each player in the building life cycle—particularly in the design and construction phases—to work within their own modeling environments and periodically combine file-based models for collaborative work or comparative analysis. This growing trend in BIM-related software development is now firmly established and can be expected to continue, for all of the reasons cited above.

It is also important for business leaders to recognize that the building industry is only in the very early years of an era of unprecedented innovation and experimentation that is only partly driven by technology. We are witnessing the emergence of many different ideas and technologies, some of which will work better than others. If this new culture of innovation and knowledge sharing can be sustained long enough, the most useful technologies will have time to mature and the best industry practices will spread rapidly.

The failure of the single building information model concept to gain traction, for example, is not necessarily a bad thing. Its full implementation would have required the wholesale disruption of existing business practices, processes, organizational structures, contractual relationships, and even individual work habits. Any technology that requires such a complete break with the status quo has a high probability of failure, regardless of its merits. It's simply unrealistic to expect that a large and highly fragmented industry can adapt to such wholesale change on so many fronts all at once. In hindsight, it is a good thing that the industry did not lock onto this entirely new business paradigm based on an entirely new technology without having had the opportunity to test and adapt it under real-world conditions. Whether by chance or intention, the industry has managed to sidestep the early ideological goal while still advancing the development and implementation of the underlying core technology.

The emerging distributed building information model paradigm allows for a more flexible and orderly integration of new technology without requiring an immediate and wholesale reordering of our entire business culture. It allows business partners to test different business practices and workflows, gain insight from their experiences, and modify their approach in a continuous cycle of innovation. It allows individual business owners to adapt their internal business practices, workflows, and technology at their own pace. Across the industry, it allows for a great deal of experimentation to take place and for a variety of business models to emerge to suit particular markets or individual circumstances, enabling both technology and business practices to develop organically. Finally, the distributed information model paradigm fosters greater market demand for interoperability—the seamless, reliable exchange of digital data—which in turn creates the market conditions for a greater array of specialized software tools.

ASSESSING FUNDAMENTAL RISKS

Though innovation is fraught with risk, the risk of implementing BIM technology is far lower than the risk of implementing CAD technology a generation ago, because it is much easier to align available BIM technologies with an organization's internal business processes and core competencies and measure the results. The transition from paper to CAD was largely a leap of faith—even in hindsight, the return on the investment is almost impossible to measure. Early adopters of BIM technology, however, are finding the benefits of BIM much easier to quantify and are realizing very substantial early gains. The rapid payback lowers risk, which fosters still greater innovation. The sooner an organization can recoup its investment on a particular BIM technology, the sooner it is free to explore other technologies. The days of being "locked into" one software tool or one software platform are over. Even the most risk-averse business leaders can comfortably exploit BIM technology to their competitive business advantage.

FOSTERING A CULTURE OF INFORMATION STEWARDSHIP

The trend in BIM technology suggests that the most viable and flexible business strategy to BIM implementation is one that emphasizes the value of information exchange to support business processes (*modeling*) over the artifact that results from those processes *(the model)*. Most participants in the building life cycle—even very experienced and knowledgeable professionals—have only a rudimentary understanding of the business activities that precede and follow their own. This is unlikely to change. We simply can't expect everyone involved in the life cycle of a building to know everything about that building, including its past and its future. We can, however, expect all those involved to develop a better appreciation of how their activities fit into and affect others throughout the life cycle.

In biological ecosystems, the many organisms that make up an ecosystem have little or no knowledge of how their behavior affects other organisms, and no understanding at all of how the entire ecosystem functions. Yet ecosystems as a whole can exhibit a very high degree of complexity, efficiency, and even apparent intelligence. Biological organisms interact with one another largely through their environment; the behavior of one organism has consequences that affect the behavior of other organisms, and the "work product" of one organism becomes a "found resource" for others. This is a form of information exchange, even though there may be no direct or conscious communication between organisms—each organism behaves autonomously in response to purely external stimuli.

The level of consciousness that we need in the building industry is only slightly higher, requiring no more than a general awareness that information created by one person may be useful to another. It isn't necessary, or even practical, to expect everyone in the building industry to understand everyone else's business processes and to anticipate just how the information they create might be used, when, and by whom. A strategy that depends on such profound understanding of the entire building life cycle by all participants in the life cycle is doomed to fail. What is important, rather, is that anyone involved in any part of the lifecycle of a building—from the geotechnical engineer analyzing a building site to the renovation or demolition contractor—recognize that the tasks they perform and the information they create are a small part of a very long sequence or cycle of tasks. Anyone can readily understand and appreciate that any building information they create might be of value to someone else for some other purpose, even if they have no idea exactly how, when, why, or by whom. Systems-minded building industry professionals regard the information they create with an attitude of *stewardship* rather than *ownership.* They are mindful that their possession of the information is temporary and that it is of potential value to someone else after it is no longer useful to them. They organize, compile, and maintain information in the most structured, integrated, and accessible manner possible. They view information as a tangible asset and a living resource.

Biological ecosystems are useful as a metaphor in yet one more way with significant implications for addressing issues of liability in the building industry: each organism is solely responsible for how it uses the resources it finds in its environment. Every available resource in the environment is accepted "as is" by all organisms, and is evaluated solely for its usefulness. Its original source is irrelevant. The organism that may have left that resource behind is not held accountable for it.

Cultivating a business environment of information stewardship is possible without disrupting any existing business processes or operations, assuming any new risks, or changing any existing business relationships. It can generate benefits that are purely internal to an organization. It can begin well before a company begins using any BIM technology. It is fundamentally about getting one's own house in order. An attitude of *information stewardship* manifests itself in effective *information management,* a necessary prerequisite to effective *information modeling.* As more and more industry professionals gain a greater understanding of the value of building information created throughout the life cycle of a building—and learn to manage their own information accordingly—more and more will be able and willing to engage in value-added information exchange.

MANAGING CULTURE CHANGE

For a BIM implementation strategy to succeed, it must be accompanied by a corresponding cultural transformation strategy. Cultural transformation is a greater challenge to the industry than any technological transformation resulting from BIM. It will require that building industry business partners regard one another differently than they do today—as true partners and collaborators with a mutual interest in a successful outcome, rather than as adversaries and potential future litigants. It will require that the industry reach beyond technology and business practices to alter the prevailing legal framework, particularly with respect to dispute resolution. Some newly emerging model contractual agreements contain the novel provision that the parties explicitly agree not to sue each other. Instead, the parties agree to work together to identify problems and correct them. The potential impact of these changes on the way we do business is simply enormous. The amount of time now spent by various team members documenting their own actions as a bulwark against possible future legal action—a no-value task, as far as the project itself is concerned—can be shifted toward completing the project in the most expeditious manner possible.

A greater climate of trust among business partners is frequently cited as a feature of the new business climate for integrated project delivery (IPD) using building information modeling. While the intensive collaboration inherent in IPD does indeed heighten the value of trust in business relationships—which makes the careful selection of business partners far more important—it would be naïve to think that complex business relationships can be built entirely on trust or that project team members always will be able to pick and choose the other members of the team. There will always be project teams made up of team members who have never worked together or do not know each other. There will always be project team members who turn out to be unscrupulous or incompetent, who fail to act in good faith, or who seek to protect their own interests at the expense of others.

In other sectors of the economy, an environment of trust is strongly supported by "trust but verify" mechanisms. The entire worldwide banking system depends heavily on trust. Not a single bank is capable of surviving the sudden demand of its depositors for all of their assets, because the vast majority of those assets are loaned out to others to generate revenue for the bank. When a bank fails, there may be little difference between its balance sheet and the balance sheet of a competing, "healthy" bank. A principal cause of bank failure is a loss of trust.

The quixotic element of trust that holds up the entire banking system is supported by robust banking regulation and partial guarantees in the form of government-backed deposit insurance. Though the analogy to banking is imperfect, business leaders in the building industry need to employ comparable trust-building mechanisms to bolster the trust between business partners. The new business culture then becomes a self-sustaining ecosystem that continuously seeks equilibrium, with players who are unable to meet the industry's high standards for trust and quality performance routinely getting squeezed out.

USING TECHNOLOGY TO BUILD TRUST AND MITIGATE RISK

In the existing building industry business climate—particularly in the building design and construction stages—the transfer of information from one party to another poses considerable risk for the author of the information. The sending party may be held accountable for the quality, completeness, and accuracy of any information they transmit, regardless of their degree of responsible control. At the opposite end of the risk scale is "no fault" information transfer. In a biological ecosystem, for example, each organism accepts the outcome of another organism's behavior as a "found" natural resource; the receiving organism is solely responsible and liable for how it uses the resource.

Between these two extremes, the Internet is a useful model for the future building industry information stewardship culture. One can find a great deal of information on the Internet, but the quality of the available information varies widely. As information consumers, each of us is responsible for validating the "found" information and assessing the risk of using it. Validation consists of two parts: determining whether the information is from a trusted source and confirming the integrity of the information itself. Integrity is assured by comparing the content against a reliable database and testing the digital data format to ensure that it is not corrupted. Some of the BIM audit and analysis tools discussed in Chapter 1 can be characterized as "data validation" tools. We can expect to see an increase in the number of offerings in this software market segment as the volume of BIM data available for analysis grows.

The ability of information recipients to validate data will shift responsibility for data integrity from authors only to both authors and recipients, while lowering the risk for both. Design professionals will be able to conduct more rigorous analyses of their designs to minimize or eliminate errors and omissions, while building owners and constructors—who will have the same access to clash detection and other data validation tools—will be held accountable for detecting errors and omissions before they result in a financial loss. This is one way in which the technology will help shift the current adversarial business climate toward a more collaborative one, simply by improving the quality of building information available.

The current reflexive response to errors or problems—to identify the responsible party and assign blame—will shift toward an environment where project team members will work collaboratively to identify mistakes early and correct them promptly. Economic imperatives, not altruism, will drive this transformation. Getting the project completed well as quickly as possible will become more important than pointing fingers and collecting damages.

A culture of information stewardship and frequent information exchange also results in much greater transparency. When every team member has access to the same information in real time, it becomes clear to everyone who is responsible for what, which team members are meeting their obligations, and where bottlenecks are occurring and why. It will become far more difficult for team members skilled in generating mountains of obfuscatory, finger-pointing paperwork to gain an edge over another team member. In a collaborative environment of information exchange, it is not just the emperor but his entire court that has no clothes. BIM, information stewardship, and information management are three interdependent components of a single integrated technology and business process.

MAINTAINING DATA EXCHANGE CAPABILITIES

An initial step toward greater information stewardship in any organization is an assessment of existing information storage, retrieval, and exchange capabilities. The more flexibly information can be exchanged, the greater the likelihood that it can be preserved in a useful form for the long term. A whole range of data exchange and storage options already exist. For example, many building design

Table 2.1 IFC Software Compliance Chart.

Application Name	Release
Active3D	4.2
Allplan	2006.2 / 2008
ArchiCad	10 / 11
AutoCAD Architecture 2008	2008 SP1
Bentley Architecture	8.5.3 / 8.9.4
Bentley Building Electrical Systems	8.5.3 / 8.9.4
Bentley Building Mechanical Systems	8.5.3 / 8.9.4
Bentley Structural	8.5.3 / 8.9.4
Bocad-3d	
DDS IfcViewer	
DDS-CAD Building	
DDS-CAD Electrical	
DDS-CAD HVAC	
DDS-CAD MEP	6.4
DDS-CAD Plumbing	
EDMdeveloperSeat™ Basic	
EDMdeveloperSeat™ Professional	
EDMmodelConverter™	
EDMmodelMigrator™	
EDMServer™	4.5
EliteCAD	11 Sp1
Facility Online	3.51
Ifc Engine Viewer	
IfcObjCounter	2.91
IfcStoreyView	2.1
IfcViewer	2
IfcWalkThrough	2.1
IfcXMLKonverter	1
MagiCAD	
Revit Build 2008	2008 SP1
SCIA-ESAPT	2001
Solibri Model Checker	4.2
Solibri Model Viewer	
Tekla Structures Precast Concrete Detailing	13
Tekla Structures Standard Design	13
Tekla Structures Steel Detailing	13
Vectorworks	2008 SP2
Vizelia IFC-VRML Viewer	

Source: National Institute of Building Sciences (NIBS)

software applications support open-standard data formats such as the Industry Foundation Classes (IFCs) of buildingSMART International (see Chapter 3), but many licensees don't know it, or have never attempted to use the IFC data format to exchange project data, and even fewer have used it as a standard data storage medium. Table 2.1 shows a list of applications that have been certified as compliant with IFC release 2x3 as of September 2008. More are continually being certified. An open certification process, in and of itself, results in greater insight and knowledge about interoperability. Shortcomings were identified in the initial process, which will be corrected in support of an improved process for future releases. For an up-to-date list of IFC-compliant applications, go to www.iai.hm.edu/ifc-compliant-software.

Even if a firm is unable to use IFCs to exchange information for its immediate business processes, routinely archiving building information data files in both their native formats and in IFC format can help ensure accessibility of the data long after the original data files can no longer be accessed because of file format changes in the original software. Additionally, nearly all software applications allow users to save data files in one or more proprietary data formats other than the native file format. While some of the original data may be lost when these "Save As" and "Import/Export" features are used, an audit of the data exchange capabilities of a firm's existing software applications can reveal the extent to which existing software tools will support at least some degree of interoperability. In some cases, the "dumbing down" of the data that occurs with these types of data conversions may be turned to a firm's advantage by helping protect against undetectable alteration of the original data files. A firm also may discover that, in addition to increasing its options for data exchange with business partners, these capabilities can be exploited for internal information exchanges between a firm's own design or business software applications.

Data exchange capabilities, both open standard and proprietary already exist in many software applications. Making effective use of this technology—which software licensees have already paid for—requires little more than exploring and testing the capabilities of existing software.

A second element of responsible information stewardship is maintaining rigorous data creation, filing, and archiving protocols. Well documented processes are the key to making them work. If the procedures and protocols are not documented, they will occur haphazardly, if at all. Enhancing a firm's exchange capabilities could be as simple as developing consistent procedures for file naming, data storage, data indexing, and data archiving so that information can be easily retrieved and validated. Most data files have searchable metadata tags (the file "properties") that are very valuable for data management but are rarely used. (Metadata is discussed in greater detail in Chapter 6.)

Some firms are successful in enforcing file naming, filing, and archiving conventions through standard operating procedures, but it is an unmanageable problem for many firms, as it depends on consistent human behavior. Software tools designed to enforce data nomenclature rules have long been available. More recently, enterprise-wide information-management software applications such as Newforma Project Center have emerged with full-text indexing and search capabilities for all file types, including e-mail, CAD, and BIM files, providing far greater "intelligent" access to proprietary data than previously possible. As a prerequisite to BIM implementation or as a strategic business goal in its own right, improved information management is likely to generate significant early returns in client service and employee productivity—without the significant investment in software and training for deploying new BIM technology.

The immediate business benefit of such simple steps is enhanced access to your organization's own information. You may discover that you have the ability to exchange information internally among different software applications that you did not previously know, or that information created for previous projects may now be exploited more effectively for future projects. Improved information management also may provide better protection against data loss and enhance business continuity. Finally, an increased awareness of the challenges of data exchange may enable you to articulate your data exchange needs more clearly to your software providers. The role of such feedback in the advancement of technology should not be underestimated.

A third step in implementing a systems approach to information management and inculcating an attitude of information stewardship is to initiate a dialogue within your organization about business processes, data sets, data formats, data validation, and electronic information exchange. Workflow and information flow within organizations are often horribly inefficient, inconsistent, and more difficult to change than external business processes, because they often involve requiring key people in the organization to change longstanding patterns of inefficient behavior. Your organization's data exchange capabilities with external business partners will improve dramatically if you begin by identifying opportunities for improved *internal* workflow and information exchanges, whether electronic or otherwise. Focus on eliminating redundant or repetitive processes. Conduct pilot information exchanges to compare and validate electronic information against traditional information exchange methods. Identify information exchange and workflow gaps and develop strategies for closing them. The knowledge you gain by improving internal workflow and information exchange, in addition to making your organization more efficient, will be invaluable for improving external exchanges.

ASSESSING TEAM CAPABILITIES

An organizational assessment of information management capabilities can be accompanied, or followed by, a collaborative assessment of the information management and information exchange capabilities of business partners. Project teams regularly form and dissolve, so the degree to which a collaborative assessment can occur and new business processes implemented may vary. But even the briefest business relationships can benefit from a regular dialogue about streamlining business practices.

A good basis for this joint effort is determining which party is the best authoritative source for a particular piece of information, and what pieces of information each authoritative source needs to provide to others to enable those third parties to perform their tasks. Each team member should analyze what it does, what information it handles, and whether it is the optimum "responsible party" for that information.

This dialogue begins informally and gradually becomes more structured and intensive as the size and complexity of the information to be exchanged increase. The scope of the dialogue might include:

- New types of building information a team member may be able to share that might be useful to others
- Which types of information, if provided by others, could help a team member perform its functions better
- How information is used in each team member's business processes and how it flows through their business systems
- Opportunities for frequent, "intermediate" information exchanges that might reduce or eliminate the number of low-value data entry tasks performed by team members
- Opportunities to eliminate overlaps or redundancies
- Information exchanges that might accelerate iterative workflow cycles

In the planning and design stages of a building project, in particular, a great deal of information that might be useful by other team members for preliminary decision making, comparative analysis, or iterative design purposes is withheld due to liability concerns or fear that it will be inadvertently incorporated into the final design. The problem is one of agreement as to the nature, quality, and appropriate use of such preliminary exchanges, and can be negotiated. For information in this category, project teams can execute a series of carefully circumscribed pilot data exchanges. As team members develop confidence in their mutual understanding of the data, they can expand the scope of such "no fault" exchanges, backed up, if necessary, by mutual indemnification agreements.

MANAGING EXPECTATIONS

Any change in business practice must be accompanied by an equitable adjustment in risk, accountability, and compensation. For example, one of the potential benefits of exchanging BIM data between an architect and a contractor is a reduction in the time needed for quantity takeoffs. But an architect might be reluctant to share the building information model for this purpose, out of concern that a building information model might be sufficiently complete to convey design intent but not sufficiently detailed or complete for quantity takeoff purposes. At the end of the construction period, an as-built BIM model is of considerable potential value to the building owner for facility management, real asset management, and operations-related purposes. But the owner and constructor or design-build team might have a different understanding of the degree to which the "as built" model represents real-world conditions, and that gap in understanding may represent an unacceptable risk to the builder.

It is not hard to imagine scenarios in which legitimate differences in understanding could lead to disputes and litigation. All parties involved with a building can agree that any information created about that building is useful to others and should be conserved, but it is extremely important that the parties have an explicit understanding regarding the scope, completeness, precision, accuracy, and appropriate use of any information exchanged. When information exchanges take place at significant milestones in the building lifecycle—when the active role of an information author ends—provisions must be agreed upon to indemnify the authoring party for any losses that may occur as a result of the inappropriate use or inappropriate reliance on the information transferred, which is no longer within the author's responsible control.

It is perfectly reasonable for the parties to a "milestone exchange" to agree to certain qualitative and quantitative standards for the information to be transferred, provided that the authoring party is appropriately compensated for any additional effort required to meet those standards that exceeds the original information needs of the authoring party or the original agreement between the parties. The best time to reach this agreement is at the time of the original agreement between the parties, so that information can be most efficiently gathered, updated, and conserved during the original process for which it was created. Too often, this issue is addressed in agreements only in the most cursory manner, requiring the authoring party to convey "a building information model" with no explicit understanding as to what the content of the model will be. If the parties are unable to define the content of the model at the time of the original agreement, then the principle of "no fault" transfer of "found" information should prevail, and the receiving party should indemnify and hold harmless the authoring party for any use of the information beyond its originally intended purpose.

Authoring parties also may be concerned about suddenly assuming responsibility and liability for information that historically has been the responsibility of others. In our first example, an architect might understandably have concern that a contractor will rely on the model—and hold the architect accountable for—material quantities. This would increase the liability of the architect for information that has been, historically and appropriately, the responsibility of the contractor. The transfer of this information from the architect to the contractor—intended to make the contractor's job easier—should not result in increased liability to the architect.

The fundamental dilemma is one of information assurance, except that in this case, it is not merely about the integrity of the electronic data or the verification of the data against an objective standard. Rather, it is about the core realms of expertise of the two parties, and who is best qualified to create which information. The resolution of this dilemma points strongly in the direction of early collaboration of the design and construction team. The constructor needs to impart enough construction knowledge to the architect to enable the architect to prepare a building information model suitable for quantity takeoff purposes, or the parties need to agree to a handoff of "responsible control" of the model at some appropriate interval (and with appropriate indemnification) so that the constructor can add quantity takeoff information to the architect's design intent model. Innovative early adopters are testing both methods.

As with any innovation, pilot testing is an important component in developing mutual information assurance. For example, an architect and a contractor could agree to an initial takeoff exercise in which a quantity takeoff of the building information model is completed independently of a quantity takeoff completed by conventional methods. The purpose of the exercise is to help both the architect and contractor gain greater insight into how to modify their modeling and business processes so that they both have confidence that the type and quality of information generated from the model is suitable for quantity takeoff purposes. The overriding goal is to streamline business processes across organizational boundaries and to enhance the profitability of both organizations. The business arrangements between the parties might subsequently be modified to compensate the architect for any additional effort required to create a richer information model, to enable the contractor to participate in the development of the model, or for both parties to share in the costs and benefits of jointly developing the model. Any change in business practice would be accompanied by appropriate indemnifications to ensure that neither party assumes any new, uncompensated, or inappropriate risks.

MEASURING PROGRESS TOWARD STRATEGIC GOALS

There is always an element of the unknown to the deployment of new technologies. Metrics can be difficult to establish for the deployment of a technology such as BIM that involves business relationships, enterprise workflow, project delivery methods, staff skill and training, and the design process. It is still possible, however, to establish goals and define objective metrics for measuring progress in BIM implementation. Not all goals and metrics can be expressed in dollars and cents, but they almost always can be quantified in some way that can be tied, at least indirectly, to the bottom line. The stronger the connection between an organization's BIM implementation strategy and profitability, the better the results of the BIM implementation are likely to be.

The Capability Maturity Model (CMM) of the National Building Information Modeling Standard (NBIMS)[1] is a good first step toward establishing BIM implementation benchmarks (see Table 2.2). The NBIMS CMM[2] is designed to measure the "maturity" of a building information model and the processes used to create it.

The use of the word *model* is an unfortunate choice of term here, adding yet another shade of meaning to a word that is already overused in this context. The term is borrowed from the software industry. It was originally developed in 1986 by the Carnegie Mellon Software Engineering Institute (SEI)[3], a federally funded research and development center, as a compendium of principles and practices for assessing the ability of government contractors to perform a contracted software project. The CCM concept has since been applied to related disciplines and activities such as software engineering, system engineering, project management, software maintenance, risk management, system acquisition, information technology (IT), and personnel management, and through NBIMS is now being applied to building information modeling.

To minimize confusion, the NBIMS CMM would be more aptly named the *Capability Maturity Index,* since that is what it truly is: an *index,* or benchmark, for measuring the *maturity* of your organization's BIM *capabilities.* It identifies eleven categories of maturity, each of which can be scored on a scale

Table 2.2 Capability Maturity Model.

Maturity Level	A Data Richness	B Life Cycle Views	C Roles or Disciplines	G Change Management (CM)	D Business process (BP)	F Timeliness/ Response	E Delivery Method	H Graphical Information	I Spatial Capability	J Information Accuracy	K Interoperability/ IFC Support
1	Basic Core Data	No Complete Project Phase	No Single Role Fully Supported	No CM Capability	Separate Processes Not Integrated	Most Response Info manually re-collected —Slow	Single Point Access No Information Assurance (IA)	Primarily Text[nd]No Technical Graphics	Not Spatially Located	No Ground Truth	No Interoperability
2	Expanded Data Set	Planning & Design	Only One Role Supported	Aware of CM	Few Business Processes Collect Info	Most Response Info manually re-collected	Single Point Access w/Limited IA	2-D Non-Intelligent As Designed	Basic Spatial Location	Initial Ground Truth	Forced Interoperability
3	Enhanced Data Set	Add Construction/ Supply	Two Roles Partially Supported	Aware of CM and Root Cause Analysis (RCA)	Some Bus Process Collect Info	Data Calls Not in BIM But Most Other Data Is	Network Access w/Basic IA	National CAD Standard (NCS) 2-D Non-Intelligent As Designed	Spatially Located	Limited Ground Truth—Int Spaces	Limited Interoperability
4	Data Plus Some Information	Includes Construction/ Supply	Two Roles Fully Supported	Aware CM, RCA and Feedback	Most Bus Processes Collect Info	Limited Response Info Available In BIM	Network Access w/Full IA	NCS 2-D Intelligent as Designed	Located w/ Limited Info Sharing	Full Ground Truth—Int Spaces	Limited Info Transfers between Commercial Off-the-Shelf (COTS) Software
5	Data Plus Expanded Information	Includes Constr/Supply & Fabrication	Partial Plan, Design, & Constr Supported	Implementing CM	All Business Process Collect Info	Most Response Info Available In BIM	Limited Web Enabled Services	NCS 2-D Intelligent As-Builts	Spatially located w/Metadata	Limited Ground Truth—Int & Ext	Most Info Transfers between COTS
6	Data w/Limited Authoritative Information	Add Limited Operations & Warranty	Plan, Design, & Construction Supported	Initial CM process implemented	Few BP Collect & Maintain Info	All Response Info Available In BIM	Full Web Enabled Services	NCS 2-D Intelligent And Current	Spatially located w/Full Info Share	Full Ground Truth—Int And Ext	Full Info Transfers between COTS
7	Data w/ Mostly Authoritative Information	Includes Operations & Warranty	Partial Ops & Sustainment Supported	CM process in place and early implementation of RCA	Some BP Collect & Maintain Info	All Response Info From BIM & Timely	Full Web Enabled Services w/IA	3-D—Intelligent Graphics	Part of a limited GIS	Limited Comp Areas & Ground Truth	Limited Info Uses IFC's For Interoperability
8	Completely Authoritative Information	Add Financial	Operations & Sustainment Supported	CM and RCA capability implemented and being used	All BP Collect & Maintain Info	Limited Real-Time Access From BIM	Web Enabled Services—Secure	3-D—Current and Intelligent	Part of a more complete GIS	Full Computed Areas & Ground Truth	Expanded Info Uses IFC's for Interoperability
9	Limited Knowledge Management	Full Facility Life Cycle Collection	All Facility Life-Cycle Roles Supported	Business processes are sustained by CM using RCA and Feedback loops	Some BP Collect & Maint In Real Time	Full Real Time Access From BIM	Netcentric Service Oriented Architecture (SOA) Based w/Common Access Card (CAC) Access	4-D—Add Time	Integrated into a complete GIS	Comp GT w/Limited Metrics	Most Info Uses IFC's for Interoperability
10	Full Knowledge Management	Supports External Efforts	Internal and External Roles Supported	Business processes are routinely sustained by CM, RCA and Feedback loops	All BP Collect & Maint in Real Time	Real Time Access w/ Live Feeds	Netcentric SOA Role Based CAC	nD—Time & Cost	Integrated into GIS w/Full Info Flow	Computed Ground Truth w/Full Metrics	All Info Uses IFC's for Interoperability

Source: National Institute of Building Sciences (NIBS)

of one to ten. Version 1 of NBIMS acknowledges that the scale values of the CMM are subjective and in need of further definition and refinement, but the eleven categories appear to address all of the relevant information management and development categories of a building information model. The scale values are useful even in their initial draft state of development, particularly if an organization defines the values more precisely for its own purposes.

In late 2007, the NBIMS Testing Team, led by Professor Tammy McCuen of the University of Oklahoma and Air Force Major Patrick Suermann, P.E., Rinker Scholar at the University of Florida, conducted a test of the NBIMS CMM by evaluating the BIM maturity of the 2007 American Institute of Architects (AIA) Technology in Architectural Practice (TAP) BIM Award winners. An important part of the test was to measure the variance in scores between individual evaluators independently scoring each project. The degree of variance would be an indicator of how consistently the CMM rating scale could be applied to the same project by different evaluators, and therefore, a measure of how useful the CMM could be to the industry as an objective measure of BIM maturity. Though refinements were made to the NBIMS CMM as a result of the exercise, the variance in scores did not exceed 5 percent in any instance, and frequently varied by no more than 1 or 2 percent.

The eleven NBIMS CMM categories and their summary descriptions are as follows.

Data Richness. Refers to the degree to which a building information model encompasses the available information about a building. The scale ranges from individual pieces of unrelated data to information that is sufficiently comprehensive and authoritative to be regarded as corporate knowledge (see Table 2.3).

Life Cycle Views. Refers to the degree to which a building information model can be viewed (and used) appropriately by any players throughout the building life cycle who may have need of the data to execute their responsibilities (see Table 2.4). The current scale presumes that building data originates in the planning and design phase of a building life cycle, and measures the number of available views cumulatively from early planning stages through facility management/operations, then beyond "building specific" professionals to real estate portfolio managers, business operations managers, and external users such as emergency first responders. The greater the number of life cycle views supported by a building information model, the less likely that building information will be redundantly entered into separate information-management or business-process systems. This category of maturity has enormous implications for building owners, because it measures the degree to which building information can be transformed into business information.

Table 2.3 Data Richness Capability Maturity Model, Detail View.

Maturity Level	Data Richness
1	Choose this selection when you have established a BIM, but have only very basic data to load.
2	As you become more advanced, additional data will be available and be entered. This is still early in the maturity.
3	At this point you are beginning to rely on the model for basic data.
4	This is the first stage when data is turned into information.
5	The data is beginning to be accepted as authoritative and the primary source.
6	Some metadata is stored and information is typically best available.
7	Most users rely on information as reliable and authoritative; little additional data checking is required.
8	The information has metadata and is the authoritative source.
9	Limited Knowledge Management implies that KM strategies are in place and authoritative information is beginning to be linked.
10	Full Knowledge Management implies a robust data-rich environment, with virtually all authoritative information loaded and linked together.

Source: National Institute of Building Sciences (NIBS)

Table 2.4 Life Cycle Views Capability Maturity Model, Detail View.

Maturity Level	Life Cycle Views
1	Data is gathered as it is available but no single phase is authoritative or complete.
2	Since basic initial data is collected during planning and design, this is typically the first phase to be made available, but can be any phase such as construction.
3	An additional phase is available, typically construction; however, the two phases do not necessarily need to be linked.
4	A third phase is added; although information does not have to be flowing, it is assumed that some is.
5	A forth phase of the facility life cycle is added and some information is flowing.
6	An additional phase is added and clearly information is flowing to operations from the design and construction phases.
7	Information collected during earlier phases is flowing to operations and sustainment.
8	A cost model is supported and costs are linked to the information related to al phases. Life cycle costing can be performed.
9	All phases of the life cycle are supported and information is flowing between phases.
10	External information is linked into the model and analysis can be performed on the entire ecosystem of the facility throughout its life.

Source: National Institute of Building Sciences (NIBS)

Table 2.5 Roles or Disciplines Capability Maturity Model, Detail View.

Maturity Level	Roles or Disciplines
1	Roles apply to people's jobs, and at this level no one's role is fully supported through the BIM.
2	Roles apply to people's jobs, and at this level there is one person's role that is fully supported through the BIM.
3	Roles apply to people's jobs, and at this level there are at least two people's roles that are partially supported through the BIM but they still have to go to other products to accomplish their jobs.
4	Roles apply to people's jobs and at this level there are at least two people's roles that are fully supported through the BIM in that they do not have to go to other products to accomplish their jobs.
5	People's jobs in planning and design are fully supported through the BIM in that they do not have to go to other products to accomplish their jobs.
6	People's jobs in planning, design, and construction are fully supported through the BIM in that they do not have to go to other products to accomplish their jobs.
7	People's jobs in planning, design, construction are fully supported and operations and sustainment are partially supported through the BIM in that they do not have to go to other products to accomplish their jobs.
8	People's jobs in planning, design, construction, and operations and sustainment are fully supported through the BIM in that they do not have to go to other products to accomplish their jobs.
9	All facility-related jobs throughout the life cycle of the facility rely solely on the BIM to accomplish their jobs.
10	All facility-related jobs both internal and external to the organization rely solely on the BIM to accomplish their jobs.

Source: National Institute of Building Sciences (NIBS)

Roles or Disciplines. Refers to the number of building-related roles or disciplines that are accommodated in the modeling environment, and thus is a measure of how well information can flow from one role or discipline to another (see Table 2.5). The scale recognizes that currently available modeling environments are unable to accommodate even one role or discipline fully. The lowest end of the scale is partial accommodation of a single discipline, rising incrementally up to an environment in which all building-related disciplines can rely on the building information model as the sole information resource to perform their jobs. Like the Life Cycle Views scale, this scale presumes that building data originates in the planning and design phase of a building life cycle, and measures the number of roles/disciplines supported cumulatively from early planning stages through facility management/operations.

Business Process. Refers to the degree to which business processes are designed and implemented to capture information routinely in the building

Table 2.6 Business Process Capability Maturity Model, Detail View.

Maturity Level	Business process
1	Business processes are not defined and therefore not used to store information in the BIM.
2	Few business processes are designed to collect information to maintain the BIM in the organization.
3	Some business processes are designed to collect information to maintain the BIM in the organization.
4	Most business processes are designed to collect information to maintain the BIM in the organization.
5	All business processes are designed to collect information as they are performed.
6	All business processes are designed to collect information as they are performed but few are capable of maintaining information in the BIM.
7	All business processes are designed to collect information as they are performed and some are capable of maintaining information in the BIM.
8	All business processes are designed to collect information as they are performed and all are capable of maintaining information in the BIM.
9	All business processes are designed to collect and some maintain data in real time.
10	All business processes are designed to collect and maintain data in real time.

Source: National Institute of Building Sciences (NIBS)

information model as an integral part of each business process (see Table 2.6). This is a key, long-term metric of progress in BIM implementation, one that should be a strategic focus of every BIM software company. Whenever information can be gathered as an integral part of a business process, the compilation of that information is achieved at no additional cost. Whenever data is compiled as a separate process, the cost is greater and resources are diverted from primary business processes, reducing the likelihood that the data compilation task will be completed consistently. Or to put it another way, any time you have to take time out of your day job to compile data for someone else to use, the chances that you will do it consistently, if at all, are slim. The scale ranges from "business processes undefined and not used to compile data" to "all business processes are designed to collect and maintain information in real time." The high end of the range is a very high standard of performance to achieve.

Change Management. Refers to the degree to which an organization has developed a documented methodology for changing its business processes (see Table 2.7). Whenever a business process is found to be flawed or in need of improvement, a formal, documented process is followed that begins with a "root cause analysis" followed by a modification of the business process based on the analysis. The scale ranges from "no evidence of documented change management" to an environment in which business processes are routinely

Table 2.7 Change Management Capability Maturity Model, Detail View.

Maturity Level	Change Management
1	No change management process awareness is evident, nor has it been implemented in the organization.
2	There is an early awareness of the need for business process definition and change management in the organization, although implementation is not yet initiated.
3	Early implementation of business process definition is underway, there is an early awareness of the need for business process definition, and there is an awareness of change management and the need for root cause analysis in the organization.
4	Business processes are in place and there is an understanding of the full change management requirement to include root cause analysis and implementation of a feedback loop.
5	Business processes are in place and the organization has begun implementing change management procedures.
6	Business processes are in place and early change management processes are identifying changes, but no process is in place to make changes.
7	Early implementation of change management is in place and some processes are being maintained through a root cause analysis process.
8	Implementation of a change management process is in place and is beginning to be exercised, but is not fully endorsed by all participants.
9	The change management processes are in place, but are not efficient, and changes typically take more than 48 hours.
10	A mature and fully operational change management process is in place and process changes are implemented within 48 hours.

Source: National Institute of Building Sciences (NIBS)

supported by an integrated change management process that includes root cause analysis and feedback loops to assess the effectiveness of the change.

Delivery Method. Refers to the robustness of the IT environment to support data exchange and information assurance (see Table 2.8). The scale ranges from "BIM is only accessible from a single workstation with no integral information assurance" to "BIM is in a netcentric Web environment, delivered as a service in a service-oriented architecture (SOA), with role-based Common Access Card (CAC) enabled to enter and access information."

Timeliness/Response. Measures the degree to which BIM information is sufficiently complete, up-to-date, and accessible to users throughout the life cycle (see Table 2.9). The scale ranges from "information is collected when needed to respond to a question" to "information is continually updated from live-feed sensors and accurately reflects real-world conditions; responses to questions are immediate and authoritative."

Table 2.8 Delivery Method Capability Maturity Model, Detail View.

Maturity Level	Delivery Method
1	The BIM is only accessible from a single workstation and has no information assurance built in.
2	The BIM is not on a network but there is control over who can access the BIM.
3	The BIM is on a network and there is basic password control over data entry and retrieval.
4	The BIM is on a network and there is control over data entry and retrieval.
5	The BIM is in a limited Web environment typically found in a single office environment; IA is not in place to control data entry or retrieval.
6	The BIM is Web enabled but IA is not in place, although there is some control to access of the information. This environment would be found in a single office/company.
7	The BIM is in a Web environment so multiple people can operate on it and there is role-based IA manually controlled.
8	The BIM is in a Web-enabled environment and is considered secure. It is not in an SOA.
9	The BIM is in a netcentric Web environment and is served up as a service in a service-oriented architecture and CAC enabled but roles must be managed manually.
10	The BIM is in a netcentric Web environment and is served up as a service in a service-oriented architecture with role-based CAC enabled to enter and access information.

Source: National Institute of Building Sciences (NIBS)

Graphical Information. Refers to the degree of sophistication or embodied intelligence of graphical information (see Table 2.10). The scale ranges from "no graphics in the BIM; text only" to "graphical information stored in the BIM is object-based, parametrically intelligent, and includes information related to time and cost."

Spatial Capability. Refers to the degree to which the building information model is spatially located in the real world according to Geographic Information Systems (GIS) standards (see Table 2.11). This metric has implications for users across the building life cycle, including energy design and analysis, authoritative coordination with public infrastructure such as water and other utilities, and timely response by emergency first responders. The scale ranges from "the facility is not spatially located" to "information from the BIM is fully recognized in the GIS environment, including support for full metadata interaction."

Information Accuracy. Measures the degree to which information reflects real-world conditions (see Table 2.12). The scale ranges from "no ground truth; information is loaded manually, not verified electronically" to "all spaces are

Table 2.9 Timeliness/Response Capability Maturity Model, Detail View.

Maturity Level	Timeliness/Response
1	Information is re-collected when needed to respond to a question—the process is slow and un-automated and has to be reinvented each time a question is asked.
2	Most of the information needed to respond to a question must be collected to respond to the question; however, there is awareness of how to obtain the information.
3	Most information is in the BIM; however, many responses to data calls involve collection of data, which is then stored in the BIM.
4	Information is stored in the BIM and many data calls can be answered with information that is already in the BIM.
5	A significant portion of the response information related to a facility is stored in the BIM.
6	Responses to data calls related to the facility are primarily stored in the BIM.
7	All emergency response information is in the BIM and that is considered the primary source of accurate information.
8	Information stored in a BIM is available real time and although not from a live feed. Processes are in place to maintain its accuracy.
9	The information is stored in a BIM and is current enough to be a reliable source for information in an emergency.
10	Information is continually updated and available from live feeds to sensors. Responses to questions are almost immediate and are accurate and relational.

Source: National Institute of Building Sciences (NIBS)

Table 2.10 Graphical Information Capability Maturity Model, Detail View.

Maturity Level	Graphical Information
1	There are no graphics in the BIM, only text.
2	2-D drawings are stored in the BIM but there is no interaction with information; the drawings were not developed with the NCS.
3	The drawings stored were developed with NCS yet are still nonintelligent and not object oriented.
4	The drawings are 2-D but are intelligent—a wall recognizes itself as a wall with properties but they are as designed and not as built.
5	The drawings are 2-D and are intelligent—a wall recognizes itself as a wall with properties and they are as built but not current.
6	The drawings are 2-D and are intelligent—a wall recognizes itself as a wall with properties and they are current.
7	The drawings are 3-D object based and have intelligence.
8	The drawings are 3-D object based and have a process in place to keep them current.
9	Time phasing has been added to the drawings so that one can see historical elements as well as being able to project into the future.
10	The drawings stored in the BIM are intelligent and object-based and include time and cost information.

Source: National Institute of Building Sciences (NIBS)

Table 2.11 Spatial Capability Maturity Model, Detail View.

Maturity Level	Spatial Capability
1	The facility is not spatially located using GPS or GIS.
2	A basic location has been established using GPS so that one can locate the facility spatially.
3	The facility is recognized in a worldview spatially but no information is shared between the BIM and GIS.
4	The facility is spatially located and some information is shared with the GIS environment.
5	The facility is spatially located and information can be shared with the GIS environment although it is not integrated and interoperable.
6	The facility is located spatially and there is full information sharing between the BIM and GIS.
7	The BIM has been partially integrated into the GIS environment.
8	Information from the BIM is recognized on a limited basis by the GIS.
9	Information from the BIM is partially recognized by the GIS environment and some metadata is available.
10	Information from the BIM is fully recognized by the GIS environment, including full metadata interaction.

Source: National Institute of Building Sciences (NIBS)

Table 2.12 Information Accuracy Capability Maturity Model, Detail View.

Maturity Level	Information Accuracy
1	There is no ground truth and information is simply loaded into the system manually or unverified electronically.
2	There is some electronic validation of information for internal spaces.
3	Space is calculated electronically and not stored as a separate data element for internal spaces.
4	Internal spaces are identified electronically and some outside information is electronically calculated.
5	Many spaces and items are identified electronically yet some items are still entered manually, both internally and externally.
6	All internal and external spaces are identified electronically.
7	Internal spaces are computed electronically and some outside information is electronically calculated.
8	All units are calculated electronically and reported. If a polygon changes shape, then the updated information flows throughout the model.
9	All internal and external areas are computed and some metrics have been established to track compliance.
10	All spaces are calculated automatically and metrics are used to ensure information is available and accurate.

Source: National Institute of Building Sciences (NIBS)

Table 2.13 Interoperability/IFC Support Capability Maturity Model, Detail View.

Maturity Level	Interoperability/IFC Support
1	There is no interoperability between software programs. Information is reloaded for each application.
2	There is some interoperability but it is not automatic or seamless. Information may be cut-and-paste at this level of maturity.
3	There is some machine-to-machine flow of information but it is not common or the norm; it is still the exception.
4	Information is flowing between COTS products, often by using products from the same vendor. The interfaces are likely proprietary.
5	In this level of maturity, information is transferred between COTS products typically from the same vendor, but not all applications are supported.
6	There are good machine-to-machine linkages at this level of maturity and information interoperability is the norm.
7	Industry Foundation Classes are used on a limited basis for interoperability with some software packages.
8	IFC use is becoming more commonplace yet is still less often used than other approaches.
9	IFC use is the norm, but not exclusively used to attain interoperability. One would expect about 70–90% IFC-based interoperability.
10	At this level of maturity, IFCs are fully implemented and used for interoperability.

Source: National Institute of Building Sciences (NIBS)

calculated automatically and methodologies are in place to ensure that information is accurate." This is a significant factor in determining the level of confidence one has in the information. If we lack confidence in the information, we are destined to re-collect it repeatedly during each phase of the building life cycle.

Interoperability/IFC Support. Measures the degree to which data can be reliably exchanged among software applications using the open-standard Industry Foundation Classes (see Table 2.13). The scale ranges from "no interoperability between software applications" to "IFCs are fully supported and used for information exchange." While any interoperability approach may work on a small scale, the only currently viable, open international standard is IFC.

TOWARD A NEW BUSINESS PARADIGM

What we have described thus far in this chapter is the essence of *information modeling.* It is about designing a reliable *system* for compiling and exchanging information in a culture of *information stewardship.* It has little to do, per se, with individual software applications or even technology. It is a mindset—a