

# Knowledge Assessment Based on Evaluation of 3D Graphics Annotation in Lesson Context

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# Research Objectives

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- Study the requirements and specifications for graphical pen annotation based eLearning environments

User requirements (i.e. professor, students), eLearning environment functional specifications, usability requirements, lesson structure, user interaction techniques.

- Integrate graphical annotation techniques in eTrace eLearning Environment

Develop eTrace eLearning environment, design and implement the client-server architecture, resource management, security, annotation model, annotation persistence. Develop lessons in various domains including Computer Science, Medicine, Physics, Mathematics, Algorithms, Computer Graphics.

- Usability evaluation for graphics annotation techniques

Design and create evaluation instruments for pen and mouse based graphics annotation; Develop test cases for graphics annotation according with usability requirements and specifications.

Usability measurement, data analysis, usability evaluation

- Knowledge assessment using graphical annotation

Define the graphical annotation evaluation model; allow the real-time evaluation of the annotations

- Collaborative working sessions based on graphical annotation

Presentation sessions; interactive working sessions

# Main objectives

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- ❑ Alternatives to multiple choice questions based knowledge evaluation
- ❑ Free graphical form expressions
- ❑ New types of questions and answers in eLearning applications
- ❑ Visual free form answer provides support for
  - ❑ creativity
  - ❑ flexibility
  - ❑ imagination
  - ❑ artistic ability
- ❑ Automatically evaluation of the annotation based answer

# eTrace Platform

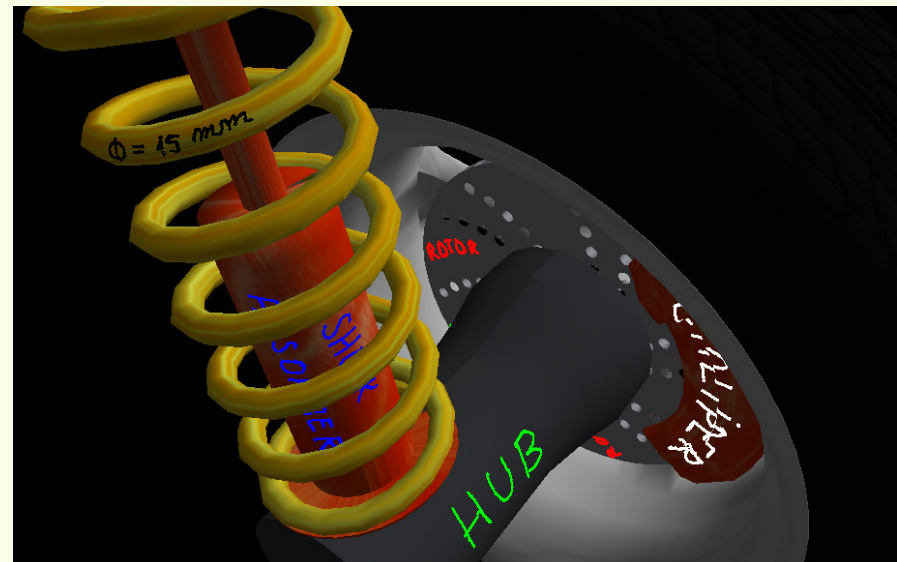
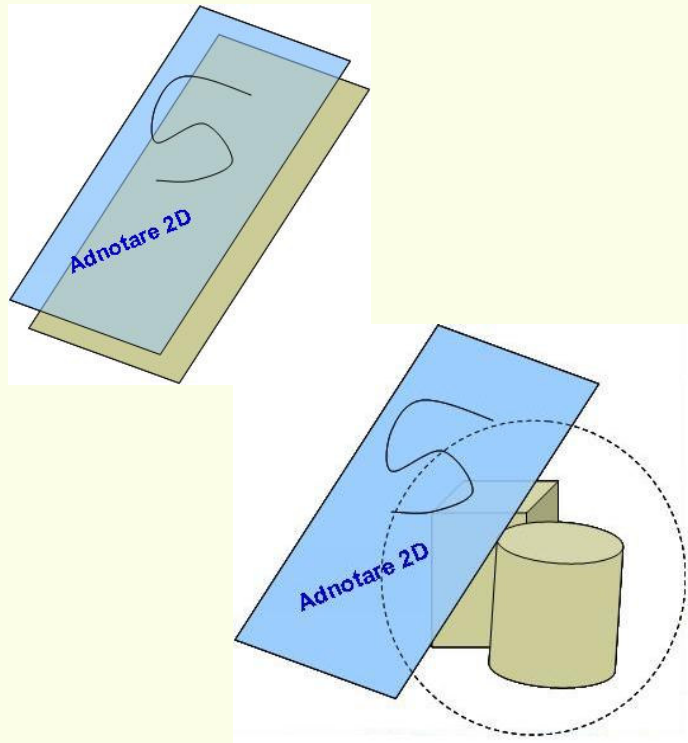
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- **eTrace** – eLearning Environment based on graphics annotation
  
- Developed at the Technical University of Cluj-Napoca (UNI-CLUJ)
  
- Developed through the I-TRACE Project  
*“Interactive Tracing and Graphical Annotation in Pen-based e-learning”*, 223434-CP-I-2005-IT-Minerva-M (2005-2007)  
<http://users.utcluj.ro/~gorgan/res/cgis/itrace/>
  
- eTrace references:  
eTrace eLearning Environment:  
<http://dataserver.mediogrid.utcluj.ro/adnotare/>  
eTrace presentation:  
<http://users.utcluj.ro/~gorgan/res/cgis/itrace/>

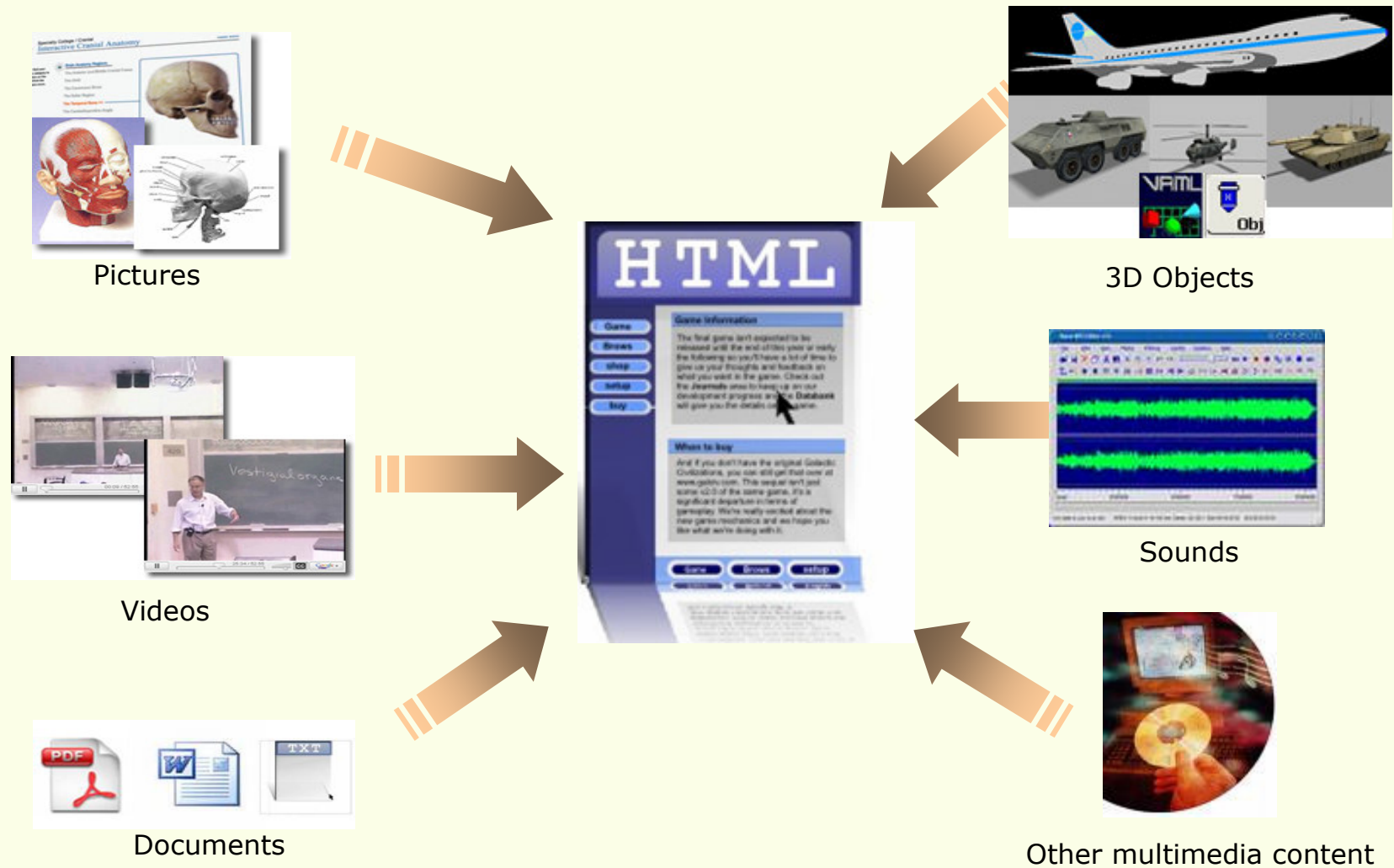
# Graphics annotation techniques

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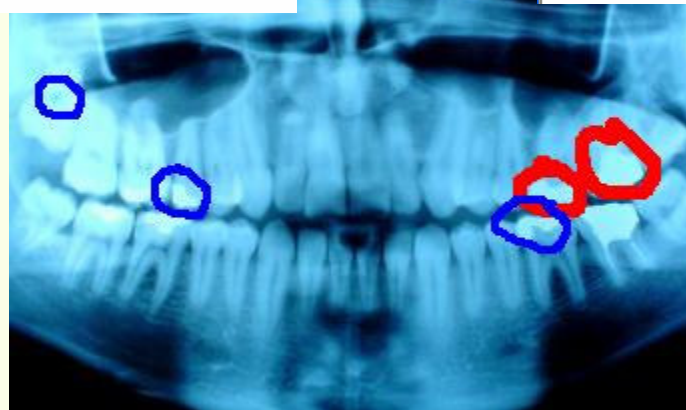
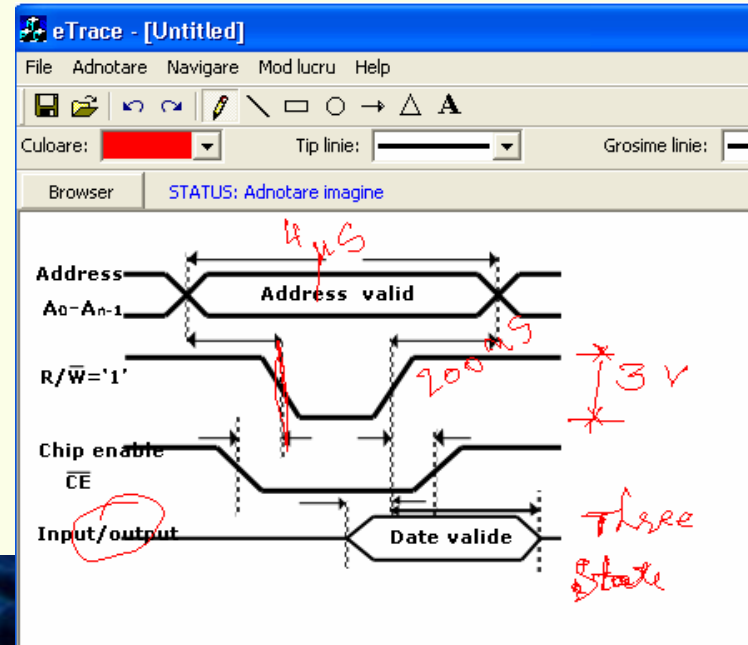
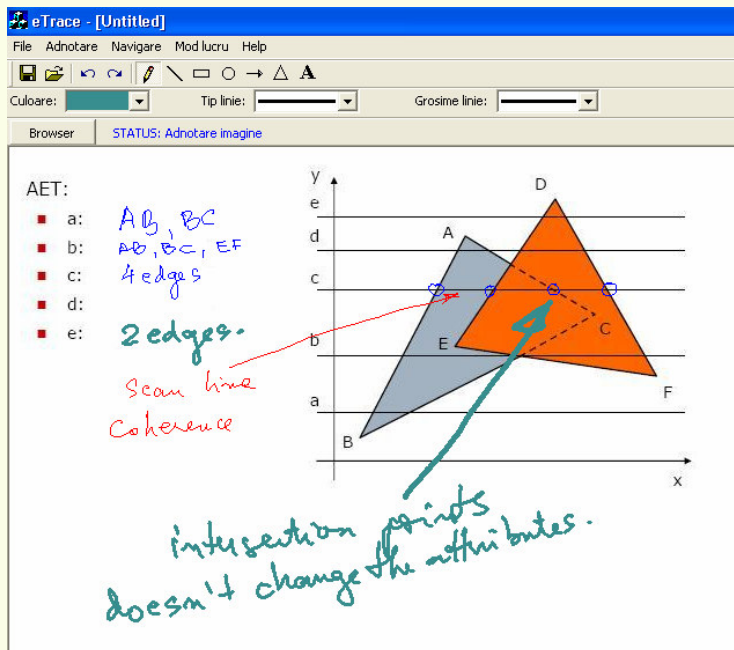
- ❑ 2D graphical annotation techniques on text, images, and documents
- ❑ 2D graphical annotation techniques for 3D objects
- ❑ 3D graphical annotation techniques on 3D objects



# eTrace – lessons creation and management



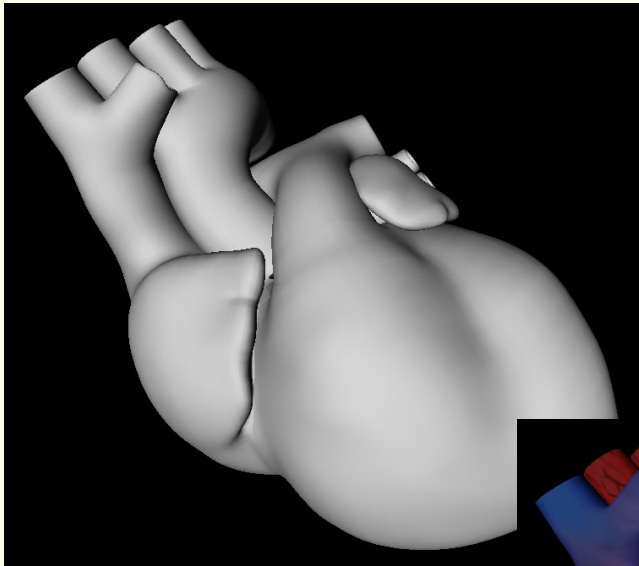
# eTrace – 2D annotations



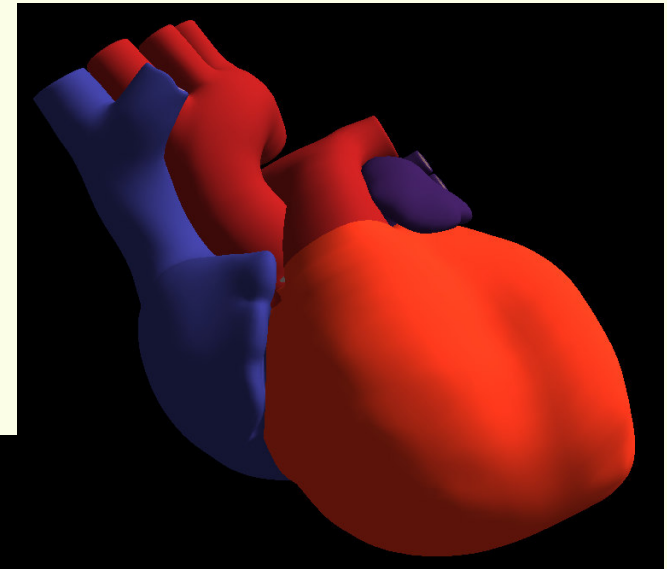
# eTrace – why using 3D objects ?

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- Fotorealistic presentation



a)



b)



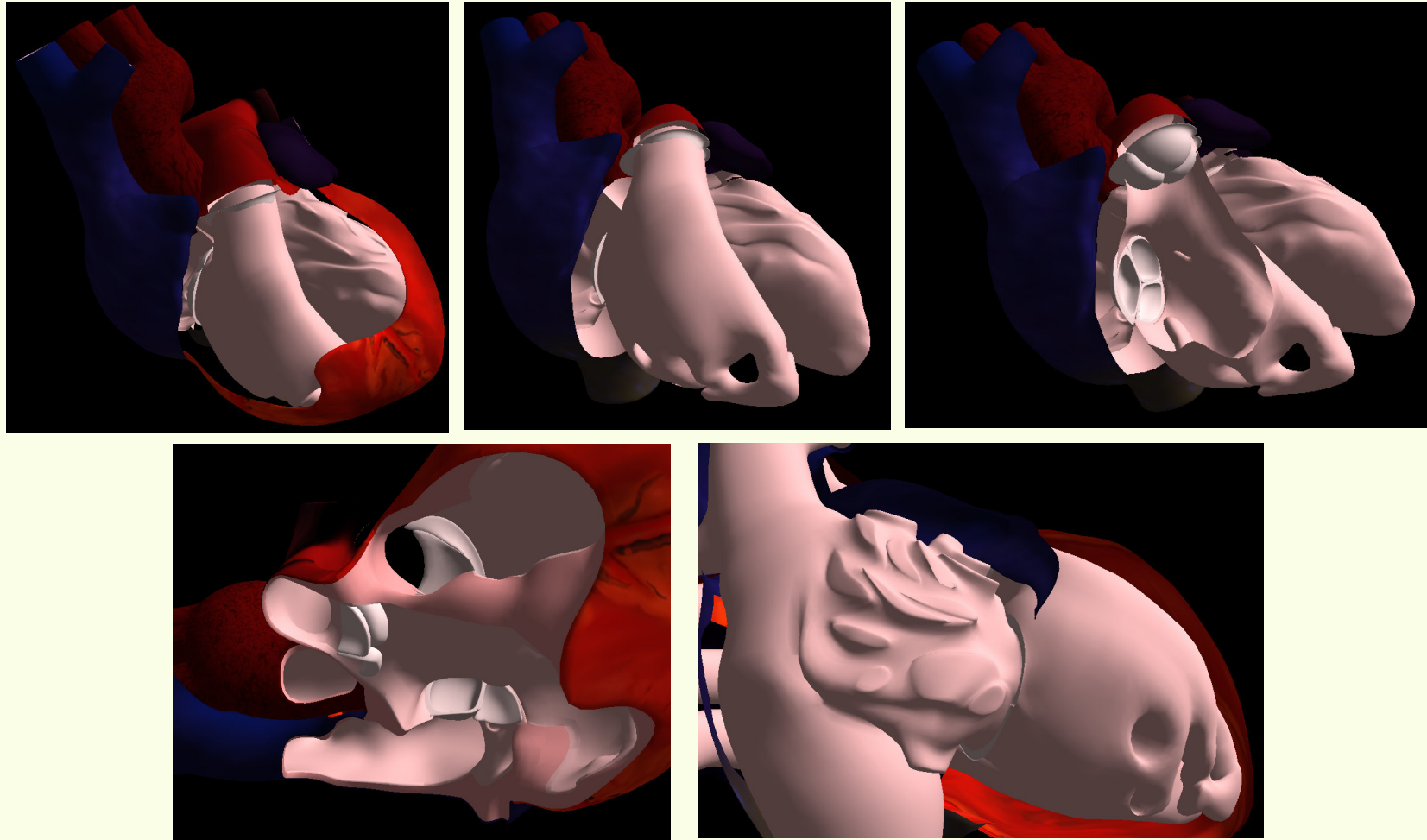
c)



# eTrace – why using 3D objects ?

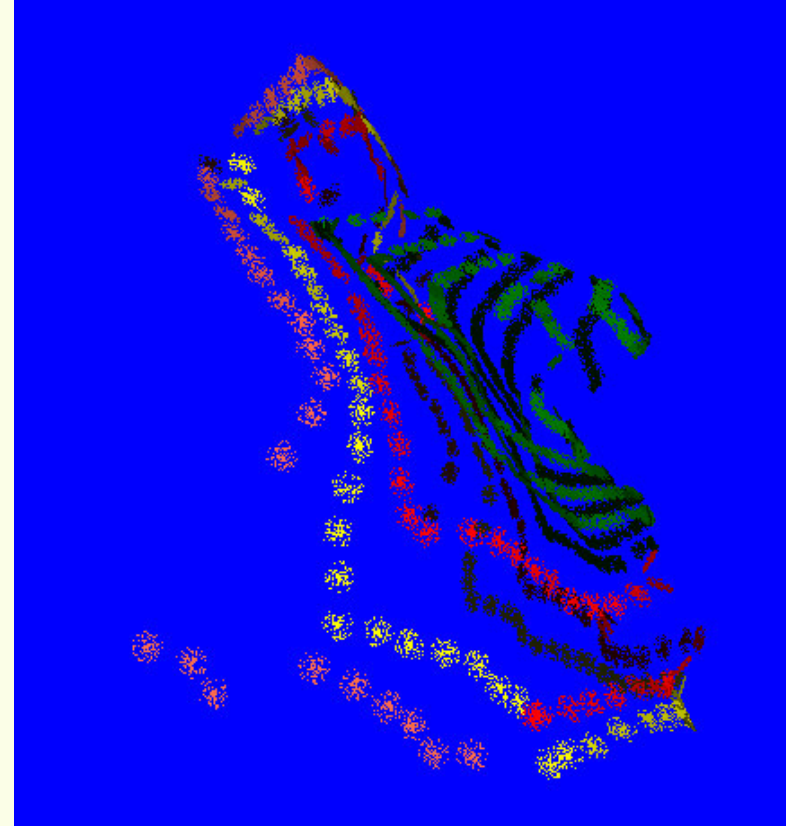
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- Detailed and global view



# Graphics annotation on 3D objects

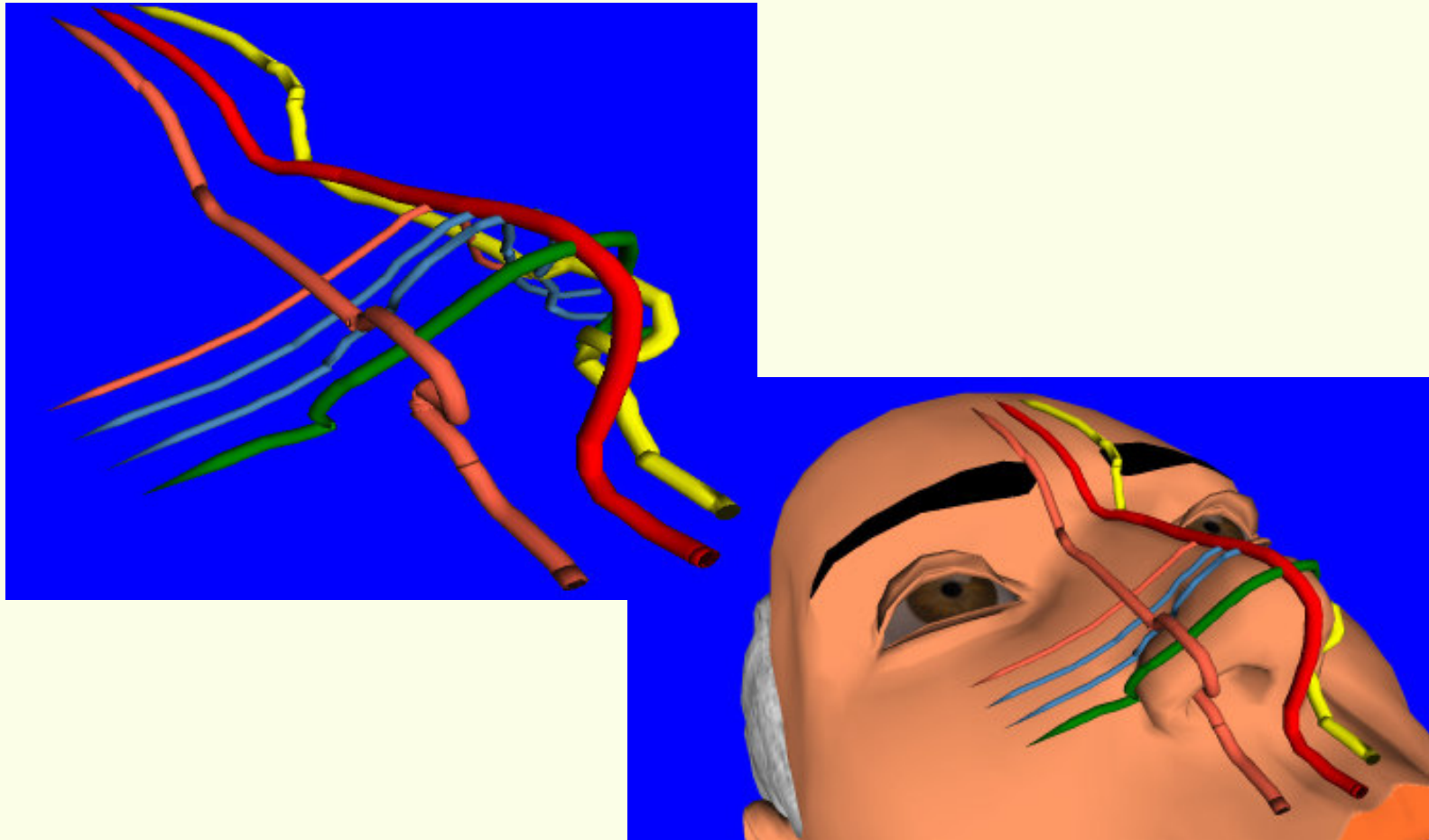
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# Graphics annotation on 3D objects

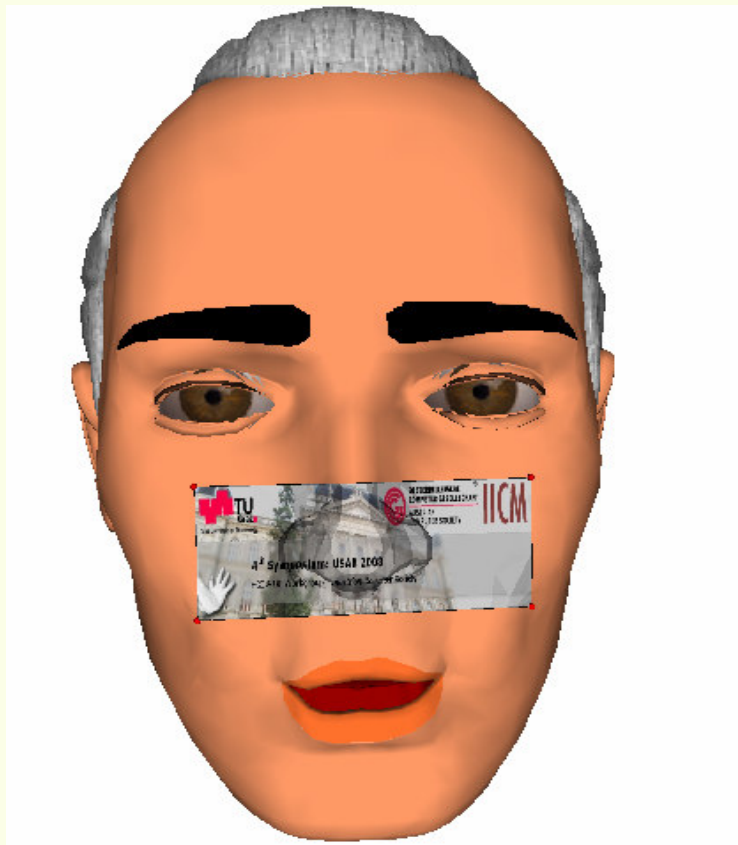
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- Different annotation attributes (cont.)



# Graphics annotation on 3D objects

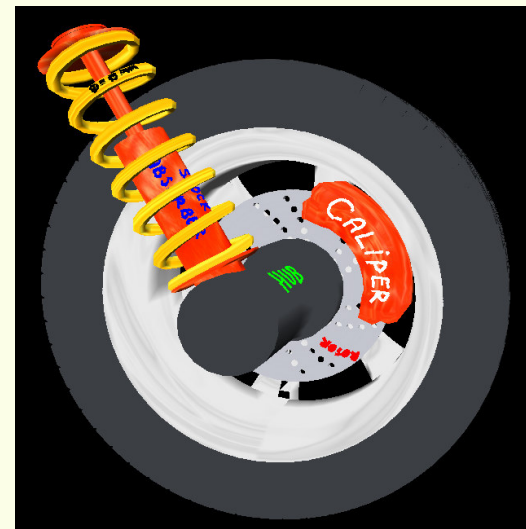
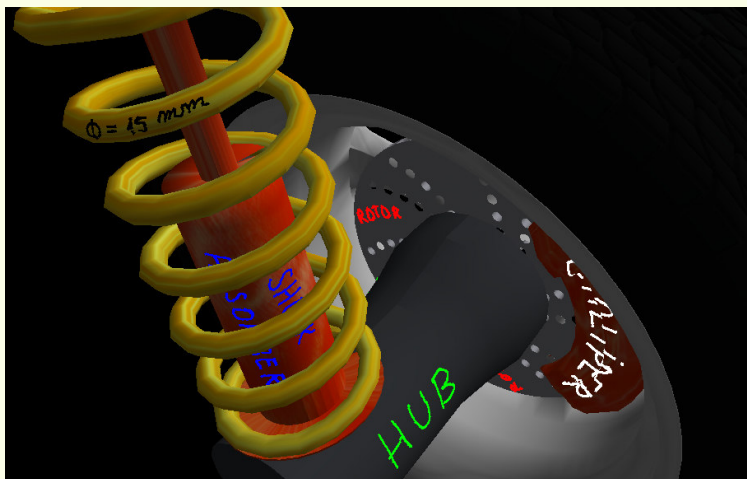
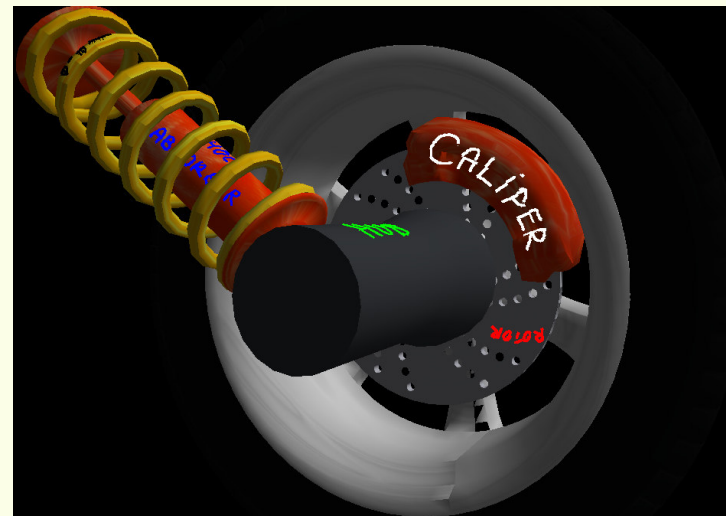
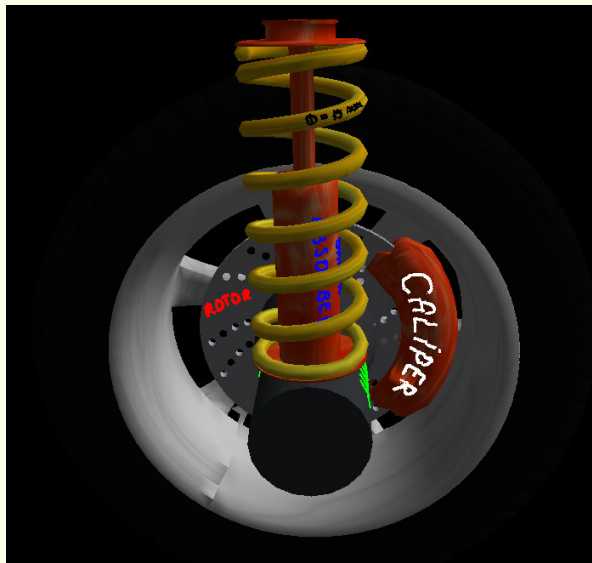
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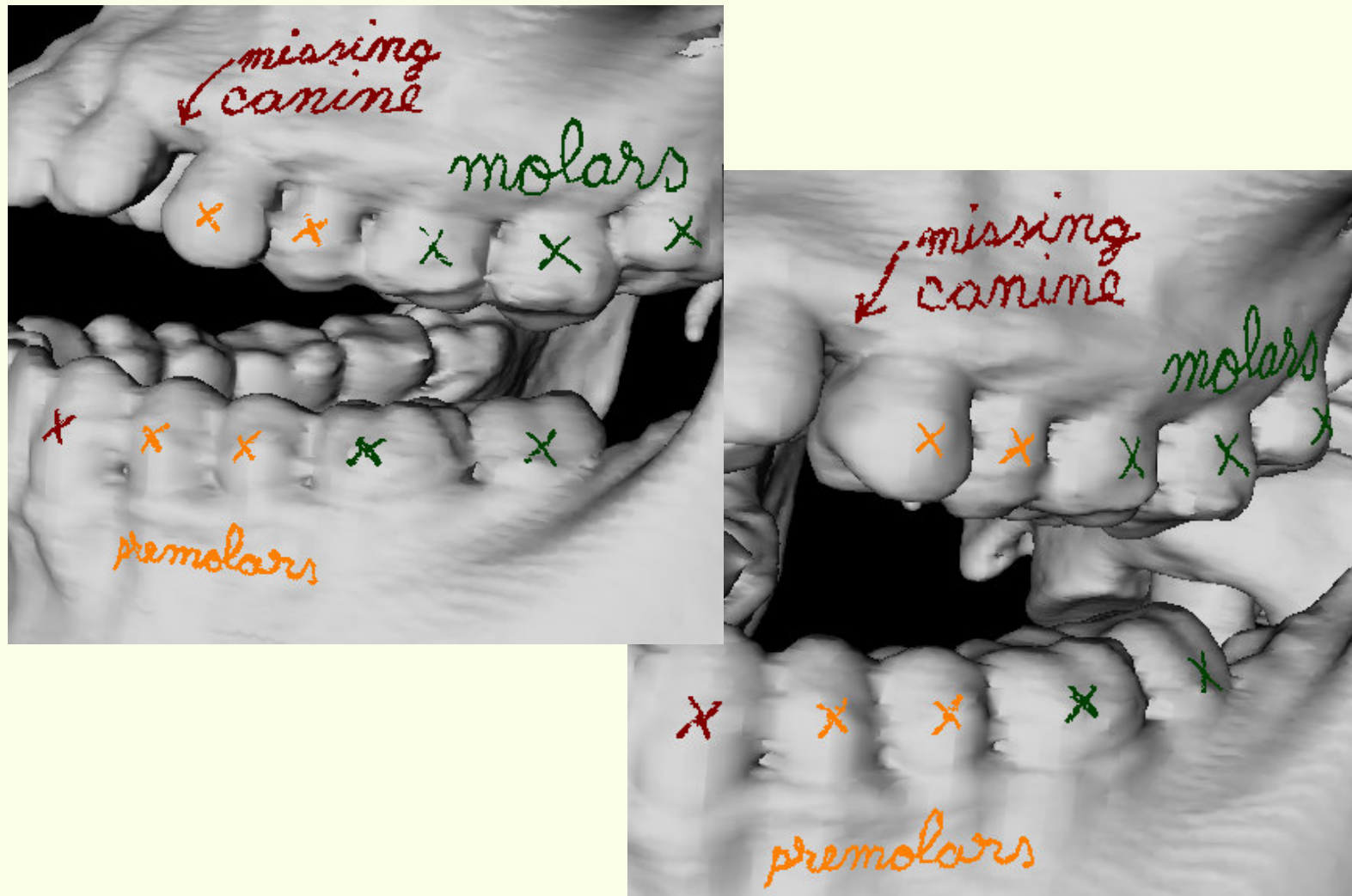
# Graphics annotation on 3D objects - Mecanics

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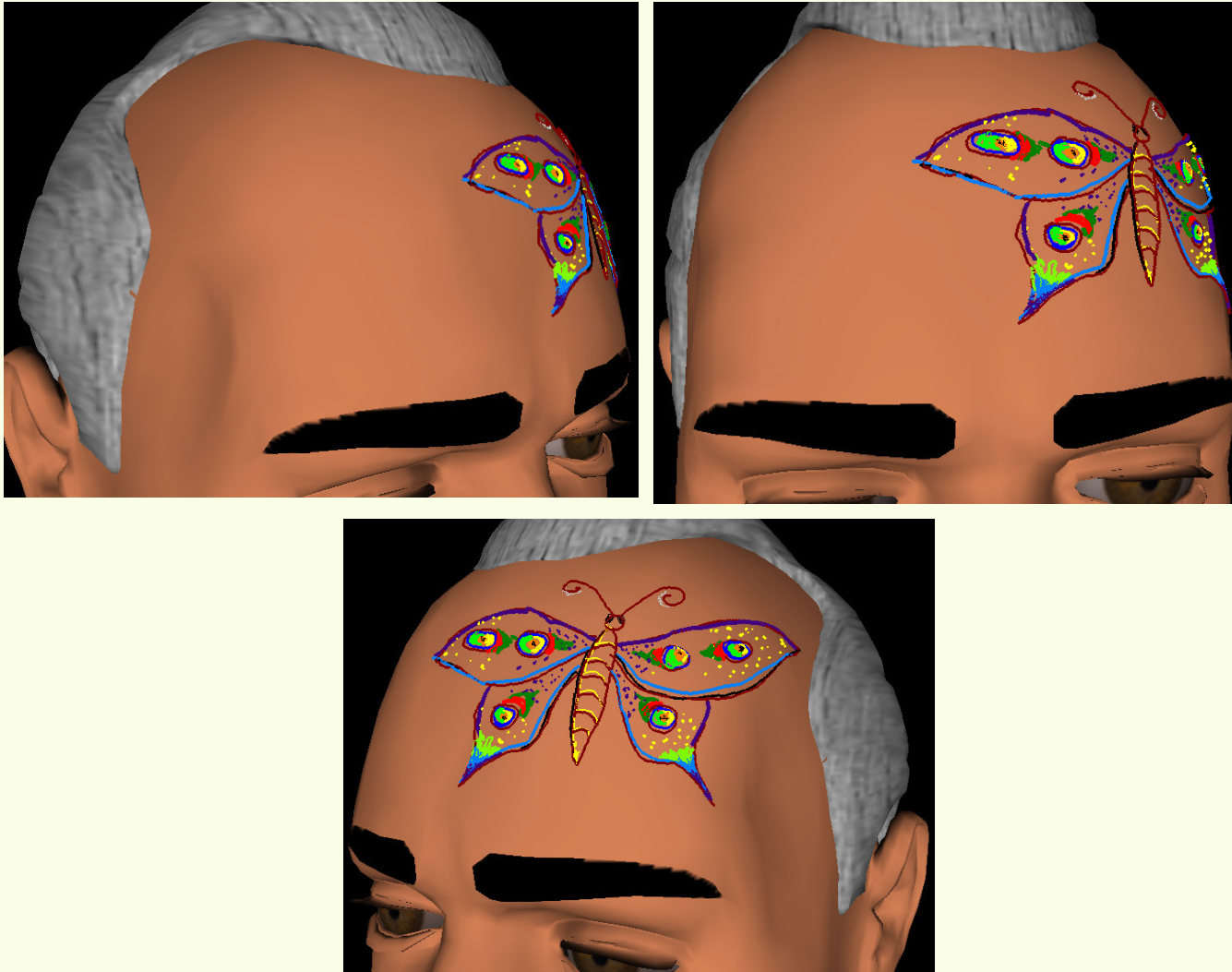
# Graphics annotation on 3D objects - Medicine

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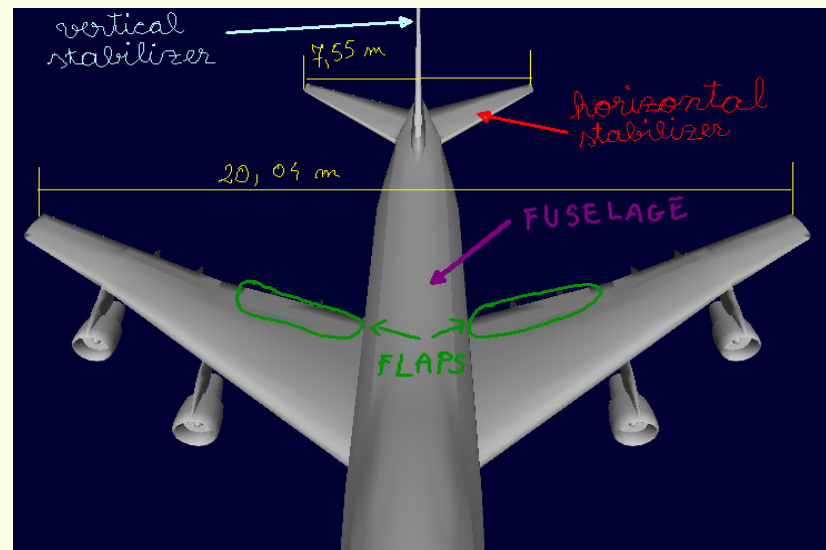
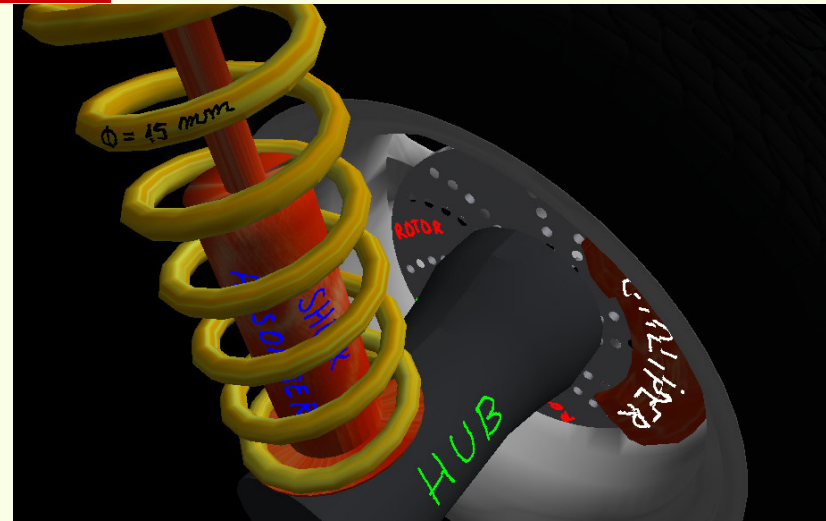
# Graphics annotation on 3D objects - Art

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# eTrace – Knowledge assessment

- Visual evaluation
  - Made by the teacher
  - Based on grades
  - Can be applied for every annotation
  - Subjective
  - Time demanding for the teacher
  - Inefficient and limitative for high scale e-Learning applications

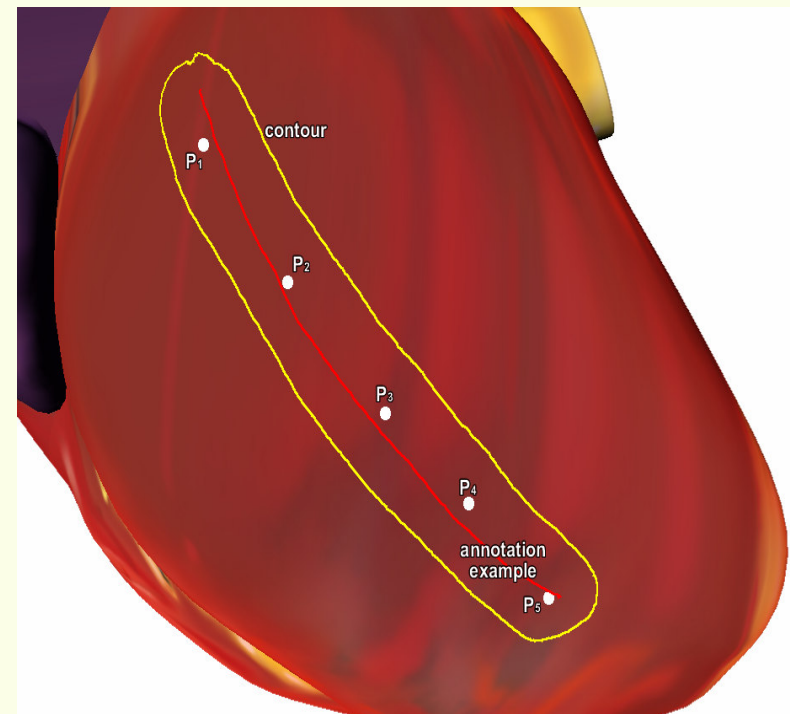




# eTrace – Knowledge assessment

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- Automatic evaluation
  - Automatically made by the system
  - Instant evaluations can be implemented
  - Avoid subjectivity
  - Recommended for global e-Learning systems
  - Can be done by comparing annotation made by students with a annotation pattern
  - Not suitable for all annotation techniques



Automatically verify that the red line is inside the yellow contour and as near as possible to the points  $P_1 \dots P_n$

# Main issues of 3D annotation and evaluation

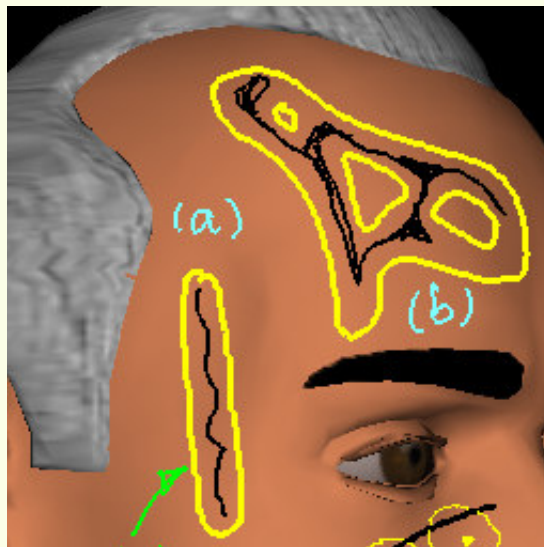
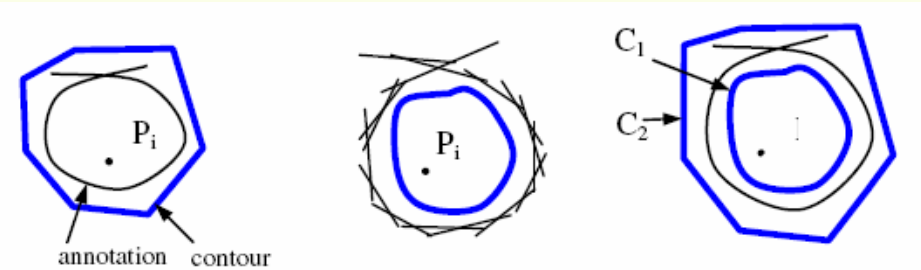
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- 3D against 2D
- Graphics algorithms
- 3D annotation model
- Annotation model along the lesson states
  - Creation, description
  - Recording
  - Execution
  - Single user/ multiple user, collaborative work, interaction devices, answer encoding etc
  - Evaluation
    - Area based
    - Gesture based
    - Pattern recognition
  - Mark computation
- Application domain
- Teaching and learning approaches

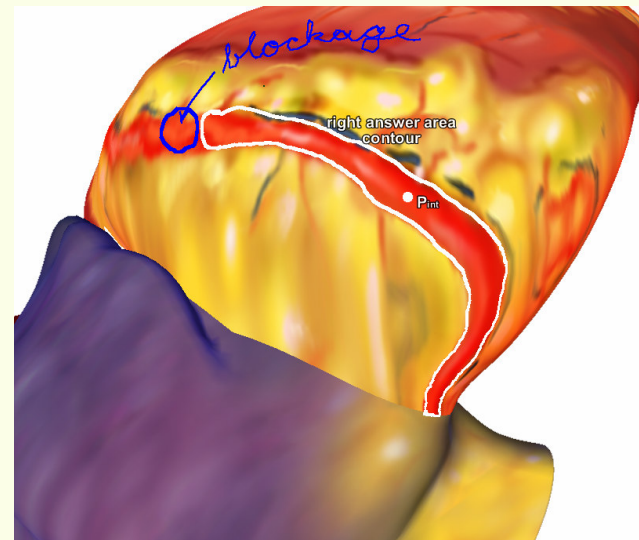
# Automatic evaluation of 3D annotations - evaluation description model (1)

## □ Contours

- Annotation inside the contour
- Annotation outside the contour
- Annotation between two contours



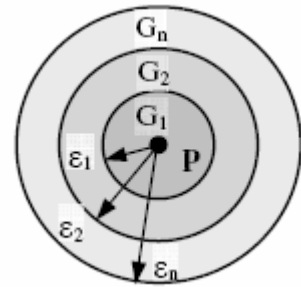
Example of contours drawn on the surface of 3D objects



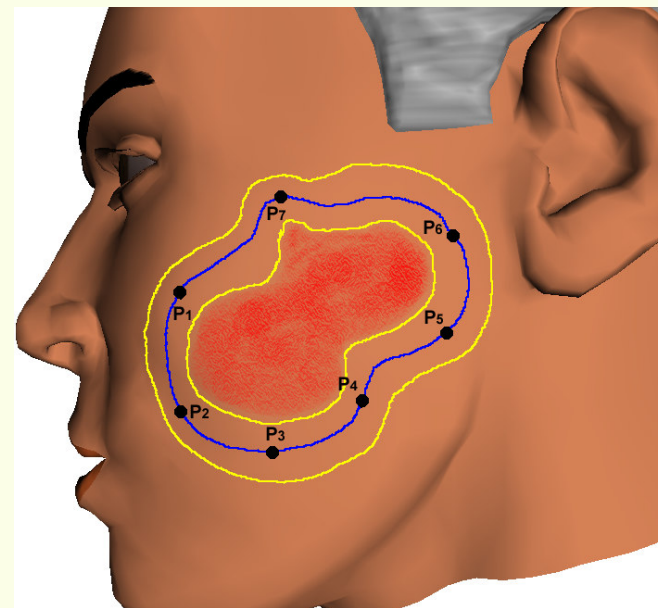
Contours used in a bypass exercise

# Automatic evaluation of 3D annotations - evaluation description model (2)

- Key points constraint



Keypoints represented on the surface of 3D objects



Keypoints used in a skin-removal exercise

# Automatic evaluation of 3D annotations - evaluation description model (3)

□ Shape pattern constraint



a) shape

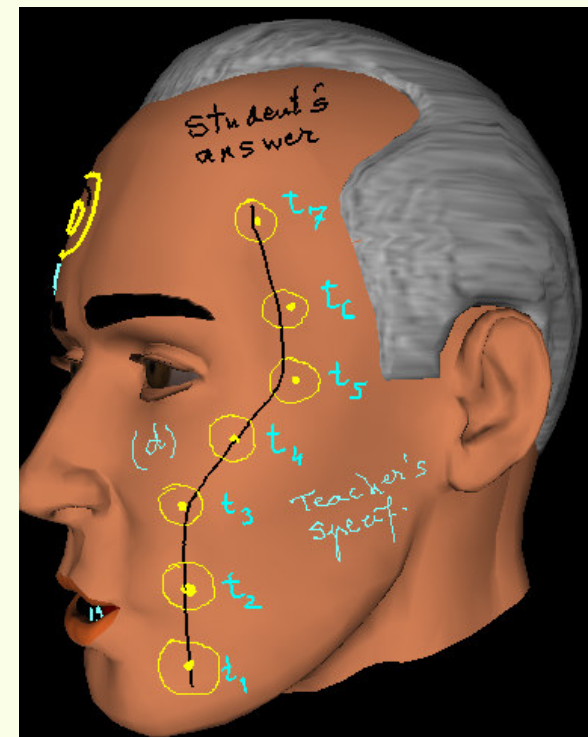


b) freehand



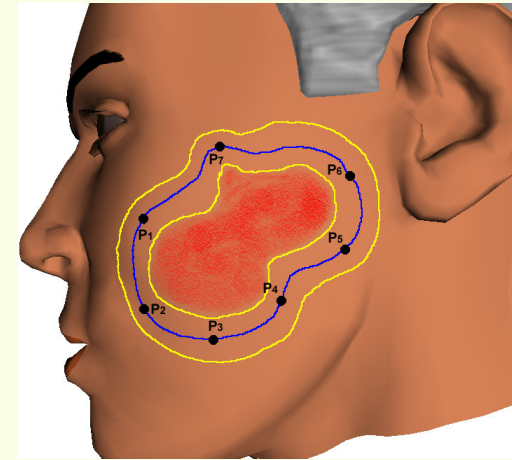
c) stroke (multi line, multi curve, multi freehand)

□ Time description



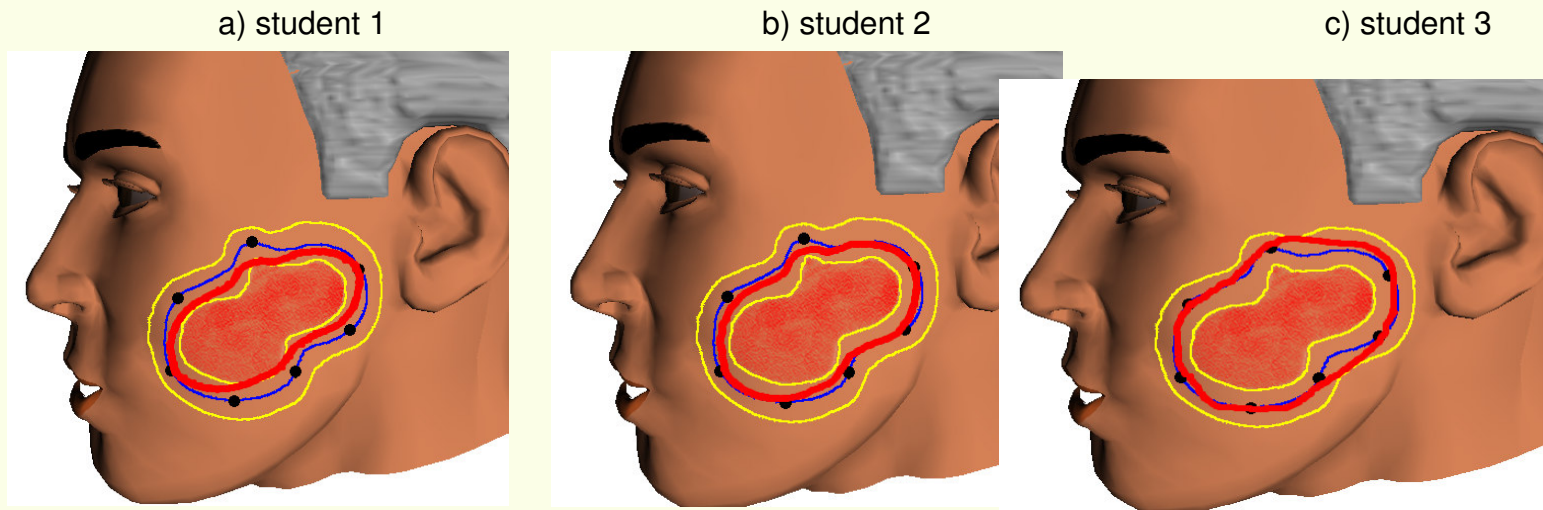
# Automatic evaluation of 3D annotations - evaluation description model (4)

□ Mark computation example



Criterion name	Criterion definition
Inside Contour (C1)	<ul style="list-style-type: none"> <li>• 1 if all the annotation points are inside the contour</li> <li>• 0 otherwise</li> </ul>
Outside Contour (C2)	the % of annotation points outside the contour
Shape pattern (S)	If the annotation is passing by a minimum distance $d$ , $\epsilon_{n-1} < d < \epsilon_n$ the grade takes the value $G_n$ .
Key-points (K)	all the key points have the same importance into the K grade
Time (T)	<ul style="list-style-type: none"> <li>• should be between 3 and 5 seconds</li> <li>• 25% penalty for every second outside the interval</li> </ul>
Final mark (M)	$M = (0.1 * C2 + 0.4 * S + 0.3 * K + 0.2 * T)$ AND $(C1 = 1)$ AND $(T > 0)$

# Automatic evaluation of 3D annotations – students answers



	Student 1	Student 2	Student 3
Inside Contour (C1)	1	1	0
Outside Contour (C2)	85% (C1 = 8.5)	100% (C1 = 10)	100% (C1 = 10)
Shape pattern (S)	S = 4	S = 7	S = 8.6
Key-points (K)	K = 6.8	K = 8	K = 9
Time (T)	3s (T = 10)	6s (T = 7.5)	2s (T = 7.5)
Final mark (M)	M = 6.4	M = 7.7	M = 0 (8.64)

# Conclusions

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- ❑ Free forms of expression
- ❑ New types of questions and answers in the eLearning applications
- ❑ Visual free form answer provides support for creativity, flexibility, imagination, and artistic ability
- ❑ Annotation based interaction techniques must be designed according with the characteristics of each interaction device
- ❑ The assessment of the annotation quality has a significant impact on the quality of the answer
- ❑ Automatically evaluation of the annotation based answer



# Future work

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- ❑ Usability of the 3D annotation techniques
- ❑ Develop automatically techniques for knowledge assessment in graphics annotation based lessons
- ❑ Multi user sessions
- ❑ Real time communication
- ❑ Develop graphics annotation lessons in various domains
- ❑ Natural user interaction techniques
- ❑ Propose technical specifications for standards concerning with
  1. Graphical annotation model
  2. User interaction techniques
  3. Automatically knowledge evaluation

# Thanks a lot!

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