

### Matematica, Forme Immagini

### CNR – IMATI Genova

### **Bianca Falcidieno**

Research – Training – Technology Transfer – Dissemination 1

## The National Research Council (CNR)

The Consiglio Nazionale delle Ricerche (CNR) is the leading Italian public institution for research. Its mission is to carry out, promote, spread, transfer and improve research activities in all sectors of knowledge growth and to develop pre-competitive applications.

The CNR scientific network is organised in 11 Departments in Rome and 110 Institutes, located throughout Italy in 20 Research Areas, and about 7000 researchers and employees.



### **IMATI GE key competences**



## IMATI GE key competences

Applied mathematics & information technologies

- **Geometric Modelling & Computer Graphics**
- Computational Geometry and Topology
- High Performance Computing
- Computational Electromagnetics
- Cognitive models based on ICT
- Applications
  - Multidimensional Media, Industrial Design, Environment, Geographical Information Systems, Bioinformatics, Medicine, Infomobility
- Activities
  - Research, Education, Technology Transfer, Dissemination
- Staff
  - > 23 staff members (4 contract researchers)
  - 3 PostDocs, 3 PhDs & 3 Master students

## **Shape Modelling and Reasoning**

### Research

- Computational Mathematics
- Shape Modelling
- Computer Graphics

### Projects/Agreements

- FOCUS K3D (CA FP7)
- AIM@SHAPE (NoE FP6)
- FIRB (Italy Israel)
- ESDI + (Spatial Data Infrastr. FP7)
- NATURE GIS (thematic Network FP7)
- CHRONIOUS (IP FP7)
- National/Regional projects
- Bilateral agreements
- CNR projects

- Applications
  - Industrial Design
  - Aesthetic Design
  - Geographical Information Systems
  - Bioinformatics
  - Medicine
  - Cultural Heritage
  - Serious Gaming
- Dissemination
  - Conferences/Workshops (FOCUS K3D conference 2010, 3DOR EG2010, SMI'10)
  - International Schools
  - High-level training

## Shape modelling group

- Riccardo Albertoni
- Marco Attene
- Silvia Biasotti
- Chiara Catalano
- Monica De Martino
- Bianca Falcidieno
- Daniela Giorgi
- Franca Giannini
- Simone Marini
- Marina Monti
- Michela Mortara
- Giuseppe Patanè
- Francesco Robbiano
- Michela Spagnuolo



## **Context: 3D models**

3D models are digital representations of either physically existing or virtual objects that can be processed by computer applications









### 3D media

- individual 3D models (static, dynamic)
- assembly of 3D components (car engines, ..)
- virtual environments (objects, avatars, cities, ..)

## Foundations of 3D modelling

- geometric modelling is the discipline that sets the foundations of the representation of 3D media
- geometric modelling and processing are based on a number of disciplines
  - geometry, algebraic geometry
  - computational geometry, discrete topology
  - computer science





## The traditional modelling pipeline



### **3D models today**

 the reduction of hardware costs makes it possible to think of "3D on the desktop"
 *low-cost graphics cards, processing speed*

3D acquisition devices are becoming more and more commonplace

Iaser scanning, photogrammetry

computer networks may now rely on fast connections at low cost

## Key data in many scientific fields

gradual shift of paradigm in science: from physical prototypes and experience to virtual prototypes and simulation

### Professional & scientific users

- Product Modeling
- Design
- Cultural Heritage
- Gaming
- Simulation
- Medicine
- Bioinformatics
- Architecture
- Archaeology





The geometry universe should be coupled with a **semantic** one

## What is a shape?

# Not only geometric and visual features but also objects' meaning in a given knowledge domain



### shape-based analysis & synthesis

### Geometry

- properties of the geometrical representation model
- properties of the surface/volume that defines the model

### Structure

identify simpler components of the model and describe the object by their configuration and/or composition

Context

Interpret the geometry and/or structure in a context to annotate high-level features (semantics)



# Shape Modelling in an indusrial context





## **Network of Excellence AIM@SHAPE**

Advanced and Innovative Models And Tools for the development of Semantic based systems for Handling, Acquiring, and Processing knowledge Embedded in multidimensional digital objects

EU FP6 Contract no. 506766 - Key Action: 2.3.1.7 Semantic-based knowledge systems

### Bianca Falcidieno, Coordinator CNR IMATI-Genova

13 partners
4 years (2004-2008)
100 researchers
85 PhD students
≈ 6.5 ML €

Web site: www.aimatshape.net

## **Mission and goals**

- Representing, modelling, & processing knowledge related to digital shapes
- Focus on 3D or 3D time varying shapes as the new wave of multimedia communication





- Represent shape semantics
- Maximise automation of the shape knowledge lifecycle
- Design common infrastructures for sharing shape models and tools
- Promote the adoption of knowledge management tools in "shapeintensive" applications



#### Ontologies

Shapes

Tools

Publications Glossary

News!

Welcome to the fourth version of the Shape Repository

#### Shape Repository

- AIM@SHAPE project
- Browse models
- Semantic search
- Geometric search
- Search by keywords.
- Shape Ontology tutorial

#### Visitor locations since Oct 16, 2007



#### News: New search page is implemented. Shape Repository Ver.4 is ready. Shape Repository open to public. < 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 > We have 521 models, containing a total of 1180 shapes.

Neptune

Hand

Show 12 💟 models per page

Category:

11:37:06

view group

Category:

Format: OBJ

Size: 10.0MB

Creator: MPII

16:51:35

Uploader: MPII

Downloads: 1014

Grp downlds: 1640

Format: OFF

Size: 161.1MB

Uploader: INRIA

Downloads: 1710

Grp downlds: 3389

ManifoldSurfaceMesh

Up.date: 2005-10-28

Sort by: Group Downloads 🎽 Current sort: Group Downloads.

AIM@SHAPE Shape Repository ~ View page

ManifoldSurfaceMesh

Creator: Laurent Saboret

Up.date: 2006-11-08

Gargoyle Category: NonManifoldMesh Format: PLV Size: 31.3MB Creator: VCG-ISTI Uploader: CNR-IMATI-GE Up.date: 2005-10-27 11:33:26 Downloads: 713 Grp downlds: 2002

Polystone Dragon scanned with a Minolta Myid 910 laser soan ...

view group

#### Buddha



Category: NonManifoldMesh Format: PLY Size: 27.5MB Creator: VCG-ISTI Uploader: CNR-IMATI-GE Up.date: 2005-10-28 15:08:51 Downloads: 626 Grp downlds: 1629

Model of a chalk sitting Buddha statue obtained through 3D S ...

Shape Repository

- news page
- browse by
- category
- upload models
- FAQs
- Inks
- statistics
- contact us contribute



#### Category: ManifoldSurfaceMesh Format: OFF Size: 48.6MB Creator: L.Saboret and M... **Uploader: INRIA** Up.date: 2006-10-26 12:12:34 Downloads: 1048 Grp downlds: 1784

A dragon laser scanned ...

view group

#### Julius Caesar Category:

ManifoldSurfaceMesh Format: OFF Size: 28.9MB Creator: INRIA and IMATI Uploader: INRIA Up.date: 2006-01-16 17:51:18 Downloads: 659 Grp downlds: 1625

Mask of Julius Caesar scanned with a Minolta Mivid

scan of t ... view group

Meshings at different resolutions of a laser range

#### view group

view group

### Accesses to the AIM@SHAPE Shape Repository 2.500.000 (100.000 downloads)



### **Coordination Action FOCUS K3D**

FOster the Comprehension, adoption and USe of Knowledge intensive technologies for coding and sharing 3D media content in consolidated and emerging application communities

EU FP7 Contract no. 214993 - Key Action: ICT-2007.4.2. Intelligent content and semantics

> Bianca Falcidieno, Coordinator CNR IMATI-Genova



8 partners duration 2008 - 2010 ≈ 1.3 ML €

Web site: www.focusk3D.eu



#### **Medicine & Bioinformatics**

#### **CAD/CAE & Virtual Product Modelling**



#### **Gaming & Simulation**

#### Archaeology & Cultural Heritage

### **BioTech, Health & Medicine**







### **Business & Education, Home & Leisure**



## **Grand challenges**

Derive symbolic representations
Goal-oriented 3D model synthesising
Documenting 3D lifecycle
Semantic visualisation and interaction
Standards

### A mathematical analysis of shapes

"We must learn from the matematicians to eliminate and discard: to keep in mind the type and leave the single case, with all its accidents, alone"

> D'Arcy Thompson On growth and form, 1917

