


The logo consists of the text 'EaaS!' in white, with a blue exclamation mark. It is enclosed within a grey circle, which is itself inside a larger, semi-transparent white circle. The background of the slide is dark blue with a pattern of white dots and lines.

EaaS!

3D models and Emulation

A series of five concentric white circles on the right side of the slide.

Euan Cochrane
PI for the EaaSI program
of work &
Digital Preservation
Manager at
Yale University Library



Overview

- Context
- Emulation, virtualization, containerization
- 3D models and emulation
- Challenges of emulation
- Benefits of Emulation and EaaS
- Getting started with Emulation

Emulation, Virtualization and Containerization

Emulation = “ an **emulator** is hardware or software that enables one computer system (called the *host*) to behave like another computer system (called the *guest*). An emulator typically enables the host system to run software or use peripheral devices designed for the guest system.”

Virtualization = emulation but with compatible hardware
(*some of the host machine's hardware is used directly by the “virtualized” computer*)
Virtualization bridges the gap between departure of recently obsolete hardware and the arrival of hardware powerful enough to emulate it

Containerization = virtualization at the Operating system level – some parts of the OS are replicated for use by each “container”



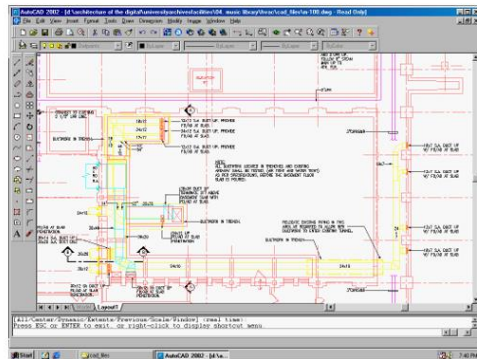
**Emulation is
a natural fit
for 3D
models**

Properties of 3D models

- Digital objects that lend themselves to **interaction** (e.g. rotation, zooming, etc)
- Digital objects that are **complex** often **dependent on with highly proprietary software** that has a continually and rapidly **evolving feature-set**
- Digital objects that may have **multiple dependencies** including on disparate data sources and other proprietary applications, add-ons and systems



Emulation for 3D models



Irving S. Gilmore Music Library Renovation 1992-1998

Yale University Library Manuscripts and Archives

AutoCAD files related to the 1992-1998 renovation of the Irving S. Gilmore Music Library within the Sterling Memorial Library building at Yale University.

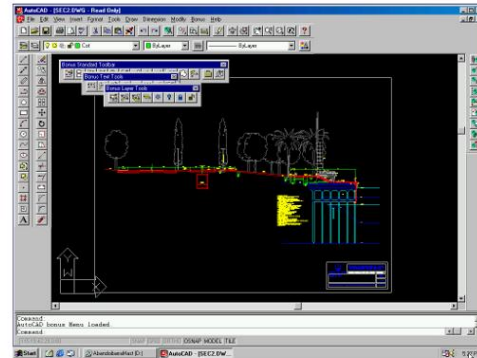
Files are made accessible using an emulated Pentium 2 PC environment running Windows 98 with AutoCAD 2002 installed.

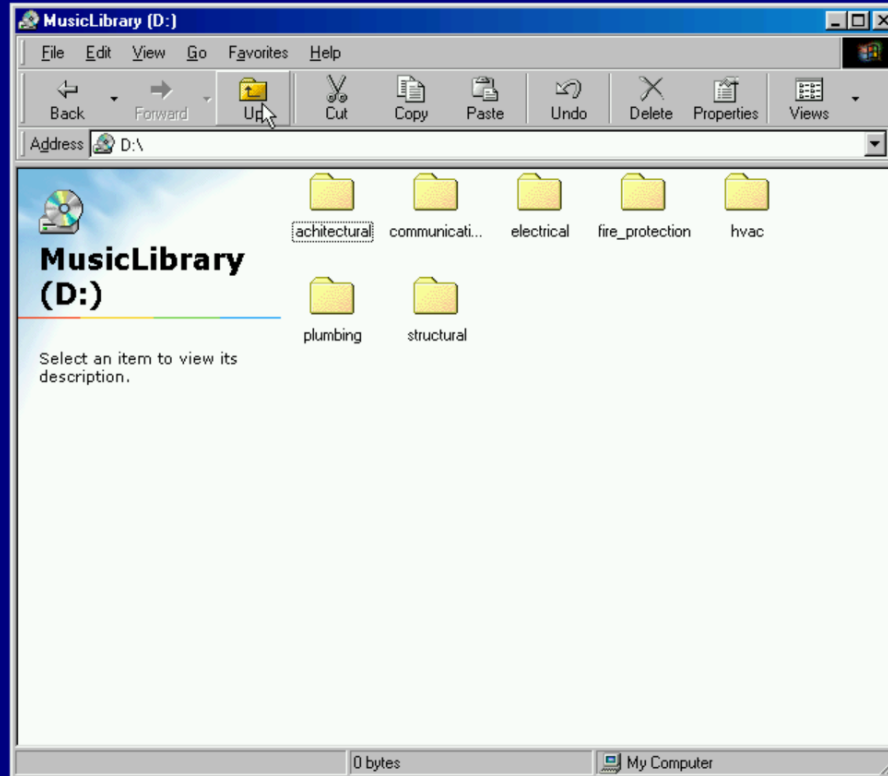
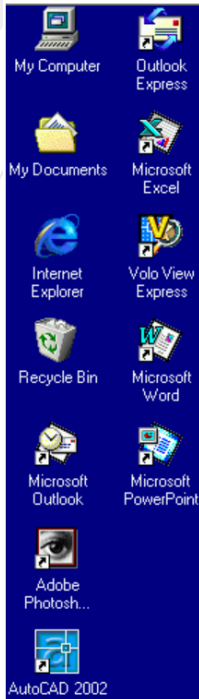
Balmori Associates Abandoibarra Master plan 1993-2012

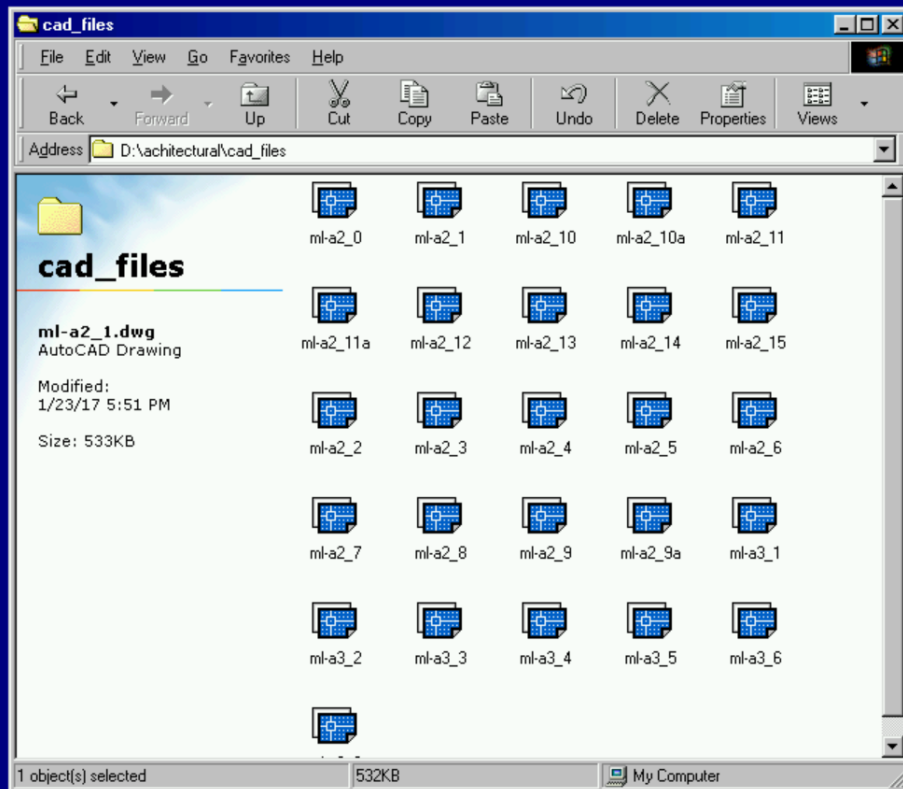
Yale University Library Manuscripts and Archives

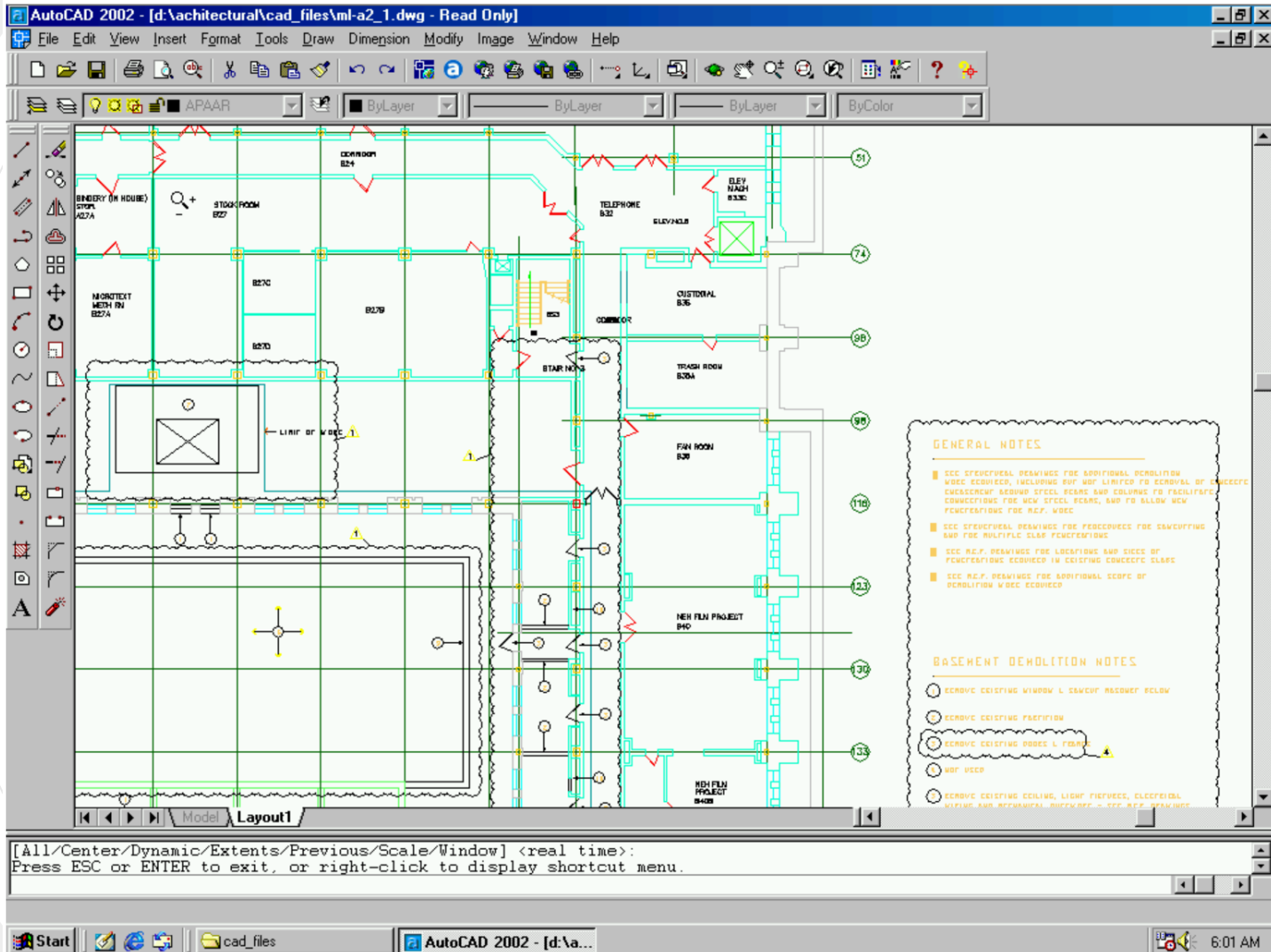
AutoCAD files created by Balmori Associates who developed the award-winning regeneration Master Plan for Abandoibarra that was implemented over the 1993-2012 period.

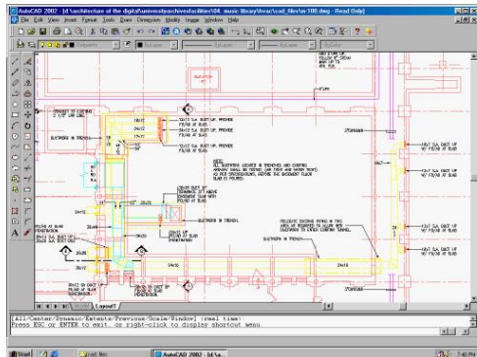
Available files cover the 1997-1999 period and made accessible using an emulated Pentium 2 PC environment running Windows 98 with AutoCAD R14.











Irving S. Gilmore Music Library Renovation 1992-1998

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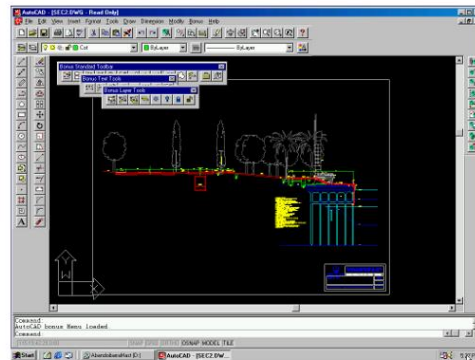
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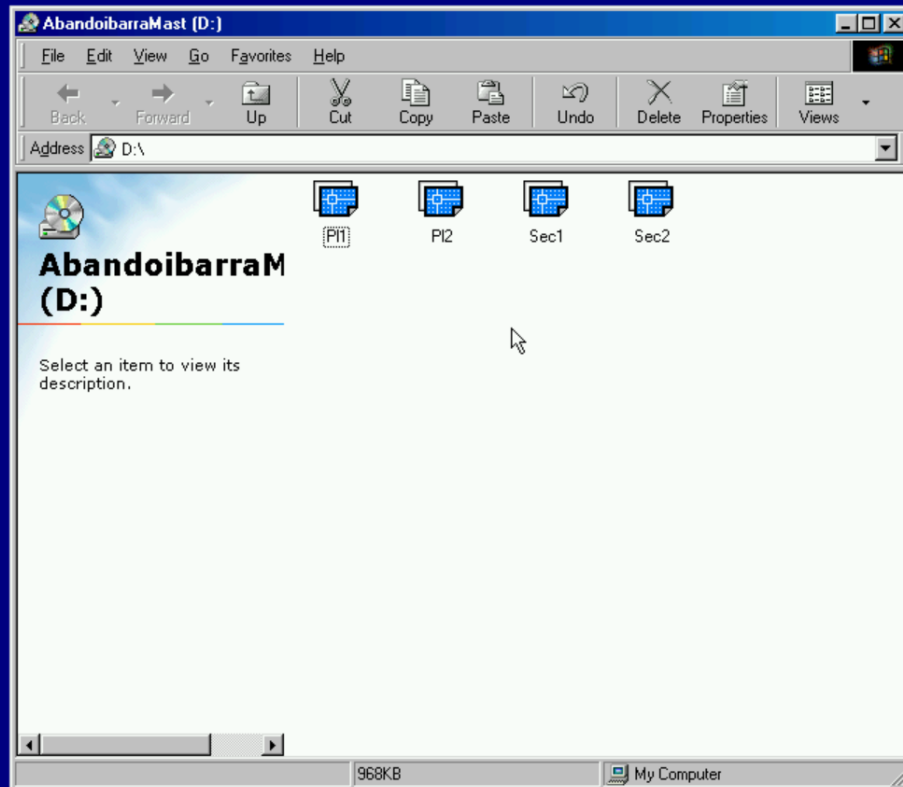
Balmori Associates Abandoibarra Master plan 1993-2012

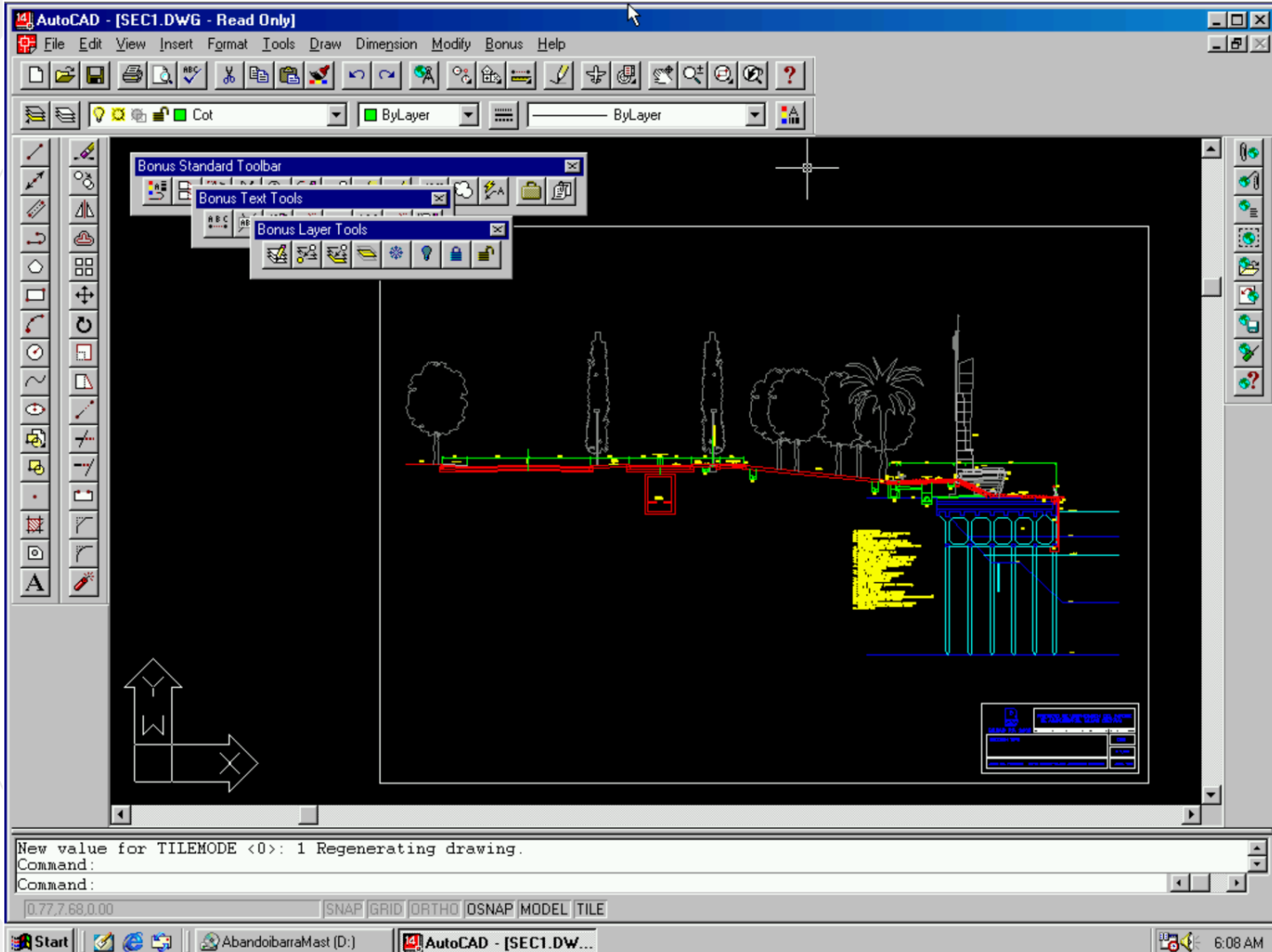
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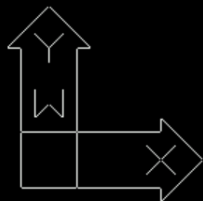


Layer 0

6.6383,4.5471

AutoCAD
* * * *
ASE
BLOCKS
DIM:
DISPLAY
DRAW
EDIT
INQUIRY
LAYER...
MODEL
MVIEW
PLOT...
RENDER
SETTINGS
SURFACES
UCS:
UTILITY

SAVE:



Loaded menu C:\ACAD\SUPPORT\ACAD.mnx
AutoCAD Release 12 menu utilities loaded.
Command:

le ●

File Assist Draw Construct Modify View Settings Render Model

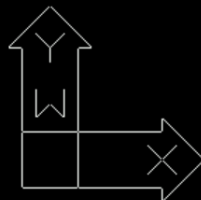
New...
Open...
Save...
Save As...
Recover...

Plot...

ASE
Import/Export
Xref

Configure
Compile...
Utilities...
Applications...

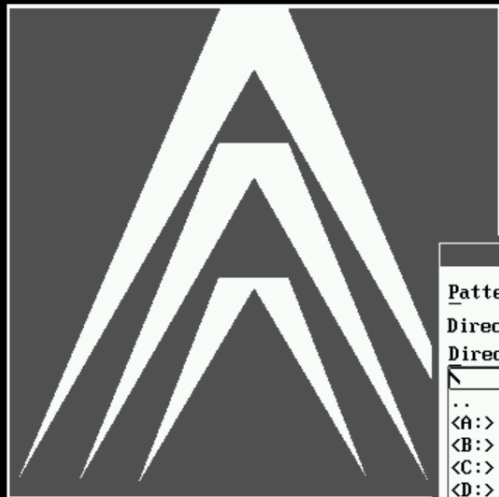
About AutoCAD...
Exit AutoCAD



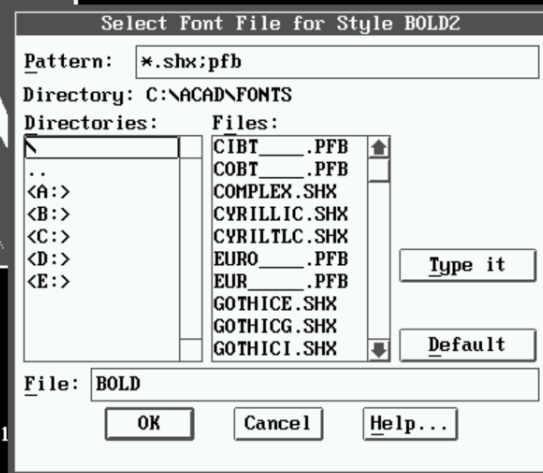
Loaded menu C:\ACAD\SUPPORT\ACAD.mnx
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Command:

AutoCAD
* * * *
ASE
BLOCKS
DIM:
DISPLAY
DRAW
EDIT
INQUIRY
LAYER...
MODEL
MVIEW
PLOT...
RENDER
SETTINGS
SURFACES
UCS:
UTILITY

SAVE:



A U T O C A D (R)
Copyright (c) 1982-92 Autodesk, Inc.
Release 12 (6/21/92) 386 DOS Extender
Serial Number: 110-10288105
Licensed to: Matula, Galasoft
Obtained from: Galavics Andr?s - 1111



121'-9", 30'-6 3/32"

ASE

BLOCKS

DIM:

DISPLAY

DRAW

EDIT

EDIT
INQUIRY

**INQUIRY
LOUED**

LAYER... MODEL

MODEL
MUSEUM

NOTES

Plot...

RENDER

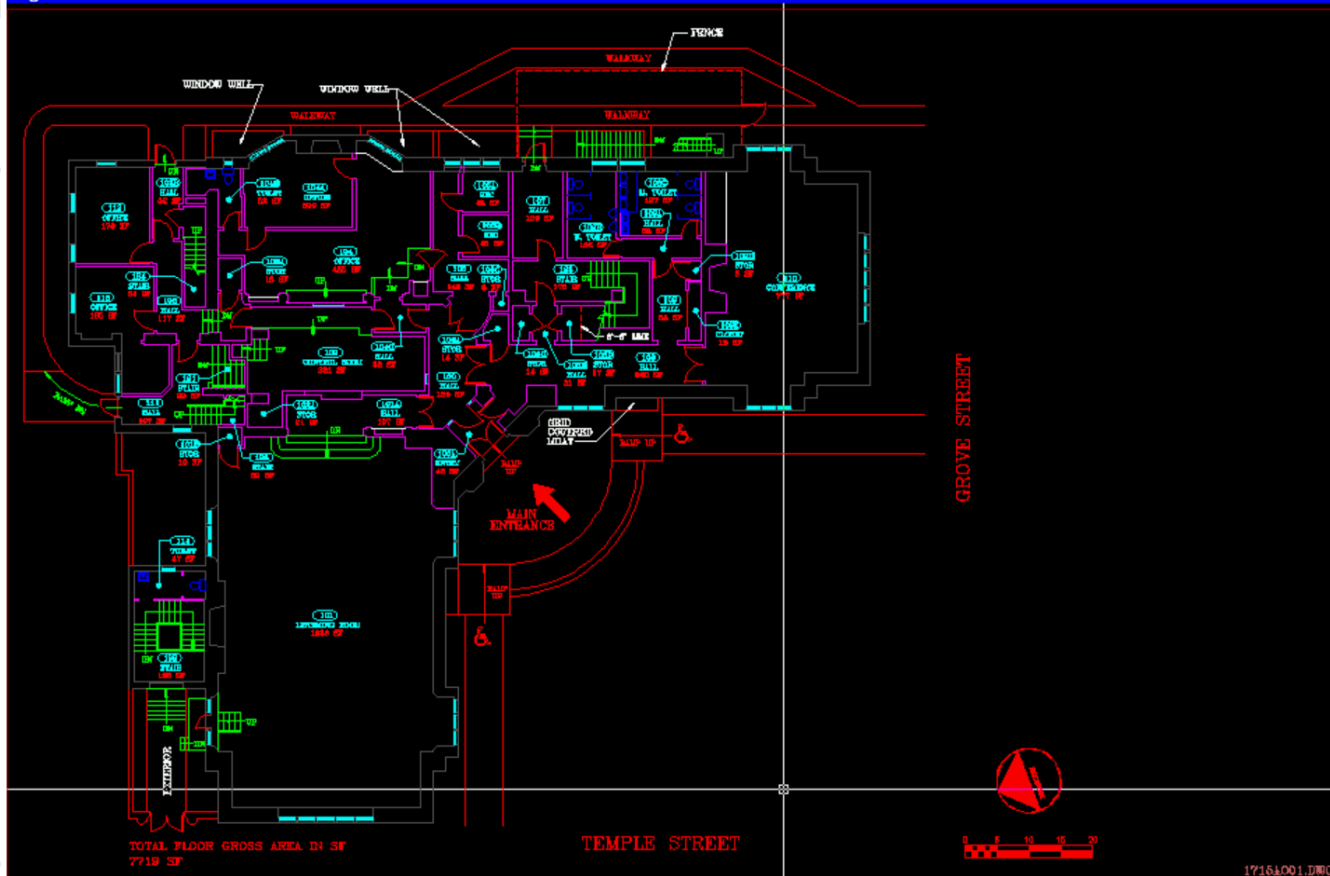
SETTINGS

SURFACES

UCS:

UTILITY

SAVE:



109 GROVE Title: First floor plan

109-111 Grove

Sheet 1/20"=1'-0" Date: 06/30/9

```
Loaded menu C:\ACAD\SUPPORT\ACAD.mnx
AutoCAD Release 12 menu utilities loaded.
Command:
```

le ●

Citation and usability with “snapshots”

Environments



Software

Objects

UVI

Networks

Import Environment

Create Environment

Import Container

OAI PMH

Settings

Emulators

Environments

Virtual machines

Object Environments

Containers

Container Runtimes

Number of Environments: 2

Page Size: 10 ▼

zoomed

	Name ↑	ID	Own...	ObjectID	Actions
<input type="checkbox"/>	Zoomed DWG Snapshot	7ce085...	shared	68348093-28f7-4a6...	Choose action ▼

[1] to [1] of [1] < > Page [1] of [1] < >



Preserving complex, networked systems



Change media



Save



Detach



Restart



Stop



Screenshot



Keyboard

Switch View



Esc



Ctrl-Alt-Del



Universal

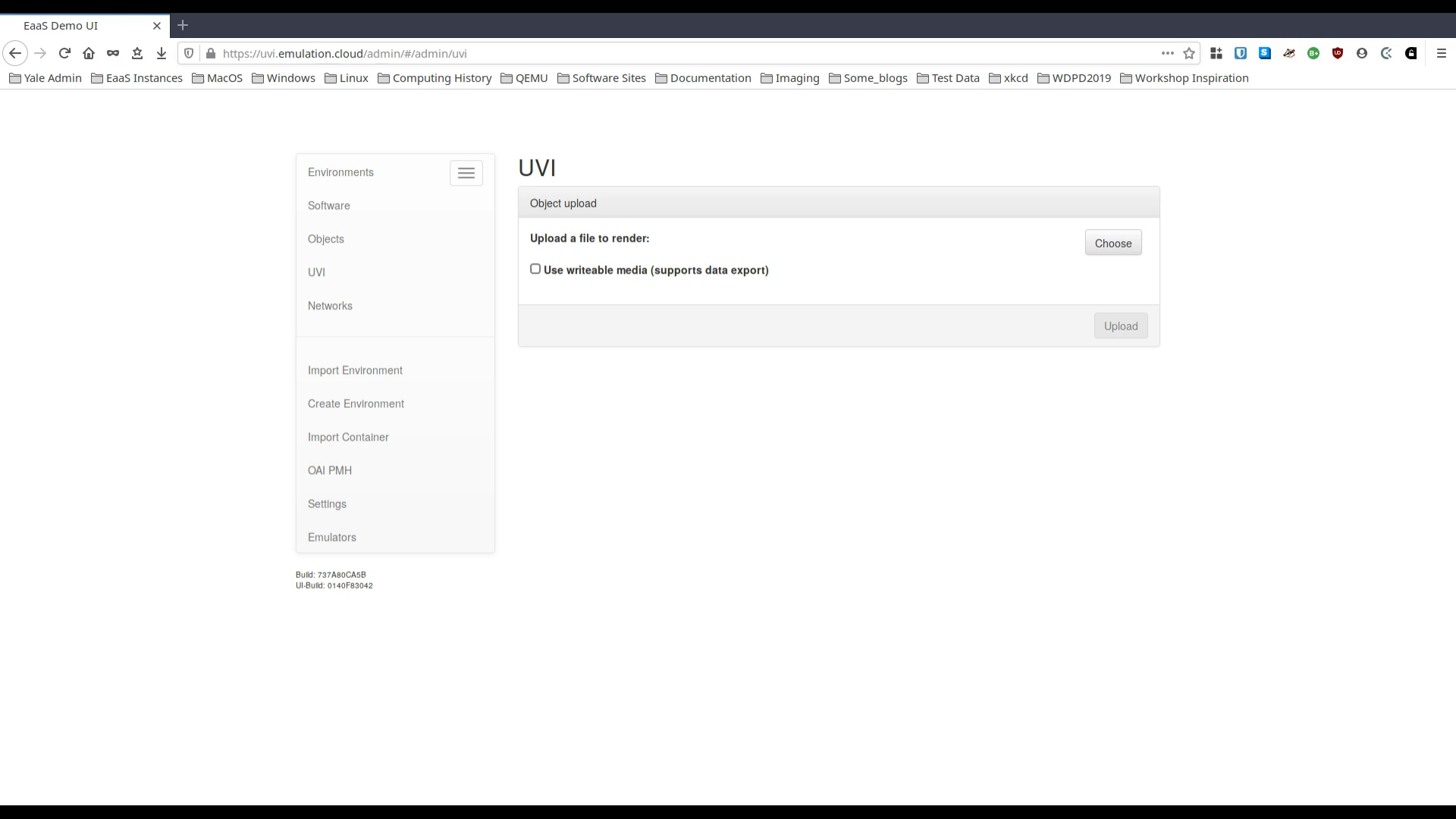
- it is intended to be able to be "universal" and (theoretically) work with any files/digital objects.

Virtual

- A homage to the Universal Virtual Computer (UVC) concept developed by IBM and the Koninklijke Bibliotheek, KB

◦ Interactor

- Rendering and viewing are primarily passive activities but digital object experiences are not passive, they're interactive



Environments



Software

Objects

UVI

Networks

Import Environment

Create Environment

Import Container

OAI PMH

Settings

Emulators

UVI

Object upload

Upload a file to render:

Choose

☐ Use writeable media (supports data export)

Upload

Build: 737A80CA5B
UI-Build: 0140F83042



Emulation Challenges

- Emulators are difficult to install, configure and scale up access to
- Legacy software can be hard to find, install and configure
- Old software can be challenging for modern users to understand
- Intellectual property concerns can deter decision-makers



The image features a large, dark blue background with several concentric white circles. In the center, the text "EaaS!" is displayed in a white, sans-serif font. The exclamation mark is stylized with a blue vertical bar and two blue dots.

EaaS!



Program Goal

To scale up access to
emulation and software
preservation infrastructure



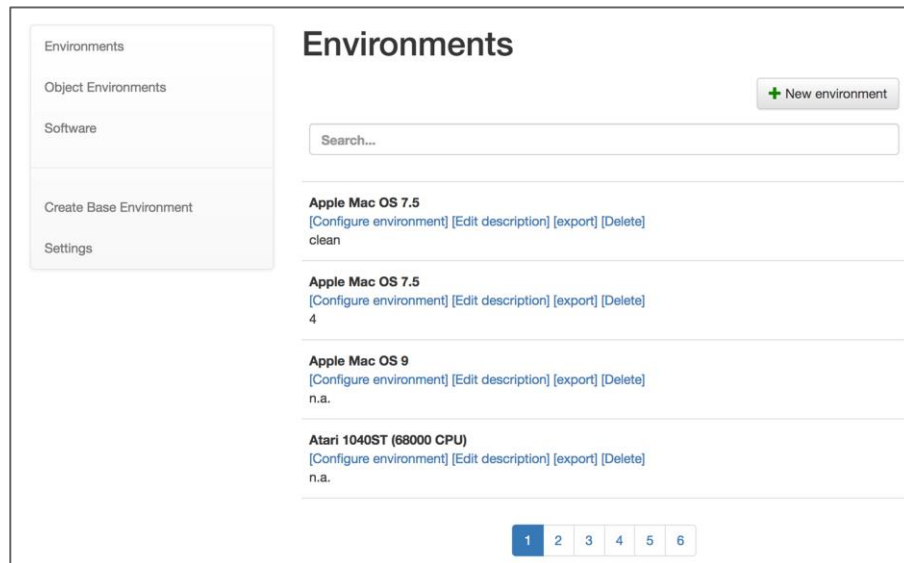
Building on bwFLA Emulation as a Service (EaaS)

What is Emulation-as- a-Service?

Simplifies access to various emulators



**Enables
management of
persistent, citable
emulation
environments**



Derivatives enable storage savings



"Base"
Environment
(e.g. Windows XP)

5 GB
(Compressed)



Derivative x1
(e.g. Windows XP + SPSS 13)

150MB



Derivative x1.1
(e.g. Windows XP + SPSS 13 + SPSS code)

1MB



Derivative x2
(e.g. Windows XP + STATA 8.2)

250MB



Derivative x3
(e.g. Windows XP+ STATA 8.2 + STATA code)

1MB



Derivative x3
(e.g. Windows XP + R 2.0.0)

50MB

Distributed Mgmt

- A network of distributed nodes, each contributing to the EaaSI service and the software development roadmap.



Simplifies access to preserved software

- In-network sharing of software images and configured environments.
- Yale University Library is configuring and sharing at least 3000 pre-configured software applications running in configured environments.

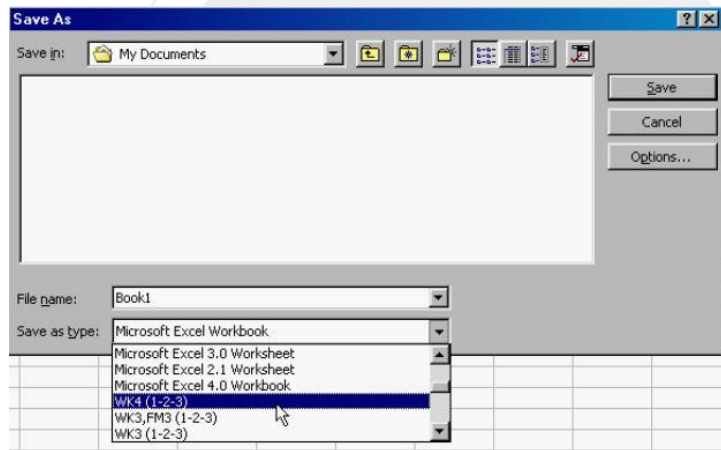


(2D) CAD software already in the EaaSI network

Name ↑	
<input type="checkbox"/>	MS-DOS 6.22 + DesignCAD 2D 3.0
<input type="checkbox"/>	MS-DOS 6.22 + DesignCAD 2D 5.0
<input type="checkbox"/>	MS-DOS 6.22 + FoxPro 2.0
<input type="checkbox"/>	MS-DOS 6.22 + Generic CADD 6.0
<input type="checkbox"/>	WFWG 3.11 + TurboCAD_for_Windows_1.0
<input type="checkbox"/>	Windows 95 + TurboCAD for Windows 3.01
<input type="checkbox"/>	Windows XP + DesignCAD v22 - 181351
<input type="checkbox"/>	Windows XP 32 Bit + R 2.9.1 + ArchiCAD 7.0
<input type="checkbox"/>	Windows XP Professional 2002 SP3 32 Bit - Base V2 + TurboCAD Designer 2D 17.0 - 10173
<input type="checkbox"/>	Windows XP Professional 2002 SP3 32 Bit Base V1 + AutoCAD LT 2006 - 5788
<input type="checkbox"/>	Windows XP Professional 2002 SP3 32-bit - Base V2 + AutoCAD 2005 11995
<input type="checkbox"/>	Windows98 AutoCAD 2002 R14 Photoshop Pagemaker Office
<input type="checkbox"/>	DOS AutoCAD R12
<input type="checkbox"/>	Ubuntu 10.10 + FreeCAD 0.10
<input type="checkbox"/>	Ubuntu 8.04 + QCad C.E. 2.0.5.0
<input type="checkbox"/>	Windows 98 Second Edition (SE) Base - V2 + AutoCAD 2000 13086

Documentation/ Discovery

- Incorporating services developed by Wikidata for Digital Preservation
- Comprehensive, open, machine-readable documentation
- Defining profile for description of software and computer environments



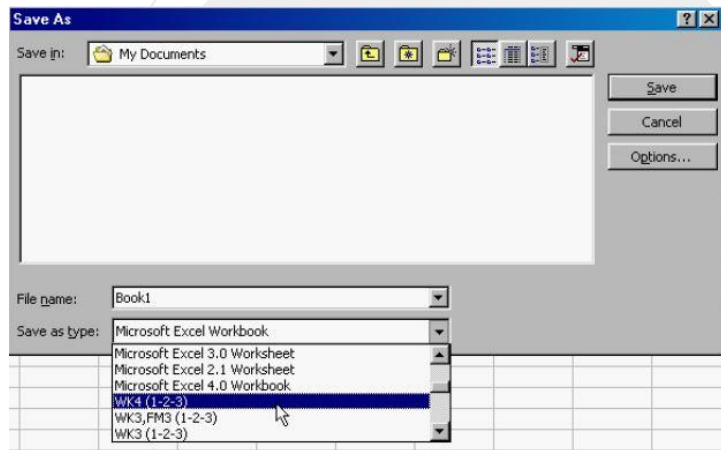
Documentation/ Discovery

Corel Presentations 11 “Open” file operation formats:

Adobe Photoshop bitmap (*.psd), AutoCAD (*.dxf), CALS bitmap (*.cal), CompuServe bitmap (*.gif), Corel PHOTO-PAINT Image (*.cpt), Corel Presentations (*.shw, *.wpg), Corel Presentations Master (*.mst), CorelDRAW File (*.cdr, *.pat), CorelDRAW Template (*.cdt), Encapsulated Postscript (*.eps), Enhanced Windows Metafile (*.emf), Freelance Graphics (*.pre), GEM Paint bitmap (*.img), Harvard Graphics (*.prs, *.ch3, *.sh3, *.sy3, *.tp3), Hewlett-Packard Graphics Language (*.hpg, *.plt), JPEG bitmap (*.jpg, *.jpeg), Kodak Photo CD (*.pcd), Lotus PIC (*.pic), MS PowerPoint (*.ppt), MacPaint bitmap (*.mac), Macintosh PICT (*.pct), Micrografx Designer (*.drw), PC Paintbrush bitmap (*.pcx), Portable Network Graphics (*.png), Scalable Vector Graphics (*.SVG), Scitex CT bitmap (*.sct), TIFF bitmap (*.tif), Truevision Targa bitmap (*.tga), Windows Metafile (*.wmf), Windows bitmap (*.bmp), WordPerfect Document (*.wpd)

Documentation/ Discovery

- Incorporating services developed by Wikidata for Digital Preservation
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Access

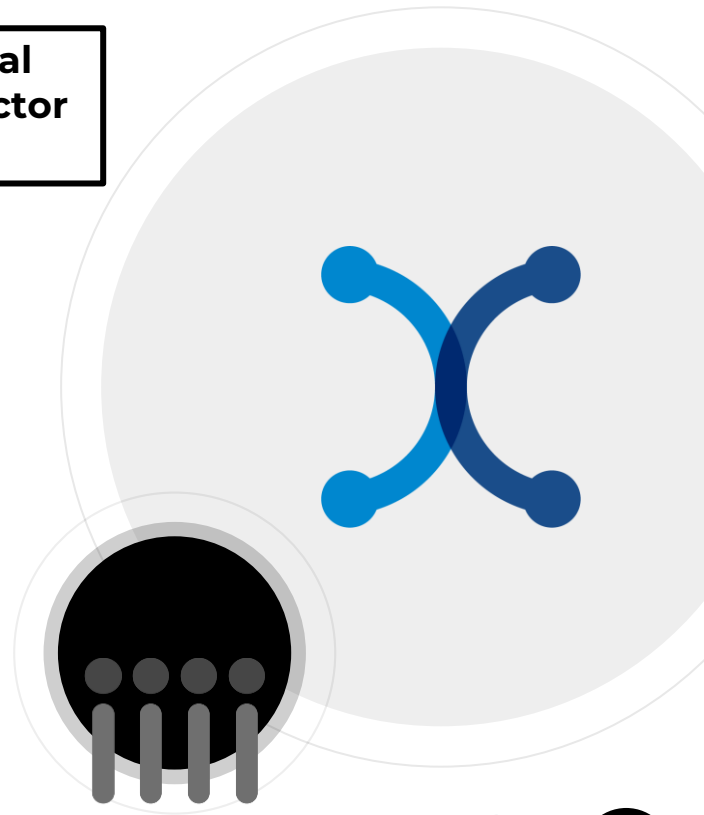
- Emulated CD-ROM environment sharing service
- Virtual Reading Rooms Service
- Scientific Software Portal
- API to enable automatic interaction with objects in original software via emulation



Access

- Emulated CD-ROM environment sharing service
- Virtual Reading Rooms Service
- Scientific Software Portal
- API to enable automatic interaction with objects in original software via emulation


**The Universal
Virtual Interactor
(UVI)**





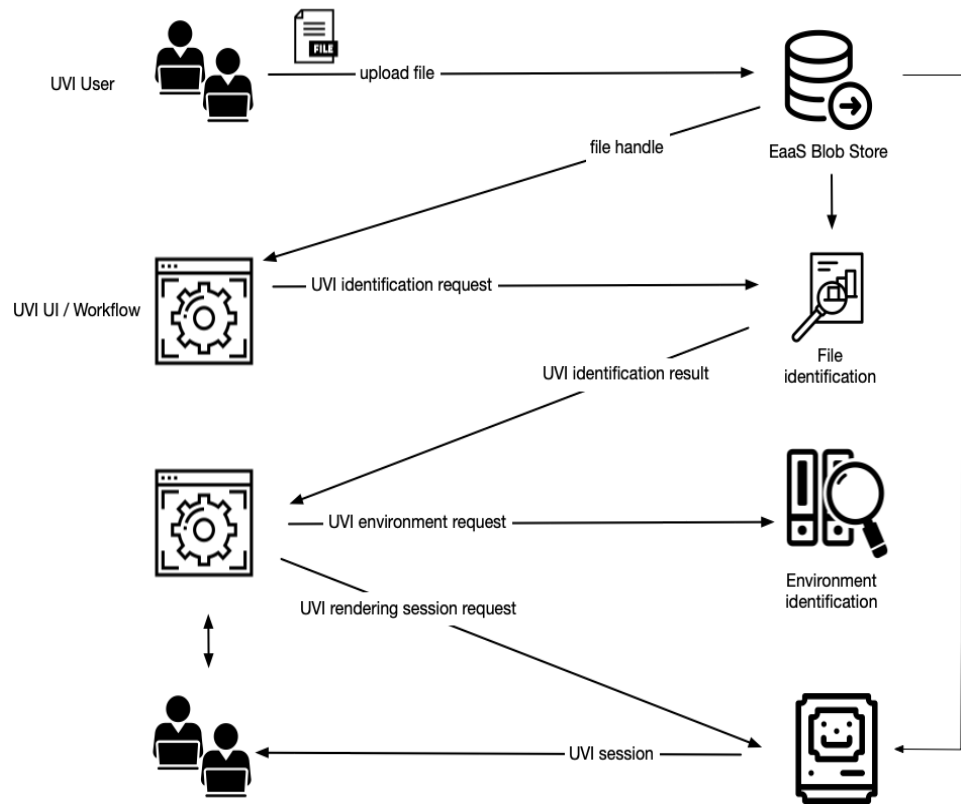
UVI Overview

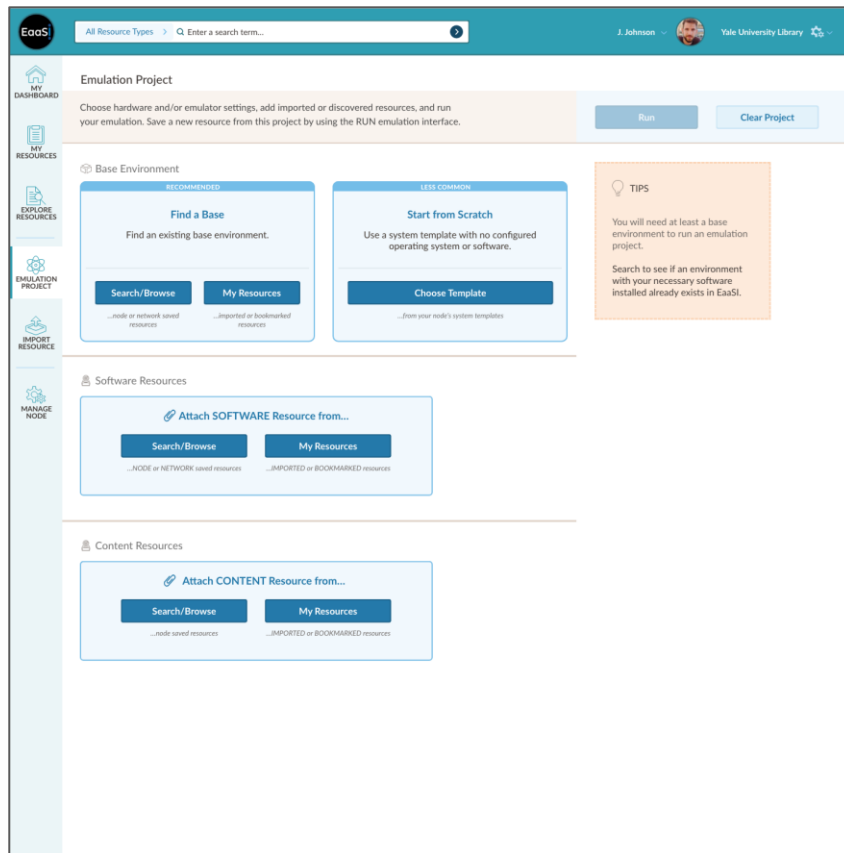
1. Click on a digital object in a catalogue or finding aid
2. Object opens automatically in the original software in browser for user-interaction

- 
- Optional printing to PDFs
 - Optional saving changes
 - Optional exporting data with/without confidentiality review

UVI Overview

- Upload file
- Identify age and format family
- Extract any useful metadata
- Match to environments and rank “best match” or a hex editor
- Autostart rendering object

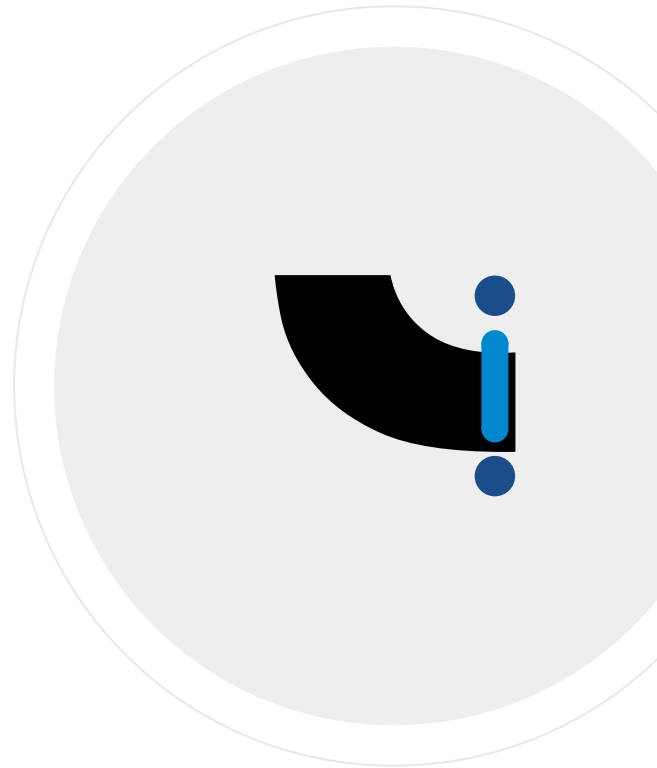




EaaSI - Updated UI Wireframe

Future developments

- Improve automation
- Enable networked environments to be preserved
- Automated package reproduction
- “Headless”/GUI-less interaction with preserved software environments (input commands, receive and save outputs e.g. data)





Emulation Challenges

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Emulation & 3D models: Benefits

- Enables replication and researcher interrogation of all functionality of the development and interaction software and it's impact on 3D models
- Increasingly EaaS to use
- Enables new forms of citation
- Can handle simple digital objects and their contexts and complex multi-system dependent objects and datasets



Getting Involved

1. Download and try an (any) emulator
2. Try out the EaaSI sandbox online <http://bit.ly/EaaSISandbox>
3. Download and try the demo docker-package <http://bit.ly/EaaSIDemo-V1>
4. Join the Software Preservation Network
www.softwarepreservationnetwork.org
5. Contribute software metadata to <https://wikidata.org>
6. Advocate for software preservation locally
7. Work to establish a legal basis for reuse of legacy proprietary software for preservation and access to digital heritage
8. Connect with the EaaSI team at eaasi@yale.edu



Our Team

- **Euan Cochrane** Principal Investigator
- **Seth Anderson** Program Manager
- **Ethan Gates** Software Preservation Analyst
- **Klaus Rechert & Oleg Stobbe (OpenSLX)** Technical Architecture and Development
- **PortalMedia** UX/UI Development
- **Jessica Meyerson (Educopia/SPN)** Communications/Outreach
- **Kat Thornton (Data Current/WikiDP)** Semantic Architect



A Very Special Thanks to the EaaSI Funders...



THE
ANDREW W.
MELLON
FOUNDATION



Alfred P. Sloan
FOUNDATION

Thank you

euan.cochrane@yale.edu

[https://www.softwarepreservationnetwork.org/
eaasi/](https://www.softwarepreservationnetwork.org/eaasi/)

Install #EaaS! for yourself using Docker
(~6GB download):

<http://bit.ly/EaaS!-Demo-V1>

The logo for EaaS! is located in the bottom right corner. It consists of the text "EaaS!" in a white, sans-serif font, with a blue exclamation mark. The text is centered within a dark blue circle, which is itself surrounded by a thin white circular border. The entire logo is set against a black background.

EaaS!