# FACADE: Future-proofing Architectural Computer-Aided DEsign

MacKenzie Smith

Associate Director for Technology, MIT Libraries

Principal Investigator, MIT FACADE Project

# MIT FACADE Project

- ☐ Develop Long-Term Archiving strategy for digital architecture data

- ☐ Especially 3D CAD models

- ☐ Demonstrate in DSpace digital archive

# Architecture Data

Recent building projects

Also applies to

- Heritage projects, e.g. renovation of central Pisa

- Historical reconstructions, e.g. World Trade Center

# Frank Gehry: MIT Stata Center

# Stata Center Data

- 16 issuances
- 14Gb
- 26,000 files
- ~60 file formats
- Multiple software versions
- Each 3D model = multiple files

- CATIA v4, v5
- AutoCAD DWG
- Digital images, video
- Email archives
- Business documents
- Buzzsaw, Citadon for correspondence, project management

NOTE: this is a subset of the complete archive

# Moshe Safdie: U.S. Institute of Peace

- ☐ Still under construction
- ☐ 60 Gb so far
- ☐ 36,000 files
- ☐ >100 file formats

- ☐ Revit and Catia v5
- ☐ Rhino, AutoCAD
- ☐ Email archive, documents, Constructware files

# Morphosis: Caltrans Headquarters

- ☐ 9.2Gb
- ☐ >16,000 files
- ☐ 400 zip archives
- ☐ 96 file formats

- ☐ Microstation 3D CAD
- ☐ AutoCAD
- ☐ Images (many types)
- ☐ PDFs, Word docs, Web pages, Powerpoints, etc.

# 3D CAD Systems in Architecture

Autodesk's **Revit**, Dassault Systemes' **CATIA**, Bentley's **MicroStation**, McNeel's **Rhino**

- ☐ Vary in parametric modeling v. inert geometry support

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

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

# Standard 3D CAD Formats

For data transfer *between* software

❑ IGES – deprecated

❑ STEP (ISO 10303)

❑ IFC   (ISO 16739)  - No NURBS

# 3D CAD Preservation

☐ Save *original* model and software
e.g. CATIA, Revit, DWG

☐ Export to *standards-based* 3D CAD format
IFC best (coordination model view)
Otherwise STEP (AP203 and other parts)

☐ Export to standard *shape file* format
e.g. IGES, VRML

☐ Export to a Web-based *presentation* format
e.g. Adobe 3D PDF, Flash

# 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, Newforma

# 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 (RFI'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 formailzation 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.



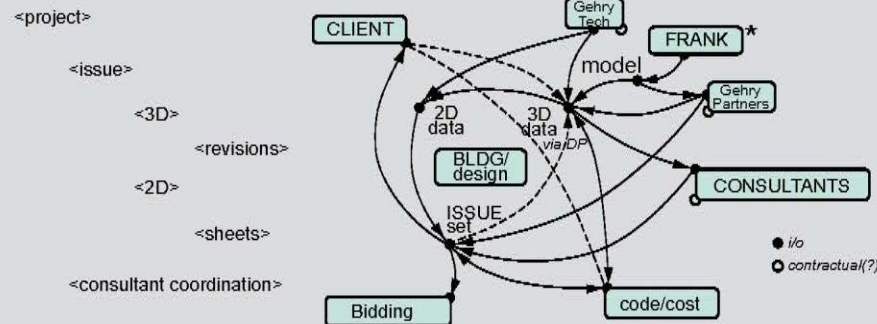**Moshe Safdie Associates,** Institute of Peace     **Gehry Partners,** Stata Center
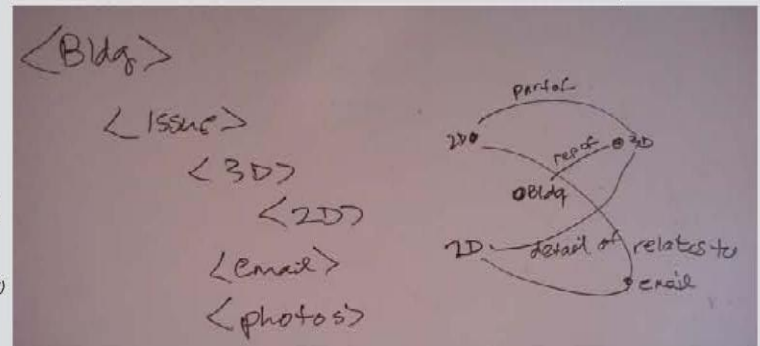
---

### systematics / hierarchies     ex. 1 *(incomplete)*



<project>

<issue>

   <3D>

     <revisions>

   <2D>

     <sheets>

<consultant coordination>

CLIENT · Gehry Tech · FRANK * · model · Gehry Partners · 2D data · 3D data *via DP* · BLDG/ design · ISSUE set · CONSULTANTS · Bidding · code/cost

● i/o
○ contractual(?)

\* F. Gehry establishes and maintains his own contract separate from Gehry Partners

### PIM representations



---

### workflow

| hierarchies | example | ontology | mapping | |
|---|---|---|---|---|
| directories | architectural _(3d, 2d, renderings) consultants _(struct, mech, etc) minutes | _element _instance _class | _office building _admin suite _senior, executive, support,... | |
| files | 3d model _exterior cladding | _attributes | _arch'l, struct., mech, energy efficiency,... | **PIM** Project Information Model |
| data | reference files _steel profiles _assemblies _mat'l specs _cost spreadsheet | _relations _events | _issue sets _evaluation (client review, code compliance cost analysis) | |

### organization modules
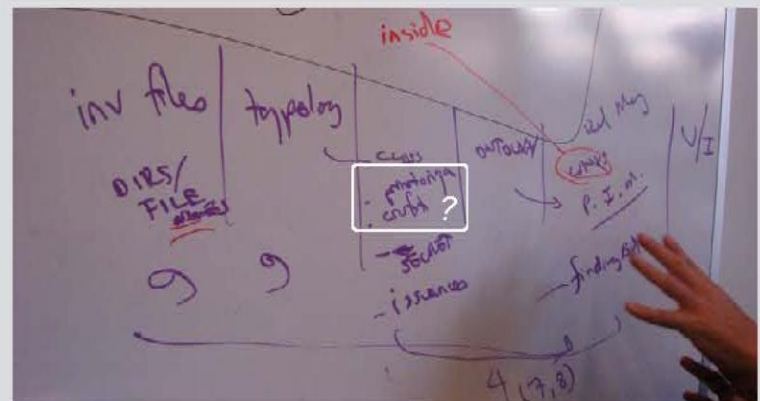
# PIM ontology
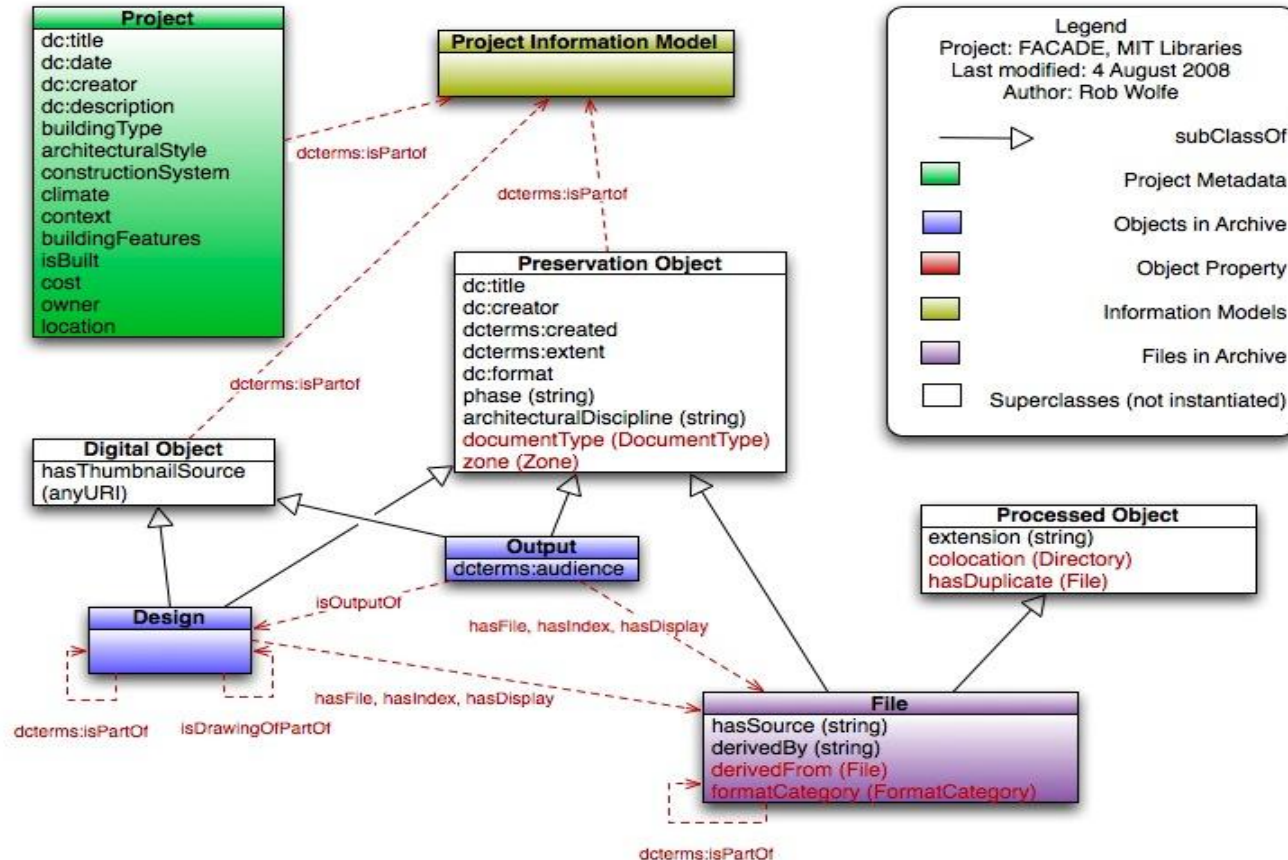
# *Every file* gets five properties

- 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

- File type
  - e.g. presentation, drawing, communication

- File Format
  - e.g. CATIA, AutoCAD, Word, PDF

# *Important files* further tagged

- **Hand-selected "Digital Objects"**

  - Output files, e.g. key client presentations

  - 3D models and 2D drawing sets

# Curators Workbench

- Tool *interviews curator*
    - e.g. project start and end dates
    - key file identification
        e.g. client presentations, 3D models

- Tool *pre-processes collection*, presents preliminary results, curator corrects, iterates

- Curator/domain expert creates 3D derivatives, other preservation copies

# DSpace Archive

- ☐ Format registry integration for technical curation support (GDFR, PRONOM)

- ☐ Map project data to DSpace data model

- ☐ Bulk ingest tools (e.g. curator workbench)

- ☐ UI based on SIMILE Exhibit

# FACADE PROJECTS

**9** Projects

ITEMS · MAP · TIMELINE · CAROUSEL

sorted by: labels; then by... · ○ grouped as sorted

## 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 revivified 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. Enrobed 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 voyeur, while at mid-day it is buttoned up against the sun, appearing to be devoid of windows entirely.

Building Light-reactive metal
Features: skin, skip-stop elevators, public 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 aluminium 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 space 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

### Search

**Is Built?**
false (3)
true (6)
**Extent**
1,050,000 sq. ft. (1)
111,000 square feet (1)
150,000 square feet (1)
18,000 sq. ft. (1)
200,000 sq. ft. (1)
258,333 sq. ft. (1)
6,000,000 square feet (1)
605,000 sq. ft. (1)
720,000 sq. ft. (1)
**Creator**
Gehry Partners, LLP (3)
Morphosis (3)
Moshe Safdie and Associates (3)
**Context**
Government Campus (1)
Small town (1)
Urban (4)
Urban University Campus (2)
Urban Waterfront (1)
**Climate**
Dry-Summer Subtropical Zone (2)
Humid Continental (2)
Humid Subtropical (2)
Mediterranean (1)
Oceanic (1)
Tropical rainforest (1)
**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 metal cladding, glass curtainwall and aluminum framing. (1)
Skylit galleries over masonry and brick. (1)
Stainless steel panels on steel frame (1)
Steel and Concrete. (2)
Steel, concrete and glass (1)
Structural steel framing, steel moment frames, steel reinforced concrete slabs, perforated aluminium panels, and glass. (1)
Titanium panels on steel frame. (1)
**Architectural Style**
Deconstructivist (1)
Expressionist (3)
High Tech (1)
Interactive (2)
Neo-Vernacular (1)
Postmodern (1)
**Contributor**
Beacon Skanska Inc. (1)
F.J. Sciame Construction Co., Inc (1)
M.A. Mortenson (1)

FACADE projects

USIP Data {Unselect Drawing Sh...

**References**

**Organized Via**

# USIP PROJECT FILES

CAROUSEL · ITEMS · **TIMELINE**

**15** DesignObject filtered from 19 originally (Reset All Filters)

080%

Roof Plan (80% CD)

USIP Roof Skin 3D Model (80% CD)

Roof Slab Edge Plan (80% CD)

Roof and Facade Enclosure General Notes and Key Plan (80% CD)

Structural Framing Roof Plan (80% CD)

Mechanical Roof Level (80% CD)

Lightning Protection Roof (80% CD)

Electrical Power Roof Level (80% CD)

Structural Setting Out Roof Plan (80% CD)

Feb      Mar      Apr      May      Jun      Jul      Aug      Sep      Oct      Nov

2006                         2007                              2008                         2009

Timeline@SIMILE

🔶 **DesignObject**

**Search**

**Type**
ProjectObject (15) ▶

**References**
United States Institute of Peace (15)
▶

**Organized Via**
Drawing Sheet Master Index (100% DD) (2)
Drawing Sheet Master Index (80% CD) (11)
(others) (2)

**File Type**
Image (13)
Image, 3D (2)

**File Format**
Adobe PDF (14)
AutoCAD DWG (13)
AutoCAD DXF (15)
IFC (2)
Revit (2)

**Creator**
Moshe Safdie & Associates (15)

**Phase**
Construction Documents (9)
Design Development (6)

**Number of Files**
0 - 5 (15)

**Contains Format Category**
Geometry (15)
Original (15)
Presentation (15)
Standard (2)

**Has File Derived By**
AutoCAD (15)
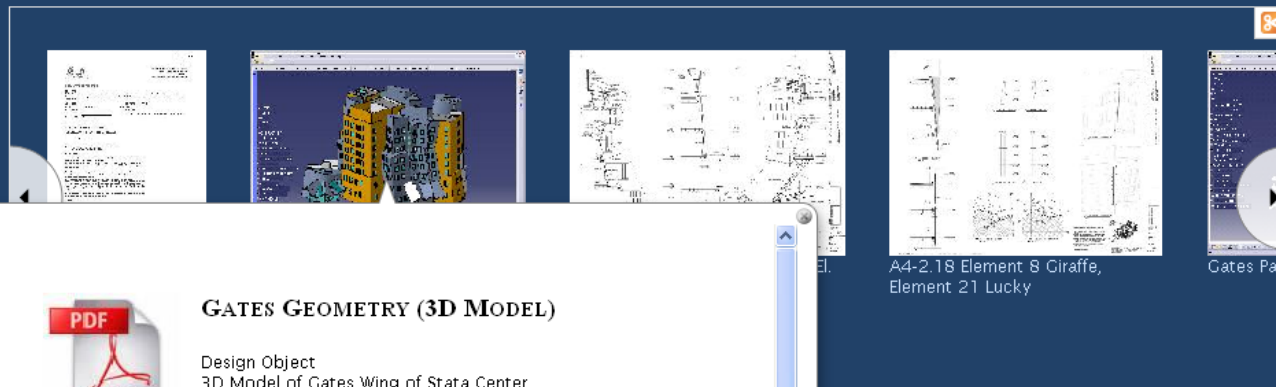
**Discipline**
Architectural (5)
Electrical (4)
Mechanical (2)
Structural (4)

**Recipient**
(missing this field) (15)

File   Edit   View   History   Bookmarks   Tools   Help

FACADE projects          |          Stata Data {select Carousel view}

## References

# STATA PROJECT FILES

CAROUSEL · ITEMS · TIMELINE

A4-2.18 Element 8 Giraffe,
Element 21 Lucky

Gates Patt

### GATES GEOMETRY (3D MODEL)

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

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

Referenced
by:

Organized
Via:

4 file(s) ▶

## Organized Via

### Search

**Type**
Organization (2) ▶
ProjectObject (9) ▶
**References**
Gates Geometry 3D Model (1)
Gates Pattern 3D Model (1)
MIT Stata Center (7) ▶
RFI 1244 (1)
(others) (4)
**Organized Via**
Catia Master Model Issue List (2)
Stata Center Drawing Sheet Master
Index (2)
(others) (7)
**File Type**
Image (2)
Image, 3D (2)
Other (2)
Presentation (2)
Text (3)
**File Format**
Adobe PDF (6)
AutoCAD DWG (2)
AutoCAD DXF (2)
AVI Video (1)
CATIA 4 Model (3)
IGES (2)
JPEG (1)
Microsoft Excel (3)
Microsoft Powerpoint (1)
STEP (2)
Text (1)
**Creator**
Beacon Skanska (1)
Bonet, Frances (1)
Gehry Partners, LLP. (9)
**Phase**
Construction (8)
Design Development (1)
Issue #8 Construction/Permit Set (2)
**Number of Files**
0 - 5 (10)
5 - 10 (1)
**Contains Format Category**
(missing this field) (4)
Geometry (4)
Original (7)
Presentation (4)
Standard (2)
**Has File Derived By**
(missing this field) (7)
AutoCAD (2)
CATIA v5 (2)
**Discipline**
(missing this field) (7)
Architectural (4)
**Recipient**
(missing this field) (6)

# The Fine Print

☐  Non-exclusive research licenses for limited access now

☐  Want broad Open Access license

☐  Need a ***model license***
- ■  AIA a non-starter (too restricted)
- ■  Ditto a typical gift agreement (too liberal)
- ■  Will interview architects
- ■  BIG PROBLEM!

# Acknowledgement

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