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ARCO



Augmented Representation of Cultural Objects

A Cultural Heritage Repository as Source for Learning Materials

Manjula Patel, Krzysztof Walczak, Fabrizio Giorgini, Martin White

5th International Symposium on Virtual Reality, Archaeology and Cultural Heritage
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Overview

- Cultural Heritage, Education and Online Learning
- The ARCO RTD Project
- Digital capture to visualisation
- Designing virtual exhibitions
- Learning Technology Standards
- Interoperability issues
- ARCO repository of cultural artefacts
- Learning through interaction and exploration
- ARCO Interoperability with external LCMS



Cultural Heritage, Education and Online Learning

- Digitised cultural artefacts can help to create rich and rewarding learning experiences
- Low cost of hardware and digitisation equipment has led to inception of numerous digitisation projects in the CH sector
- However, digitisation is still costly in terms of the amount of time and effort required; we can justify cost of digitisation by:
 - Using digital objects in multiple applications
 - Re-using, re-purposing and adapting digital artefacts in multiple contexts
- Early work in online learning focused on
 - Online learning and teaching
 - Computer Assisted Learning (CAL)
 - Investigation of instructional models and user interfaces
- Further advances in technology (Virtual and Augmented Reality)
 - Research into immersive experiences
- Development of a networked information environment
 - Learning resources are distributed (VLEs, DLEs)
- Digital Libraries and Repositories
 - Accessibility, sharing, interoperability, re-use
 - Technical and metadata standards facilitate search, retrieval, evaluation and sharing of information resources



The ARCO RTD Project

- ARCO started in October 2001 as a three year RTD project
 - Key Action II – Multimedia Content and Tools
 - Action Line III.1.6 – Virtual representation of cultural and scientific objects
- Co-funded by the EC under the 5FP
 - Total investment is 2.8M Euro inclusive of 2.05M Euro from the EC
- 7 partners, including two museum pilot sites, from 4 European countries
 - United Kingdom: [University of Sussex \(coordinator\)](#),
[UKOLN@University of Bath](#), [Victoria and Albert Museum](#),
[Sussex Archaeological Society](#)
 - France: [Commissariat à l'Energie Atomique](#)
 - Poland: [Poznan University of Economics](#)
 - Italy: [GIUNTI Publishing Group](#)

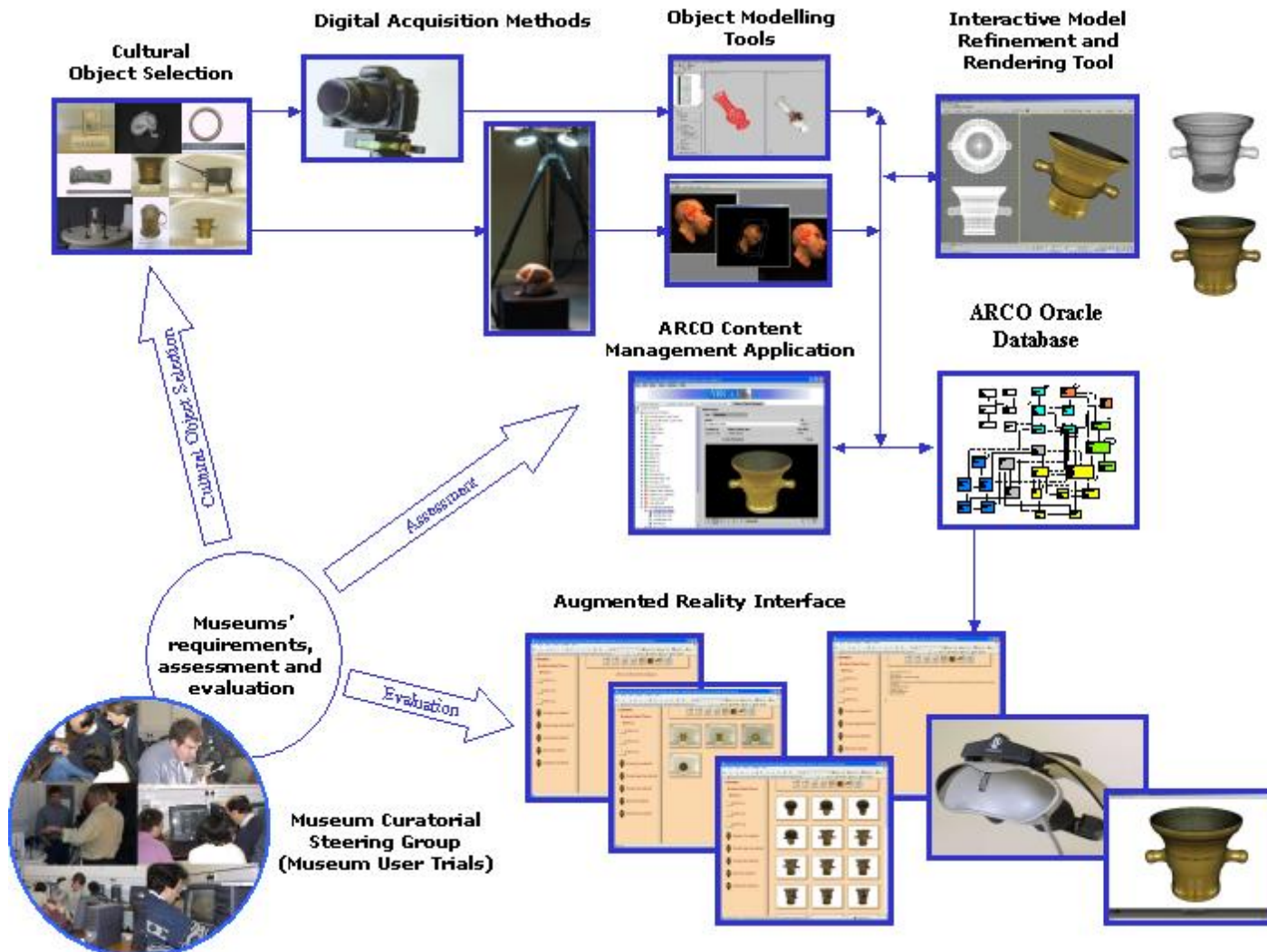


Motivation for the ARCO Project

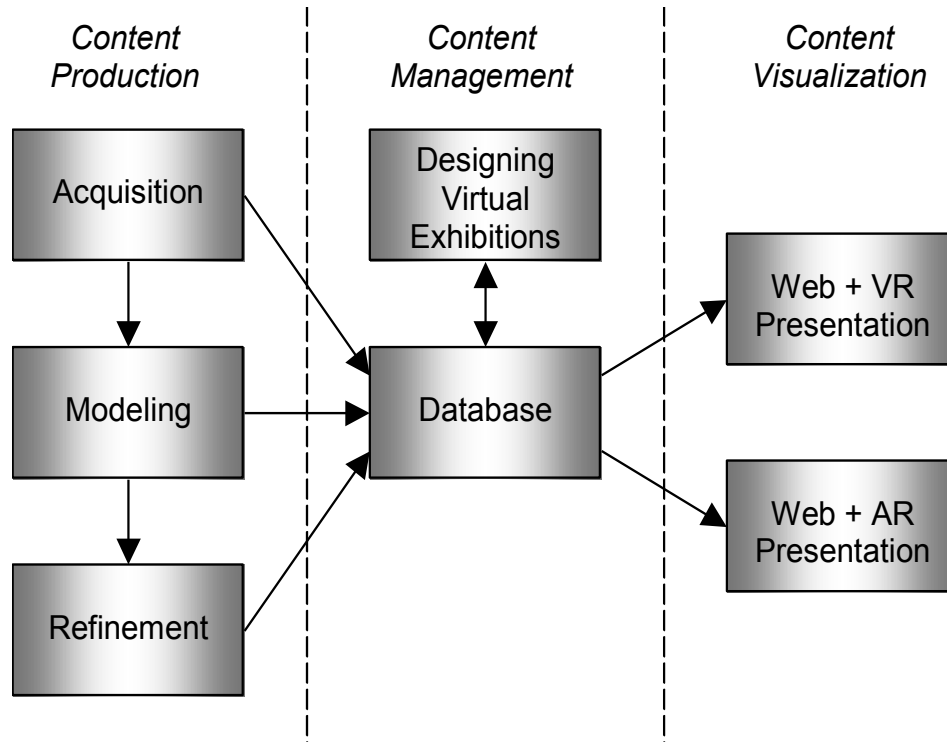
- Develop technology and expertise to help museums **create**, **manipulate**, **manage** and **present** cultural objects in virtual exhibitions both within museums and over the Web
- Why?
 - To provide wider access to cultural heritage artefacts
 - To allow museums to have an online (3D) presence
 - To enable interaction with digital representations of museum collections
- How?
 - Building a set of tools and processes for: digital capture of artefacts, 3D modelling and refinement, database and content management, visualisation in virtual and augmented reality environments
 - Interoperability i.e. an Open Architecture
 - XML Data Exchange between components and other systems
 - Internet, Web, graphics and metadata standards
- Applications
 - Virtual digital museum environments
 - Use of Cultural Heritage artefacts in online Learning



ARCO Prototype Systems and Components



ARCO System Architecture



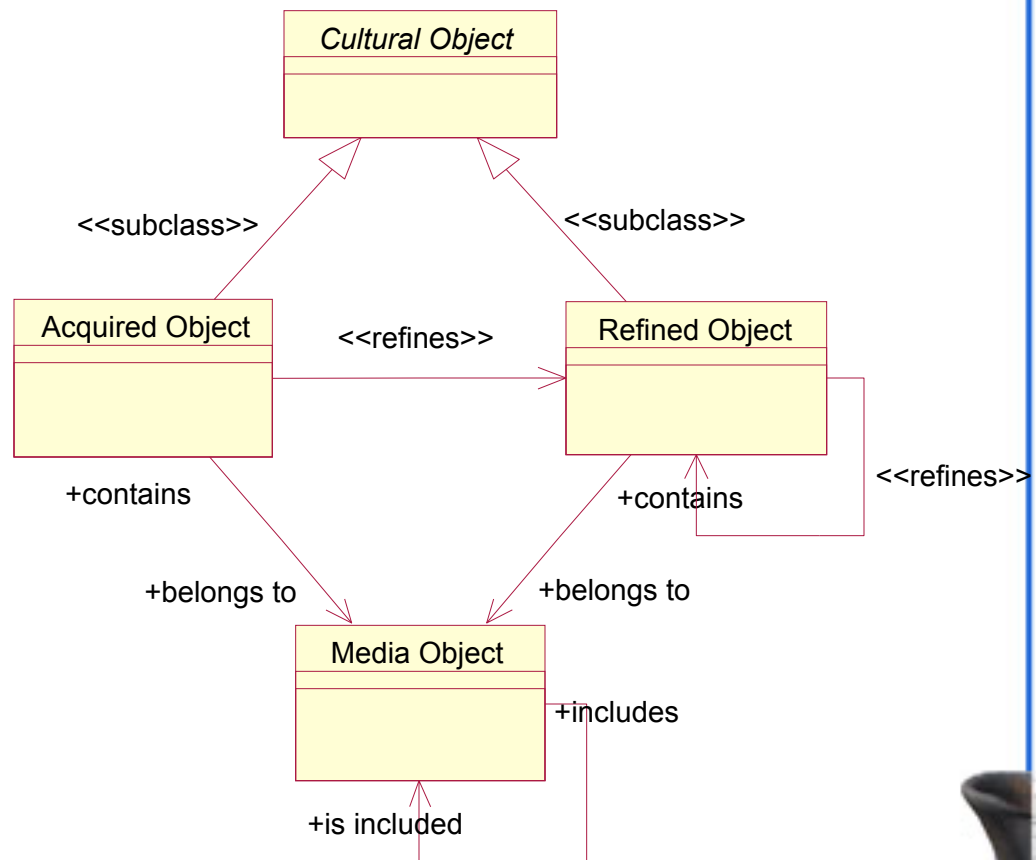
ARCO Data Model

Cultural Object (CO): descriptive curatorial metadata, surrogate for the physical artefact

Acquired Object (AO): digital representation of the physical artefact

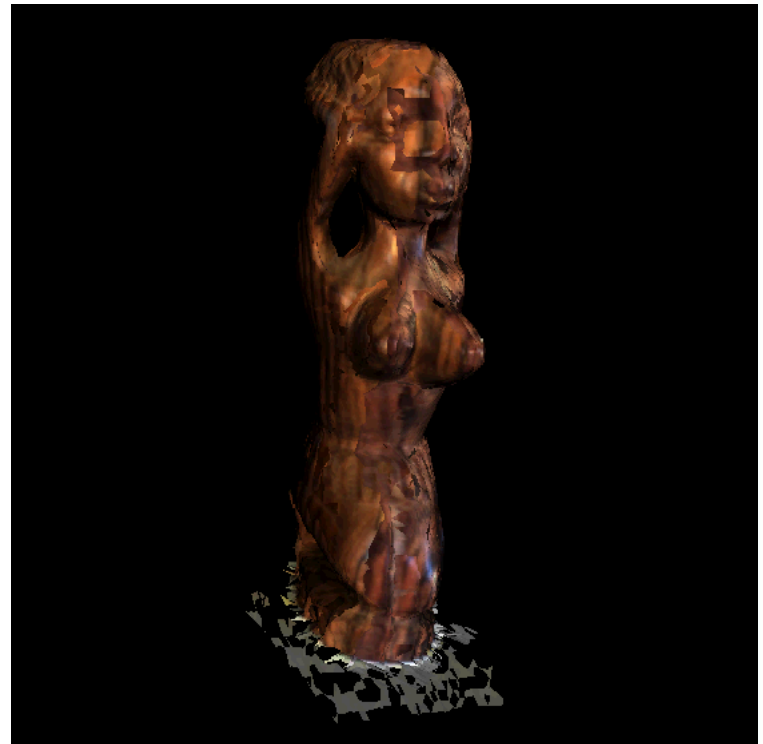
Refined Object (RO): acquired (or refined) object which has been modified

Media Object (MO): individual object which makes up a digital representation (3D model, texture maps, description etc.)



Digital Capture

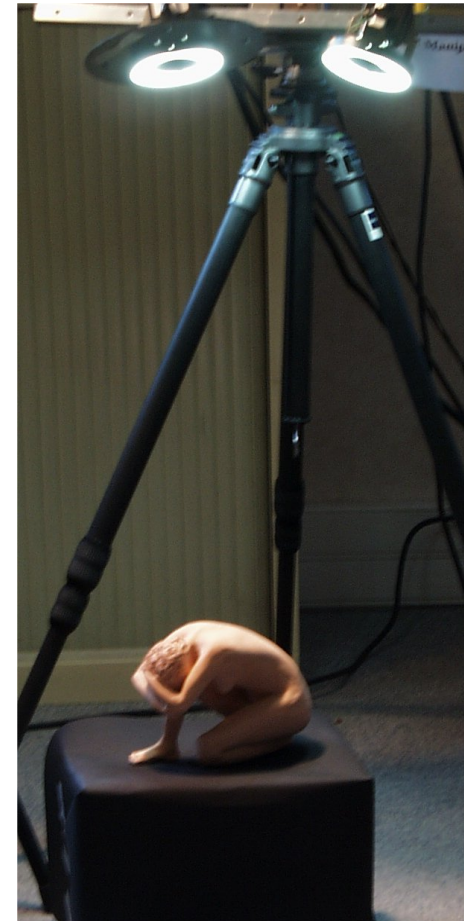
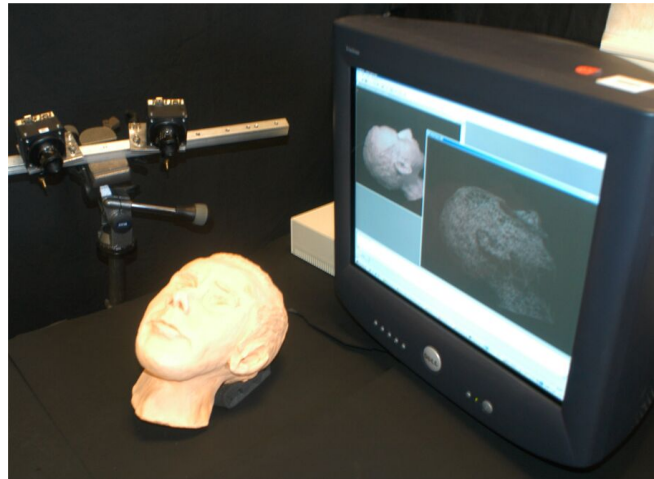
- Method of modelling depends on features of the objects
 - Objects with simple geometry are modelled with modified 3ds max or Maya
- For complex models we use a custom built stereo digital camera system:
 - Result should be an accurate 3D model of the artefact in terms of shape, texture and resolution
 - Automated stereo reconstruction as far as possible
 - No contact between equipment and artefact
 - Artefacts should not be subject to prolonged or harsh lighting conditions
 - Portable in order to gain access to fragile artefacts
 - Ease of use for museum staff who are not experts in 3D measurement



ARCO Object Modeller

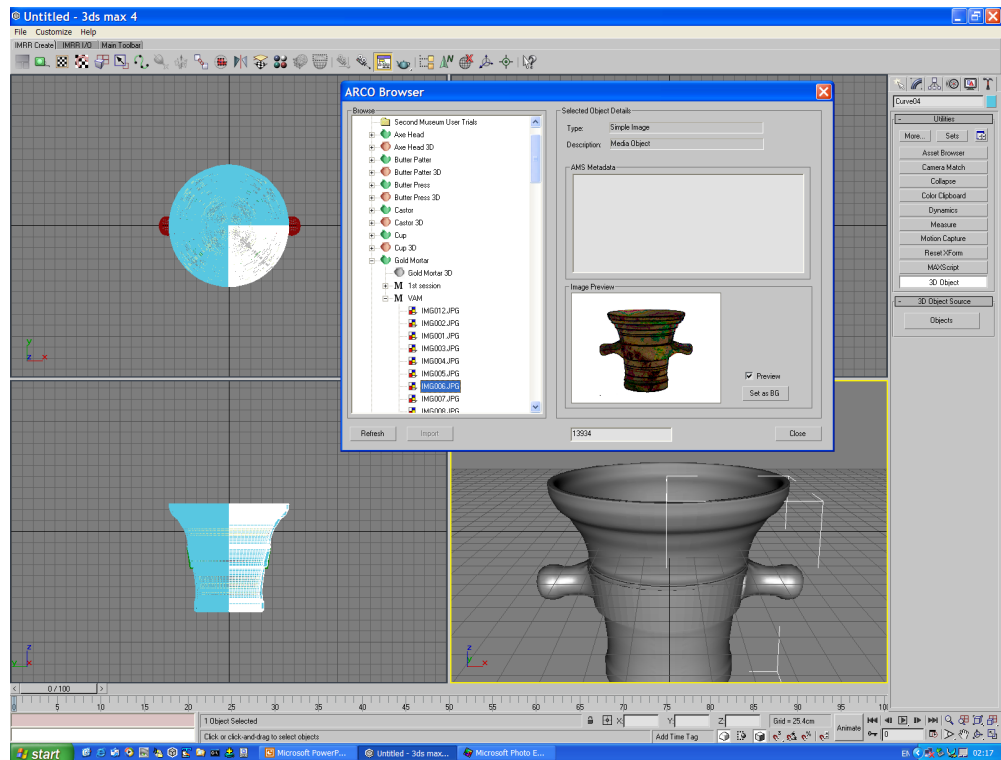
Custom built object modeller comprises hardware and software (stereo photogrammetry):

- Image acquisition combined with structured light projection
- Object geometry and textures are extracted from sequences of stereo images and merged to produce a 3D textured model
- 3D visualisation and model enhancement
- Image registration and merging of 3D meshes
- Export of VRML models



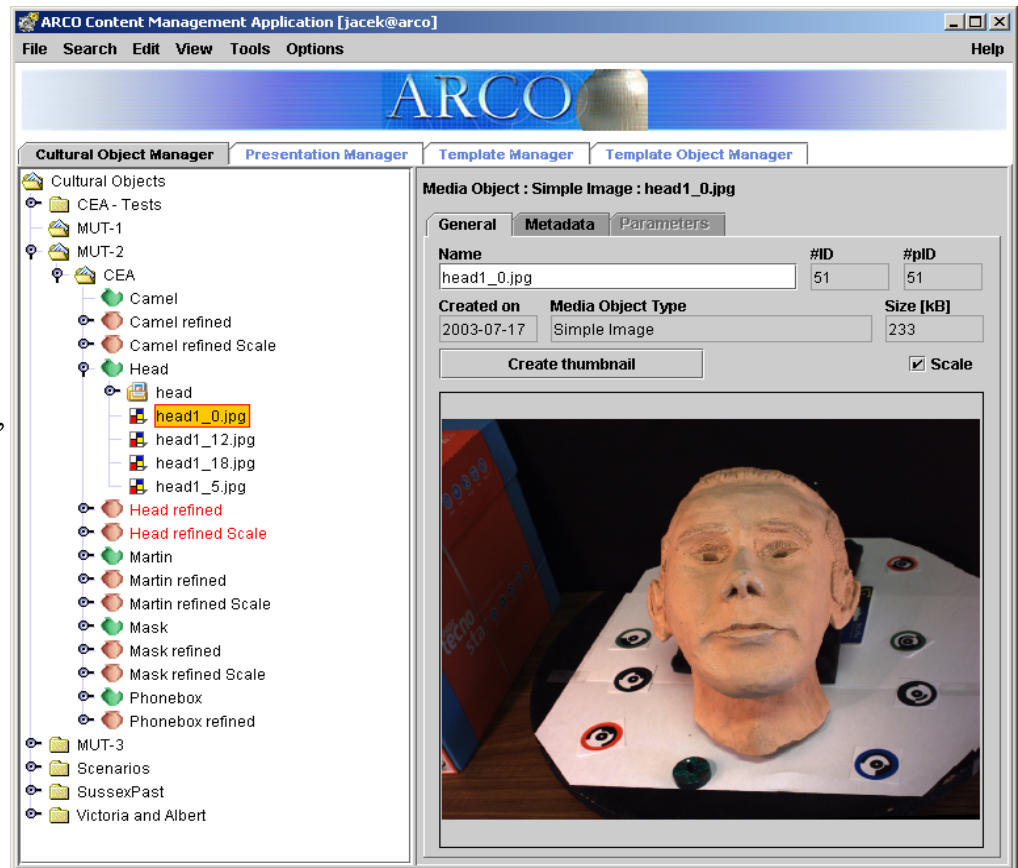
3D Modelling and Refinement

- A tool for interactive model refinement and rendering
 - based on 3ds max
- Creation of simple models and refinement of digitised models
 - smoothing the object geometry
 - reducing polygon count
 - re-applying lighting
 - repairing missing parts
- Database connectivity
 - search and browse objects
 - import and export models (including models generated using other methods, e.g. Mechanical scanning, Laser scanning)



Storing and Managing Repository Contents

- All persistent data is stored in a database for consistency (Oracle 9i ORDBMS –XML enabled)
- Museum staff manage the database through a Content Management Application (ACMA)
 - GUI for import, export and data manipulation
 - Several data managers: CO Manager, Presentation Manager, Template Manager, Template Object Manager
- Separation of content from presentation information means that COs can be used in a variety of applications and environments

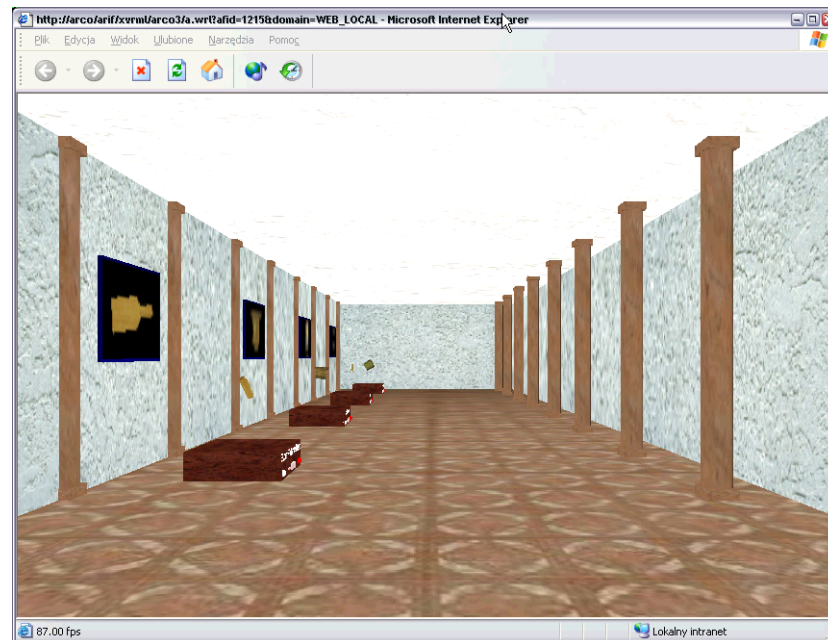
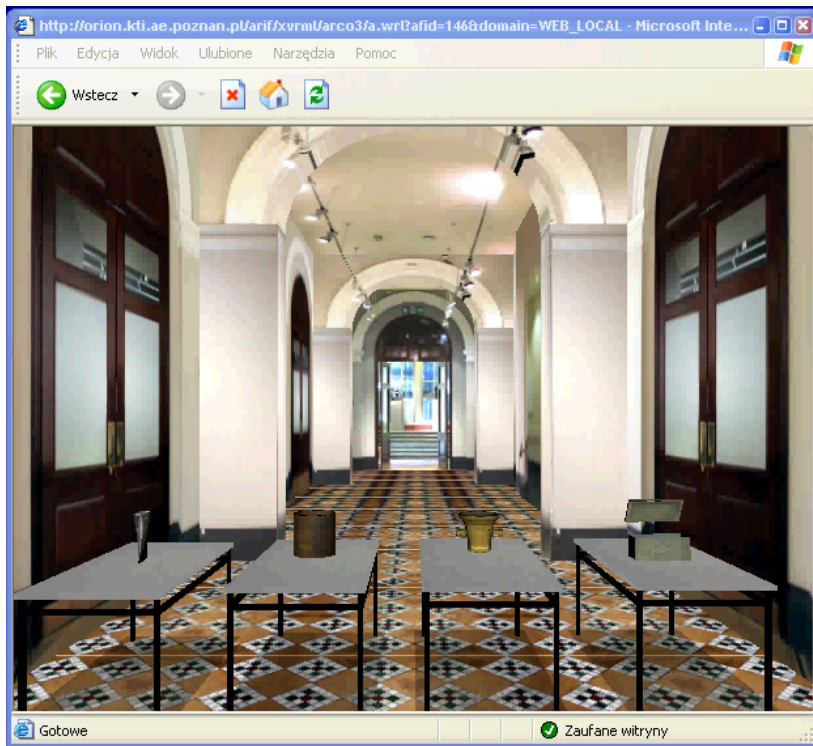


Designing Virtual Exhibitions

- Presentation manager in ACMA
- X-VRML – high-level XML-based language for creating dynamic VR models and parameterised presentation templates
- Dynamic creation of exhibitions by combining data and X-VRML templates
- Template instances for:
 - Search interfaces
 - Parameterised browsing
 - Virtual exhibitions
- Presentation Domains
 - Same database content visualised in different ways by applying different X-VRML templates



Virtual Exhibitions and 3D Galleries



Learning Technology Standards

- Prominent Learning Technology standards making bodies:
 - Instructional Management Systems (IMS) Global Learning Consortium
 - Advanced Distributed Learning (ADL) Initiative (SCORM –Shareable Content Object Reference Model)
 - European Centre for Standards/Information Society Standardisation System Learning Technologies Workshop(CEN/ISSS WS-LT)
 - Institute of Electrical and Electronic Engineers (IEEE) Learning Technology Standards Committee (LTSC)
 - International Standards Organisation (ISO) Sub-Committee 36 (SC 36)
 - Dublin Core Metadata Initiative (DC-Ed)
 - BSI Committee IST/43 Information Technology for Learning, Education and Training
- Areas for standards and specifications:
 - Share content between systems
 - Enable users to search, locate and retrieve appropriate content
 - Plan educational scenarios and formulate instructional design
 - Deliver educational content tailored to a learner's requirements
 - Create and deliver computer aided assessments
 - Record and share learner information
 - Ensure educational content is accessible to all users



Learning Objects

- A Learning Object is a digital learning resource that facilitates a single learning objective and which may be reused in a different context
 - *“any entity, digital or non-digital, that may be used for learning, education or training”* (IEEE Learning Object Metadata Standard)
- Granularity is a major issue (authoring, deployment, re-purposing):
 - Small LOs can be easily re-used
 - Larger, complex and composite LOs less easily re-used but provide added-value
 - Media object; Information object; Learning Object; Composite LO; Course
- IEEE LOM (to simplify discovery, management and exchange of LOs)
 - Metadata Standard for Learning Objects
 - 77 elements to describe re-usable learning material
 - Used by IMS and ADL (SCORM)
- IMS Content Packaging
 - Standard for packaging groups of LOs into re-usable content for exchange



Interoperability Issues

- Syntactic interoperability: *technical ability of data from multiple and previously unknown or unplanned sources, to work together when combined*
- Semantic interoperability: *in addition involves the consistent use of metadata vocabularies and classifications*
- Interoperability in ARCO
 - Data exchange between ARCO components
 - Data exchange with external systems
 - Both are based on XML
- Compatibility with best practice in the Cultural Heritage Sector
 - mda's SPECTRUM comprises procedures for documenting objects and the processes that they undergo
 - use of Dublin Core metadata for resource discovery
- To maximise versatility of digitised objects
 - store primary resources –LTSC notion of self-contained “assets” (small media objects used in creating LOs)
 - no added-value in terms of educational information



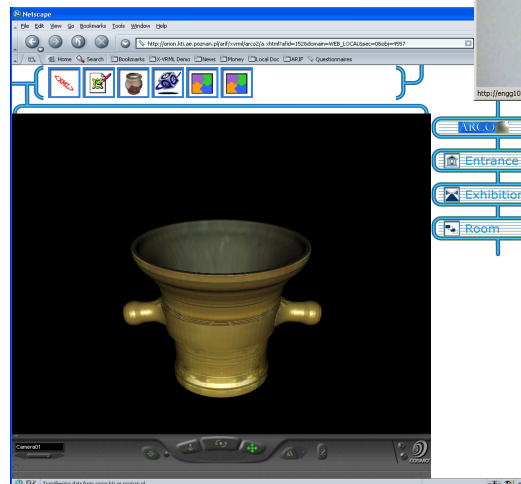
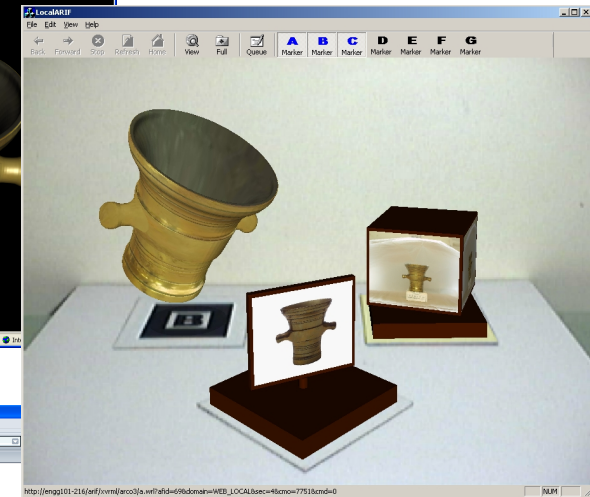
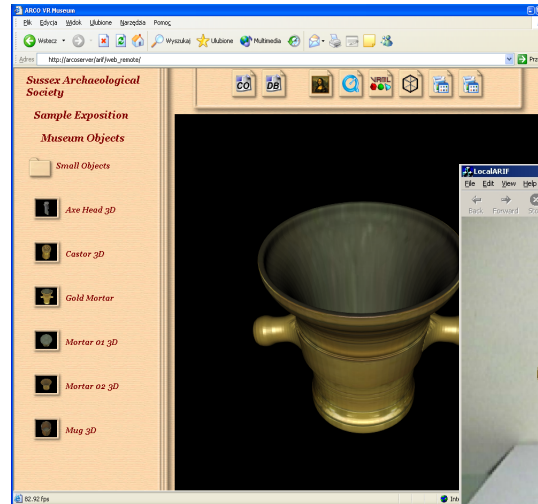
ARCO Repository of Cultural Artefacts

- Types of multimedia objects:
 - Simple Image, Image Collection, Panorama Image, Multi-resolution Image, Description, Sound, VRML/X3D 3D Model, QuickTime VR, and 3ds max Project
 - New types of media object can be added
- AMS –ARCO Metadata Schema, is a vocabulary for describing the whole pipeline of processes from digitisation to visualisation:
 - Descriptive curatorial metadata (mda SPECTRUM)
 - Resource discovery metadata (DCMES)
 - Technical metadata (preservation)
 - Presentation metadata (templates)
 - Themed metadata (intelligence, effort report)
 - Administrative metadata
 - ARCO specific elements



Learning through Interaction and Exploration

- Visualisation of ARCO media objects from the repository
 - VRML models, metadata, images, virtual exhibitions etc.
- Three visualisation interfaces, same database contents
 - Remote web interface (search, browse)
 - Local museum touch-screen (search, browse)
 - Local augmented reality environment (interact)




Touch-screen display in a museum

Touch screen displays can be used within museums to browse and search for particular exhibitions or objects:


Cultural Object's Metadata search

	in	<input type="text" value="name"/>		find	<input type="text" value="word"/>	<input type="text" value="castor"/>
	and	<input type="text" value="format medium"/>		find	<input type="text" value="word"/>	<input type="text" value="brass"/>
	and not	<input type="text" value="anywhere"/>		find	<input type="text" value="word"/>	<input type="text" value="PL"/>

[more less](#)




Search




Entrance


Cultural Object Metadata search results:
Found: 3 result(s).



Castor
whole:form:cylindrical with fitted domed lid.strapwork handle footed base.engraved legend opposite handle
... <source>LEWSA:1964.1.158</source>
<name>castor</name>
<nameAlternative>trophy</nameAlter...



Brass Castor
whole:form:cylindrical with fitted domed lid.strapwork handle footed base.engraved legend opposite handle
... <source>LEWSA:1964.1.158</source>
<name>castor</name>
<nameAlternative>trophy</nameAlter...



Castor refined KTI
whole:form:cylindrical with fitted domed lid.strapwork handle footed base.engraved legend opposite handle
... <source>LEWSA:1964.1.158</source>
<name>castor</name>
<nameAlternative>trophy</nameAlter...

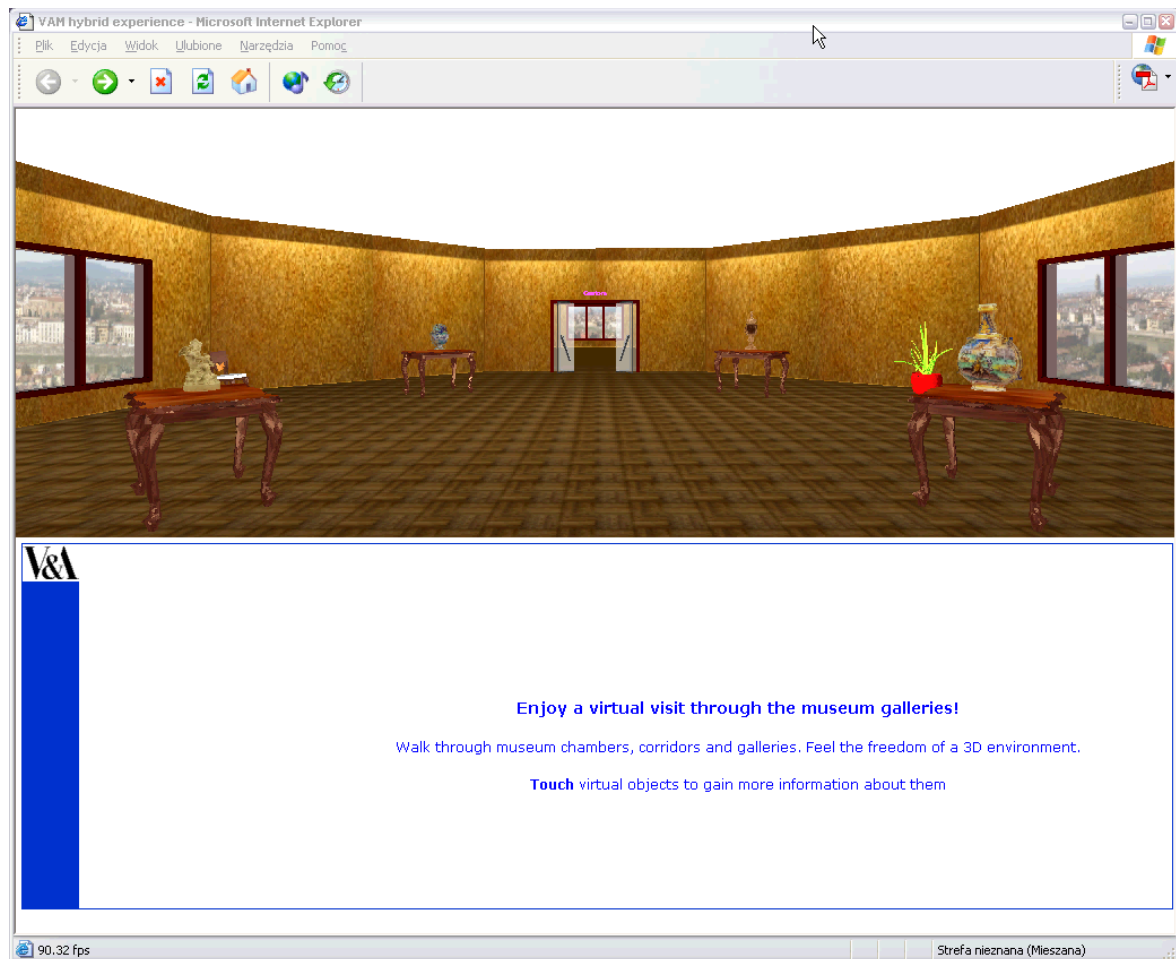
www.arco-web.org

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An Interactive Virtual Gallery

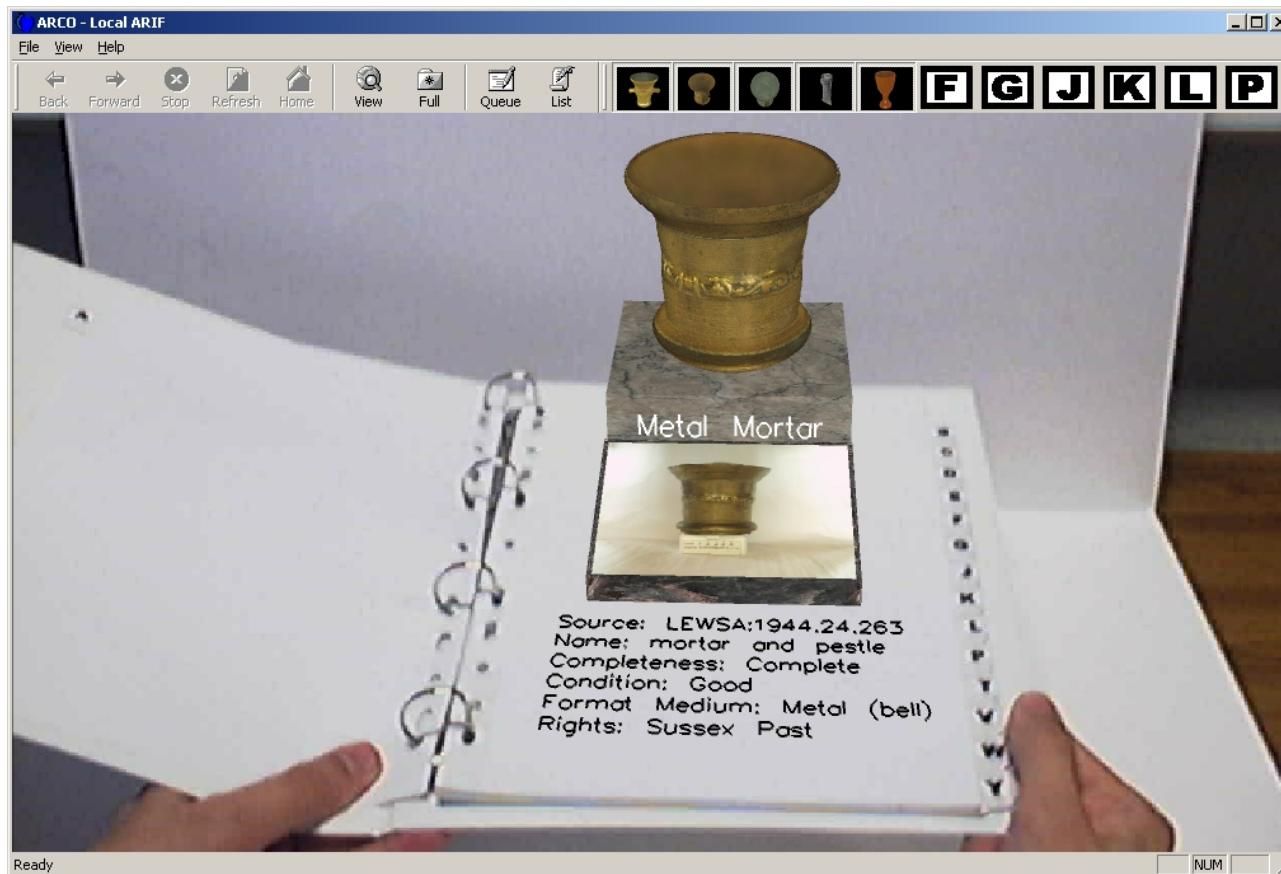
Users can browse objects by walking along the gallery and interacting with artefacts

Metadata details and contextual information is displayed at the bottom of the screen



An Interactive Cultural Heritage Book

A more engaging way of browsing exhibitions ...



Learning Scenario: Anne of Cleves House

ARCO - Local ARIF
File View Tools Help

Back Forward Stop Refresh Home View Full Queue List **A B C D E F G J K L**

Anne of Cleves House *home research education membership shop*

Welcome to Anne of Cleves House

ANNE OF CLEVES HOUSE is a 16th century timber-framed Wealden hall-house that formed part of Anne's divorce settlement from Henry VIII in 1541. The house contains wide-ranging collections of Sussex interest, including Sussex pottery, and the bedroom and kitchen are furnished to reflect an earlier period.



On the next page, you can explore the virtual reconstruction of the kitchen of Anne of Cleves House. You can also find the virtual reconstructions of the individual kitchen utensils used in Tudor times. You can learn more about each of them by clicking on them answering simple multiple-choice questions. To start this interactive experience click on the ARCO logo below.

This presentation is powered by ARCO technology

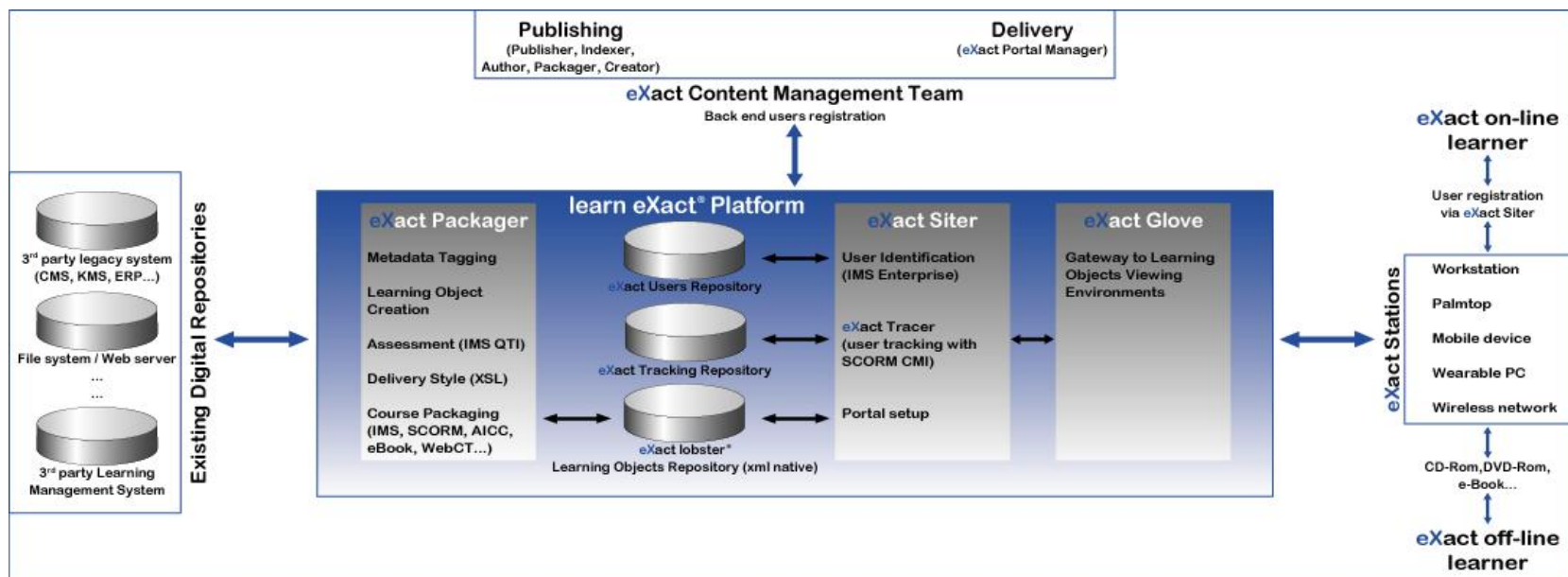


Home - Research - Membership - Education - Archaeology store - E-mail us
Fishbourne Roman Palace - Lewes Castle - *Anne of Cleves House* - Michelham
Priory - Marlipins - The Priest House - SiteMap
© THE SUSSEX ARCHAEOLOGICAL SOCIETY



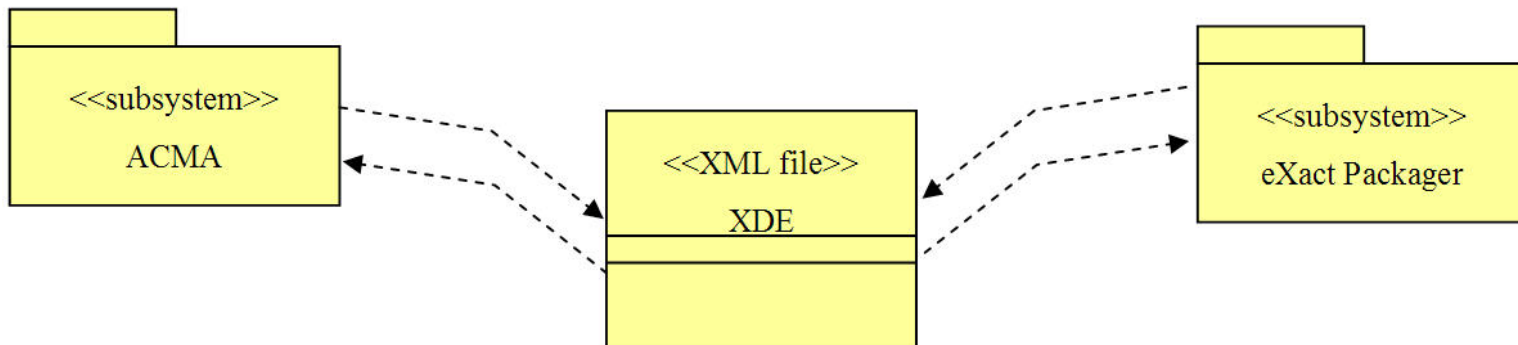

ARCO Interoperability with External Systems

- A Learning Content Management System (Learn eXact)
 - XML, LOs, IMS/SCORM
- Composed of three modules:
 - Content authoring (eXact Packager)
 - Learning Management System (eXact Siter)
 - Digital repository (eXact Lobster)



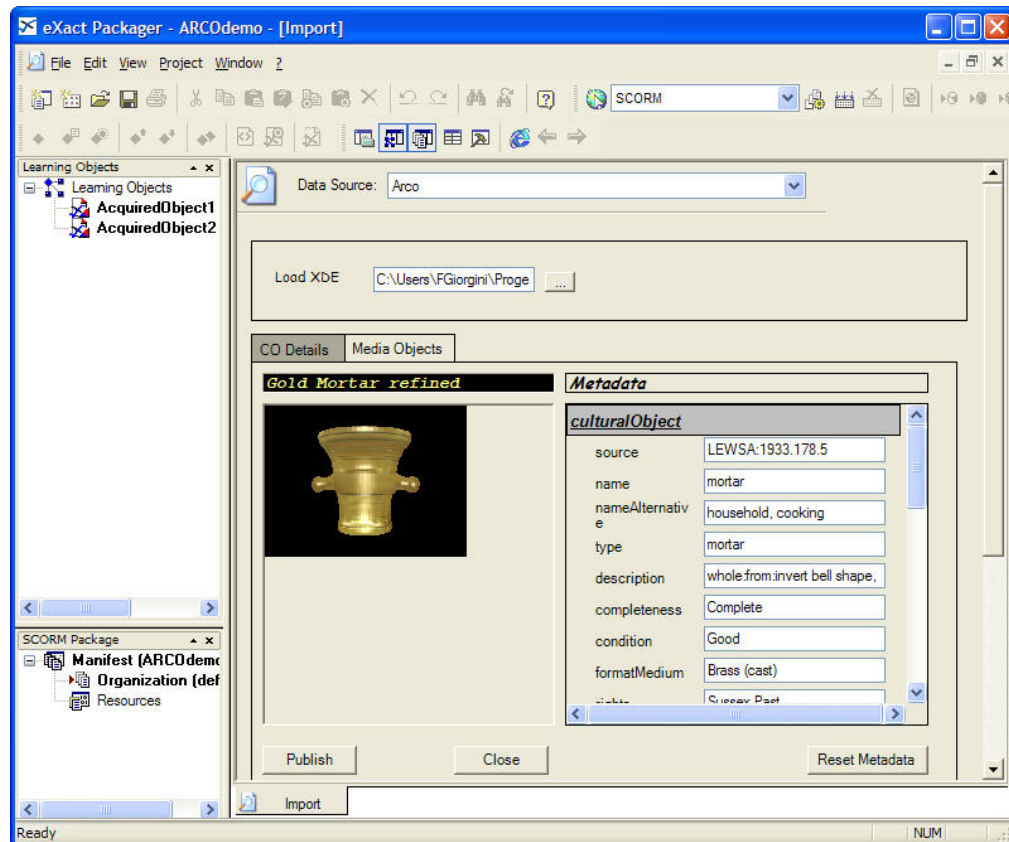
Interoperability between ARCO and Learn eXact

- Communication is 2-way:
 - COs and related metadata can be exported to Learn eXact for use in creating more complex LOs
 - Component resources of a LO can be exported from Learn eXact into the ARCO repository
- Integration exploits the XDE interchange format
 - based on XML
 - archive of COs and related metadata
 - optimised for data exchange
- Communication is between ACMA and eXact Packager



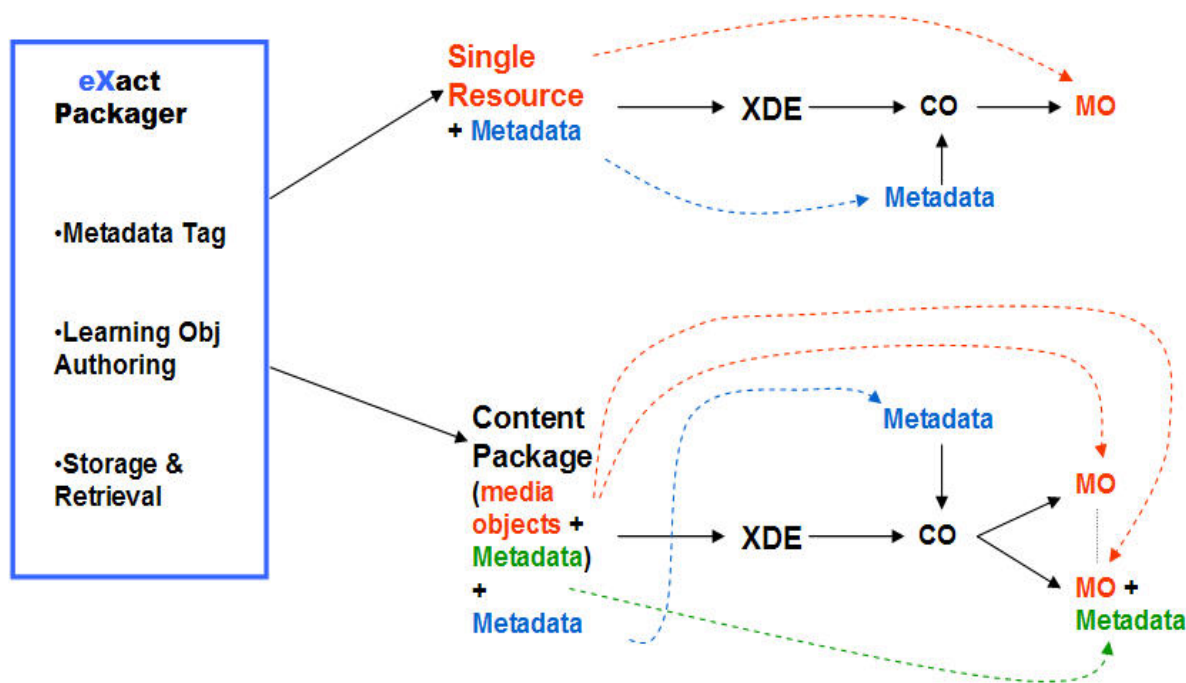
Data Export from ARCO to Learn eXact

- ACMA can be used to export either a single CO or a collection of COs into XDE format
- eXact Packager parses the XML file for physical multimedia files and associated metadata –images, videos, VRML etc.
- ARCO AMS metadata is extracted and mapped to IMS Metadata 1.2



Data Import from Learn eXact to ARCO

- Export from eXact Packager can be a single resource or an IMS CP
- IMS Metadata is mapped to ARCO AMS
- Export of IMS CP requires additional work
 - extraction of list of objects and related metadata
 - decomposition into COs and MOs



Conclusions and Further Work

- By developing a repository of primary multimedia cultural objects and making them easily accessible it is possible to support differing instructional models
 - Edutainment type scenarios for informal learning
 - Export to external LCMS for use in creating complex LOs and more formal teaching, learning and training
- Cultural heritage repositories important in making heritage resources readily available for 24/7, global access
 - Access to objects that would not otherwise be available to the masses
 - Will play an important role as data-providers in Open Access Initiative
- Resource discovery and technical metadata crucial in re-use of primary resources
- Digital rights management and copyright issues are also pertinent
- ARCO system currently under-going field trials
- ARCO system used in EPOCH showcase ‘Multimodal Interface for Safe Presentation of Valuable Objects’





ARCO



Augmented Representation of Cultural Objects

Thank you –Questions?

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