Geometric Reasoning Lab

What is a Geometric Reasoning Laboratory?

blackboards

liveboards

Geometric Reasoning Lab

Appeals to Three Communities

- Expert Really-Existing Mathematicians (REM)

  Differential geometers and topologists

- Novice REM's

  Students, people who use or play with math

- Researchers in foundations of computer graphics and geometric computation

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General questions

- REM: a special case of the study of language and information.
- How do REM's (re-)associate meanings to marks?
- Can we capture some geometrical or topological meaning at intermediate layers of representation between gesture (eg chalk + talk) and TeX?
- Translation problem

  Rich mathematical structures vs

  Rich manipulators

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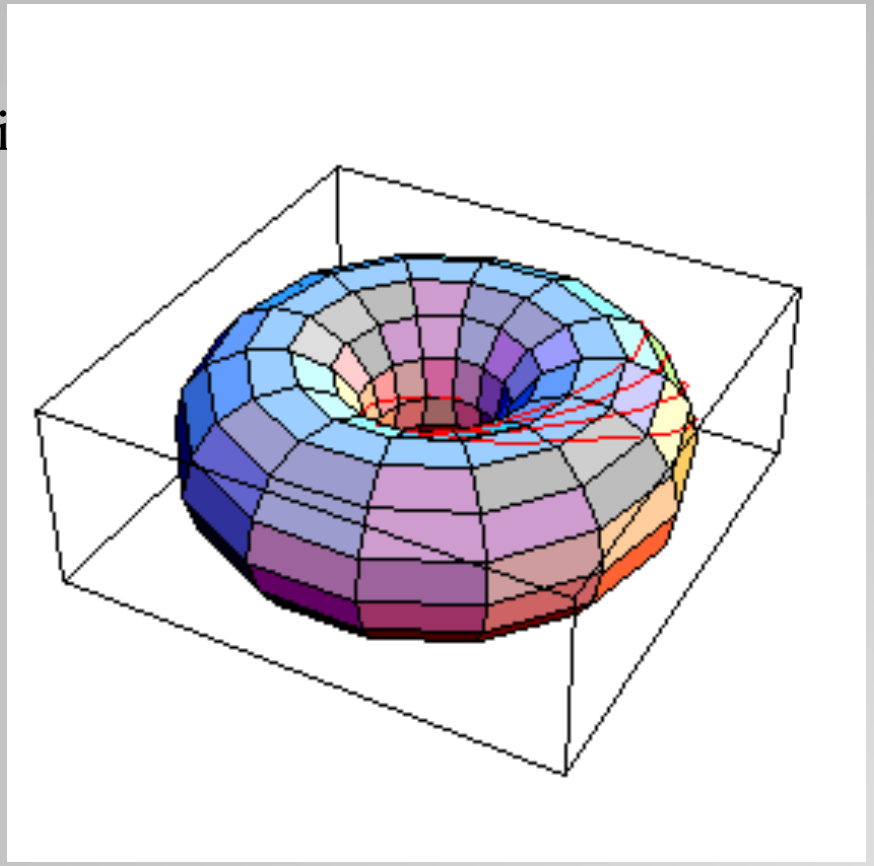
Mathematical example: DG

- Variational problems:
  - Geodesics on Riemanni
    - torus, Klein torus
  - Charged knots
- Cosmology



Mathematical example: Topology

- Fixed point theorems, no vector space structure

Mathematical example: PDE

- Compactly supported perturbations of analytic objects

Mathematical example: GMT

- Deformation theorem

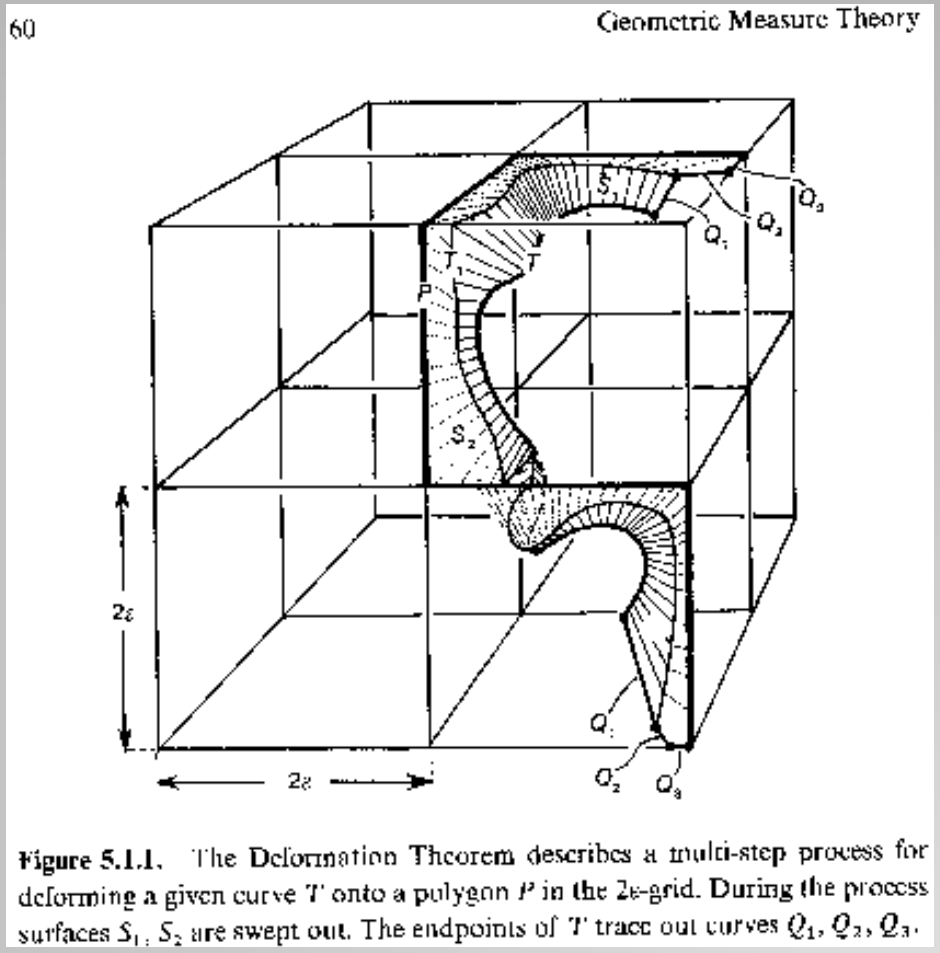


Figure 5.1.1. The Deformation Theorem describes a multi-step process for deforming a given curve T onto a polygon P in the 2ε-grid. During the process surfaces S_1, S_2 are swept out. The endpoints of T trace out curves Q_1, Q_2, Q_3.

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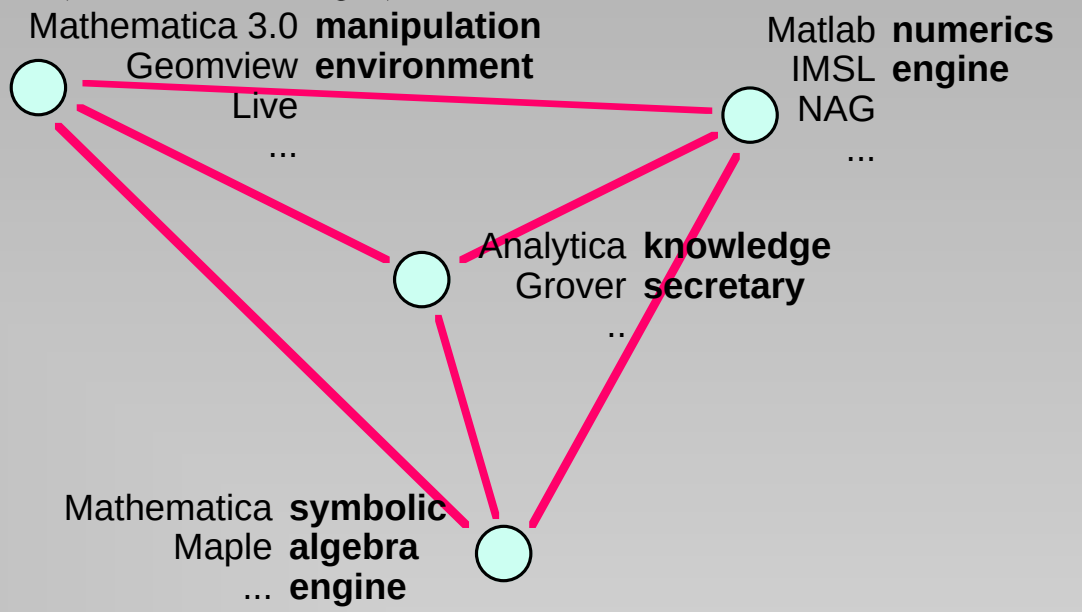
Components for a prototype



- Direct manipulation, structured interface
- Symbolic algebra engine
- Numerics engine
- Knowledge database

Technical Questions: Representations

- Representations of geometric objects, actions, and assertions about them
- Level of description
- Level of manipulation
- Scope of representation, eg.

  MESH vs DXF

  Polyhedral chains of dim 0,1,2, or 3

  Riemann surfaces and complex functions

  Zerosets of ideals in Q[x]

- How should REM's and algorithms manipulate those layers?

Technical Questions: Architecture

- Fine or coarse-grain?
- Shared/converted models
- Translation between representations

	shared model	independent models
fine grain		
coarse grain		

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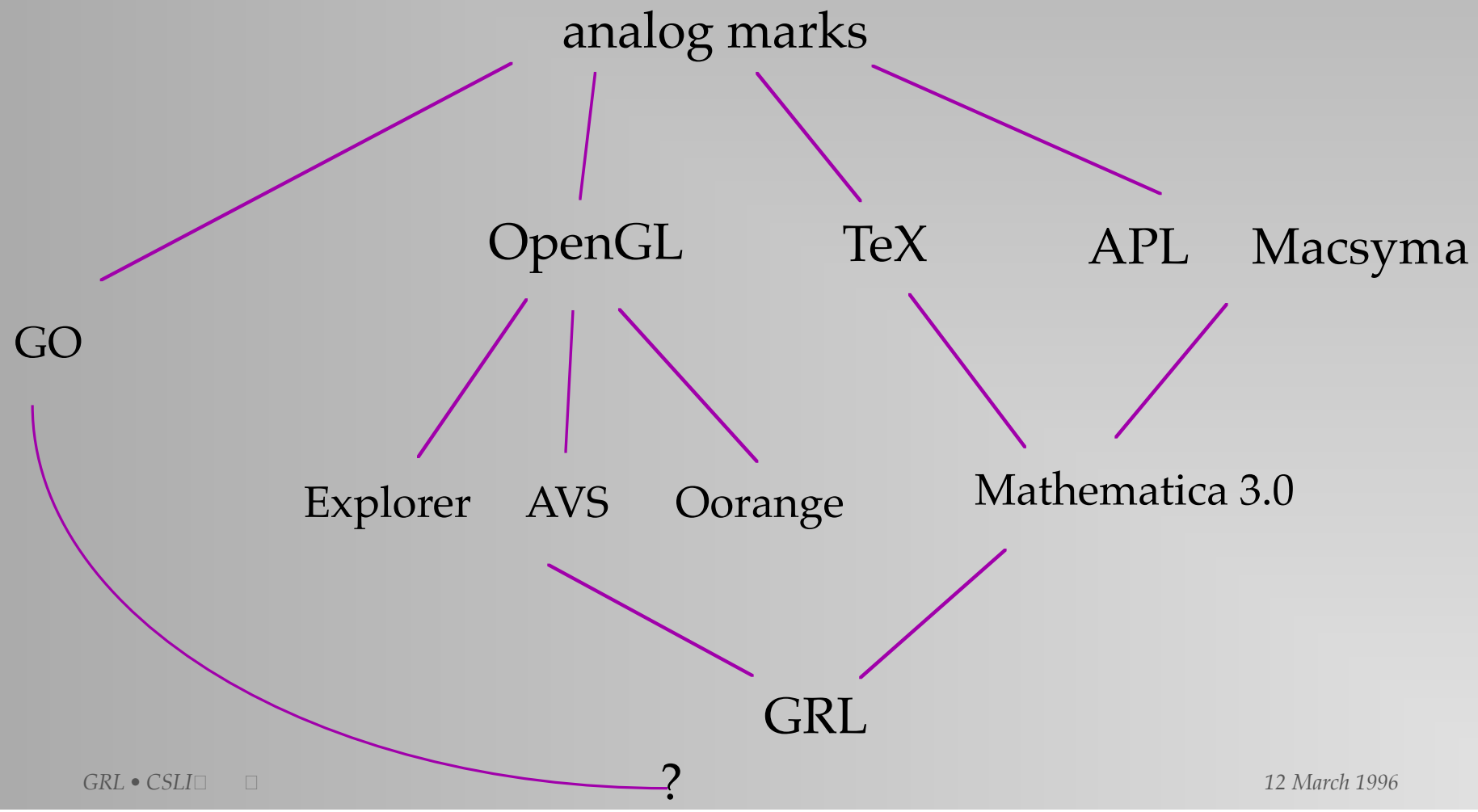
Genealogy



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Survey of relevant work: Integrated systems

- Mathematica
- Axiom/Scratchpad
- Oorange, AVS (Pinkall, Gunn)

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Survey of relevant work: Symbolic algebra

- WRI
- Waterloo Maple
- Axiom
- EuroMath, ...

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Survey of relevant work: Scientific computation

- Labview
- Matlab
- AVS
- NAG, IMSL

Survey of relevant work: Structured interfaces

- Language: Mathematica 3.0
- Instrument kit/graph: Oorange
- Immersion: VRML editors?

  M -> Sound, M -> VRML exist
- Performance: PREMO (ISO) editors??

Survey of relevant work: Languages

- ML

  sophisticated type mechanism

  no math expertise
- Scheme?
- Oorange (Objective-C classes) ??
- Pisces (C functions) ???

Survey of relevant work: Knowledge databases

- Axiom
- Analytica
- ?

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Questions, Tasks

- What connections are there to other CSLI projects?
- What is an appropriate audience?
- Who might fund this research?
- Build prototype for that audience