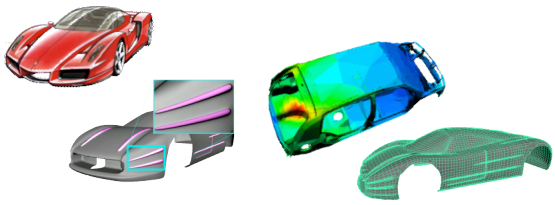
3D media

SSMS'08: Summer School on Multimedia Semantics

geometric representations for 3D media

metadata and ontologies for 3D media (AIM@SHAPE)

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



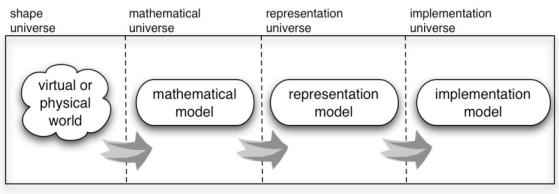
.. created by design ..

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

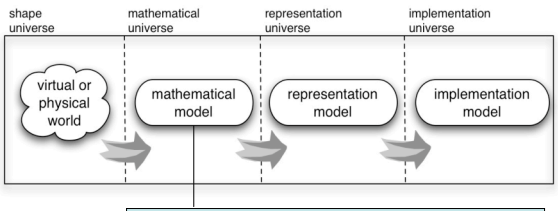
.. created by acquisition ..

- developed for the CAD/CAM industry first, with focus on ***solid and rigid objects***
- wireframe models
- 1970 – .. ***geometric models***, such as boundary representations (B-reps) and CSG
- Terminology and definitions of the foundations of geometric modelling were introduced in the seminal of Requicha, 1980

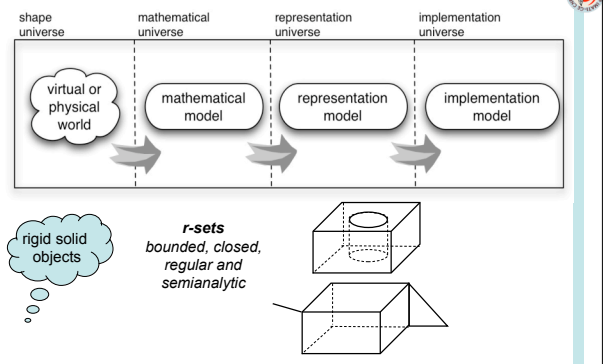
Aristides G. Requicha, *Representations for Rigid Solids: Theory, Methods, and Systems*, ACM Computing Surveys, 4(12), 1980

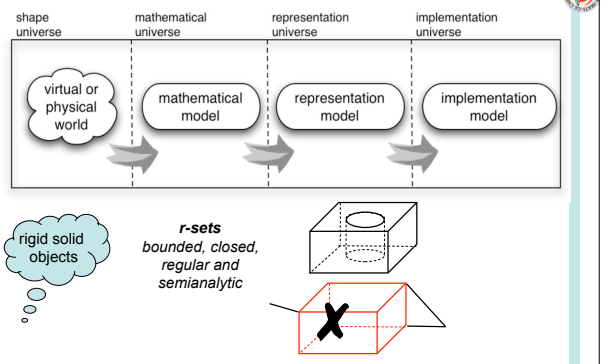


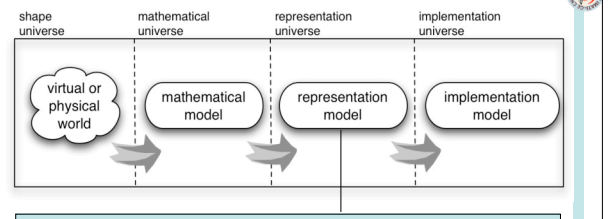
the modelling pipeline is based on the abstraction of the **geometric** nature and properties of 3D objects



identify the class of subsets of the Euclidean 3D space whose properties corresponds to the properties of the objects to be modelled



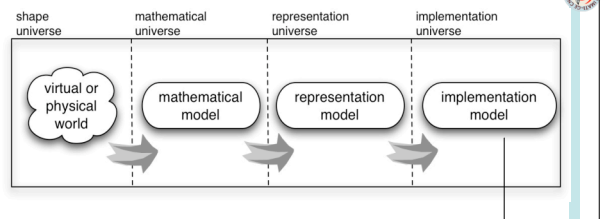




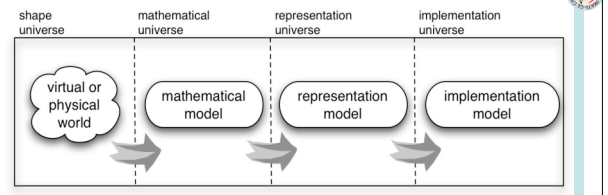
Representation models are finite symbol structures, constructed with symbols from an alphabet according to syntactical rules.

The collection of all syntactically correct representations is the representation universe.

Not all representations correspond to *valid* models.



define the data structure to store the representation model

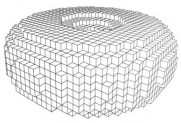


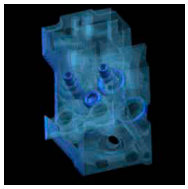
a sound definition of the mathematical and representation spaces and of their mapping are crucial to determine the properties of the modelling framework (eg, validity, uniqueness, non-ambiguity, ..)

- ✓ there are many and distinct digital models to represent the same object digitally
- ✓ the choice of the digital model is strongly influenced by the application context or usage of the model
- ✓ each class of models has its own properties, metadata

wrt 2D media, 3D calls for the documentation of **knowledge** pertaining to the **geometric representation** level

- ✓ Cell decompositions
  - spatial occupancy enumeration (voxels, regular space partitioning,..)
  - object-based (tetrahedra, octrees)
- ✓ Constructive Solid Geometry (CSG)
- ✓ Boundary models
  - triangle meshes
  - B-reps
- ✓ Sweeps
  - generalized cylinders, generic sweeps





courtesy of Tom Funkhouser

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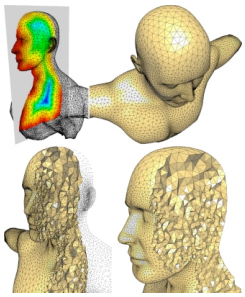

courtesy of Pierre Alliez

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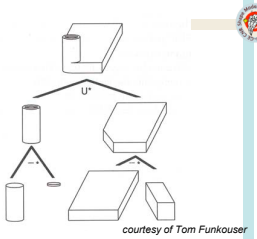

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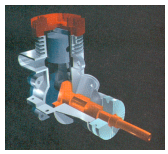

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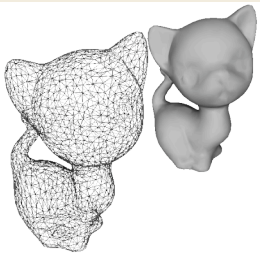

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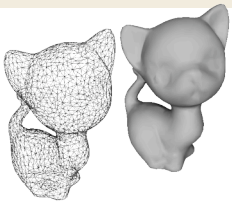

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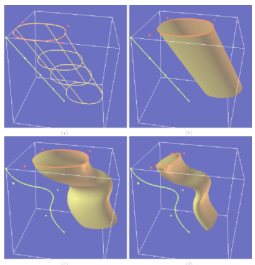
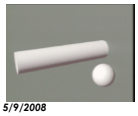


courtesy of Dimitri Terzopoulos

- ✓ different representation models can be used for representing the same object
- ✓ different file formats can be used for the same representation model
  - triangle meshes: WRL, OFF, PLY, 3Dmax, COLLADA, ..



1987: from solid rigid CAD to .. deformable (re)-active models !!!

Dimitri Terzopoulos SIGGRAPH Award winning paper

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1990: from CAD models to .. Marilyn Monroe !!!

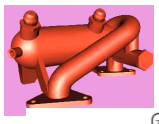
Virtual Marilyn : MIRALab, University of Geneva
Nadia Magnenatt-Thalmann

nowadays, not only rigid solids..

- ✓ dynamic shapes
- ✓ elastic and deformable models
- ✓ animation of natural objects and/or natural phenomena (eg, humans, water, clouds, plants, cloths)
- ✓ from geometric models to physically-based models (*already embed some kind of semantics*)
- ✓ more elaborate and especially *higher-level* representation of the shape

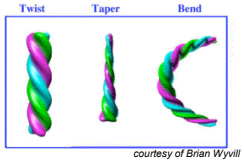
nowadays, not only rigid solids..

- ✓ implicit models
  - F(x,y,z)=0

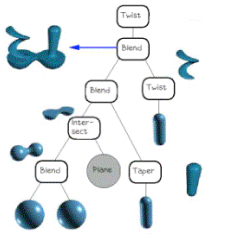


Bill Lorensen SIGGRAPH 99 Course #4 Notes

- ✓ CSG "new generation"
  - Blob tree



courtesy of Brian Wyvill



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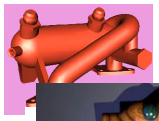

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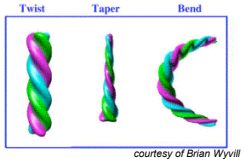

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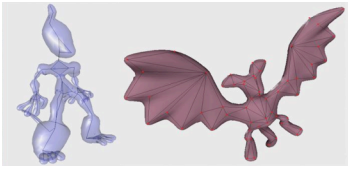
nowadays, not only rigid solids..

- ✓ Skeleton-based implicit surfaces



courtesy of Marie-Paule Cani

- "polygon soups" are very common in non-professional environments
- NURBS, B-reps, implicits, parametric, "high-quality" triangle meshes are used in professional domains for scientific and entertainment applications

first efforts toward *semantics* 3D

- sophisticated representations of the shape of 3D objects: what is missing to make them more *easy* to model, more *intelligent* in interactive virtual environments, more "*self-descriptive*" about what is their content & meaning ?

2004 : AIM@SHAPE
(actually, started much earlier …)

- semantics and/or knowledge maybe related to various aspects of 3D media
  - the object itself (real or virtual)
  - the digital representation of the object
  - the use or purpose of the object in a given application context

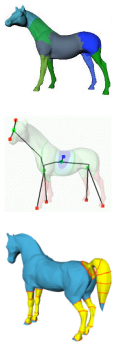
www.aimatshape.net

- knowledge technologies & shape modelling
  - AIM@SHAPE project: the 1st big effort towards the coupling shape modelling with knowledge technologies
  - 4 years (2004-2008), ≥ 6Mio €, 13 partners, coordinated by Bianca
  - tangible results: the Digital Shape Workbench with its Shape Repository
    - models with certified properties
    - documentation of models and tools via ontologies
    - promotion of benchmarking

- key issue: knowledge technologies as the way to promote and adopt
  - (better) documentation of existing algorithms and methods
  - culture of replicability of results
  - benchmarking
- benefits for the SM community
  - avoid re-inventing the wheel, better focus on really open research issues instead of incremental work
  - more scientific approach

the AIM@SHAPE view

- Geometry
  - *properties of the representation model*
  - properties of the surface/volume that defines the model
- Structure
  - *simpler parts of the model and their configuration and/or composition*
- Context
  - *Interpret the geometry and/or structure in a context to annotate high-level features (semantics)*



geometric knowledge

context-driven knowledge

the AIM@SHAPE experience

- not easy to convince the CG community about the usefulness of knowledge technologies such as metadata/ontologies
- research activities focused on method to segment, analyse and interpret shapes
- concentrate on learning how to use and develop ontologies to supports researchers in computer graphics in their activities
  - sharing shape models
  - high-quality models with certified properties
  - benchmarking
  - services for processing shapes

… if we are lucky, "demo" …

the AIM@SHAPE success !!

- ✓ the keyword "semantics" appears more frequently in our shape analysis papers, more concern about the *meaning of the segmentation task*
- ✓ great success of the shape repository, related ontologies and *smart* services for model search, retrieval and "selective" downloading

questions ?

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