

# The Future in Computer Graphics Education

*Report from the joint  
Eurographics-SIGGRAPH workshop on  
Computer Graphics and Visualization  
Education (GVE'99)  
Coimbra, Portugal, July 1999*

SIGGRAPH  
Los Angeles

# The Future in Computer Graphics Education



## **Chair:**

***Michael B. McGrath***

## **Panelists:**

***Werner Hansmann***

***Dena E. Eber***

***Judith R. Brown***

***José Carlos Teixeira***

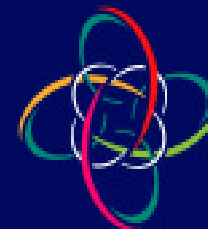
# The Future in Computer Graphics Education



*For further information see:*

***[www.eg.org/WorkingGroups/GVE/GVE99](http://www.eg.org/WorkingGroups/GVE/GVE99)***

***[www.education.siggraph.org/conferences/GVE99](http://www.education.siggraph.org/conferences/GVE99)***



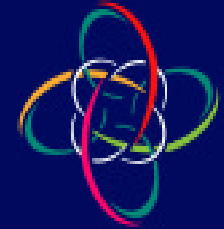
# Computer Graphics in the CS Curriculum

**Werner Hansmann**

**University of Hamburg, Germany**

**[hansmann@informatik.uni-hamburg.de](mailto:hansmann@informatik.uni-hamburg.de)**

# Computer Graphics in the CS Curriculum



## *Overview*

- Questions
- Recommendations
- Conclusions

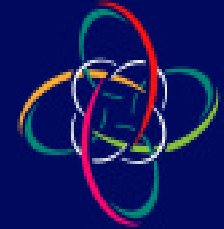
# Computer Graphics in the CS Curriculum



## *Questions*

- How do we teach: top-down or bottom-up?
- At what level should we be teaching CG?
- What is the job market for our students?
- What skills should students have?
- What topics should be taught?
- What is the balance of lecture/reading/lab/projects?
- What is the role of collaboration?

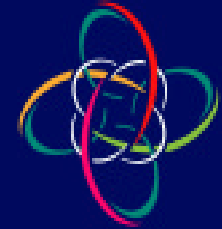
# Computer Graphics in the CS Curriculum



## *How do we teach?*

- Trend towards top-down using high level API
  - *start with API*
  - *replace API pieces with students' own details*
- Top-down first course can raise students' motivation in a second course

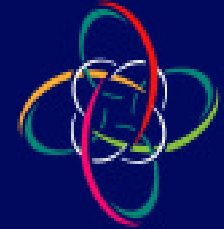
# Computer Graphics in the CS Curriculum



## *At what level should we be teaching?*

- 3rd year out of 4 year program of study
- Prerequisites:
  - *programming, algorithms, data structures*
  - *3D analytic geometry, linear algebra*
- Benefits for other CS courses:
  - *CG is a source of examples for motivation*
  - *solidifies knowledge of math and programming*

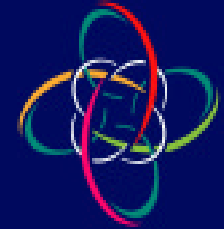
# Computer Graphics in the CS Curriculum



## *What is the job market for our students?*

- Scientific visualization
- Entertainment
- Web-based applications
- CAD / CAM
- Software companies developing graphics packages
- System development where general graphics skills or event-driven programming is required

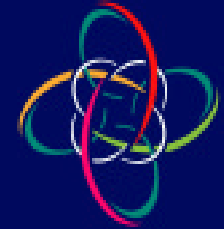
# Computer Graphics in the CS Curriculum



## *What skills should students have?*

- Communication / social / management skills
- Esthetic sensibility
- Technical skills (cf. topics)
- Ability to know how to learn: eg.
  - *ability to acquire knowledge of a new system on their own*

# Computer Graphics in the CS Curriculum



## *What topics should be taught?*

- Rendering pipeline, coordinate systems
- Event-driven programming
- Basic geometric modeling, hierarchical modeling
- Introduction to color theory
- Physics of illumination, interaction of light and matter
- Hidden line / hidden surface removal, shading
- Simple animations and interaction
- Special course: Visualization

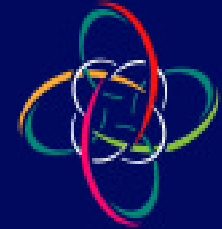
# Computer Graphics in the CS Curriculum



## *What is the balance of lecture/reading/lab/projects?*

- Lecturing method: use power of our medium, CG
- Present lecture on concepts and technical basis
- Lectures vs. labs and projects:
  - *lectures must be general, as opposed to*
  - *different lab exercises for different categories of students*
- CG textbooks should be reference texts

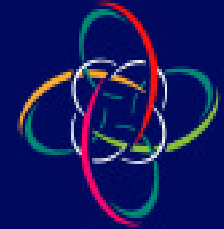
# Computer Graphics in the CS Curriculum



## *What is the role of collaboration?*

- Inter-disciplinary:
  - *Arts*
  - *Animation*
  - *Engineering*
  - *Scientific visualization applications*
- Group projects

# Computer Graphics in the CS Curriculum



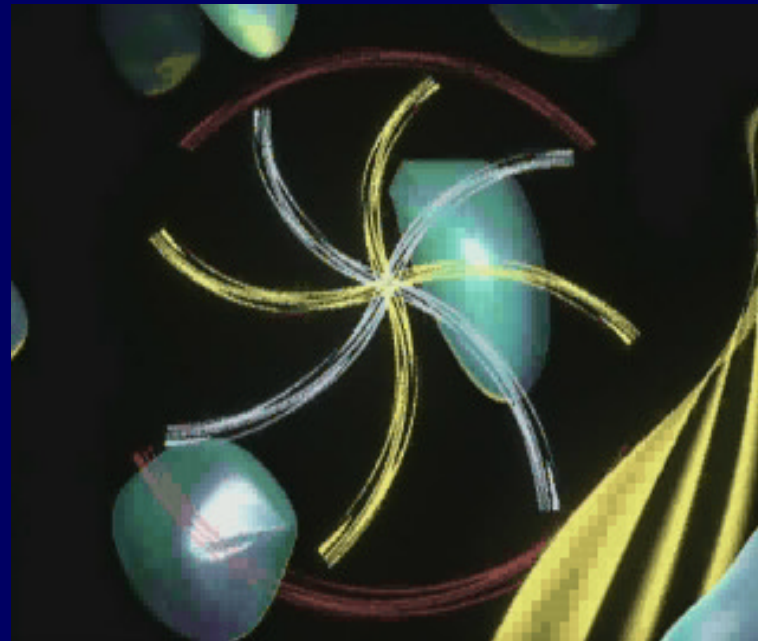
## ***Conclusions***

- Rendering pipeline remains important
- 3 essential features of beginning CG course:
  - *CG is fundamentally 3 D*
  - *a great deal of CG is interactive*
  - *CG is fundamentally visual*
- CG has rich potential as capstone course
- Graduate CG education depends on institutions' /  
instructors' specialties

# COMPUTER ARTS CURRICULUM IN HIGHER EDUCATION



***Dena Elisabeth Eber***  
***deber@christo.bgsu.edu***



SI99GRAPH  
Los Angeles

# COMPUTER ARTS CURRICULUM



## *Areas of Concern*

- Content
  - *Overall Curriculum*
  - *Course Work*
- Interdisciplinary Issues
- Teaching Issues
- Assessment
- Focus Areas

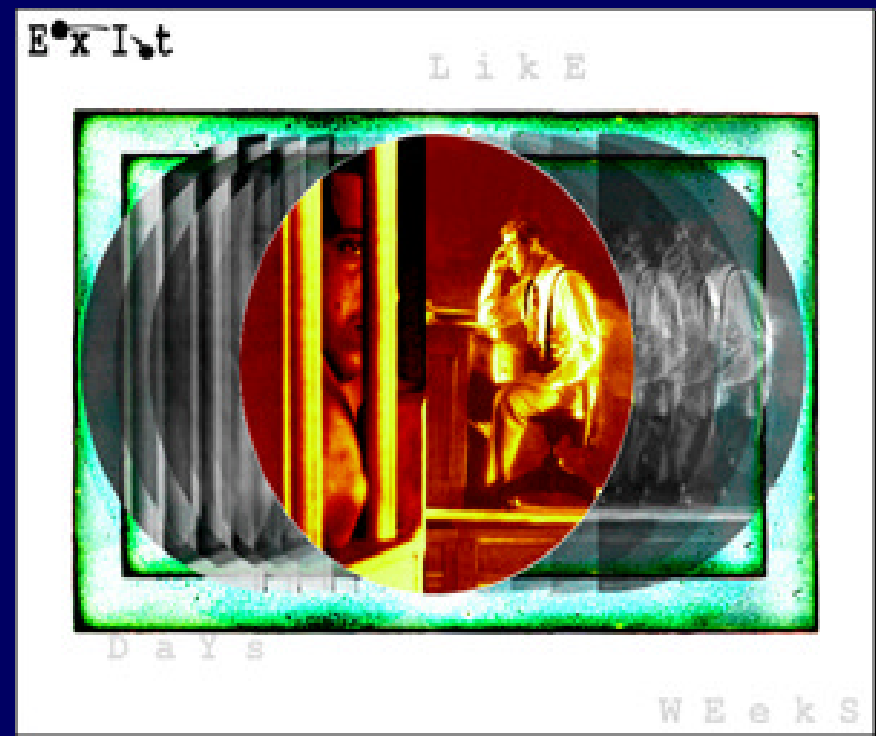




# CONTENT

## **Overall Curriculum**

- Span many disciplines
  - *Computer science, film*
  - *Other academics*
- Determine focus areas
  - *General*
  - *Topic based*
- Flexible evolving curriculum





# CONTENT

## *Course Work*

- Focus on creative and technical concepts
- Ground digital arts in history & theory
- Stress problem solving and resourcefulness

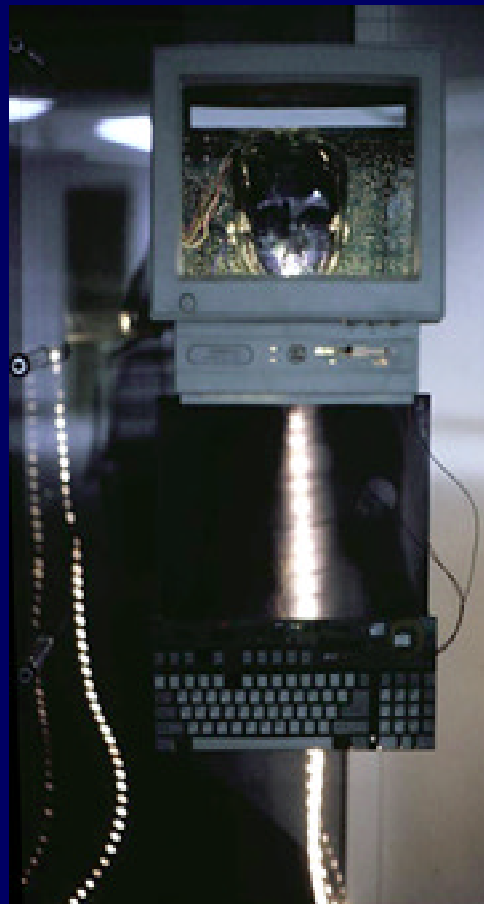




# CONTENT

## ***Course Work***

- Group & individual communication skills
- Introduction course
  - *Digital concepts*
  - *Variety of expression*





# CONTENT

## **Course Work**

- Foundations
  - *Include digital visual concepts as part of foundations for all*
  - *Require traditional foundations for all computer art students*
  - *Time*
- **Start computer art core as soon as possible**





# INTERDISCIPLINARY ISSUES

## *Foster Environments That Encourage:*

- Dialogue
- Collaboration and common projects between
  - *Departments*
  - *Disciplines*
  - *Cultures*
  - *Industry*





# TEACHING ISSUES

## *Critical Issues*

- Limited resources
- Funding & technical support
- Teacher workload

## *Basic Competency*

- Prior to college
- Provide course work for those without background

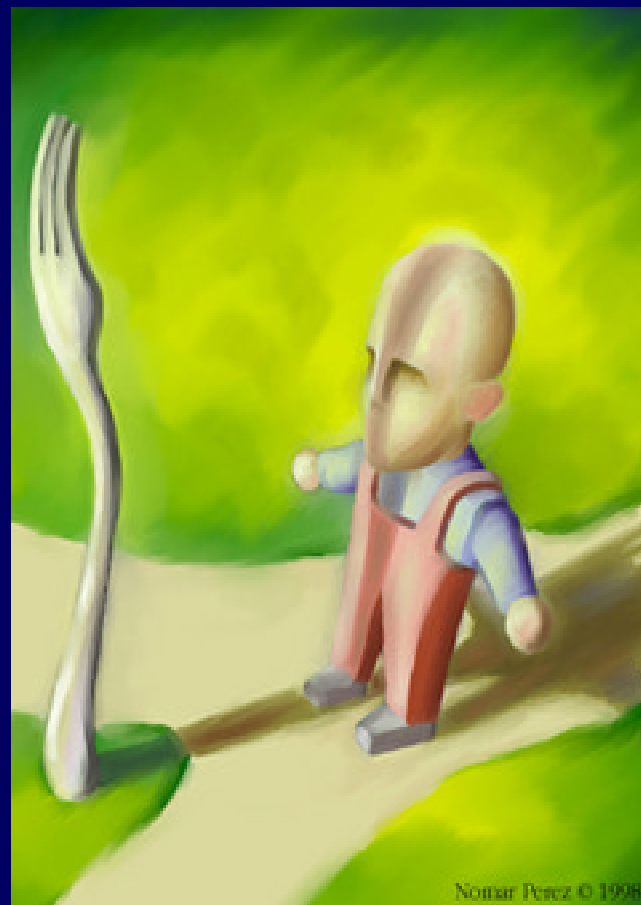




# ASSESSMENT

## *Still Need to Develop*

- Objective ways to measure
  - *Student achievement*
  - *Departmental progress*
- Internal and external evaluation





# FOCUS AREAS

## *Disciplines in Digital Arts*

- The still
  - Imaging, 3D modeling
- Time
  - Animation, video
- Interactivity
  - Interactive CDs, web
- Interdisciplinary (in art)
  - Photography, painting



# SUMMARY AND CONCLUSION



## *The use of computers in the arts:*

- Builds on artistic traditions
- Embraces new forms of creativity

## *Recommendations*

- Encompass artistic & technical concepts, problem solving, expression, & collaboration in courses
- Balance art & technology



# SUMMARY AND CONCLUSION



***Technology will change, but good art fundamentals will not.***



# Computer Graphics for Teaching



*Judith R. Brown*  
*The University of Iowa*

# Computer Graphics for Teaching



**Bezier, B-spline and NURB Curves**

Examples Figure Help

Points

Click the Start button to introduce the

**Bezier and B-spline Curves and Surfaces**

Bezier and B-splines Curves and Surfaces

Curves

Bezier, Composite Bezier, B-splines periodic, non-periodic, non-uniforme

Surfaces

Bezier, B-splines, rational, non-rational

Non-Rational

Rational

Weights: 1 2 3 1 1; 1 3 3 1 1; 1 4 5

Points

0	0	0	0	1	1	1	1	2	2	2	2	4	4	4	4	5	5	5	5
0	1	2	4	5	0	1	2	4	5	0	1	2	4	5	0	1	2	4	5
1	2	3	2	1	2	3	4	3	2	3	4	3	2	3	4	3	2	1	2

Please, introduce the points; each line is a matrix of the points components (xy and z components, respectively).

OK

Clear Screen

Quit

Andres Iglesias

SI99GRAPH  
Los Angeles

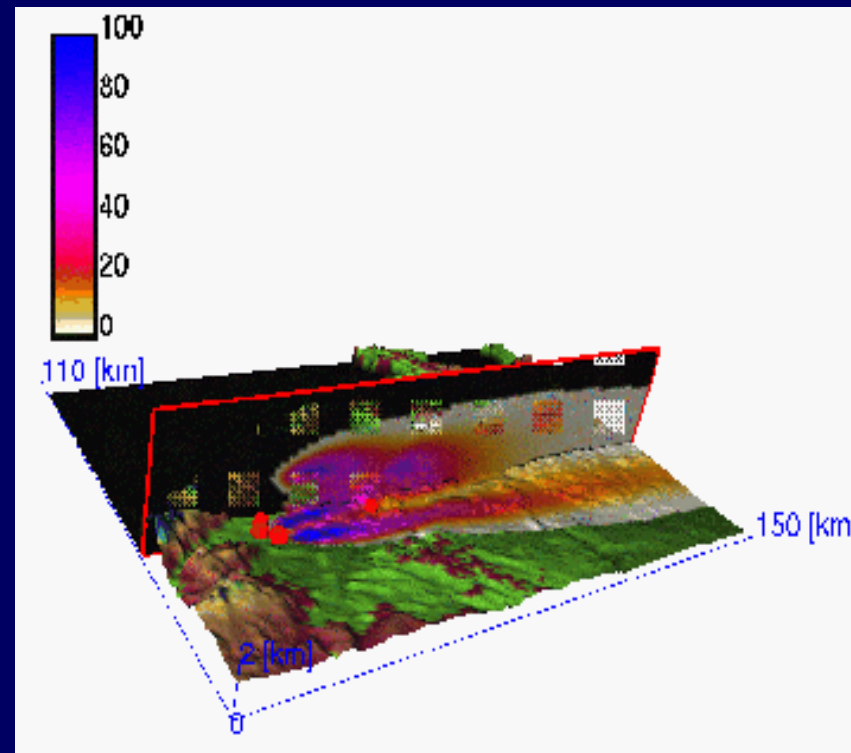
# Computer Graphics for Teaching



J. Miguel Leitao

SI99GRAPH  
Los Angeles

# Computer Graphics for Teaching



Pavel Slavik & Frantisek  
Hrdlicka

SI99GRAPH  
Los Angeles

# Computer Graphics for Teaching



## *Issues*

- Finding what exists already
- Finding other educators
- Lack of recognition/rewards
- Difficulty measuring effectiveness
- Challenges understanding other disciplines/cultures
- Inadequate hardware/software/networks

# Computer Graphics for Teaching



## *Recommendations*

- SIGGRAPH/Eurographics portal of resources
- Work towards effective international communications
- Seek collaborations
  - *multidisciplinary*
  - *multi-cultural*
  - *industrial*

# Computer Graphics for Teaching



## *Projects*

- Compile list of current resources
- Review current and new resources
- Refereed journal on computer graphics and teaching
  - *list existing publications with educational sections*
  - *proposed book “Computer Graphics: Tools & Techniques for Teaching”*

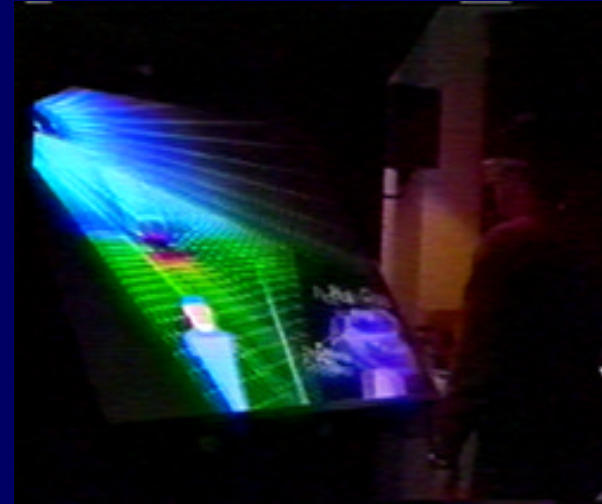
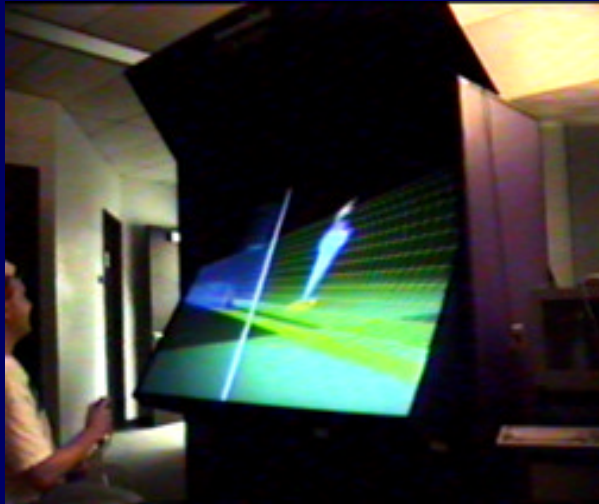
# Computer Graphics for Teaching



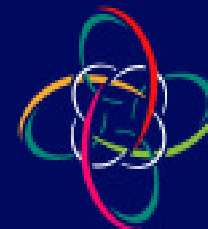
## *Projects*

- Investigate tools for collaborating
  - *interdisciplinary classes*
  - *joint classes across distance*
  - *students interacting globally*
- Note importance of networks
  - *local, national, international*

# Computer Graphics for Teaching



Iowa - Taiwan  
Collaboration



# Computer Graphics Courseware

**José Carlos Teixeira**

**University of Coimbra - Portugal**

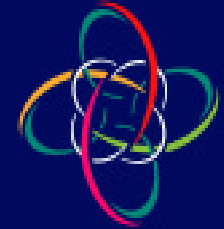
**teixeira@mat.uc.pt**



# Courseware Authoring Process

## Produce courseware for better teaching and learning

- follow the technological developments
- support individual, online and more autonomous learning
  - *learner model*
  - *distribution and interaction with the content*
  - *model the knowledge acquisition*

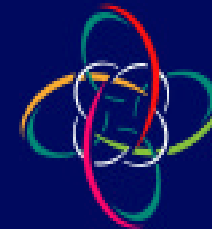


# Courseware Authoring Process

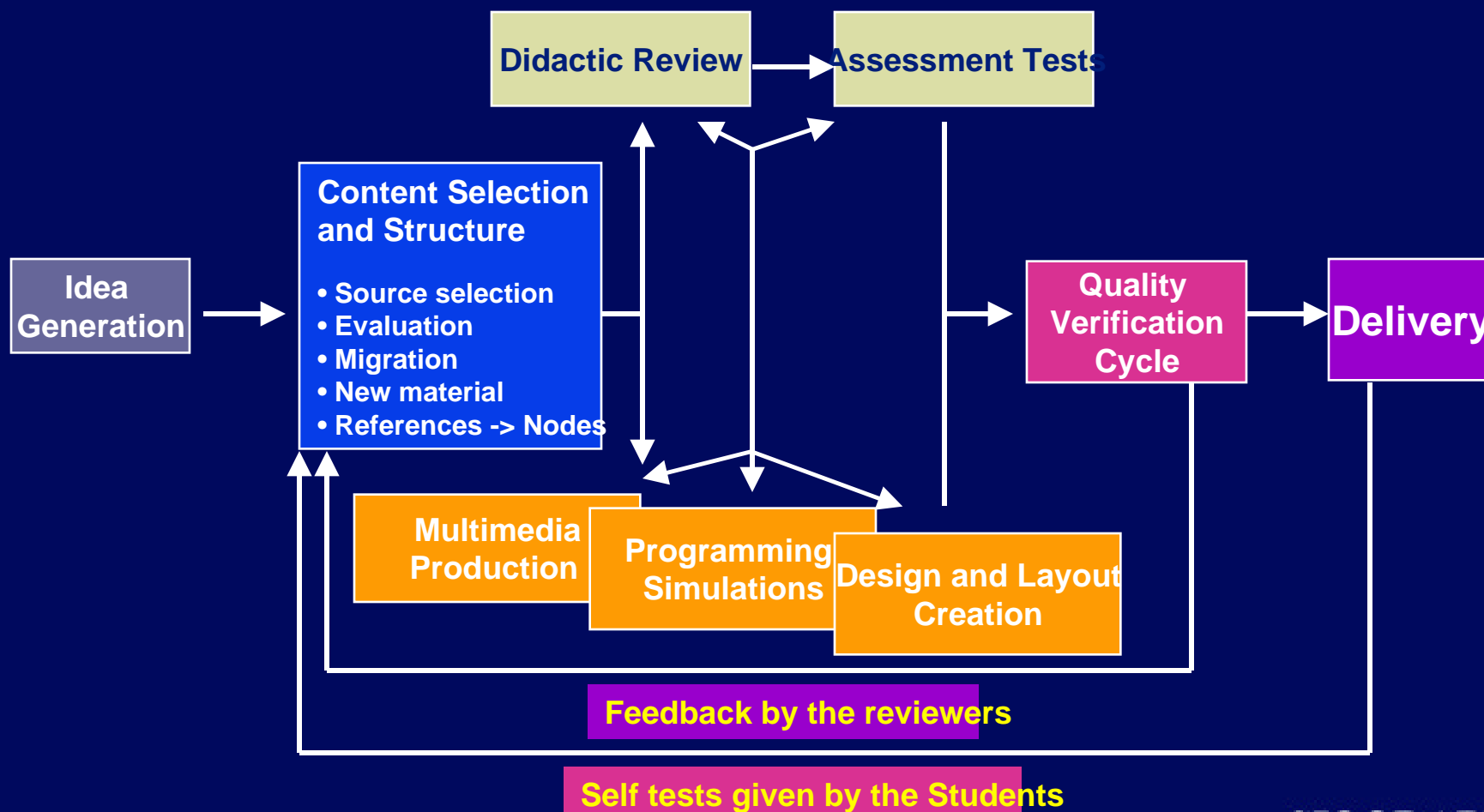
## Assume a cooperative approach with different roles

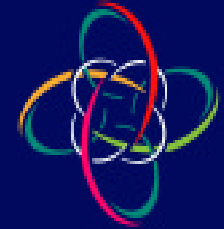
- **teacher:** concept, pedagogic and didactic, assessment
- **artist:** graphics design
- **multimedia expert:** multimedia production
- **programmer:** simulations, ...
- ...

**Don't forget quality certification !**



# Courseware Authoring Process





# Cost of Courseware Production

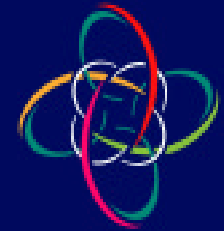
## High-quality courseware is very expensive

- 1 study hour could represent 100 hours of development !

## Cost depends on:

- content
- media used
- use of templates
- reuse of previously developed material

**Don't forget the production management !**



# Media

## Our specification of media:

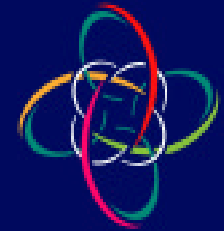
- mechanisms for the delivery of content to users
  - *education, arts, entertainment, ...*
  - *communication between humans and dissemination of information*

## Interactive media

- active participation of the users -> feedback

## Multiplicity of devices and standards

- barrier to the creation and dissemination of media



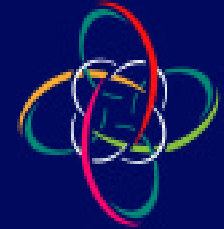
# Media

## **New frameworks for communication**

- Web, interactive television, virtual environments, ...

## **Knowledge to be acquired**

- artists and technologists for media should have a good understanding of computer graphics, animation and image processing



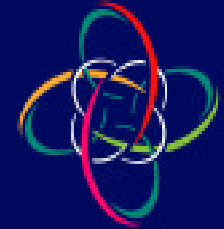
# Media

## Design

- design criteria particular to each type of media
- visual design
- design of the process
- design of tools for media production

## Quality

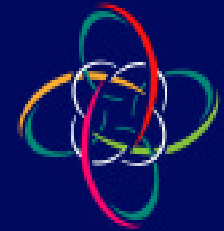
- choice of appropriate media to express the ideas
- economy in the use of media



# Courseware use

## Different issues for different types of courseware

- general-purpose courseware
  - *great pedagogic and didactic care*
  - *modularity to allow the use by large*
- specific courseware
  - *higher-level knowledge units*
  - *less modular*
  - *higher design and production costs*



# Courseware Use

## Re-use of course materials

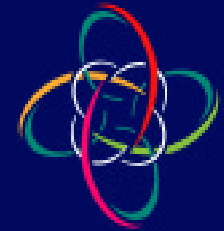
- use of the same courseware modules in the production of different courseware entities

## Multiple use of course materials

- use of the same courseware modules by many users

**Do we really re-use course materials ?**

# MODULARITY



# Modularity

## Separation of Content from Structure

- sequence is not mixed with content

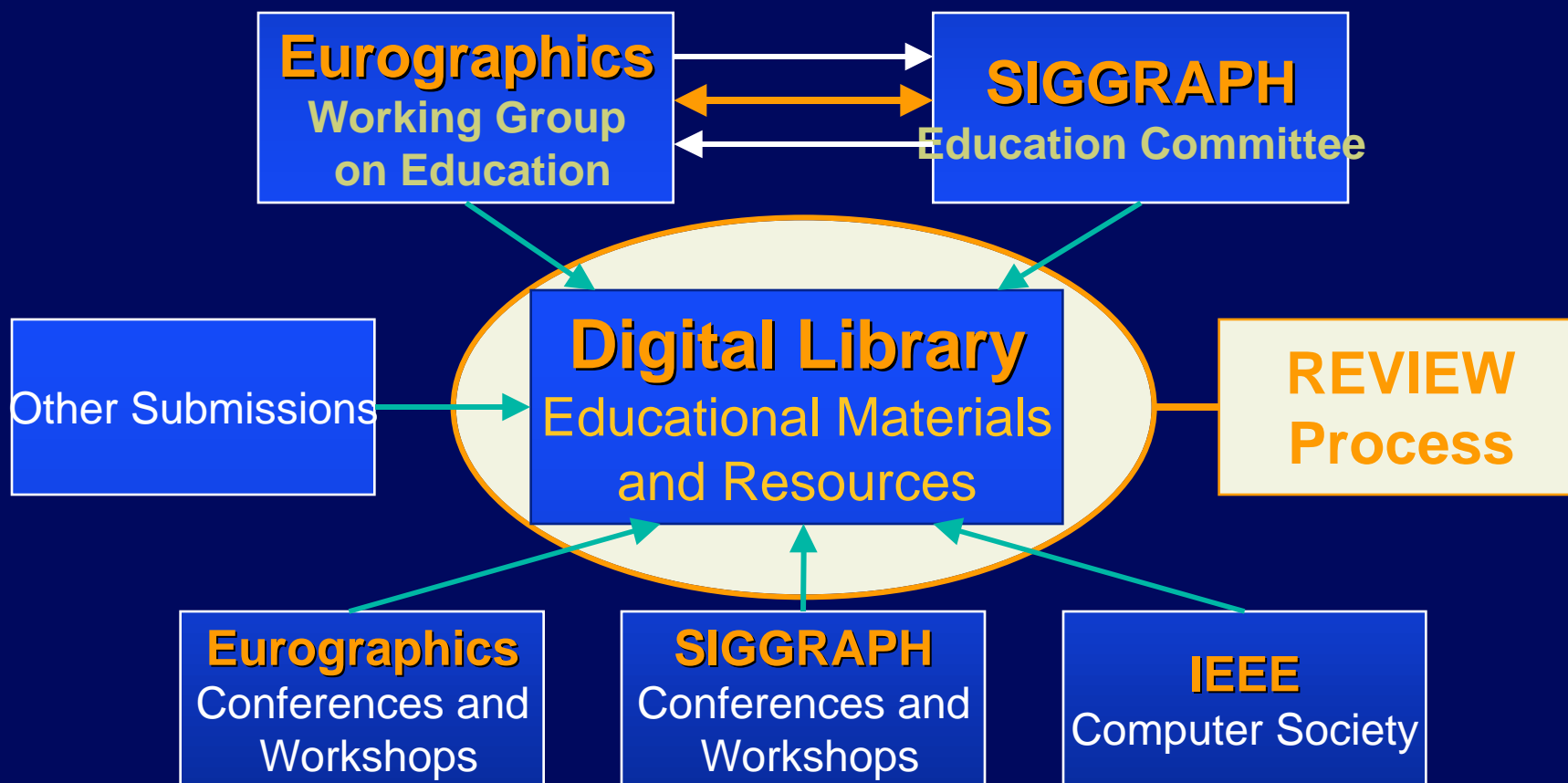
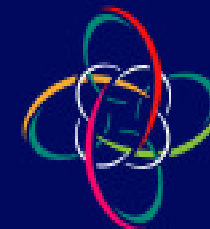
## Autonomous sequences

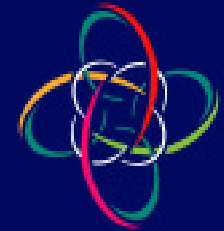
- basic structured courseware

## Database Management

- indexing system
- management of versions

# Co-operation SIGGRAPH- Eurographics





# Courseware Issues

- encourage the implementation and use of courseware resource centres
- ensure confidence by quality control of the courseware available
- teach instructors and students to effectively use courseware
- improve international co-operation and networking to allow for an appropriate access to resources