MIT Libraries

"Preserving Brand-New Buildings"

FACADE

Future-proofing Architectural Computer-Aided Design

William Reilly - Technical Projects Manager, Tech. R&D, MIT Libraries

http://facade.mit.edu/presentations/REILLY_DLFFall2008_MIT_FACADE.ppt.htm

- **MacKenzie Smith**
  Associate Director for Technology, MIT Libraries
  Principal Investigator, FACADE Project
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  Head, Rotch Library of Art and Architecture
  MIT Libraries

In conjunction with:

MIT | SA+P
Department of Architecture

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

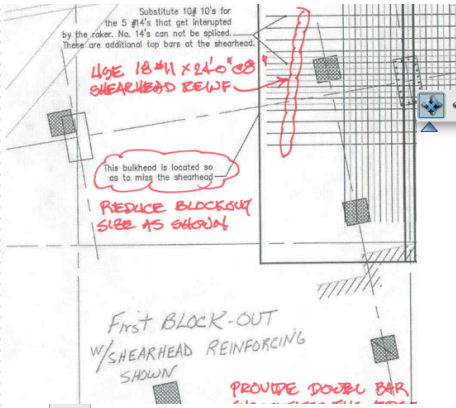
- Frank Gehry, MIT Stata Center
  - Cambridge, Mass. (2004)
  - CATIA

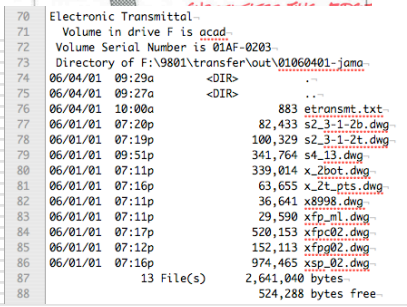
- Moshe Safdie, U.S. Institute of Peace
  - Washington, D.C. (2009)
  - Revit

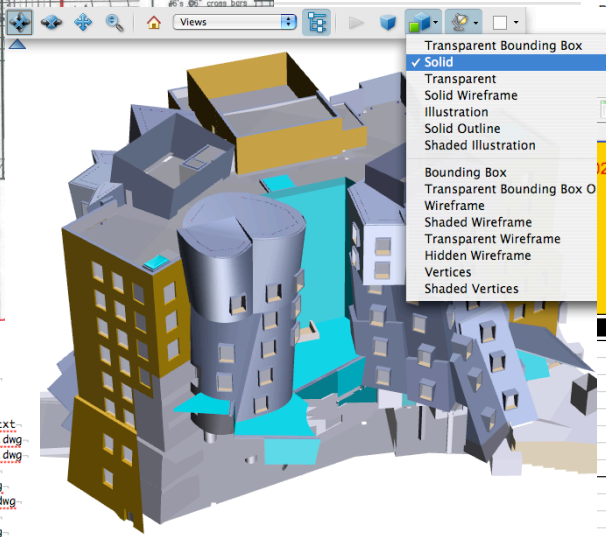
- Thom Mayne, Caltrans
  - Los Angeles, Calif. (2004)
  - Microstation

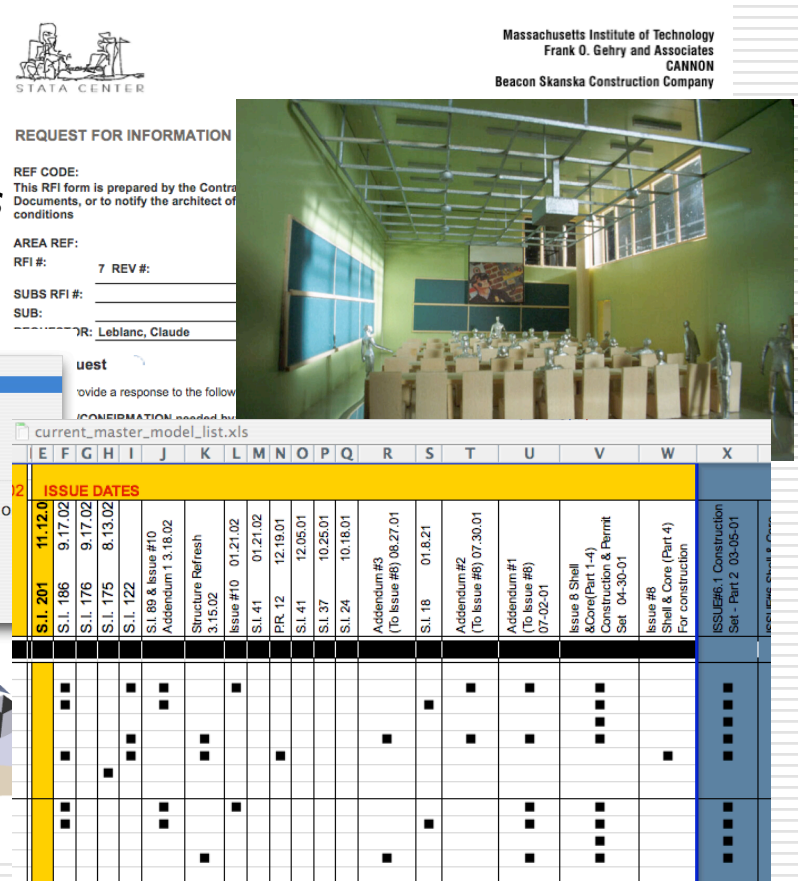
“Meta” Data

- 10Ks of files
- 10s of Gbs
- 100+ file formats
- File system
- Almost no metadata
- *Collab. systems*



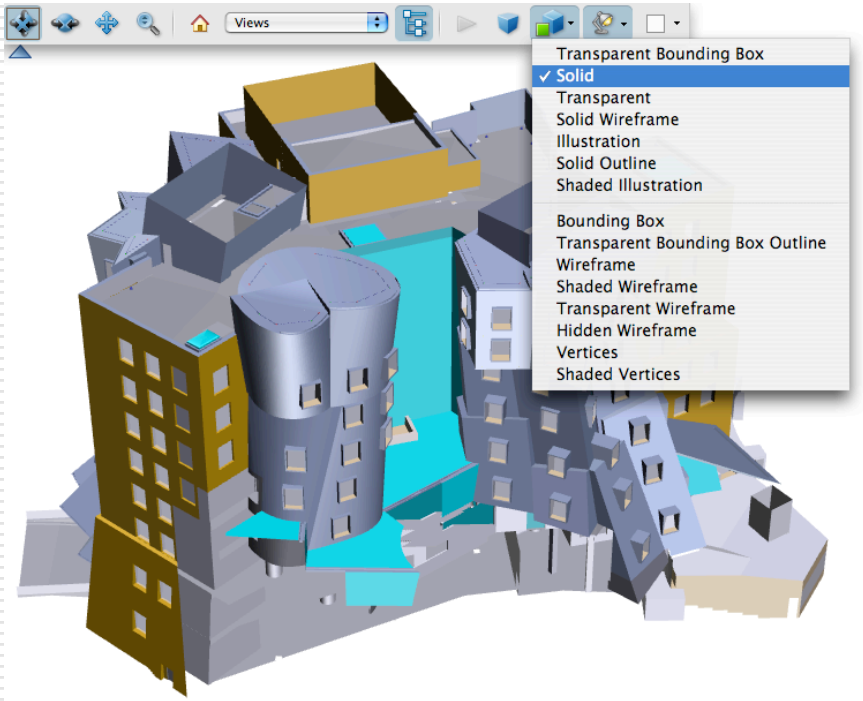


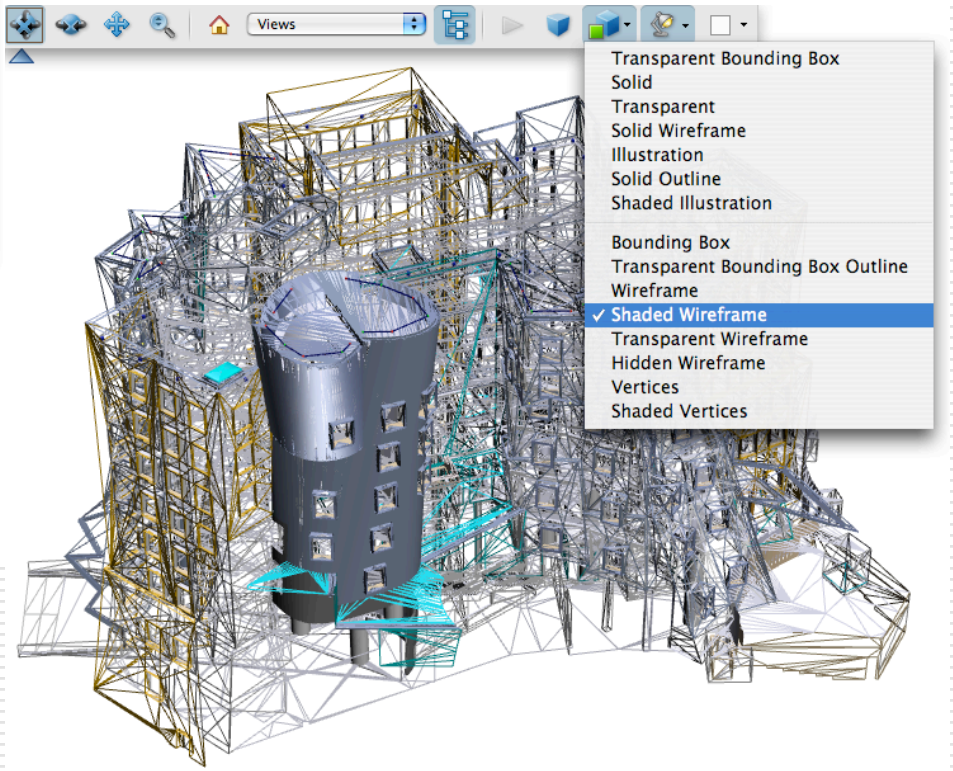




3D CAD

3D PDF: Quick Look

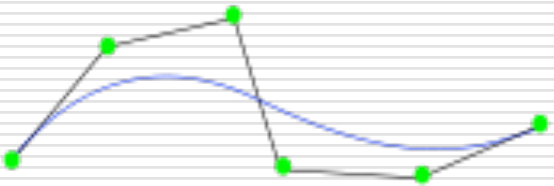


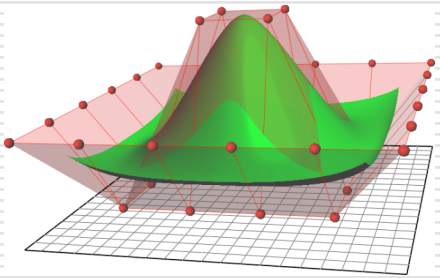


Terminology: Geometry

- NURBS "Non-Uniform Rational Basis Splines"

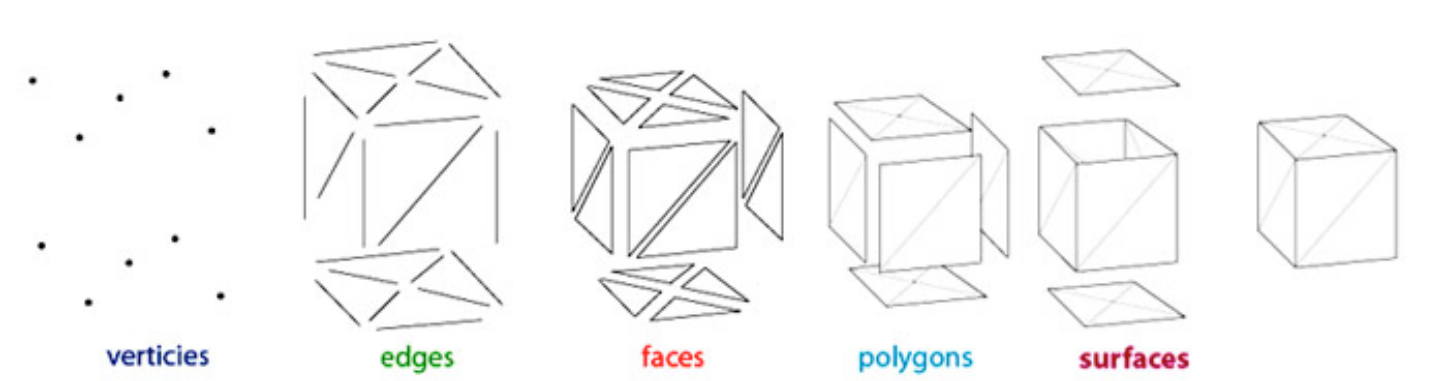
  Freeform curves, surfaces. Weighted points





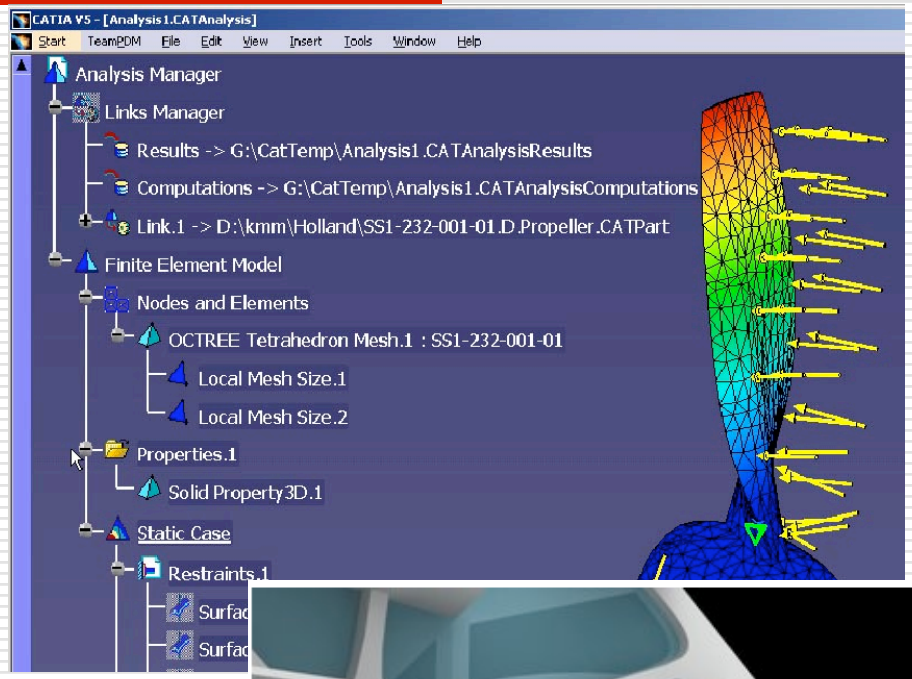
- Mesh Collection of vertices, edges and faces

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



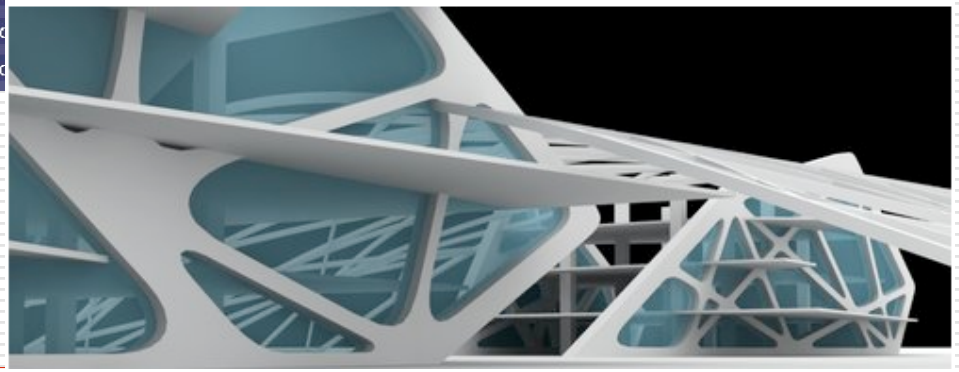
Terminology: Parametric

- 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

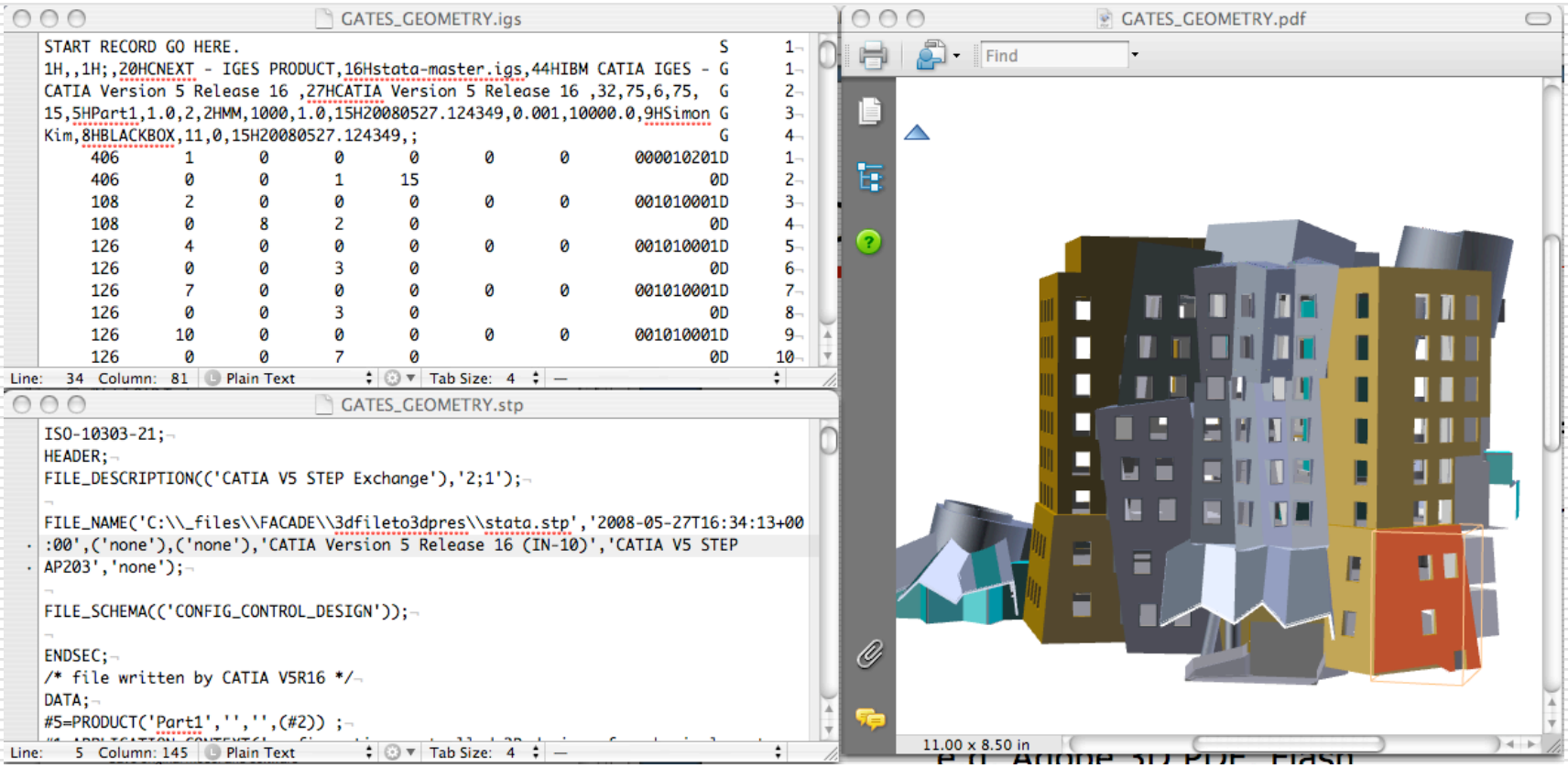
Blue signifies formats under study

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

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, Newforma

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 (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>

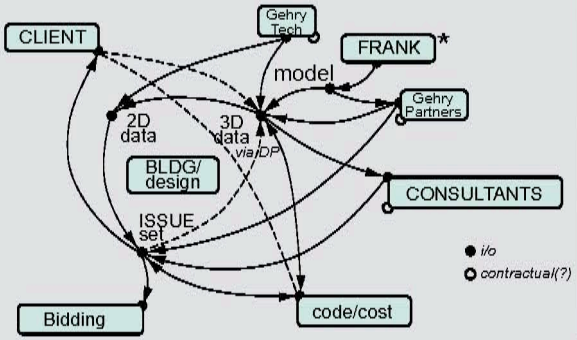
<3D>

<revisions>

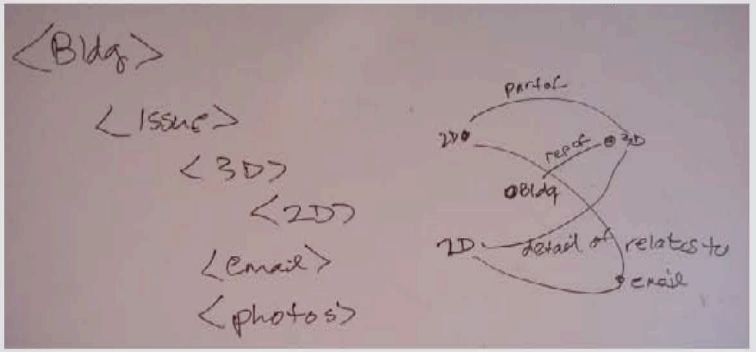
<2D>

<sheets>

<consultant coordination>



PIM representations



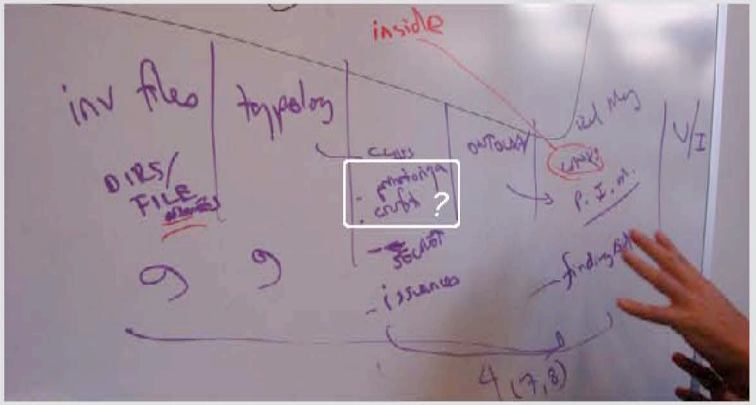
* F. Gehry establishes and maintains his own contract separate from Gehry Partners

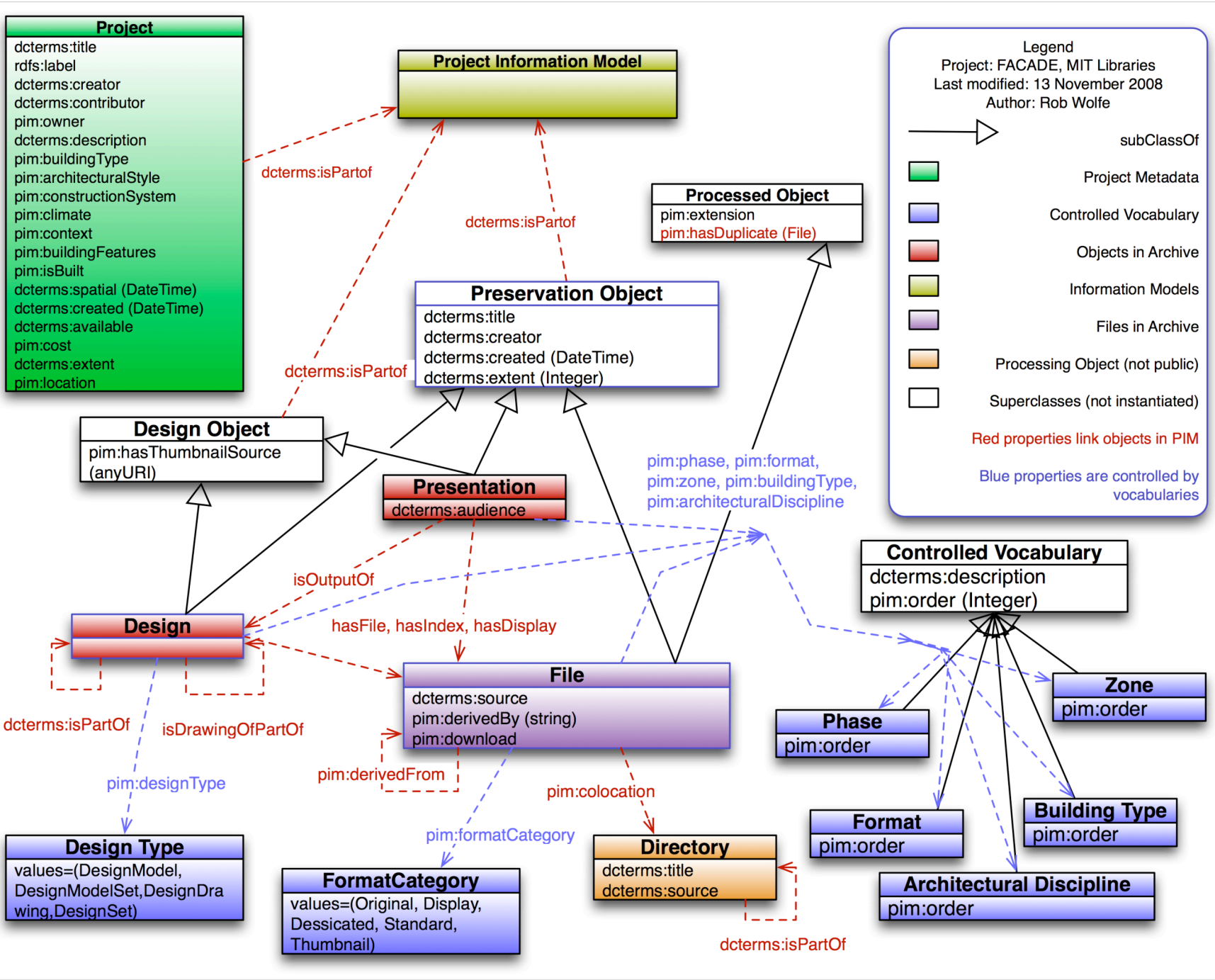
workflow

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,...
data	reference files _steel profiles _assemblies _mat'l specs _cost spreadsheet	_relations _events	_issue sets _evaluation (client review, code compliance cost analysis)

PIM Project Information Model

organization modules



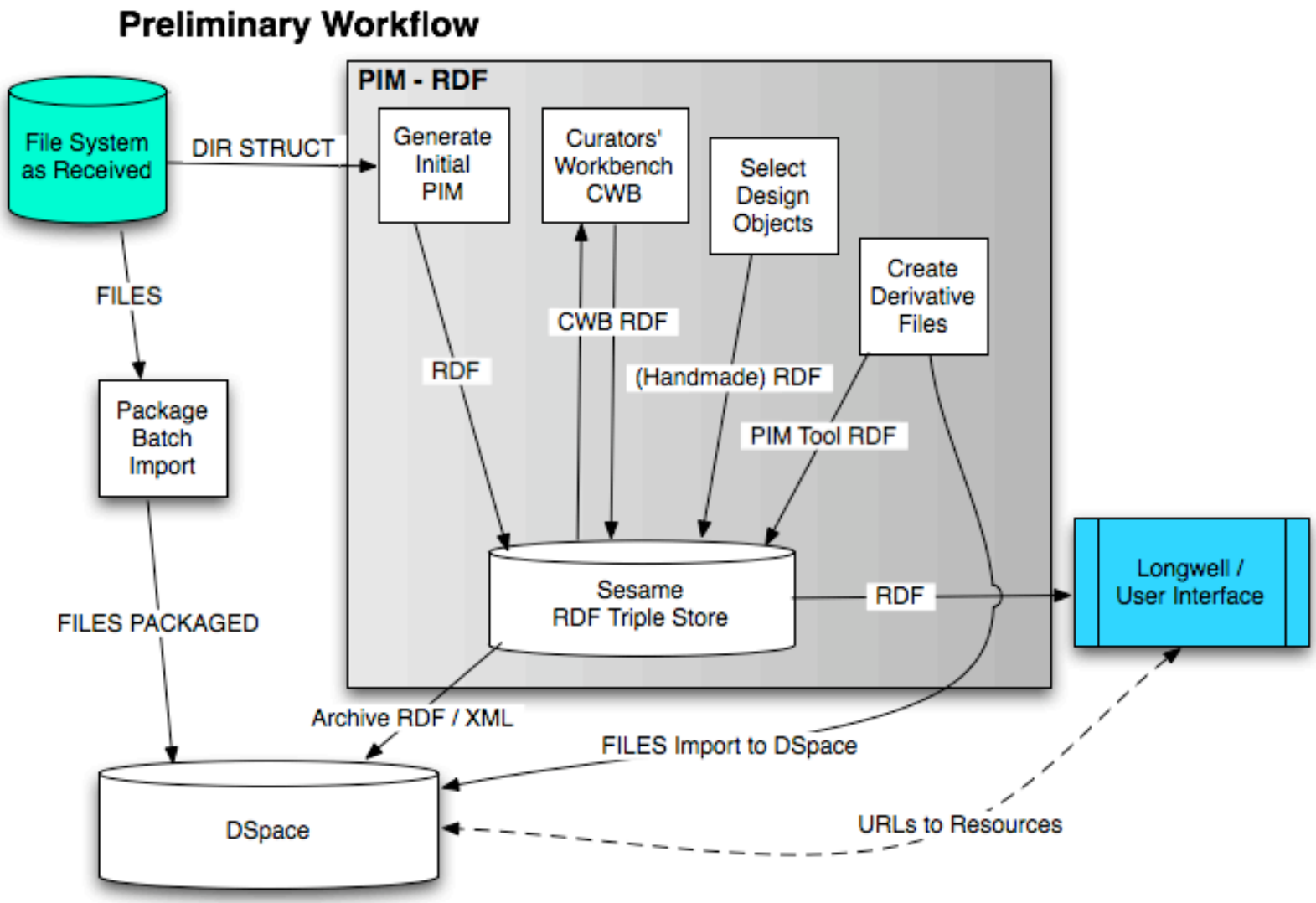

Project
dcterms:title
rdfs:label
dcterms:creator
dcterms:contributor
pim:owner
dcterms:description
pim:buildingType
pim:architecturalStyle
pim:constructionSystem
pim:climate
pim:context
pim:buildingFeatures
pim:isBuilt
dcterms:spatial (DateTime)
dcterms:created (DateTime)
dcterms:available
pim:cost
dcterms:extent
pim:location
Project Information Model
dcterms:isPartof
dcterms:isPartof
dcterms:isPartof
Processed Object
pim:extension
pim:hasDuplicate (File)
Preservation Object
dcterms:title
dcterms:creator
dcterms:created (DateTime)
dcterms:extent (Integer)
Design Object
pim:hasThumbnailSource (anyURI)
Presentation
dcterms:audience
pim:phase, pim:format, pim:zone, pim:buildingType, pim:architecturalDiscipline
Legend
Project: FACADE, MIT Libraries
Last modified: 13 November 2008
Author: Rob Wolfe
subClassOf
Project Metadata
Controlled Vocabulary
Objects in Archive
Information Models
Files in Archive
Processing Object (not public)
Superclasses (not instantiated)
Red properties link objects in PIM
Blue properties are controlled by vocabularies
Controlled Vocabulary
dcterms:description
pim:order (Integer)
isOutputOf
Design
hasFile, hasIndex, hasDisplay
File
dcterms:source
pim:derivedBy (string)
pim:download
Zone
pim:order
Phase
pim:order
dcterms:isPartOf
isDrawingOfPartOf
pim:designType
pim:derivedFrom
pim:colocation
pim:formatCategory
Format
pim:order
Building Type
pim:order
Design Type
values=(DesignModel, DesignModelSet,DesignDrawing,DesignSet)
FormatCategory
values=(Original, Display, Dessicated, Standard, Thumbnail)
Directory
dcterms:title
dcterms:source
Architectural Discipline
pim:order
dcterms:isPartOf

Properties on Objects [1 of 2]

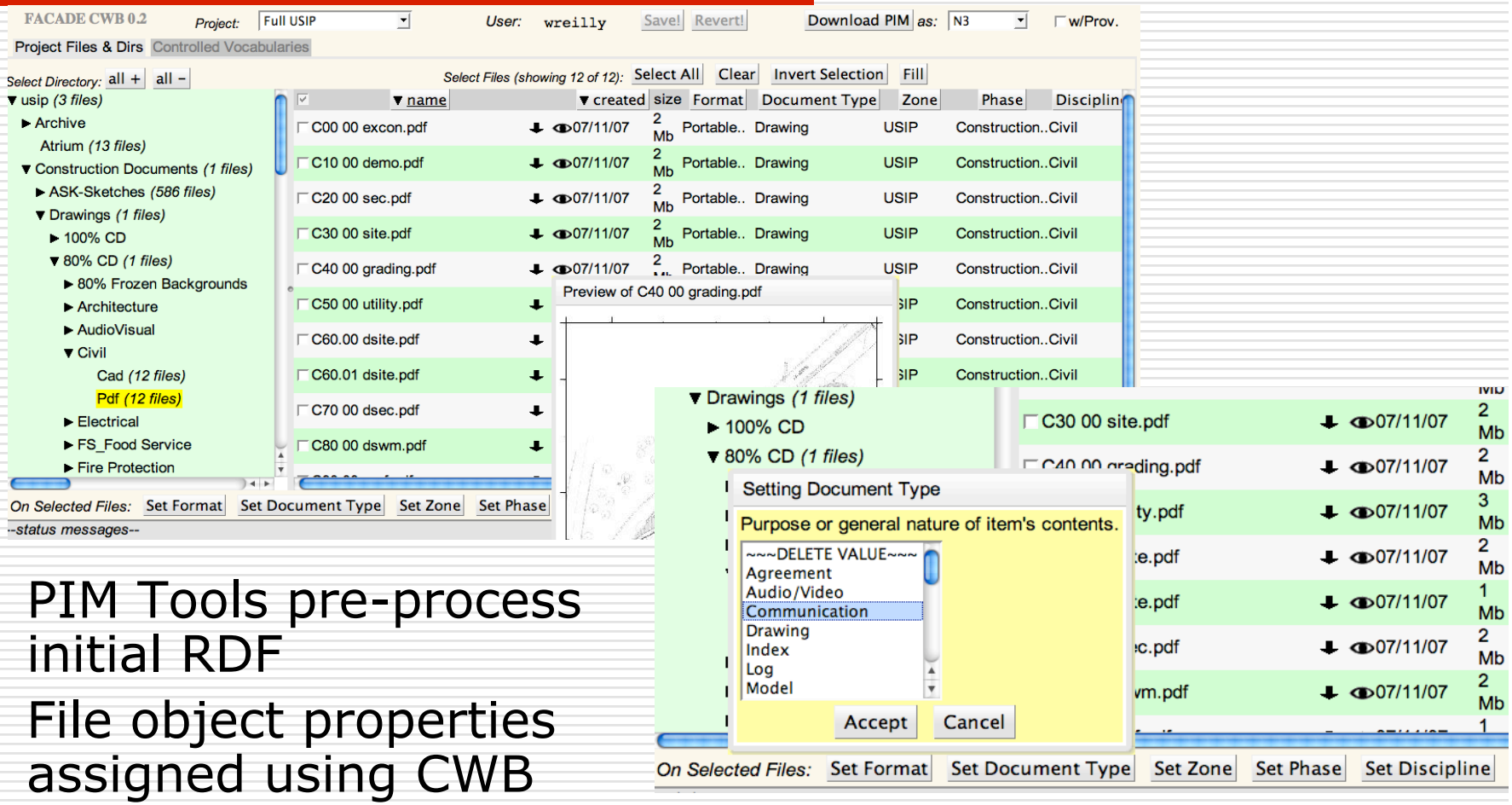
- Every *File* gets five properties
  - Project Phase
    e.g. concept, design, construction, etc.
  - Building Zone/System
    e.g. Stata Center, Gates Tower, 4th floor
  - Architectural Discipline
    e.g. architectural, electrical, mechanical, structural
  - Document Type
    e.g. presentation, drawing, 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


Preliminary Workflow
PIM - RDF
File System as Received
DIR STRUCT
Generate Initial PIM
Curators' Workbench CWB
Select Design Objects
Create Derivative Files
FILES
CWB RDF
RDF
(Handmade) RDF
PIM Tool RDF
Package Batch Import
Sesame RDF Triple Store
RDF
Longwell / User Interface
FILES PACKAGED
Archive RDF / XML
FILES Import to DSpace
DSpace
URLs to Resources

Curators' Workbench (CWB)



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

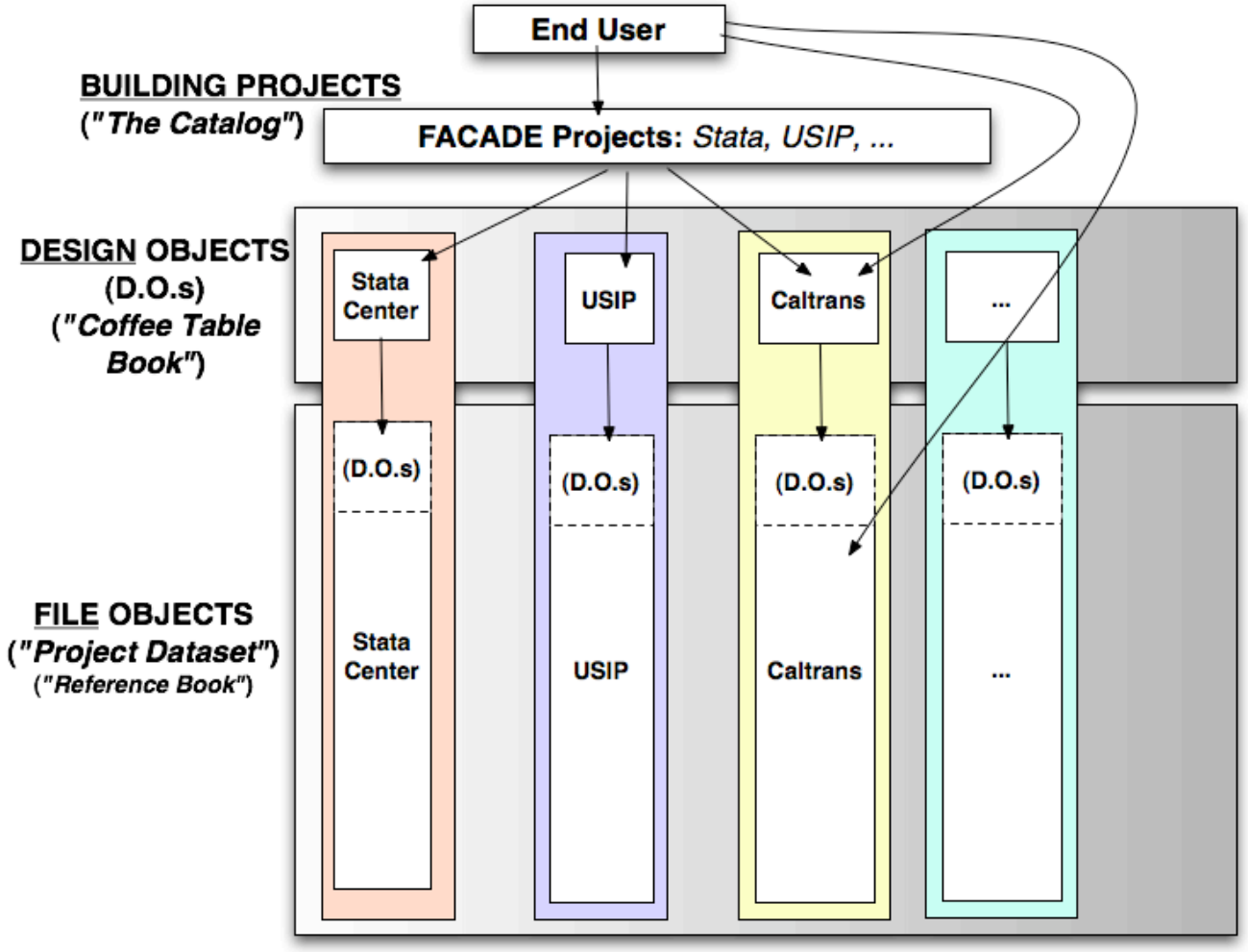
DSpace Archive

- 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



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

FACADE projects - Mozilla Firefox

File Edit View History Bookmarks Tools Help

FACADE Projects

ITEMS · MAP · TIMELINE · CAROUSEL

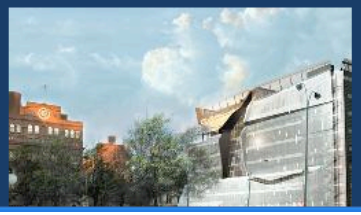
9 Projects

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 Features: Light-reactive metal skin, skip-stop elevators, public exhibition gallery.
Cost: $190,000,000
Building Type: Administrative Government Facility
Contributor: The Clark Construction Group, Inc.
Location: Los Angeles, CA, U.S.A.
Architectural Style: Interactive
Alternative names: Caltrans
Extent: 1,050,000 sq. ft.
Is built? true
Climate: Dry-Summer Subtropical Zone
Creator: Morphosis
Construction System: Structural steel 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)

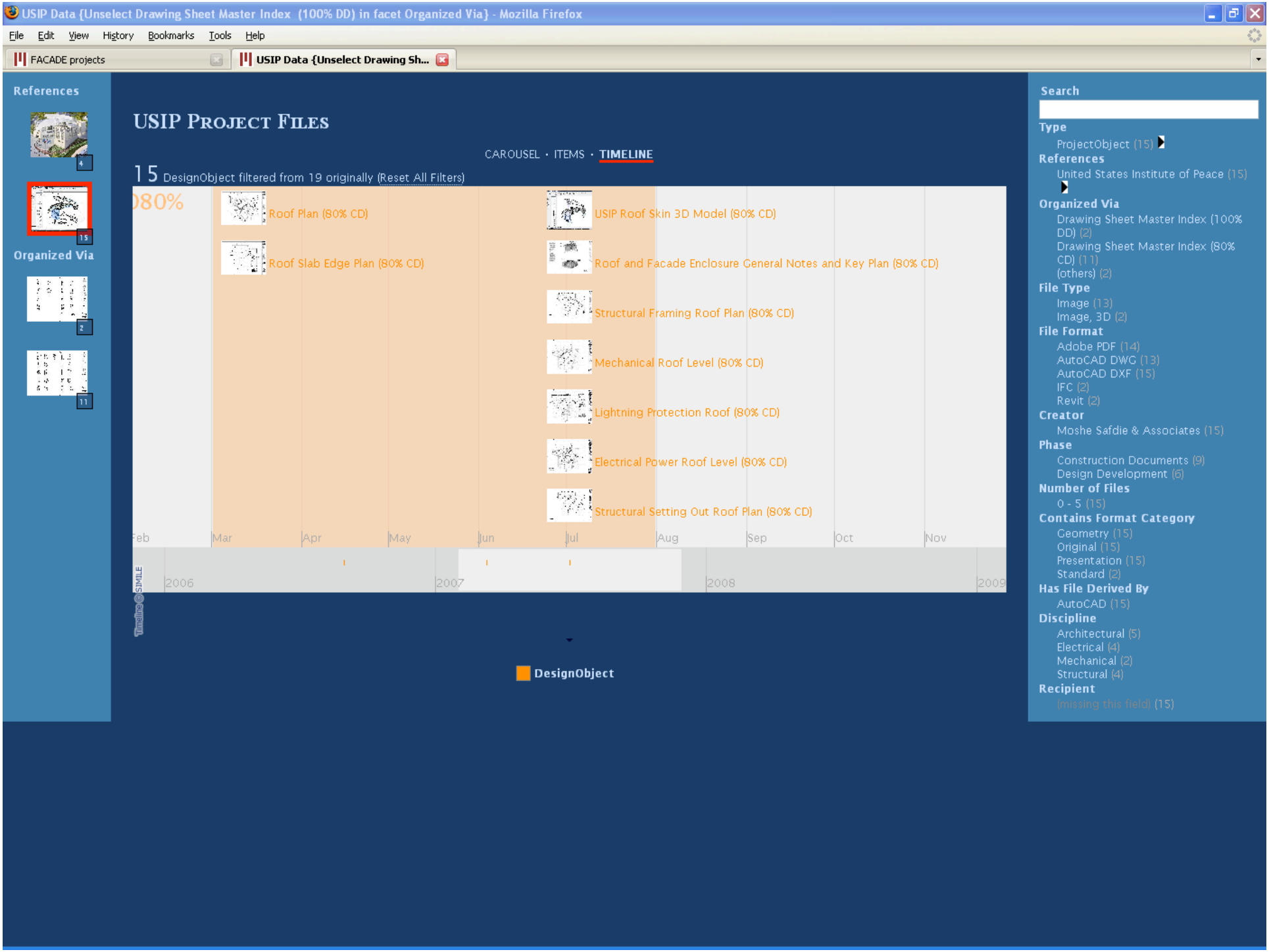
Context
- Government Campus (1)
- Small town (1)
- Urban (4)
- Urban University Campus (2)
- Urban Waterfront (1)

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)


USIP Data {Unselect Drawing Sheet Master Index (100% DD) in facet Organized Via} - Mozilla Firefox
File Edit View History Bookmarks Tools Help
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)
Roof Slab Edge Plan (80% CD)
USIP Roof Skin 3D Model (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)

Stata Data {select Carousel view} - Mozilla Firefox

File Edit View History Bookmarks Tools Help

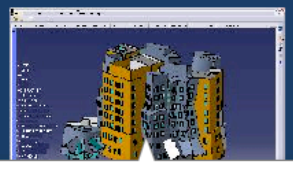
FACADE projects | Stata Data {select Carousel view}

References

Organized Via

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)

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)

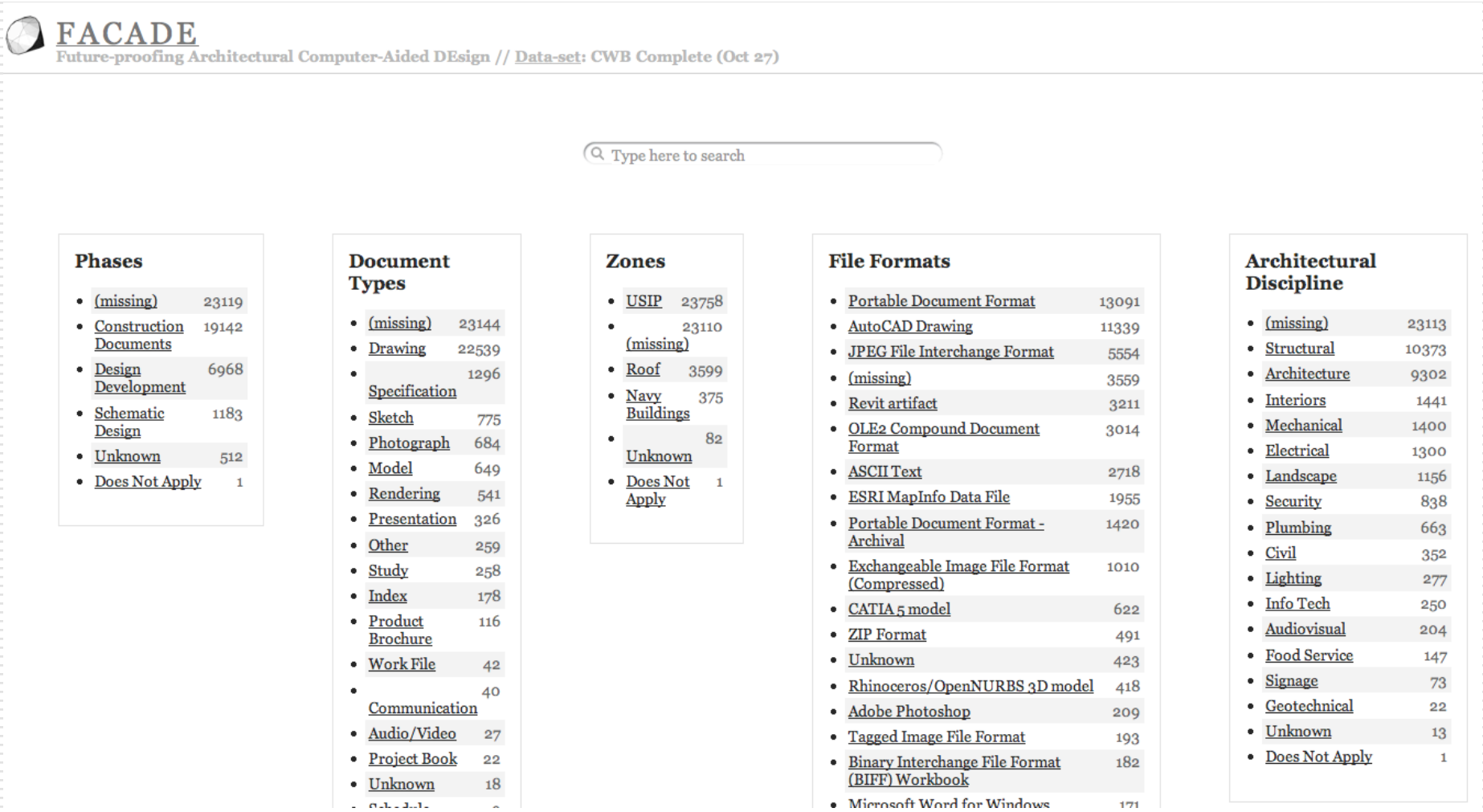
Contains Format Category
- (missing this field) (4)
- Geometry (4)
- Original (7)
- Presentation (4)
- Standard (2)

Has File Derived By
- (missing this field) (7)
- AutoCAD (2)
- CATIA v5 (2)

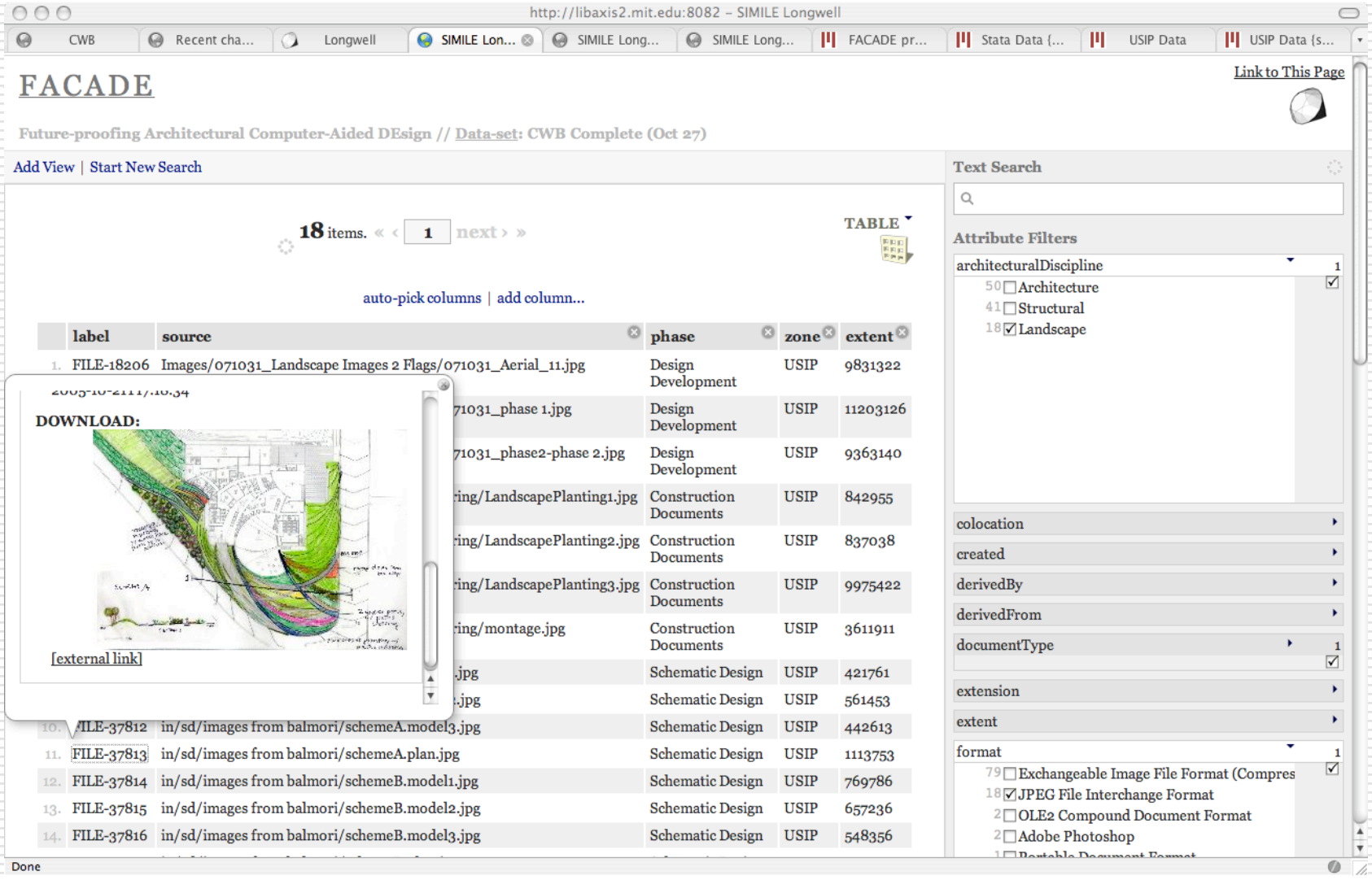
Discipline
- (missing this field) (7)
- Architectural (4)

Recipient
- (missing this field) (6)

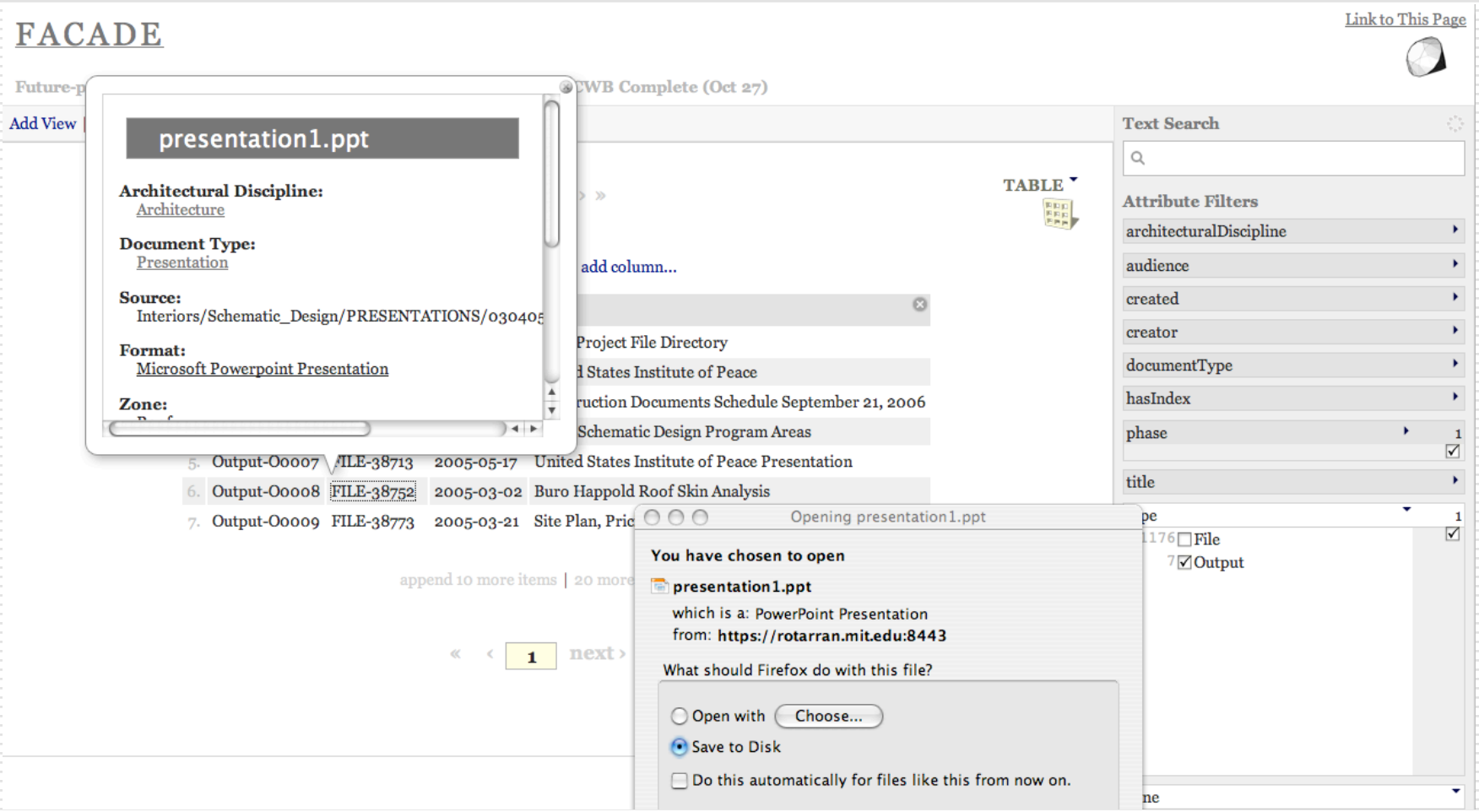
Longwell, "Starting Points"



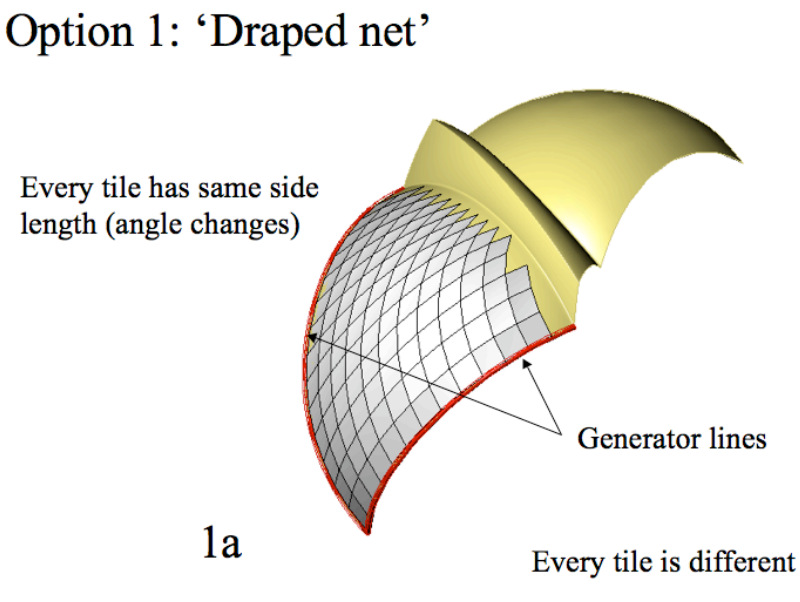
Longwell, Table w. Popup

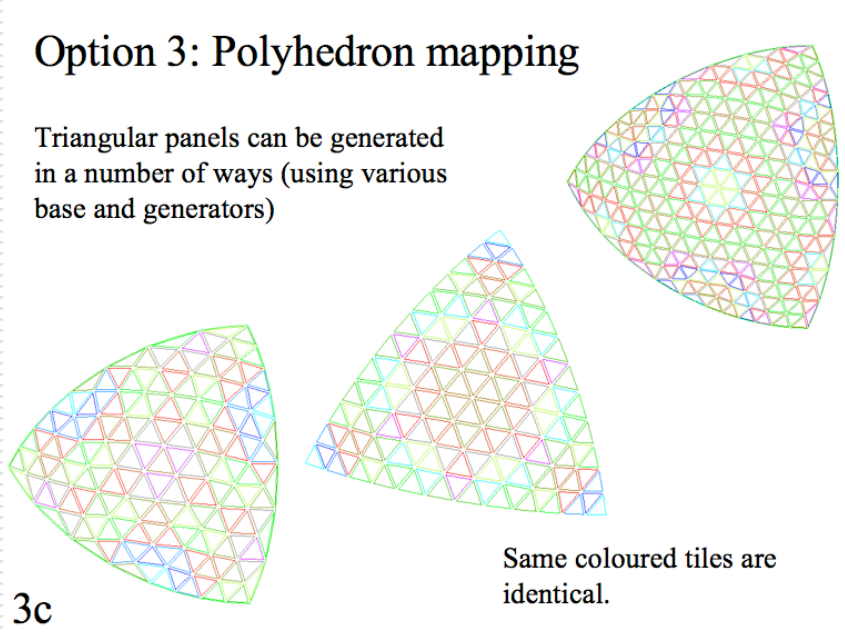


“Presentation” 0008 (.PPT)



Client Presentation Design Object O-0008 (.PPT)





Moshe Safdie Assoc. presentation1.ppt

Mall, Washington DC

Moshe Safdie Assoc. NCPC_03_06.ppt

View, without USIP Building…

Moshe Safdie Assoc. NCPC_03_06.ppt

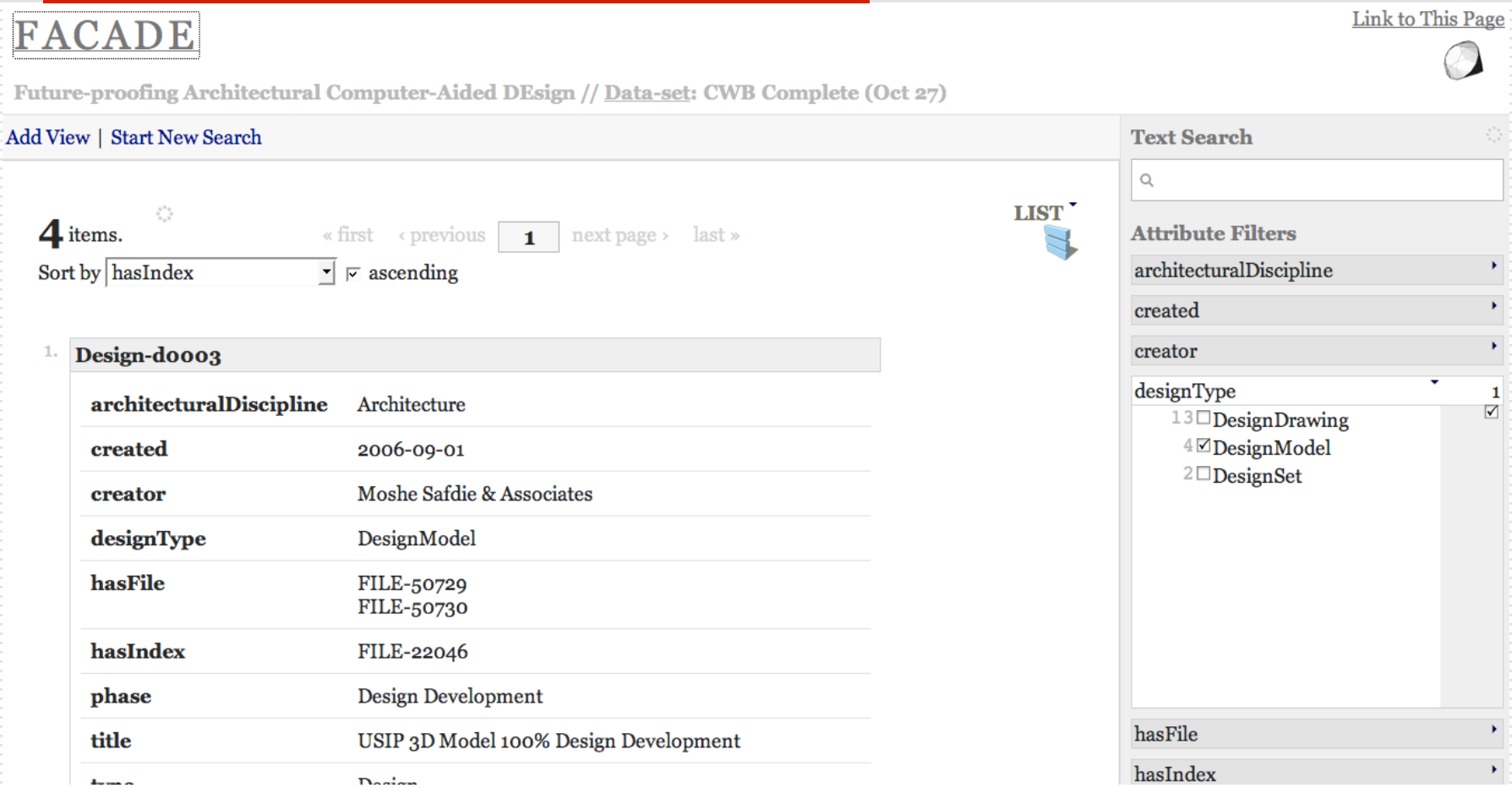
A: View from West Potomac Park, South of USIP adjacent to Lincoln Memorial without USIP building

There it is!

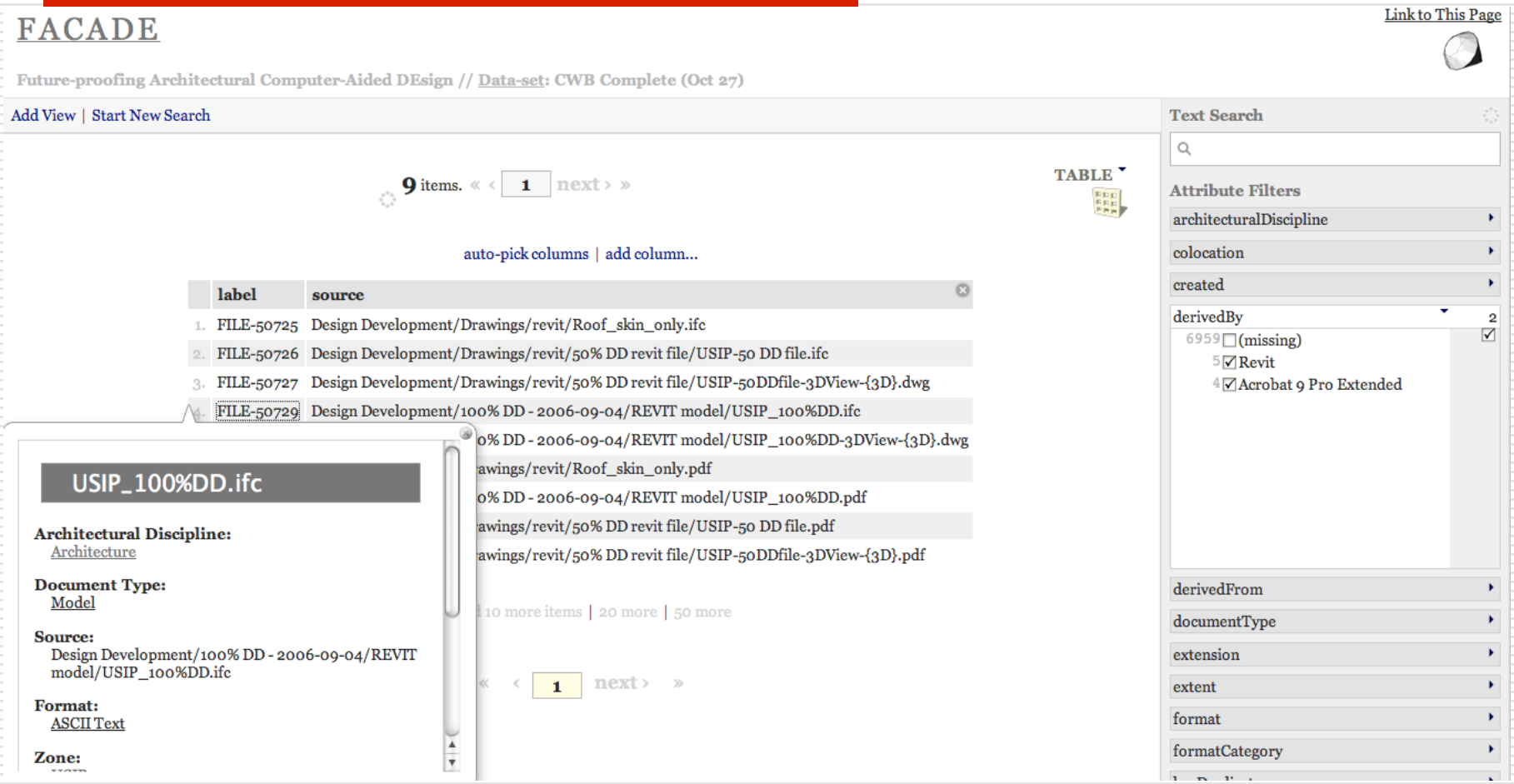
Moshe Safdie Assoc. NCPC_03_06.ppt

A: View from West Potomac Park, South of USIP adjacent to Lincoln Memorial

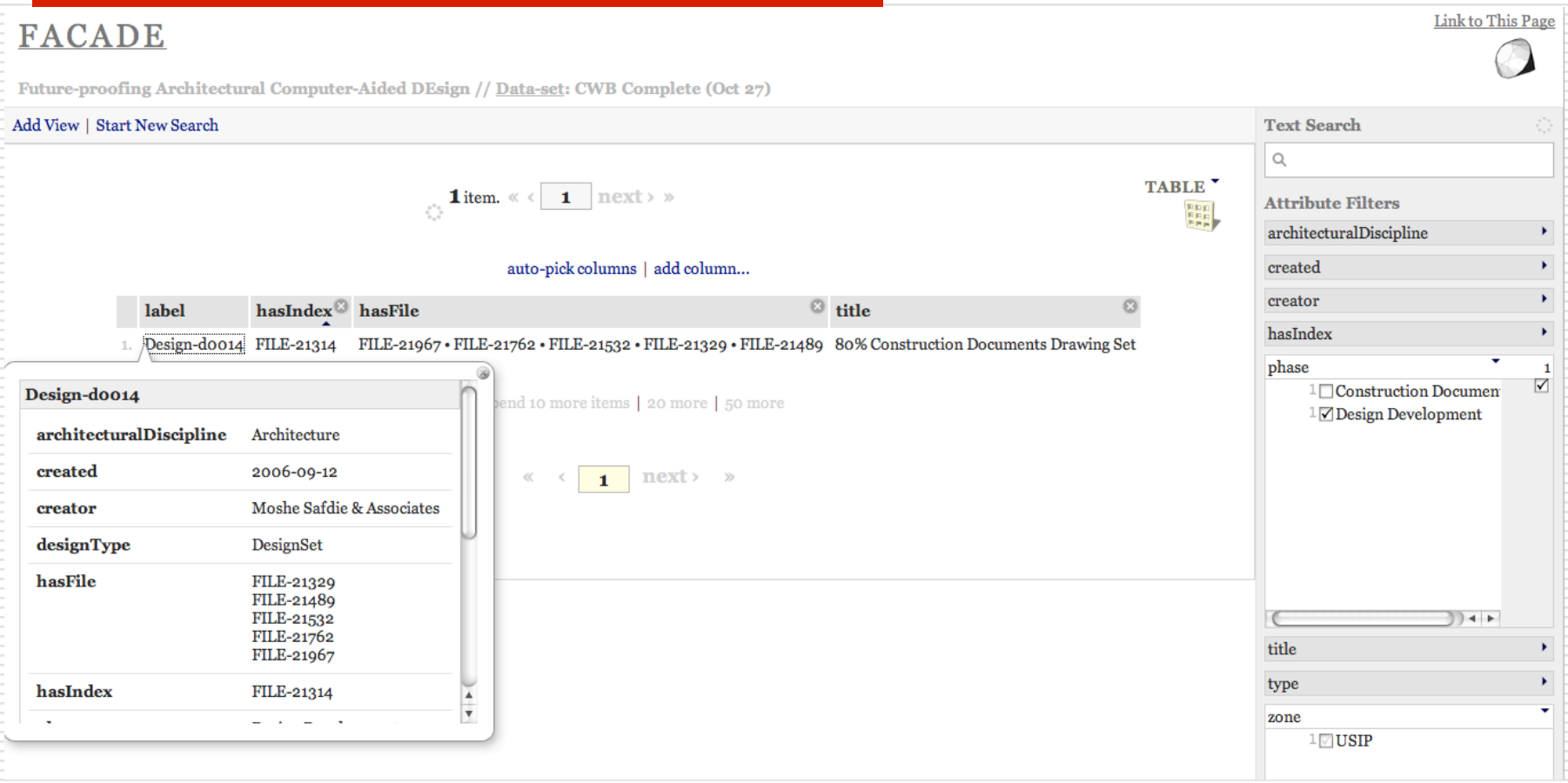
Design Model (d0003)



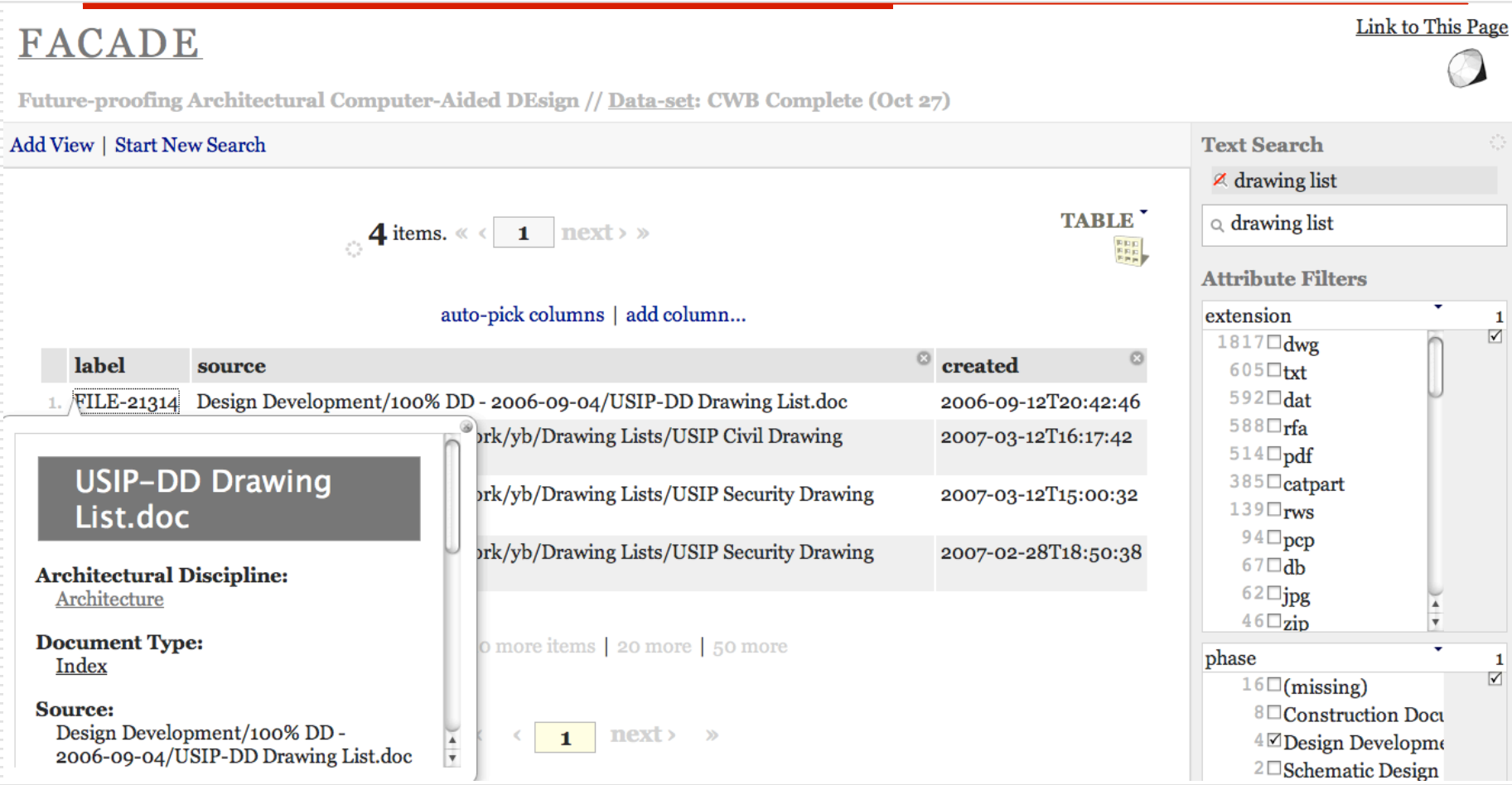
Derivative File .IFC (50729)



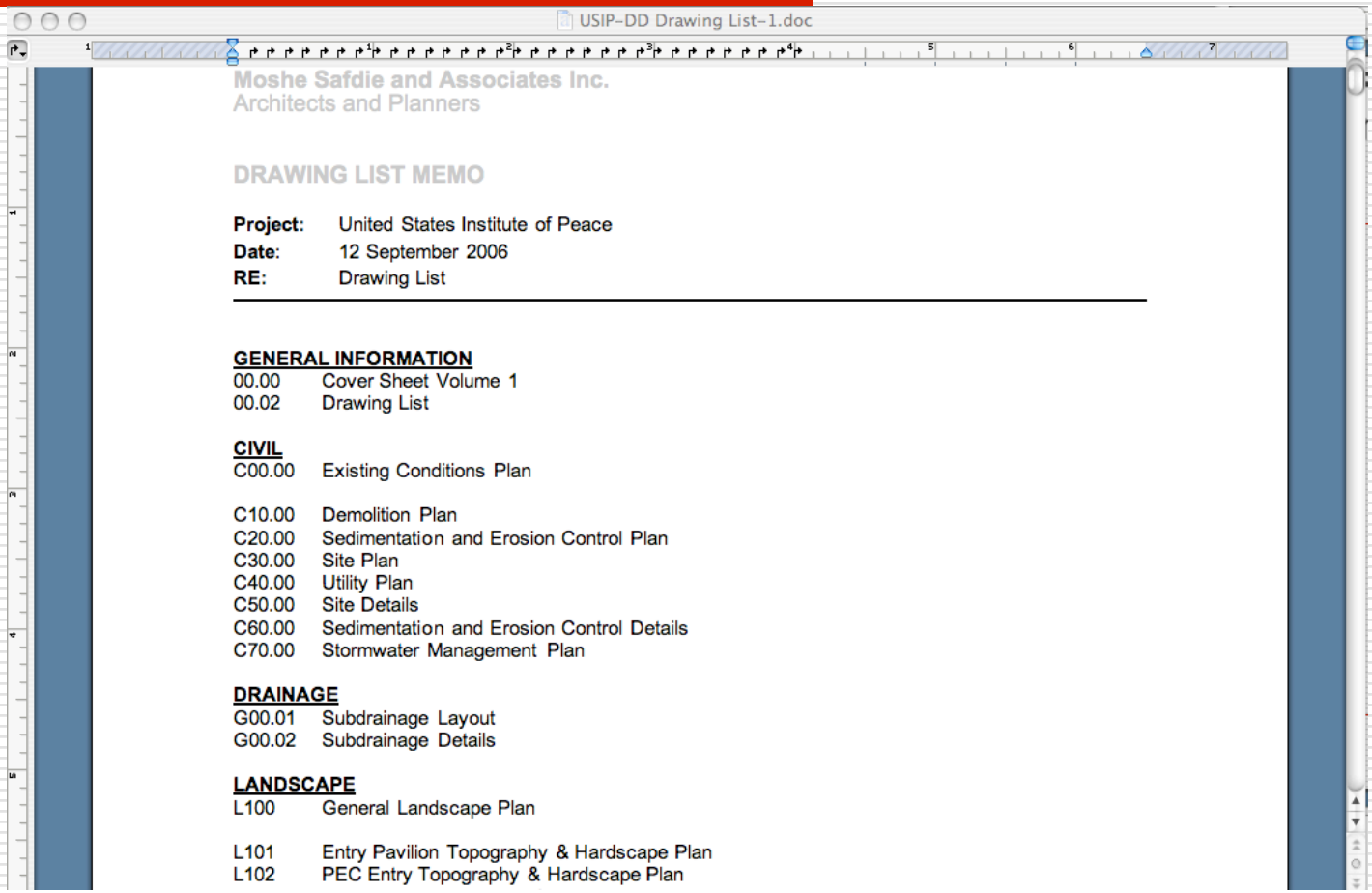
Design Set (d0014)



Index File to Design Set (21314)



Word .DOC Index to .DWGs



USIP-DD Drawing List-1.doc

Moshe Safdie and Associates Inc.
Architects and Planners

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
C00.00 Existing Conditions Plan

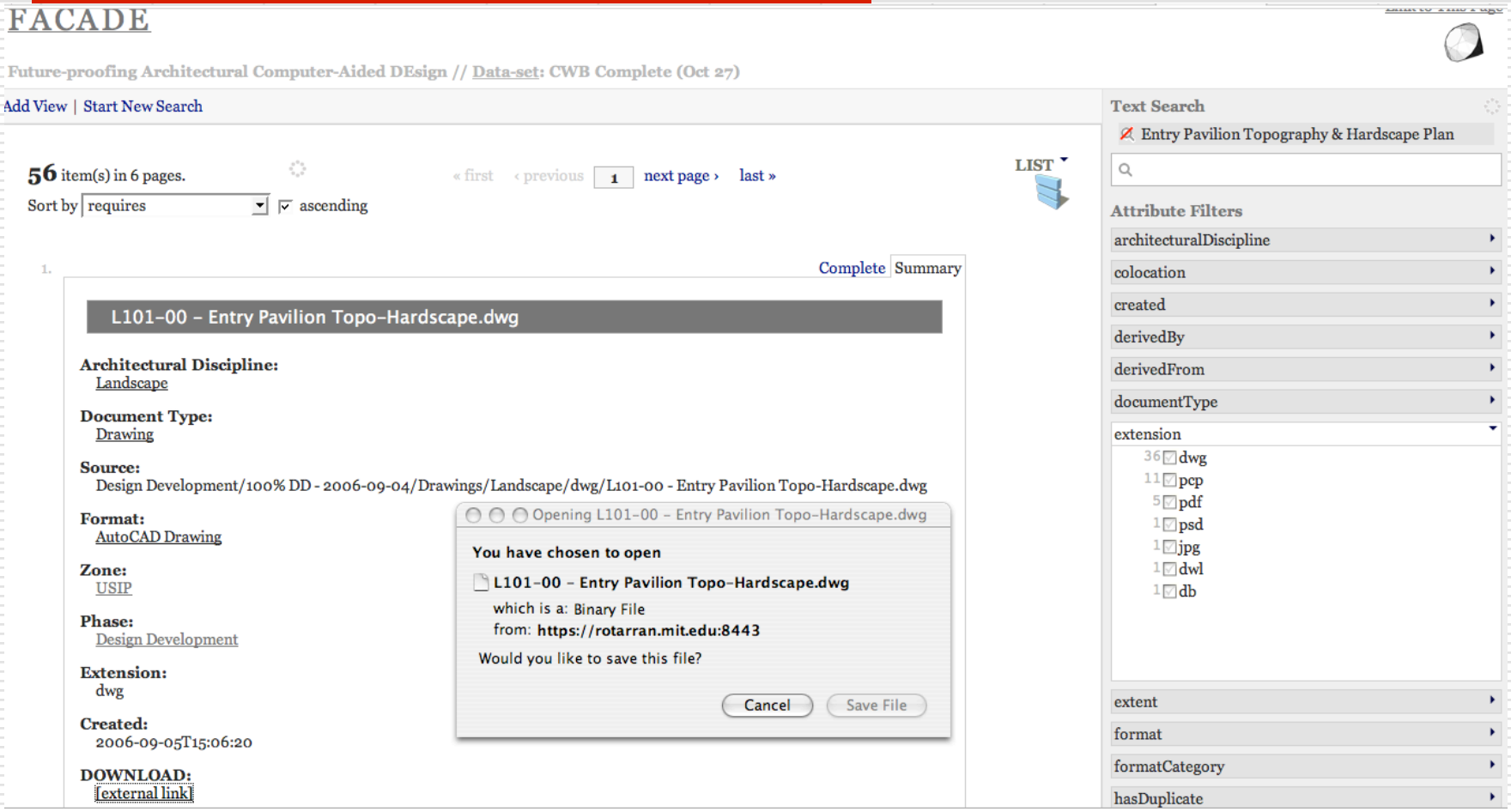
C10.00 Demolition Plan
C20.00 Sedimentation and Erosion Control Plan
C30.00 Site Plan
C40.00 Utility Plan
C50.00 Site Details
C60.00 Sedimentation and Erosion Control Details
C70.00 Stormwater Management Plan

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

- 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**

Contents of Talk *(review)*

- 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

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

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.

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