“Preserving Brand-New Buildings”

FACADE

Future-proofing Architectural Computer-Aided Design

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MIT Libraries

In conjunction with:

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Contents of Talk

- Project Scope
  - Problem, Goals
  - Audiences, 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, Goals

- Current architectural data is being lost.
  - Firms, libraries, museums, archives face challenge

- Develop Long-Term Archiving strategy for digital architecture data
  - Especially 3D CAD models

- Demonstrate in DSpace digital archive
  - Using SIMILE’s Longwell faceted browser
Audiences

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

Blue signifies future 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

- Research (Historians, Scholars)
  - (Design) Study history of design, “design intent”
  - (Business) Study process, techniques, economics

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

- General (Public, Casual, Educational)
  - Study architectural history; view buildings, designs
Datasets We’re Working With

- Frank Gehry, MIT Stata Center
  - CATIA

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

- Thom Mayne, Caltrans
  - Microstation
“Meta” Data

- 10Ks of files
- 10s of Gbs
- 100+ file formats
- File system
- Almost no metadata
- Collab. systems
3D CAD
3D PDF: Quick Look
Terminology: Geometry

- **NURBS** “Non-Uniform Rational Basis Splines”
  Freeform curves, surfaces. Weighted points

- **Mesh** Collection of vertices, edges and faces

http://en.wikipedia.org/wiki/Nurbs
http://en.wikipedia.org/wiki/Polygon_mesh
Terminology: Parametric

- Parametric
  - CATIA
  - Revit
  - Microstation

- Non-Parametric
  - Rhino
  - Maya

“Features” vs. just underlying geometry

Freeform surface modeller...
3D CAD Systems in Architecture

- Dassault Systemes’ **CATIA** (Stata Center)
- Autodesk’s **Revit** (U.S. Inst. Peace)
- Bentley’s **MicroStation** (Caltrans)

- Vary in parametric modeling v. inert geometry support
- Vary in complex (**NURBS**) v. simple geometry (**Mesh**) support

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

- Project deliverable: format representation information
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

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

Blue signifies formats under study
3D CAD Preservation

- **Original as Received:**
  - 0. Save *original* model and software
    - e.g. CATIA, Revit, DWG

- **Derivatives:**
  - 1. Export to *rich* standards-based 3D CAD model format
    - IFC best (“Coordination” Model View)
    - Otherwise STEP (AP203 and other parts)
  - 2. Export to *dessicated* standards-based shape file format for pure geometry
    - e.g. IGES, VRML
  - 3. Export to a Web-based *display* format
    - e.g. Adobe 3D PDF, Flash
3 Derivative Formats: IGES, STEP, 3D-PDF
3D Model Interactivity

If CAD software only exports *inert geometry*, the original parametric model is lost – i.e. the preservable artifact is not authentic.

*Does that matter?* probably not...

- Doesn’t fully represent design intent
- Can recreate a parametric model later
- Can manipulate the model view (e.g. 3D PDF)
Preserving Other Data

- Adopt existing best practices
  - 2D drawings, other documents in PDF/A
  - Images in TIFF
  - Video in MPEG-4
  - ASCII (mbox) for email archives

- But what about project management system data??
  - e.g. Buzzsaw, Constructware, Newform
Ontology
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.
- Contracts and surveys
- Images, video, other media files
- Every client issuance

Linked together in a relationship map
**F.A.C.A.D.E. Project Information Model / ONTOLOGIES**

**the Project Information Model**

sort and classify all the available data - 2d, 3d and construction administration (CPI's, change orders) - and map their relations. Model this as an ontology that can be called in an environment such as DSpace or the semantic web.

this formalization of building components is required so that they can be linked/represented in a predictable structure. In this manner, a reasoning methodology can be applied to other works.

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**systematics / hierarchies**

<table>
<thead>
<tr>
<th>Project</th>
<th>Issue</th>
<th>3D</th>
<th>Design</th>
<th>2D</th>
<th>Sheets</th>
<th>Consultant Coordination</th>
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</thead>
<tbody>
<tr>
<td>CLIENT</td>
<td>FRANK</td>
<td>CONSULTANTS</td>
<td>Bidding</td>
<td>code/cost</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**PIM representations**

---

**workflow**

<table>
<thead>
<tr>
<th>Directories</th>
<th>Architectural</th>
<th>Func. (3D, 2D, renderings)</th>
<th>Consultants</th>
<th>Minutous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tiles</td>
<td>3D model</td>
<td>Exterior cladding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data</td>
<td>Reference file</td>
<td>Steel profiles</td>
<td>Assemblies</td>
<td>Material specs</td>
</tr>
</tbody>
</table>

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**organization modules**

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Properties on Objects [1 of 2]

- 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
  - Hand-selected “Design Objects”
    - Client presentations, etc.
    - 3D models and 2D drawing sets
  - Privileged access in user interface
Curators’ Workbench (CWB)

- PIM Tools pre-process initial RDF
- File object properties assigned using CWB
DSpace Archive

- Preservation and dissemination
- UI external to DSpace
- Bulk ingest tools (e.g. Curators’ Workbench; DSpace “packager” importer)
- Format registry integration for technical curation (GDFR, PRONOM, DSpace internal)
User Interface
End User Path to Datasets

- Different faceted browse tools
- Different scaling issues
- Different audience needs
- Some navigation, linking, indexing challenges

BUILDING PROJECTS
("The Catalog")

FACADE Projects: Stata, USIP, ...

DESIGN OBJECTS
(D.O.s)
("Coffee Table Book")

FILE OBJECTS
("Project Dataset")
("Reference Book")
What We’re Going to See

- Exhibit for FACADE Projects
  - Exhibit / Longwell for “Coffee Table Book”
- Longwell for USIP “Reference Book”
  - Design Objects (slides)
    - Client Presentation (.PPT)
    - Design Model (.RVT), then Derivative File (.IFC)
    - Design Set, Index (.DOC), Drawing (.DWG)
  - Files (demo)
    - Arch. Discipline: Landscape
    - Phase: Schematic Design
    - Doc. Type: Sketch, Specification
CALTRANS DISTRICT 7 HEADQUARTERS

The new Caltrans District 7 Headquarters covers an entire city block downtown Los Angeles, directly opposite City Hall, in the midst of an increasingly revitalized area. The building is the first to be commissioned under the State of California’s Design Excellence Program. Roughly L-shaped in plan, the building is composed of two main volumes. The 13 story larger volume stretches along the entire block between 1st and 2nd Streets and is set back 155 feet from Main Street. The smaller four story volume, extends from the larger volume to Main Street and occupies approximately one-half the length of the site, from mid-block to 2nd Street. Enveloped in a constantly changing mechanical skin that is alternately open or closed depending on the conditions of outside temperature and sunlight, the building’s fundamental property is that of transformation. At dusk the building is transparent, textured and windowed everywhere to invite the viewer, while at mid-day it is buttoned up against the sun, appearing to be devoid of windows entirely.

Building Light-responsive metal
Features: slab, slab-shed
Exhibition gallery
Cost: $190,000,000
Building Administrative
Type: Government Facility
Contributor: The Clark
Construction Group, Inc.
Location Los Angeles, CA, U.S.A.

Architectural Interactive
Style
Alternative Caltrans
names: Extent 1,050,000 sq. ft.
Is built? true
Climate: Dry-Summer Subtropical Zone

Creator: Morphosis
Construction Structural steel
System: framing, steel moment frames, steel reinforced concrete slabs, perforated aluminum panels, and glass

Context: Urban
Start Date: 2002
End Date: 2004

COOPER UNION NEW ACADEMIC BUILDING

Designed largely to house Cooper Union’s Albert Nerken School of Engineering—one of the top three specialized engineering schools in the nation—the building will also provide institutional spaces for the Humanities and Social Sciences, the Irwin S. Chanin School of Architecture and the School of Art. The structure will function as both a space for study and

Architectural Style
Deconstructivist (1)
Expressionist (3)
High Tech (1)
Interactive (2)
Neo-Vernacular (1)
Postmodern (3)

Contributor
Beacon Skanska Inc. (1)
F.J. Scoliere Construction Co., Inc (1)
M.A. Montesano (1)

Cooper Union New Academic Building
GATES GEOMETRY (3D MODEL)

Design Object: 3D Model of Gates Wing of Stata Center.

Creator: Gehry Partners, LLP
Phase: Construction
Date: 2002-12-03

Organized Via:

4 files:

- Gates Geometry PDF
- Gates Geometry DWG
- Gates Geometry DXF
- Gates Geometry IGES

File Format:
- PDF (4)
- DWG (2)
- DXF (2)
- IGES (2)
- JPG (1)
- Microsoft Excel (1)
- Microsoft PowerPoint (1)
- STEP (1)
- Text (1)

Creator:
- Beacon Skanska (1)
- Bonet, Frances (1)
- Gehry Partners, LLP (2)

Phase:
- Construction (9)
- Design Development (1)
- Issue #5 Construction/Permit Set (2)

Number of files:
- 0 - 5 (19)
- 5 - 10 (1)

Contains Format Category:
- Geometry (4)
- Original (2)
- Presentation (2)
- Standard (2)

Has file Derived By:
- AutoCAD (2)
- CATIA V5 (2)

Discipline:
- Architectural (7)
- Structural (6)

Recipient:
- Architecture (6)
### Longwell, “Starting Points”

#### FACADE

#### Phases
- (missing) 23,119
- Construction Documents 19,142
- Design Development 6,968
- Schematic Design 1,183
- Unknown 512
- Does Not Apply 1

#### Document Types
- (missing) 23,114
- Drawing 22,539
- Specification 1,296
- Sketch 775
- Photograph 684
- Model 649
- Rendering 541
- Presentation 326
- Other 259
- Study 258
- Index 178
- Product Brochure 116
- Work File 42
- Communication 40
- Audio/Video 27
- Project Book 22
- Unknown 18
- Schedule 6

#### Zones
- USIP 23,758
- Roof 3599
- Navy Buildings 375
- Unknown 82
- Does Not Apply 1

#### File Formats
- Portable Document Format 13,091
- AutoCAD Drawing 11,339
- JPEG File Interchange Format 5,554
- Revit artifac 3,559
- OLE Compound Document Format 3,014
- ASCII Text 2,718
- EPRI MapInfo Data File 1,955
- Portable Document Format - Archival 1,420
- Exchangeable Image File Format (Compressed) 1,010
- CATIA 5 model 622
- ZIP Format 491
- Unknown 423
- Rhinoceros/OpenNUB3 3D model 418
- Adobe Photoshop 209
- Tagged Image File Format 193
- Binary Interchange File Format (HEF) Workbook 182
- Microsoft Word for Windows 171

#### Architectural Discipline
- (missing) 23,113
- Structural 10,373
- Architecture 9,302
- Interiors 1,441
- Mechanical 1,400
- Electrical 1,300
- Landscape 1,156
- Security 858
- Plumbing 663
- Civil 352
- Lighting 277
- Info Tech 250
- Audiovisual 204
- Food Service 147
- Signage 73
- Geotechnical 22
- Unknown 13
- Does Not Apply 1
Longwell, Table w. Popup

**FACADE**


Add View | Start New Search

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<thead>
<tr>
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<th>source</th>
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<tr>
<td>71031_phase2-phase 2.jpg</td>
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<tr>
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<td>in/ad/images from balmori/schemeB/model1.jpg</td>
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</tbody>
</table>

**Attribute Filters**

- architecturalDiscipline
  - Architecture
  - Structural
  - Landscape

**Text Search**

- Q

**Location**

- created
- derivedBy
- derivedFrom
documentType
extensionextentformat

- Exchangeable Image File Format (Compress
- JPEG File Interchange Format
- OLE2 Compound Document Format
- Adobe Photoshop
- Portable Document Format
Client Presentation Design
Object O-0008 (.PPT)

Option 1: ‘Draped net’

Every tile has same side length (angle changes)

Generator lines

Every tile is different

Option 3: Polyhedron mapping

Triangular panels can be generated in a number of ways (using various base and generators)

Same coloured tiles are identical.
Mall, Washington DC
View, without USIP Building...
There it is!
Design Model (d0003)
Derivative File .IFC (50729)
Design Set (d0014)
Index File to Design Set (21314)
Word .DOC Index to .DWGs

DRAWING LIST MEMO

Project: United States Institute of Peace
Date: 12 September 2006
RE: Drawing List

GENERAL INFORMATION
00.00 Cover Sheet Volume 1
00.02 Drawing List

CIVIL
C30.00 Existing Conditions Plan
C10.00 Demolition Plan
C20.00 Sedimentation and Erosion Control Plan
C30.00 Site Plan
C40.00 Utility Plan
C50.00 Site Details
C80.00 Sedimentation and Erosion Control Details
C70.00 Stormwater Management Plan

DRAINAGE
G00.01 Subdrainage Layout
G00.02 Subdrainage Details

LANDSCAPE
L100 General Landscape Plan
L101 Entry Pavilion Topography & Hardscape Plan
L102 PEC Entry Topography & Hardscape Plan
DWG “L101,” from Index (21693)
What We’re Going to See

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- User Interface
Outcomes, *forthcoming* ...

**INSTITUTIONS:**
- Open source, production quality software (repository; U/I)
- Format representation for 3D CAD
- Preservation strategy for 3D CAD
- Ontology, workflow for other materials
- Intellectual property issue

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

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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.

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