Curating Architectural 3D CAD Models

FACADE

Future-proofing Architectural Computer-Aided Design

William Reilly
Technical Projects Manager
MIT Libraries’ Technology R&D

MacKenzie Smith
Associate Director for Technology, MIT Libraries
Principal Investigator, FACADE Project

Ann Whiteside
Head, Rotch Library of Art and Architecture
MIT Libraries

In conjunction with:

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Purpose for Presentation

- Awareness talk:
  - Fairly focussed problem: 3D materials, from field of architecture

- Wider applicability...
  - 3D formats preservation (science, etc.)
  - Ontology approach (large scale, non-organized dataset)
Contents of Talk

- Project Scope
  - Problem Statement; Project Proposal
  - Data Producers: Architecture Firms Today
  - Data Consumers: Audiences, Future Use Cases
  - Datasets We’re Working With

- 3D CAD
  - Data Formats; Standards; CAD Tools
  - Preservation Strategies

- Ontology
  - Project Information Model, Workflow
  - Metadata, “Curators Workbench”
  - DSpace Archive

- User Interface
Project Scope

- Problem Statement; Project Proposal
- Data Producers: Architecture Firms Today
- Data Consumers: Audiences, Future Use Cases
- Datasets We’re Working With
Problem Statement

- Current architectural data is being lost.
  - Architectural historians, scholars, teachers concerned
  - Libraries, museums, archives face challenge
  
  *(Practitioners less so, but ...)*
Reasons Behind Problem

- CAD (3D) is complex!
  - Highly proprietary, non-standard, backwards incompatibilities, obsolescence of softwares and formats

- 3D digital preservation new territory
  - Lack of tools, standards, approaches
FACADE Project Proposal

Prof. Bill Mitchell & MIT Libraries

- Develop optimal long-term archiving strategy for digital architectural data
  - Especially 3D CAD models

- Demonstrate in DSpace digital archive
  - With SIMILE user interface discovery tools

- Using Frank Gehry MIT Stata Center dataset
  - Advanced 3D CAD tool CATIA
Data Producers: Architecture Firms

- Technology
  - Design
  - Communications, Management

- 3D CAD increasing in complexity
  - “BIM” recent initiative (Building Information Modelling)
  - Yet standards for use, naming, interoperation lacking
Building Information Modelling

Building Information Modeling Opportunities

Planning  Design  Construction  Operations  Sustainment
Building Information Modelling

Building Information Modeling Opportunities

- Geospatial Info
- Product Selection
- Fabrication
- Ordering/Delivery
- Invoicing/Payment
- Computerized Maintenance Management System (CMMS)

Planning

Design

Construction

Operations

Sustainment

Legal Info

Engineering Analysis

Code Compliance Checking

Computer Aided Facility Management
What are Firms Doing, re: CAD, digital data?

- Not So Good (status quo):
  - Creating lots more CAD every day, but unorganized
  - Continuing to rely on proprietary formats for current and mid-term purposes
  - Not archiving for long-term
  - Not preparing (don’t know how) materials for archive
What are Firms Doing, re: CAD, digital data?

- Good (progress):
  - (Beginning to) recognize the issues
  - Attempting to make data interchange standards work
  - Trying to embrace BIM: richer CAD might aid interchange efforts, heighten need for longer-term archive solution
Data Consumers: Audiences

- Practice (Architects, Designers, Engineers)
- Research (Historians, Scholars)
- Teaching (Instructors, Students)
- General (Public, Casual)
Audience
Use Cases

- Practice (Architects, Designers, Engineers)
  - (Internal) Perform current work; re-use recent work
  - (External) Data interoperation with partner firms
  - (“Read Only”) Consult own work

Blue signifies future use cases
Audience
Use Cases

☐ Research (Historians, Scholars)
  ■ (Design) Study history of design, “design intent”
  ■ (Business) Study process, techniques, economics
Audience
Use Cases

- Teaching (Instructors, Students)
  - (Design) Study history of design, “design intent”
  - (Practice) Study models to learn, extend CAD
  - (Computation) Capabilities, constraints, on design

Blue signifies future use cases
Audience
Use Cases

☐ General (Public, Casual, Educational)
  - Study architectural history; view buildings, designs
Audiences Consulted

- Advisory Board
  - Architectural historian
  - 3D engineer
  - World cultural heritage
  - Architecture faculty
  - Practicing architects
  - CAD researcher
  - Architecture CAD platform CIO
  - Architecture IT consultant
Audiences Consulted

- MIT School of Architecture Faculty
- MIT architecture advanced grad. students
- Architecture firm visits
- Architecture firm libraries
- DCC 3D preservation seminars
- AIA Congress workshops
- CAD vendors discussions
Datasets We’re Working With

- Frank Gehry, MIT Stata Center
  - CATIA

- Moshe Safdie, U.S. Institute of Peace
  - Revit

- Thom Mayne, Caltrans
  - Microstation
Data

- Design data
  - 3D Models
  - 2D Drawings
Data and “Meta” Data
# Concordance of Data Formats

**Merged Format Concordance for FOG/A**

**Frank O. Gehry's Stata Center**

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3D CAD

- Data Formats; Standards; CAD Tools
- Preservation Strategies
3D PDF: Quick Look
3D CAD Modelling Tools

- Vary in complex (NURBS) v. simple geometry (Mesh) support

- Vary in parametric modeling v. inert geometry support

**How CAD products encode geometric and parametric models is unique and proprietary**
Data Exchange Formats

- Open, Standards-Based
  - Model Information
    - STEP (ISO 10303)
    - IFC (ISO 16739)
  - Geometry Information
    - IGES
    - VRML
    - STL
- Display formats (generally available)
  - 3D PDF
  - Flash

Blue signifies formats under study

- Various Industry Data Exchange Solutions
  - Navisworks
  - Collada
  - DXF / DWF
  - DWG / DGN
  - Viewers
  - ...

May 19, 2009 © MIT Open Repositories 2009 - Atlanta 27
3 Derivative Formats: IGES, STEP, 3D-PDF
IFC Viewer: Solibri
Ontology

- Project Information Model, Workflow
- Metadata, “Curators Workbench”
- DSpace Archive
PIM - Project Information Model

Entire architecture/design *project*

- Initial sketches
- 3D CAD models, 2D CAD drawings
- Formal outputs (e.g. client presentations)
- Correspondence, RFIs, ASIs, etc.
- Consultant reports, obligatory certificates, documents
- Images, video, other media files
- Every client issuance

Linked together in a *relationship map*
Early Ontology Design

- Prototype One
  - “Business Objects”
  - Context, relations
  - Scaling issues...

May 19, 2009
Properties on Objects [1 of 2]

Prototype Two
(latest approach)

Every *File* gets five properties

- Project Phase
  e.g. concept, design, construction, etc.

- Building Zone/System
  e.g. Stata Center, Gates Tower, 4th floor

- Architectural Discipline
  e.g. architectural, electrical, mechanical, structural

- Document Type
  e.g. presentation, drawing, communication

- File Format
  e.g. CATIA, AutoCAD, Word, PDF
Properties on Objects [2 of 2]

- **Important files** further tagged
  - Specially curated "Selected Objects"
    - 3D models and 2D drawing sets
    - Client presentations, etc.
  - Privileged access in user interface
Curators’ Workbench (CWB)

- File object properties assigned
- Selected Objects identified
DSpace Archive

- Preservation, dissemination, access control
- FACADE UI external to DSpace
- Bulk ingest tools (e.g. Curators’ Workbench; DSpace “packager” importer)
- Format registry integration for technical curation (GDFR, PRONOM, DSpace internal)
FACADE DSpace Info Model

- Prototype One
  - Selected Object = Item
    - File(s) = Bitstreams

- Prototype Two
  - File = Item
  - File = Bitstream
  - (Selected Objects constructed by RDF graph)
User Interface
FACADE Projects Catalog: Timeline View

The U.S. Institute of Peace Headquarters

Designed by renowned architects Moshe Safdie and Associates, the headquarters is a symbolic architectural statement of our nation's commitment to peace, visible along the capital skyline. The building will be environmentally-friendly and LEED certified. It will have three distinct sections linked together by atriums covered by a series of wing-like roof elements constructed of steel frames and white translucent glass.

Building Steel and glass Features: roof feature intimating the wings of a dove.
Cost: $65,000,000
Building Administrative Type: Government Facility
Contributor: Unknown
Location Washington, D.C., U.S.A.

Architectural Expressionist Style:
Alternative USIP names:
Extent 150,000 square feet
Is built? false
Climate: Humid Subtropical

Creator: Moshe Safdie and Associates
Construction Steel, concrete System: and glass
Context: Government Campus
Start Date: 2005
End Date: 2009

Construction System
Custom perforated stainless steel panels attached to a tube steel frame bolted to concrete building frame. (1) Poured-in-place concrete, custom steel frame, hand-set brick, custom
Caltrans Project “Exhibit”: Tiles View
Caltrans “Longwell”: “Starting Points” View

Caltrans District 7 Headquarters

Featured Data-Sets:
- Design Drawings, Models and Sets
- Photographs

Phases
- (missing) 13471
- Construction Documents 10373
- Design Development 1904
- Competition 512
- Pre-Schematic Design 506
- Schematic Design 380
- Post-Construction Documents 164
- Does Not Apply 2

Document Types
- (missing) 13485
- Drawing 10946
- Photograph 1641
- Communication 441
- Specification 201
- Presentation 132
- Work File 119
- Unknown 115
- Model 65
- Product Brochure 55
- Rendering 54
- Sketch 34
- Other 17
- Circularly Filed 3
- Agreement 2
- Index 2

Zones
- 13469 (missing)
- 12192 Caltrans
- 12544 Core Building
- 12514 Plaza 172
- 131 Traffic
- Does Not Apply 3
- South Section 1

File Formats
- Microstation CAD 8758
- JPEG File Interchange Format 1.01 4708
- AutoCAD Drawing 2000-2002 3168
- AutoCAD Drawing R14 3035
- (missing) 1291
- ASCII Text 1084
- AutoCAD Shape/Font File 906
- Tagged Image File Format 1 496
- ISO8859 Text 488
- Hewlett Packard Vector Graphic Plotter File 396
- Adobe TrueType Font data 285
- Portable Document Format 1.2 249
- AutoCAD Colour-Dependant Plot Style Table 245

Architectural Discipline
- (missing) 13482
- 13088 Architecture
- Structural 412
- Interiors 102
- Security 67
- Food Service 38
- Plumbing 32
- Mechanical 26
- Signage 23
- Landscape 15
- Lighting 13
- Audiovisual 6
- Civil 3
- Electrical 2
- Does Not Apply 2
- Info Tech 1
Longwell: Table View, with Popup

Caltrans District 7 Headquarters

Featured Data-Sets:

Download:

18 items. « [1]  next »

auto-pick columns | add column...

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<td>Structural</td>
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Outcomes (forthcoming...)

**INSTITUTIONS:**
- Open source, production quality software (repository; U/I)
- Preservation strategy, format info, for 3D CAD
- Ontology, workflow

**MIT:**
- Evaluating work products
- Pilot Fall 2009

**USERS:**
- Avail. of materials
- Improvement over “File System” organization
- Some add’l. metadata
Acknowledgement

This project is made possible by a grant from the U.S. Institute of Museum and Library Services

The views and conclusions contained of this presentation are those of the author and should not be interpreted as representing the official policies, either expressed or implied, of the IMLS or the U.S. Government.

http://facade.mit.edu
End User Path to Datasets

BUILDING PROJECTS

FACADE Projects Catalog: Stata, USIP, Caltrans ...

SELECTED OBJECTS

FILES