University of Bath

Metadata Requirements for Digital Museum Environments

Manjula Patel
UKOLN, University of Bath
m.patel@ukoln.ac.uk

www.arco-web.org

Department of Computer Science Seminar, University of Bath, 9th January 2004

Overview

- The ARCO RTD Project
  - Project goals, Prototype systems and components

- Metadata requirements
  - User requirements, Functional requirements, Interoperability and standards, Museum best practice

- Digital capture to virtual exhibition
  - ARCO system architecture, Digitisation of artefacts, 3D modelling and refinement, Storing and managing cultural objects, Designing virtual exhibitions

- Metadata for digital museums
  - ARCO data model, Types of metadata, ARCO Metadata Element Set (AMS)

- Metadata management
  - Metadata schema manager, Metadata instance editor

- Visualisation and interaction
  - Virtual and Augmented reality environments

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

Goals of the ARCO Project

- Develop innovative 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 collections

- How? By building a set of tools and processes from digitisation to visualisation:
  - Digital capture of artefacts, 3D modelling and refinement, Database and content management, Visualisation in virtual or augmented reality environments
  - Interoperability i.e. an Open Architecture
    - XML Data Exchange between components and other systems
    - Internet, Web, graphics and metadata standards

ARCO Prototype Systems and Components

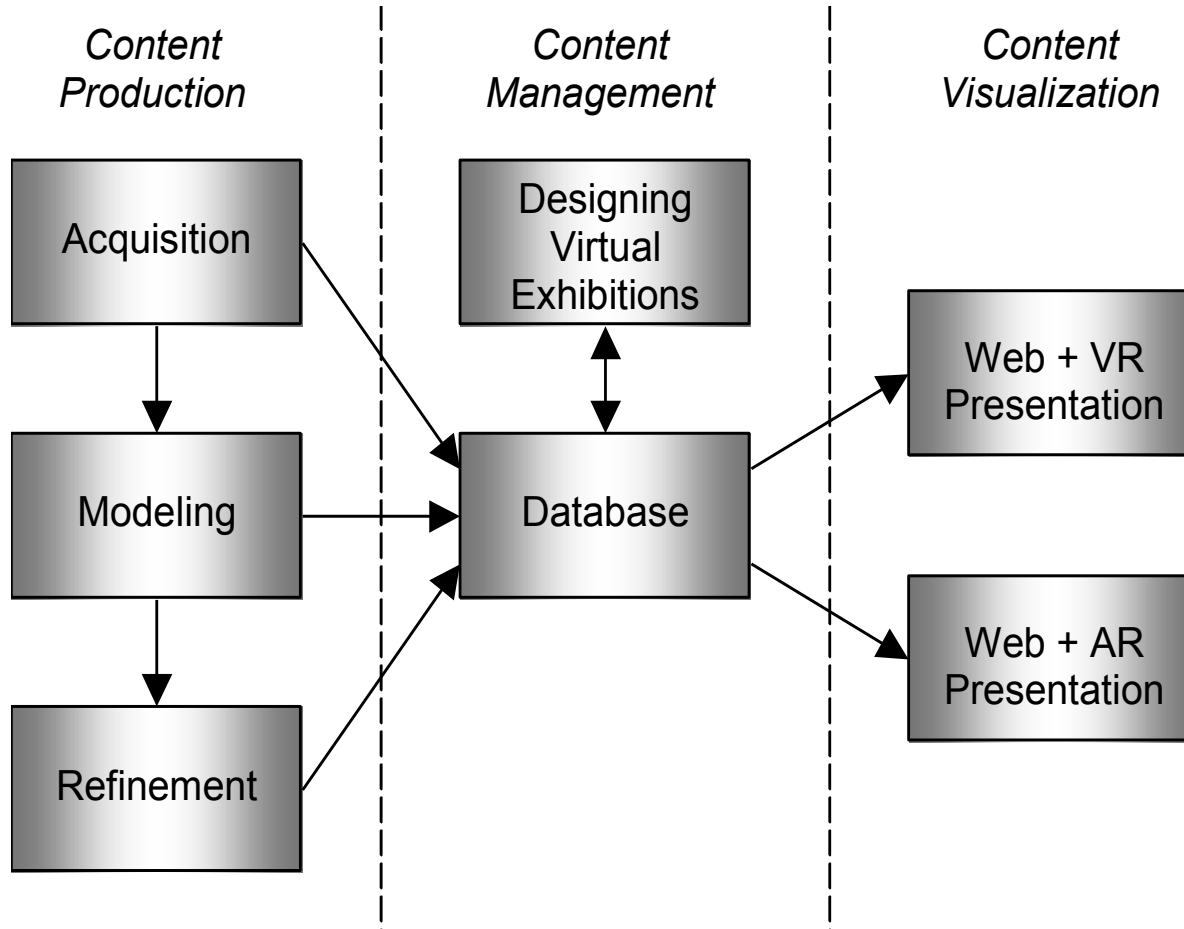**Department of Computer Science Seminar, University of Bath, 9th January 2004**
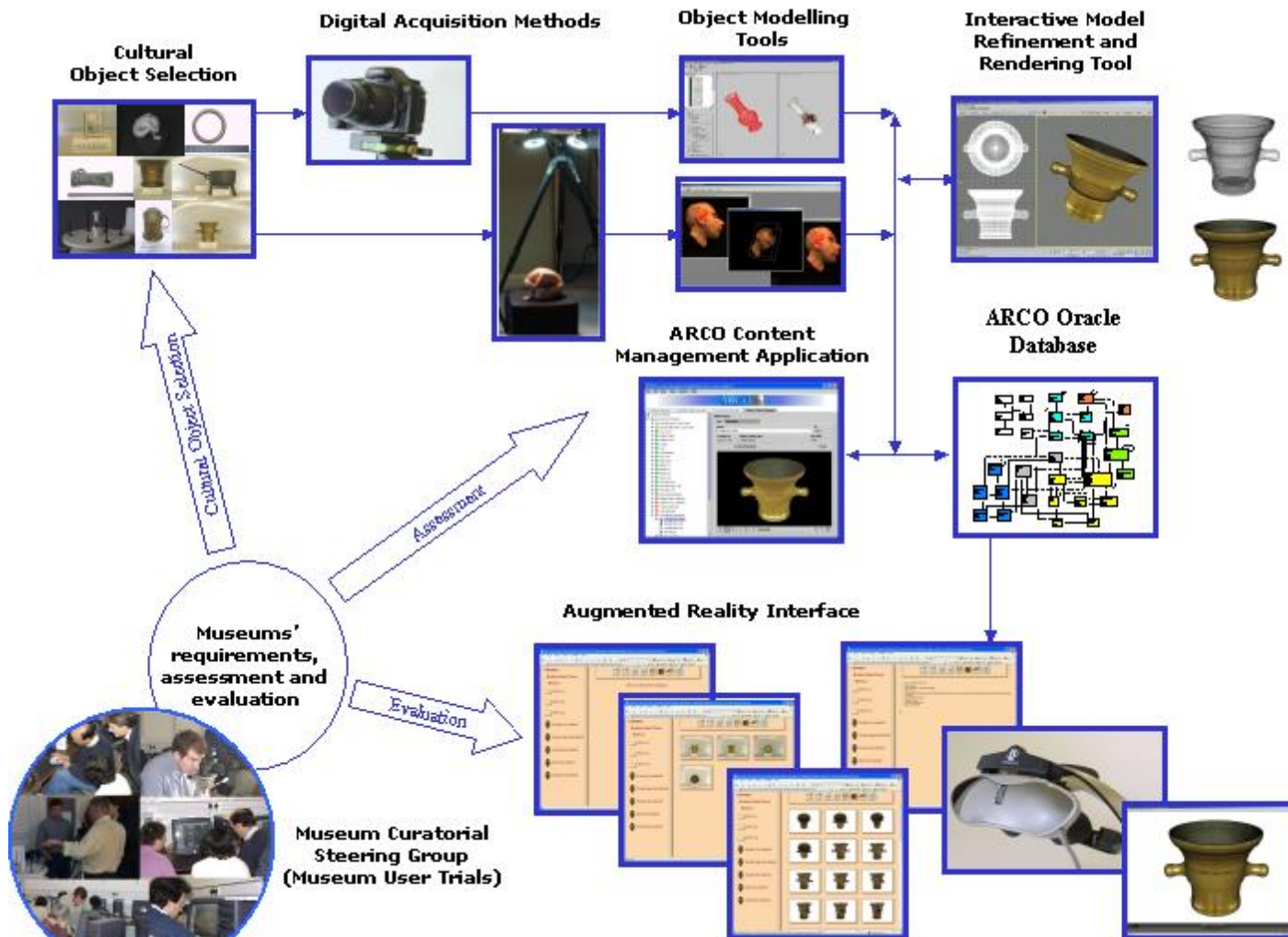
Metadata Requirements for Digital Museums

- User Requirements

  – Museum curator, Cataloguer, Digital Photographer, Object Modeler, Object Refiner, Content Designer, End-user

- Functional Requirements

  – Conversion from physical to virtual representations
  – 3D object representation, manipulation, management, visualisation
  – Design of exhibitions and interactive scenarios

- Interoperability and Standards

  – Internet standards (XML, VRML/X3D, HTML)
  – W3C Recommendations (XML Schema, XSLT, XPath)
  – Metadata standards (mda SPECTRUM, Dublin Core)
  – 3D graphics standards (VRML/X3D, OpenGL, DirectX)

- Museum Best Practice

  – Review of standards, VAM (Picture Library), SussexPast (MODES)

ARCO System Architecture

Content Production | *Content Management* | *Content Visualization*

Acquisition → Modeling → Refinement

Designing Virtual Exhibitions ↔ Database

Database → Web + VR Presentation

Database → Web + AR Presentation

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

Department of Computer Science Seminar, University of Bath, 9th January 2004
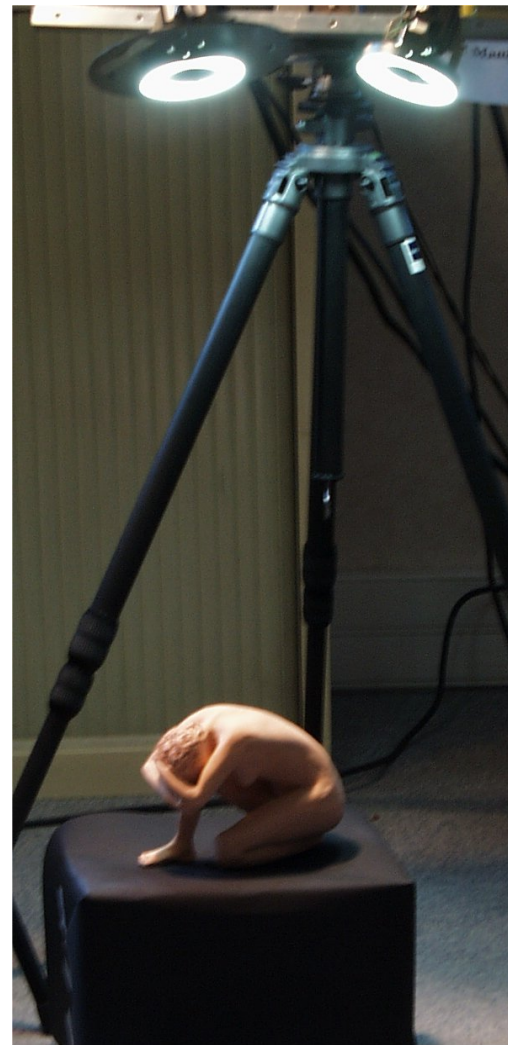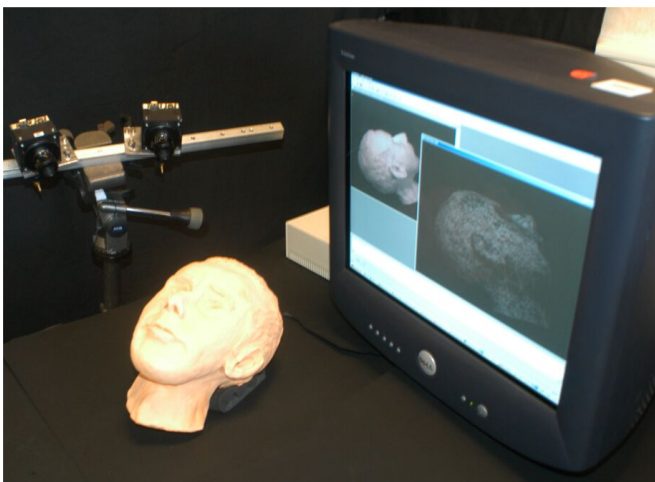
3D Modelling and Refinement

- 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)

Department of Computer Science Seminar, University of Bath, 9th January 2004
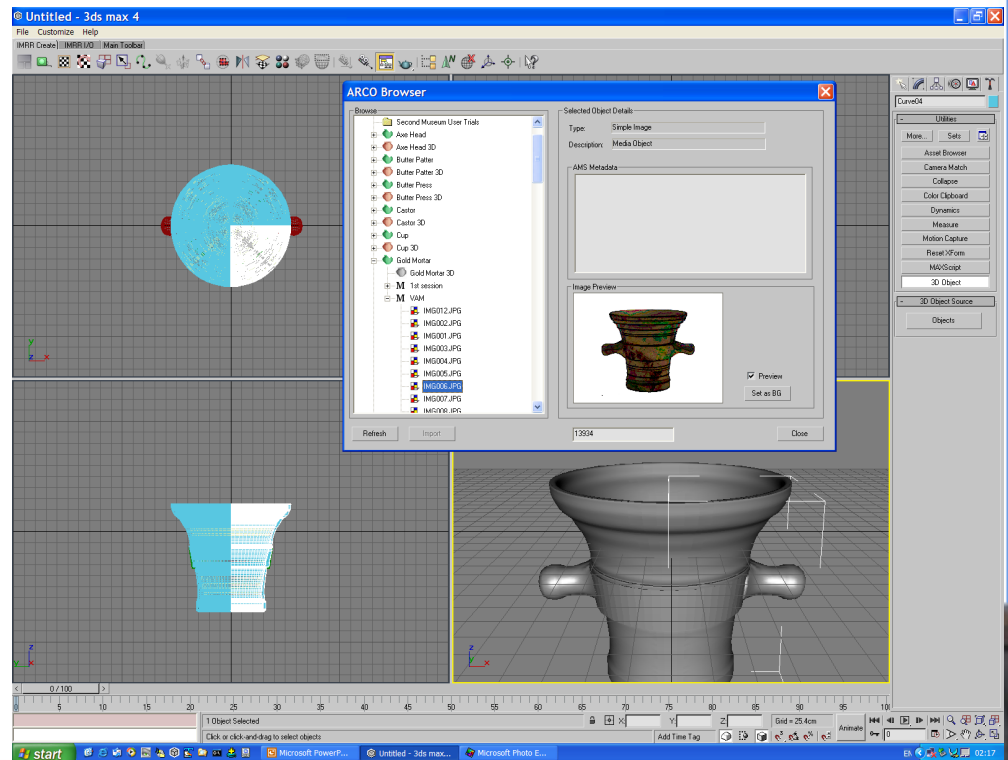
Examples of digitised artefacts

Sample media objects representing cultural artefacts in the database:

- Images from the photogrammetry process
- VRML models exported from model refinement stage

Department of Computer Science Seminar, University of Bath, 9th January 2004

Storing and Managing Digital Objects

- All ARCO data is stored in a database for consistency (Oracle 9i ORDBMS)

- Museums do not manage the database directly, but through a Content Management Application (ACMA)

- Several managers for ease of data manipulation
  - Cultural objects
  - Visualisation templates
  - Virtual exhibitions
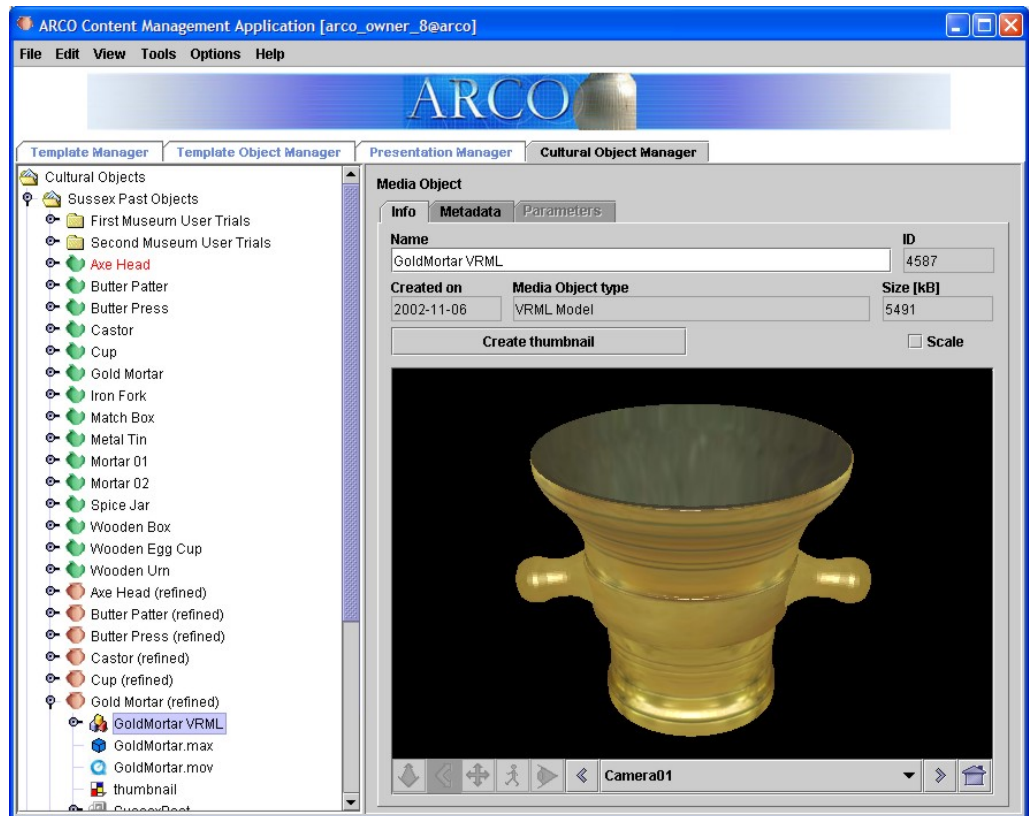
Designing Virtual Exhibitions

- 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 Museum Exhibitions
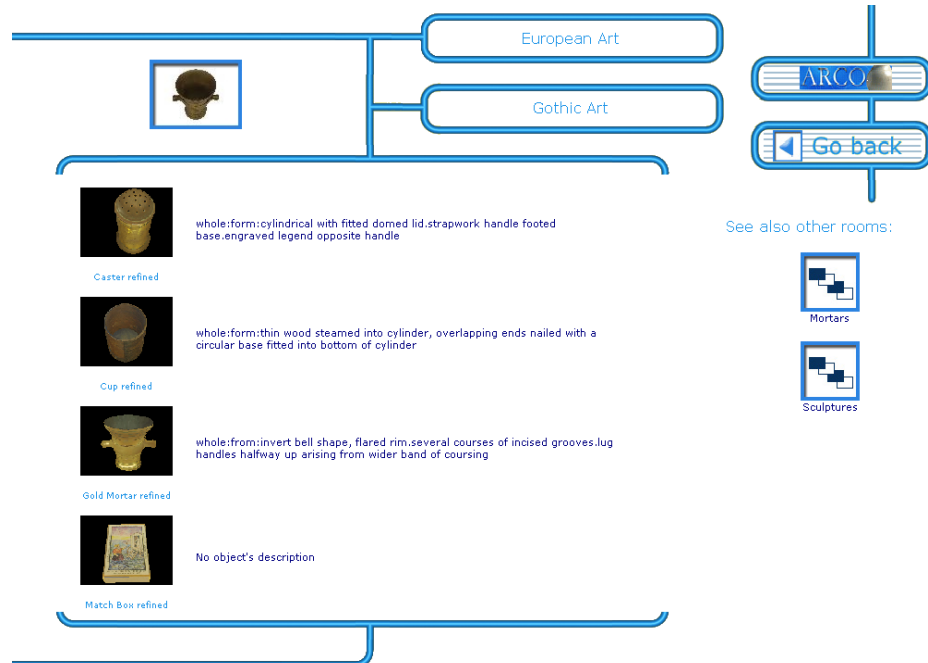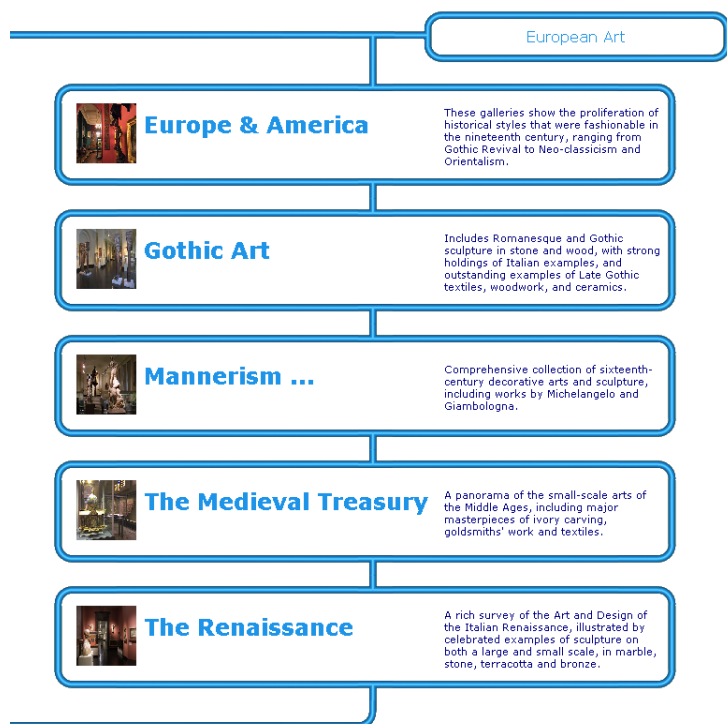
Walkthrough of Museum Exhibitions and Galleries

Department of Computer Science Seminar, University of Bath, 9th January 2004

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.)

Cultural Object

<<subclass>>   <<subclass>>

Acquired Object   <<refines>>   Refined Object

+contains   +contains   <<refines>>

+belongs to   +belongs to

Media Object

+includes

+is included
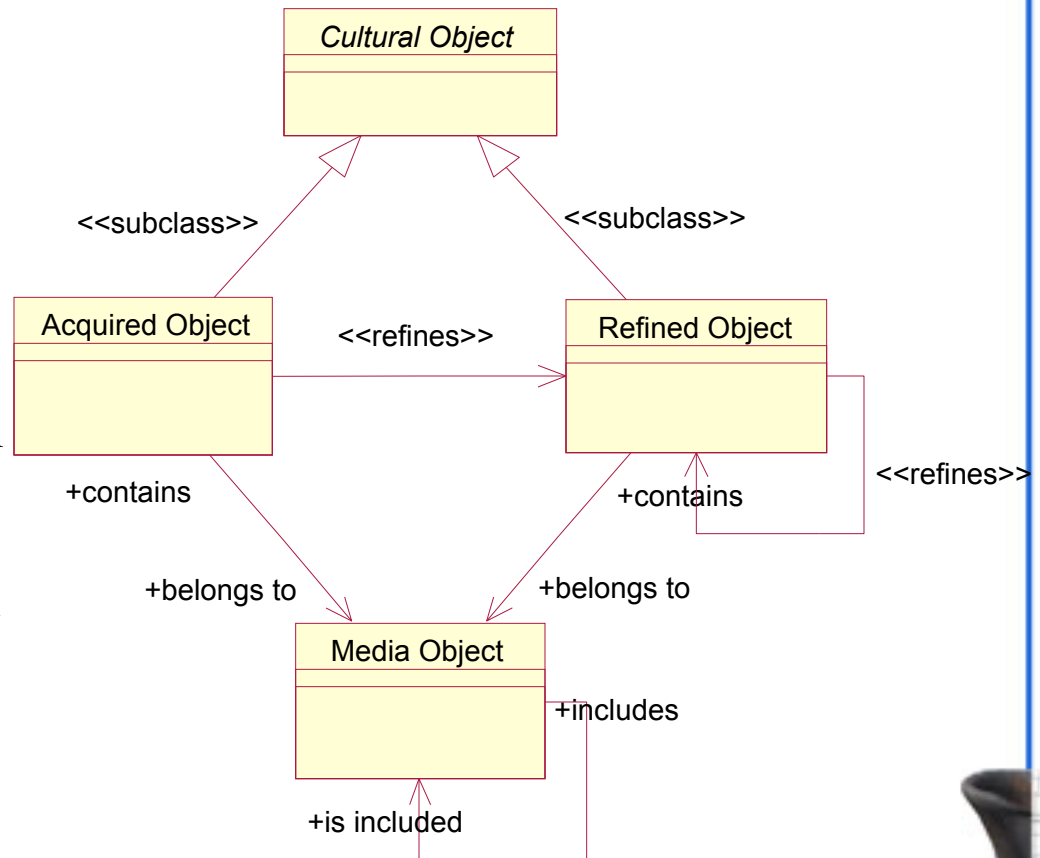
ARCO Metadata Element Set

- AMS –ARCO Metadata Schema, is a vocabulary for describing all the processes from digitisation to visualisation:
  - Descriptive curatorial metadata (mda SPECTRUM)
  - Resource discovery metadata (DCMES)
  - Technical metadata (preservation)
  - Themed metadata (intelligence, effort report)
  - ARCO specific elements
- Interoperability
  - Data exchange between ARCO components
  - Cross domain visibility
  - Compatibility with museum best practice
- Implemented with XML Schemas

AMS – Logical Structure

Different groups of users need access to different parts of the metadata (security manager in ACMA):

- Acquired Objects are described by
  - Administrative metadata
  - Cultural Object metadata
  - Acquired Object metadata
- Refined Objects are described by:
  - Administrative metadata
  - Cultural Object metadata
  - Acquired Object metadata
  - Refined Object metadata
- Media Objects are described by:
  - Administrative metadata
  - General Media Object metadata
  - Media Type Specific metadata (six media types at present)

| Admin |
| Cultural object |

| Admin |
| Acquired Object |

| Admin |
| Refined Object |

| Admin |
| Media Object |

| Media Type |

| Media Type |

| Media Type |

. . . .
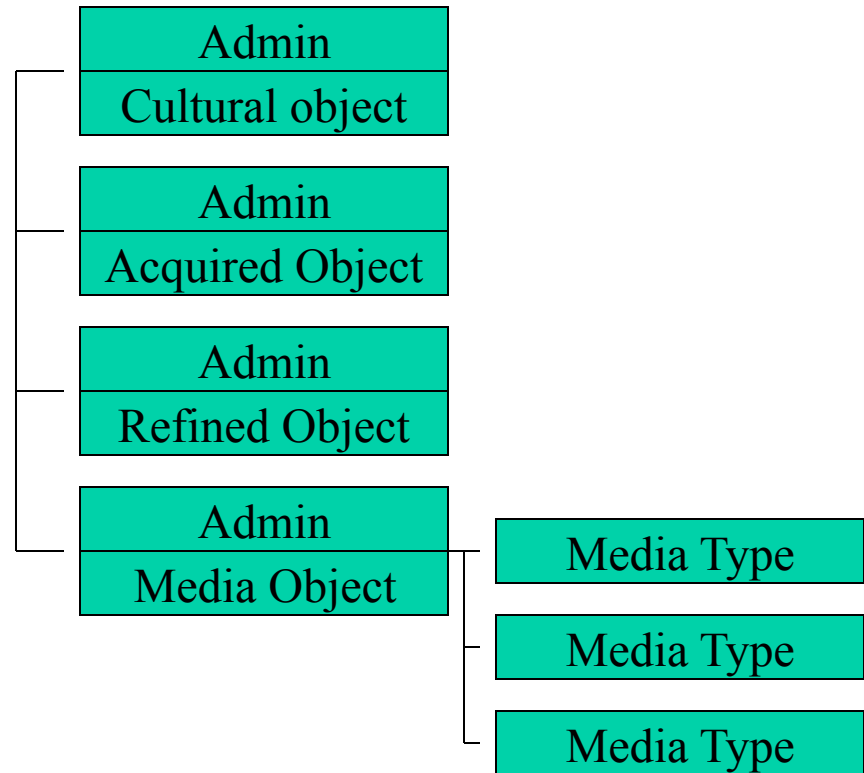
AMS Vocabulary Terms (1)

Type of Metadata	AMS Vocabulary Terms
Administrative	Creator, Date Created, Date Modified
Cultural Object	Source, Name, Name Alternative, Creator, Contributor, Object Production Date, Object Production Place, Type, Description, Rights, Completeness, Condition, Production Period, Production Technique, Material, Dimension, Components, Owner, Acquisition Source, Accession Date, Field Collection Date, Field Collection Method, Field Collection Place, Field Collector, Current Location, Accession Date, Field Collection Date, Field Collection Method, Field Collection Place, Field Collector, Current Location
Acquired Object	Identifier, Name, Creator, Contributor, Publisher, Date Created, Description, Rights, Format, Format Extent
Refined Object	Relation is version of
Media Object	Name, Type, Subject, Description, Date Created, Technique, Creator, Format Extent, Rights, Skill Level, Person Effort

AMS Vocabulary Terms (2)

Type of Metadata	AMS Vocabulary Terms
Media Type Specific	
Simple Image	Image Size, Resolution, Compression Method, Compression Factor, Colour Depth
Description	Length, Character Set
3D Studio Max Project	Software version, Required Extensions
VRML Model	VRML Version, Number of Textures, Composite, Animated
Panorama Image	Number of Images, Step Angle
Multi-resolution Image	Resolutions, Software, Algorithms

AMS and the ARCO Data Model

Entities in the data model have differing sets of metadata associated with them …

Department of Computer Science Seminar, University of Bath, 9th January 2004
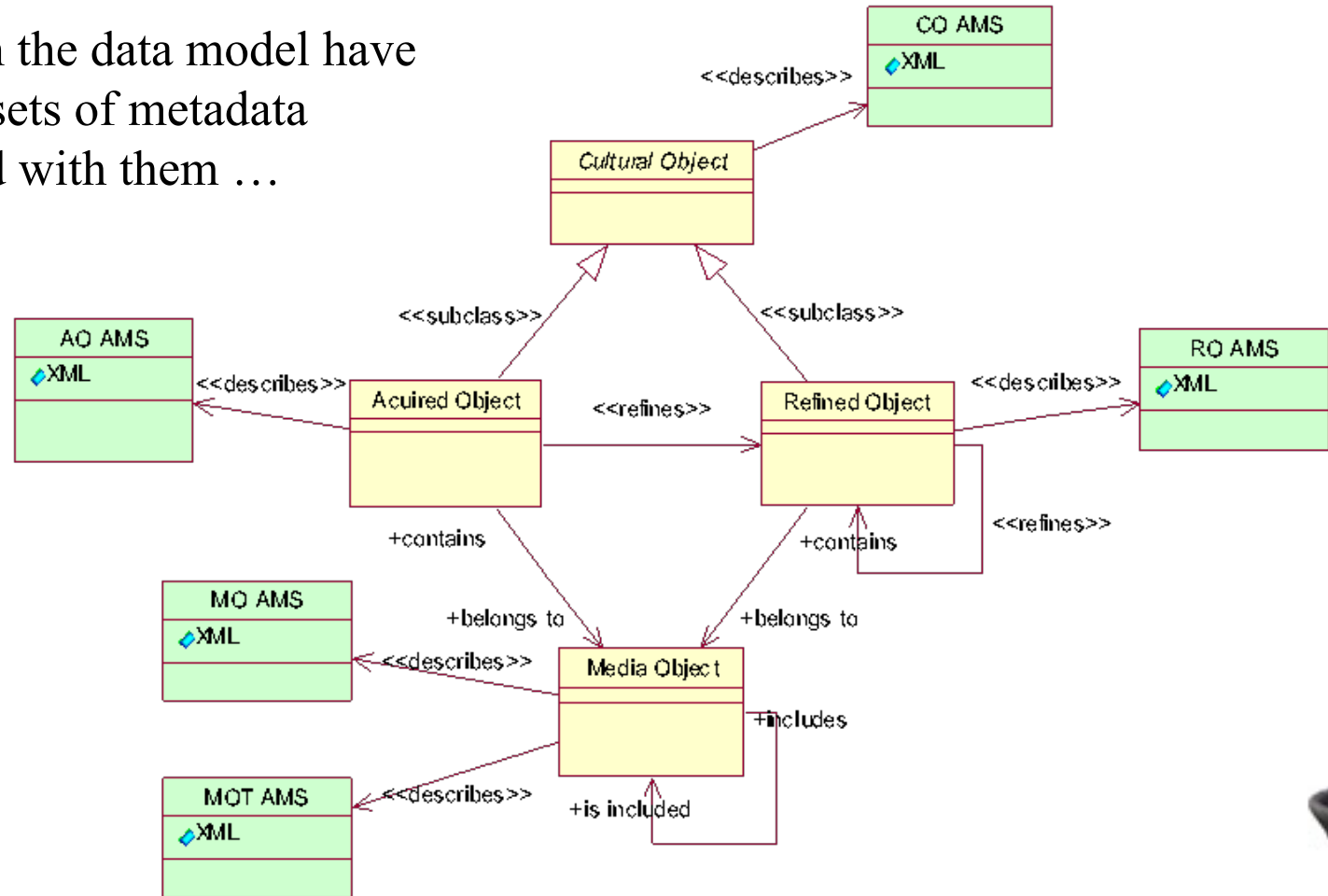
ARCO Metadata Schema Manager

- Caters for evolution of the AMS specification
- Provides ability to add metadata specification for new MOs
- Import and export of metadata specifications

Department of Computer Science Seminar, University of Bath, 9th January 2004
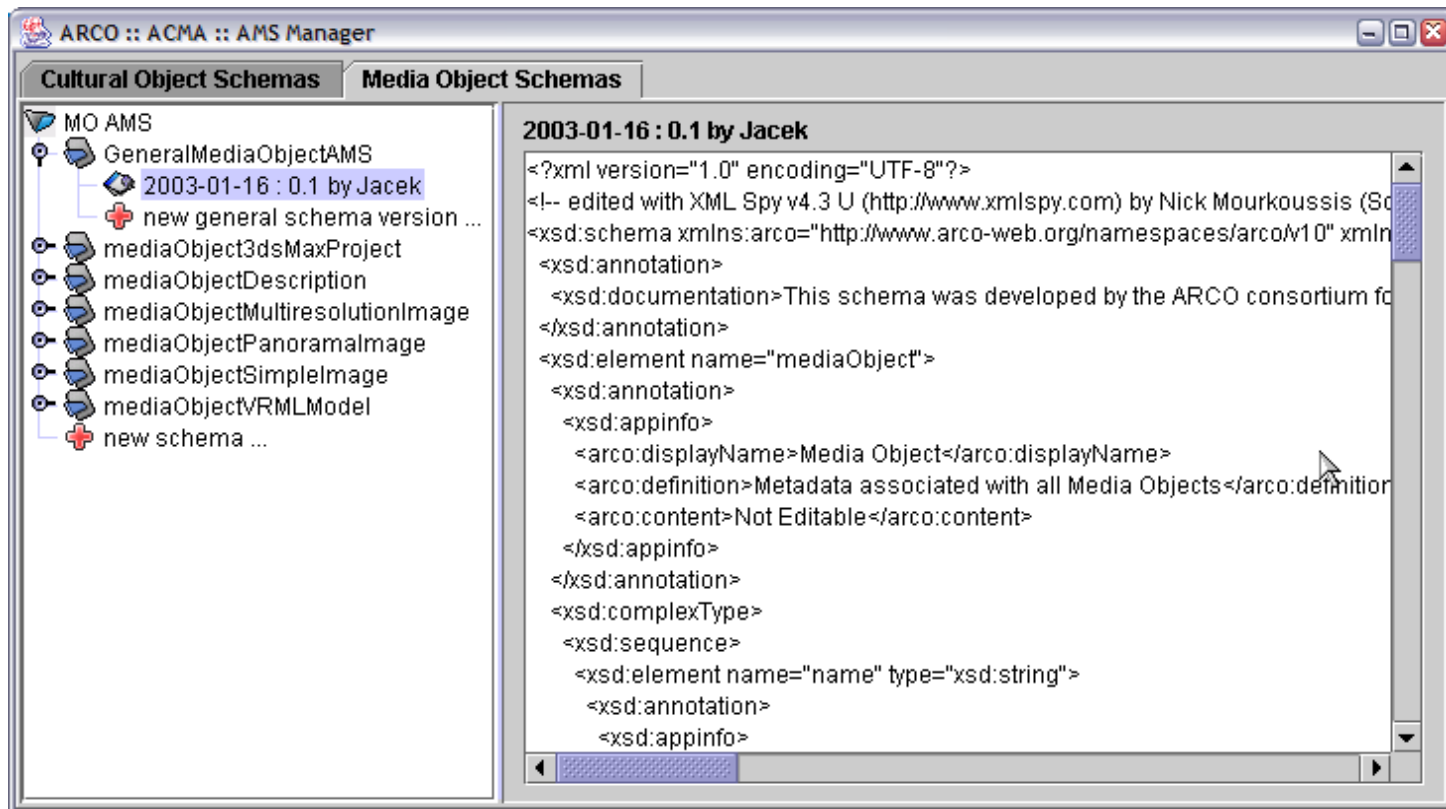
ARCO Metadata Instance Editor
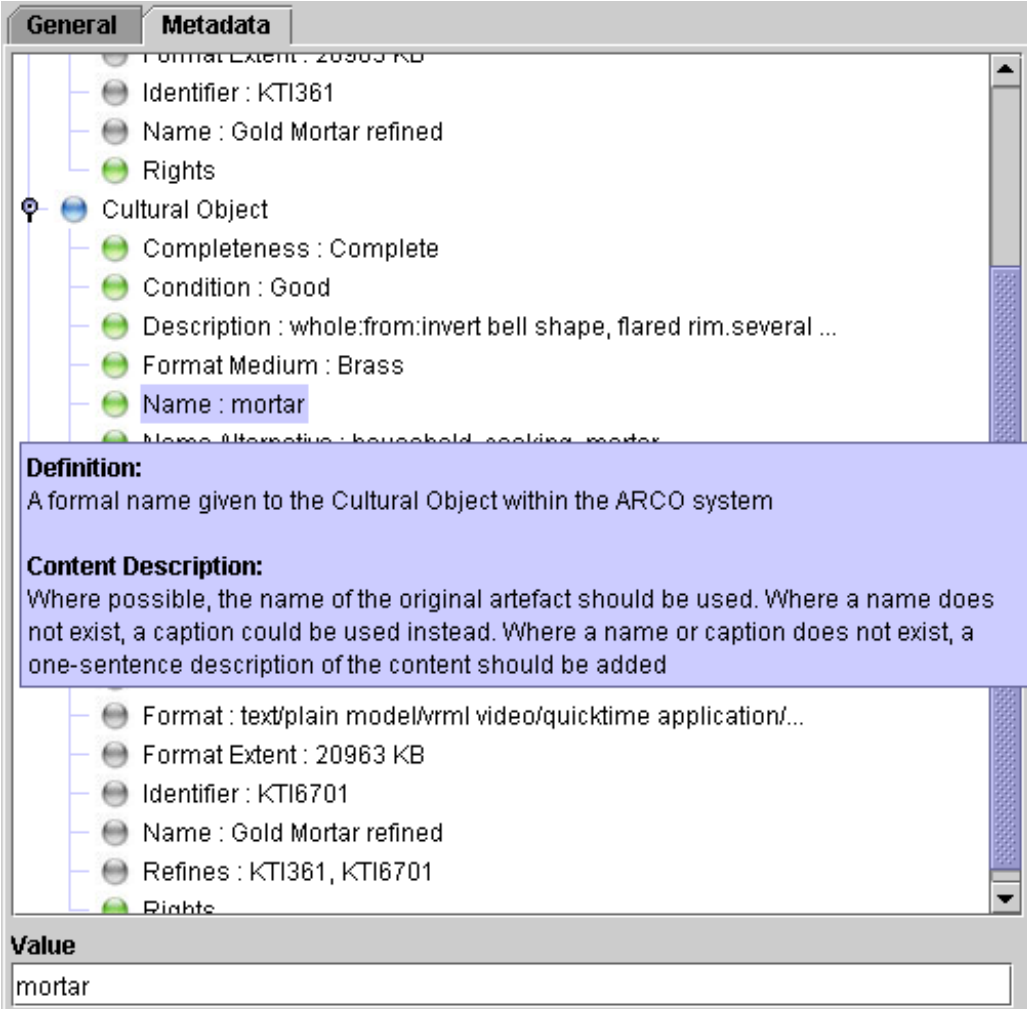
Provides guidance in authoring and editing instance metadata:

- mandatory elements inserted automatically
- every action is verified against a schema specification
- auto-generation of some technical elements (e.g. *Format Extent* –size in bytes)
- enumerations or controlled vocabularies displayed in drop-down menus

General | Metadata

Format Extent : 26963 KB
Identifier : KTI361
Name : Gold Mortar refined
Rights
Cultural
Add ▶ Source
Com
Name
Con
Delete
Name Alternative
Description : wh... e, flared rim.several ...
Creator
Format Medium
Contributor
Name : mortar
Date Created
ortar
Name Alternativ
Type
Rights : Sussex
Description
Source : LEWSA
Completeness
Type : mortar
Condition
Refined Object
Production Period
Creator : Owner
Production Method
Date Created : 2... 00
Format : text/pla... time application/...
Format Extent :
Format Medium
Identifier : KTI67
Dimensions
Name : Gold Mo
Coverage Spatial
Refines : KTI361
Components
Rights
Rights

Value
Owner

ARCO Metadata Editor: Content Guidelines

Content guidelines or cataloguing rules are displayed if provided by the schema creator …

Visualisation of digitised artefacts

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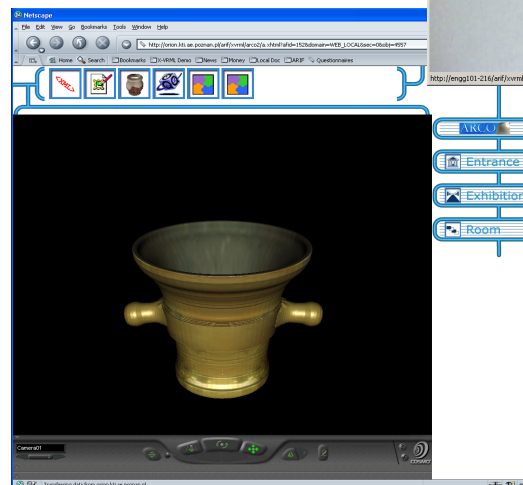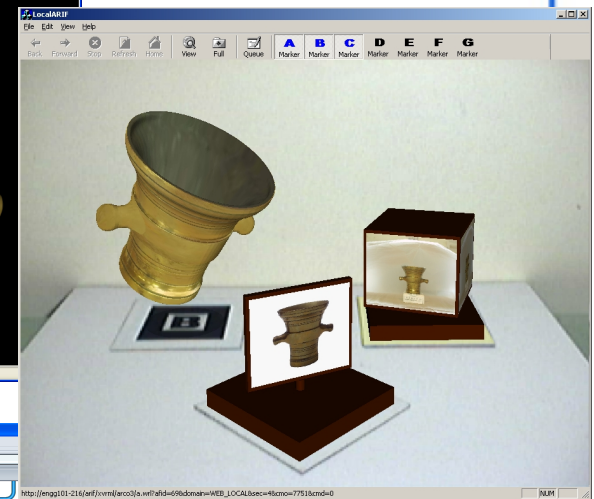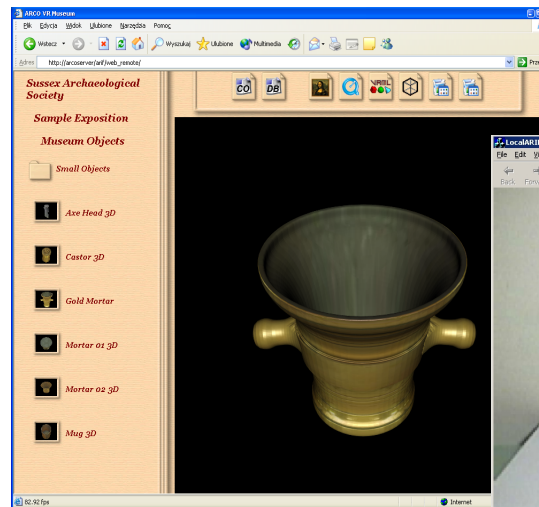
Metadata display over the Internet

Web interface caters for browsing of exhibition hierarchies and metadata associated with CO, AO, RO and MOs:

Touch-screen display in a museum

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

Department of Computer Science Seminar, University of Bath, 9th January 2004

A virtual exhibition as a 3D Gallery

Users can browse objects by walking along the gallery:

- detailed information via interaction elements integrated into stands

- interaction with objects: zoom, rotate, reset

- optional semi-transparent window for metadata display

- metadata updated to correspond with closest object
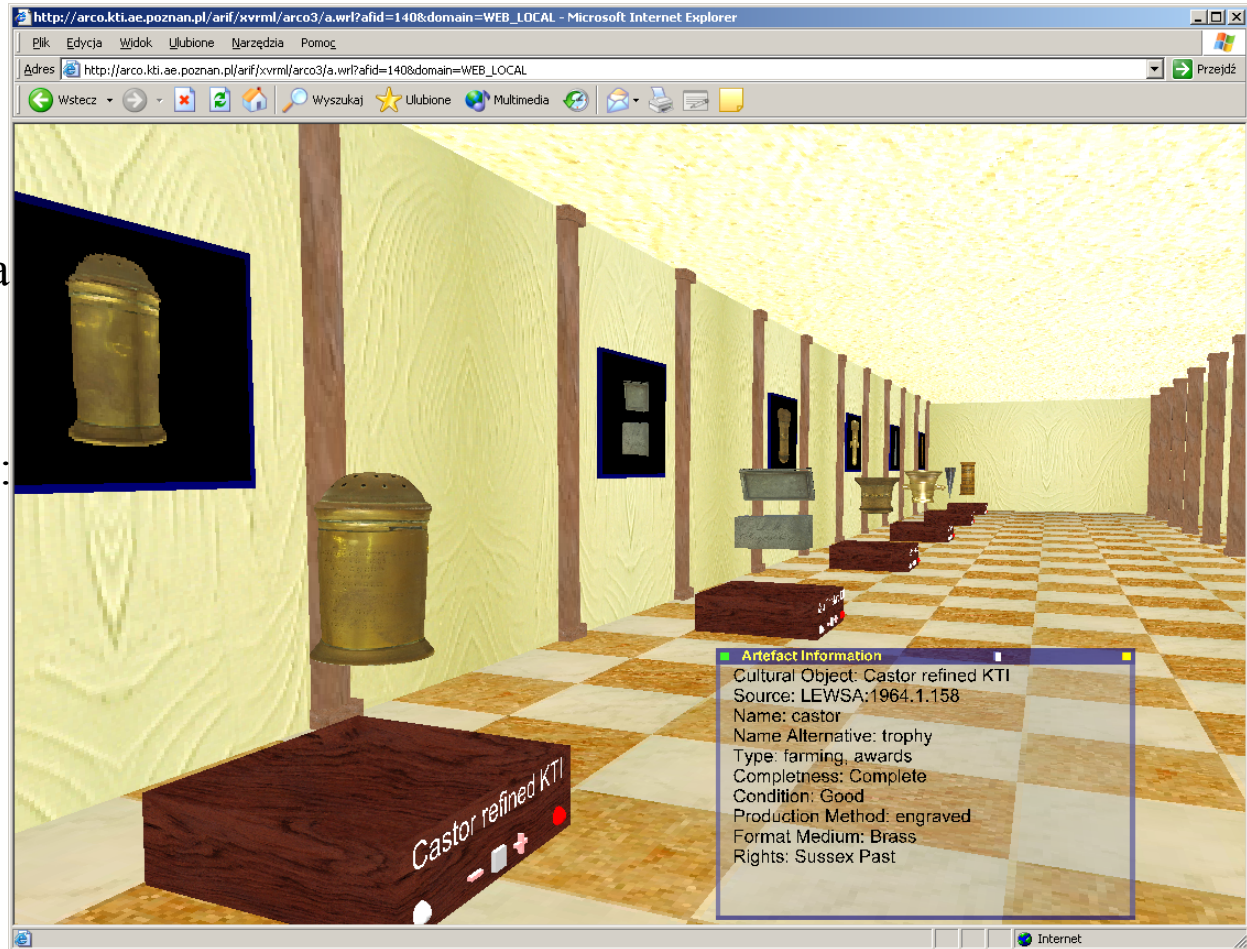
An Interactive Cultural Heritage Book

A more engaging way of browsing exhibitions …

An Interactive Learning Scenario

- A 3D model and a question are displayed on physical markers
- Three possible answers are assigned to three other markers
- The user can answer the question by turning over one of the markers
- Depending on whether the answer is correct or not, an appropriate response appears in the augmented reality scene …
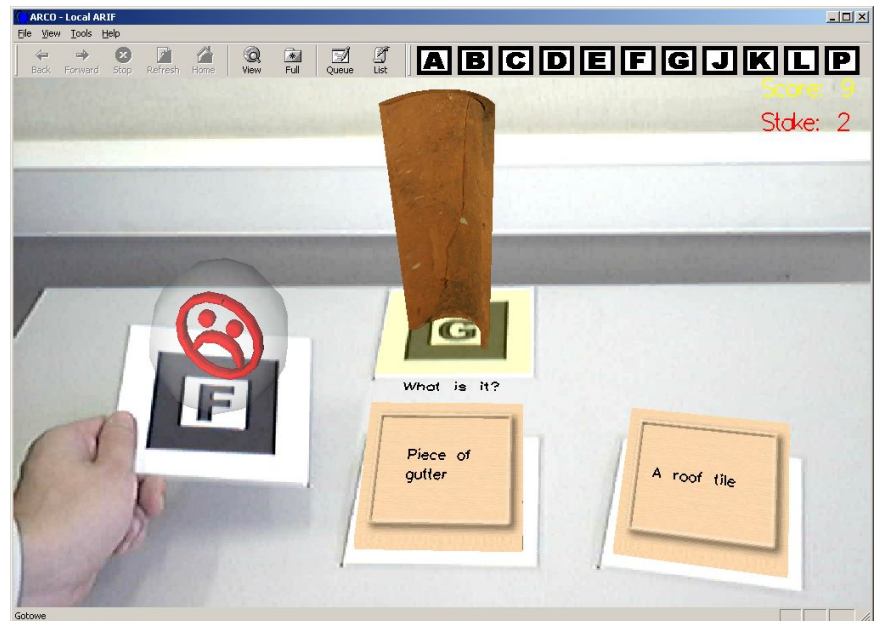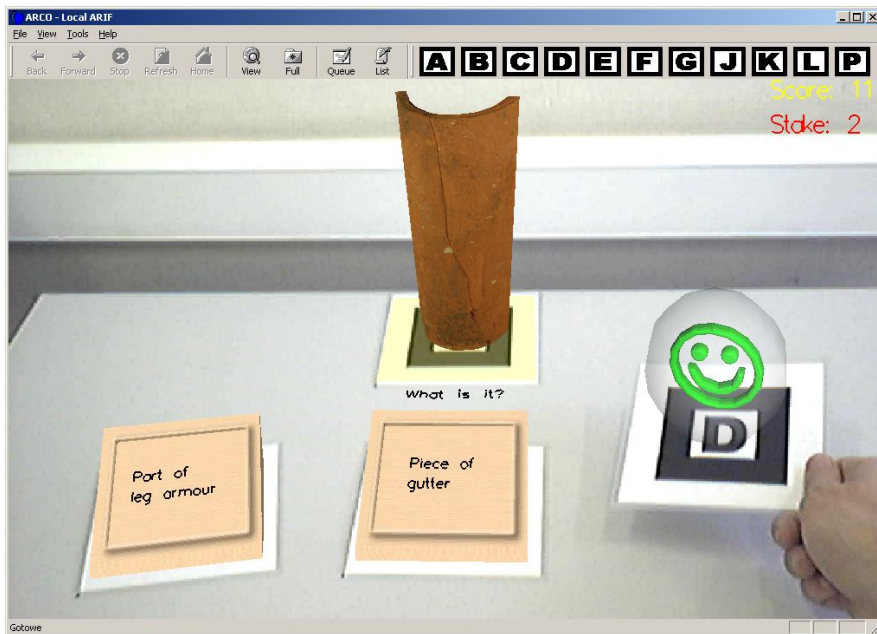
Conclusions

- ARCO is developing an open architecture that integrates state-of-the-art with ARCO specific technologies to enable museums to build virtual exhibitions
  - Digitisation and modelling of 3D museum artefacts
  - Refinement and creation of the 3D virtual museum artefacts
  - Object relational database and content management
  - Visualisation of museum exhibits in virtual environments
  - Integrated through XML technologies (X-VRML, AMS, XDE)
- The system can be used to serve a didactic function as well as enhancing the experience of cultural objects through interaction
- Metadata plays a central role in enabling and supporting system functionality
- Visit us at the ARCO website:
  - http://www.arco-web.org/