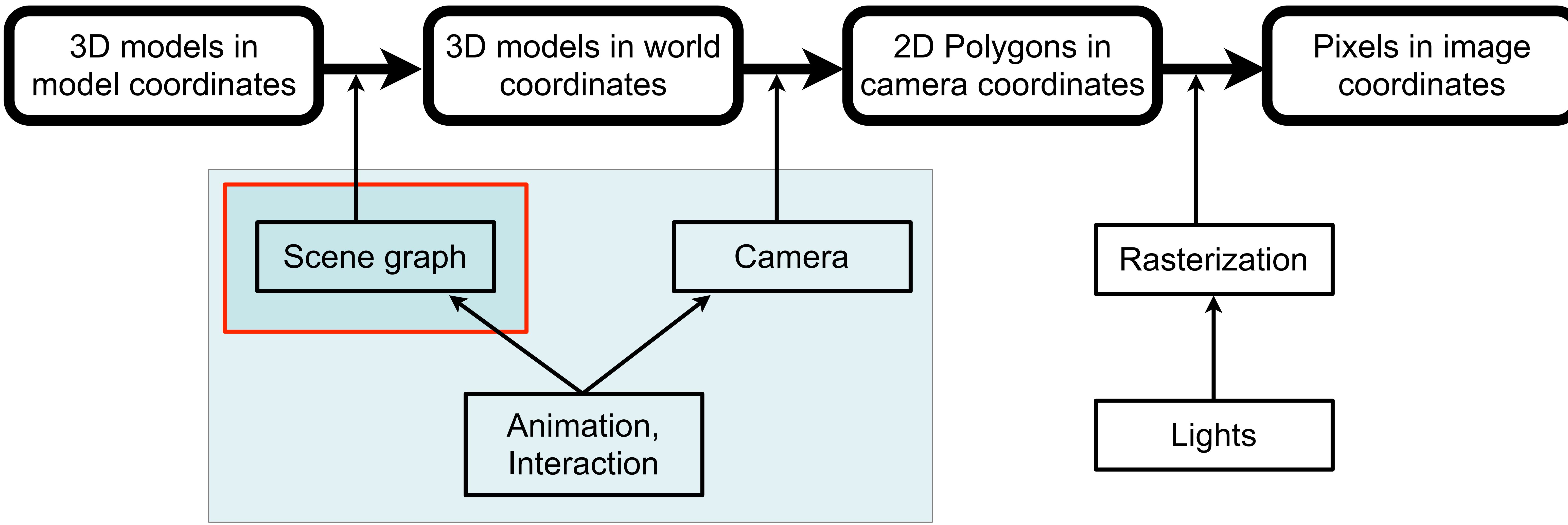
Chapter 5 - The Scene Graph

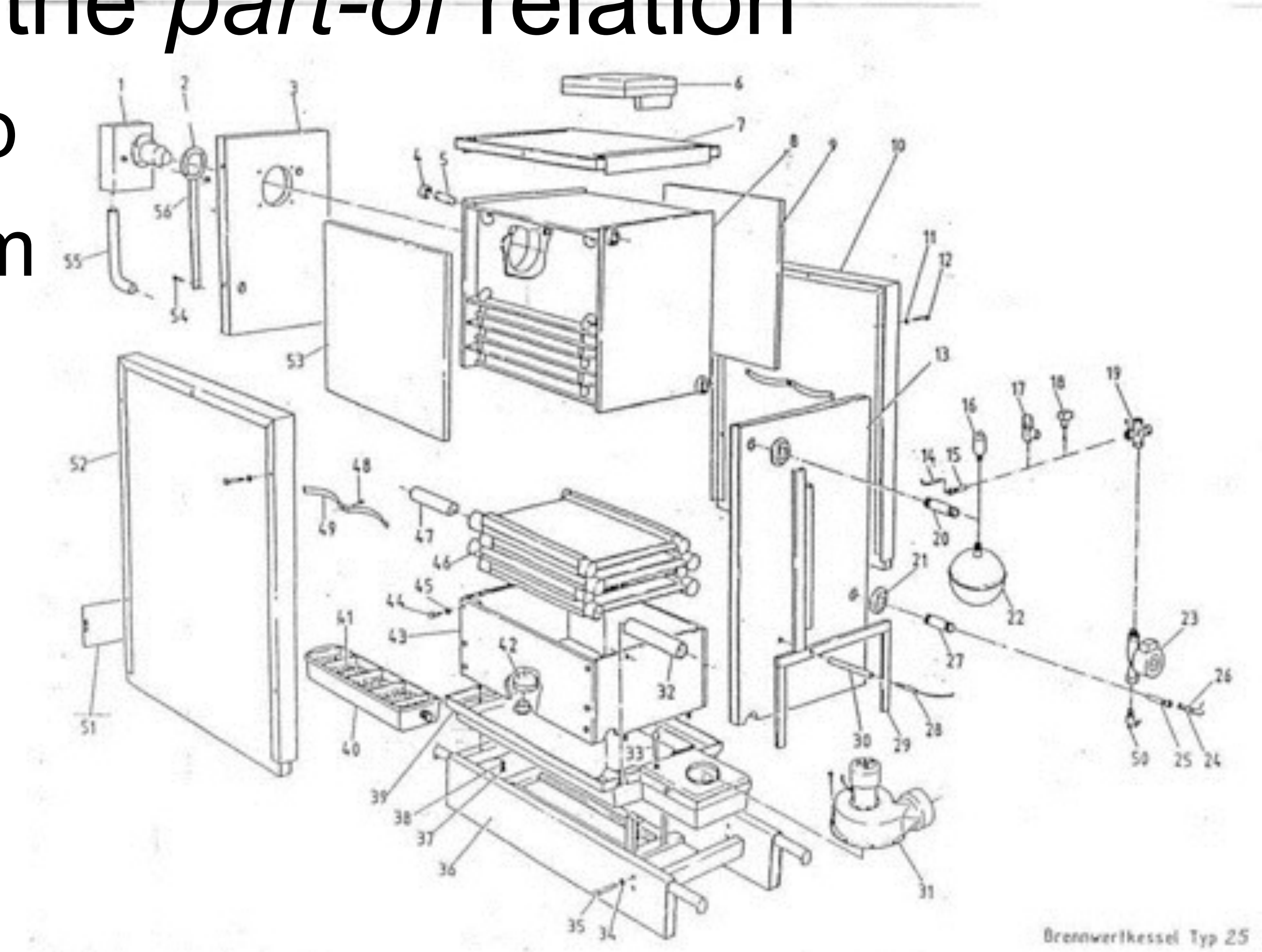
- Why a scene graph?
- What is stored in the scene graph?
  - objects
  - appearance
  - camera
  - lights
- Rendering with a scene graph
- Practical example

The 3D Rendering Pipeline (our version for this class)



Why a Scene Graph?

- Naive approach:
  - for each object in the scene, set its transformation by a single matrix (i.e., a tree 1 level deep and N nodes wide)
    - advantage: very fast for rendering
    - disadvantage: if several objects move, all of their transforms change
- Observation: Things in the world are made from parts
- Approach: define an object hierarchy along the *part-of* relation
  - transform all parts only relative to the whole group
  - transform group as a whole with another transform
  - parts can be groups again



http://www.bosy-online.de/Veritherm/Explosionszeichnung.jpg

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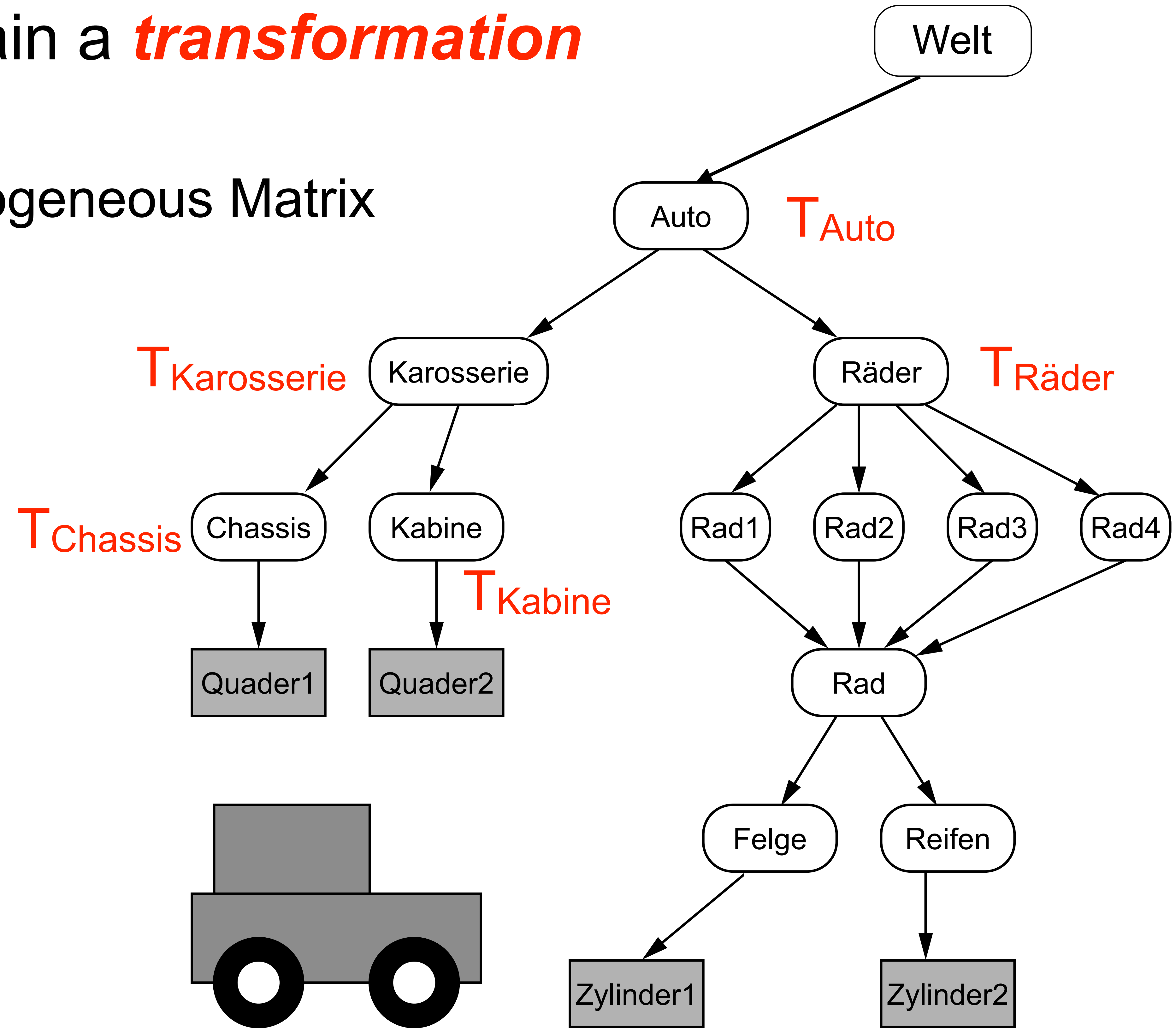
Geometry in the Scene Graph

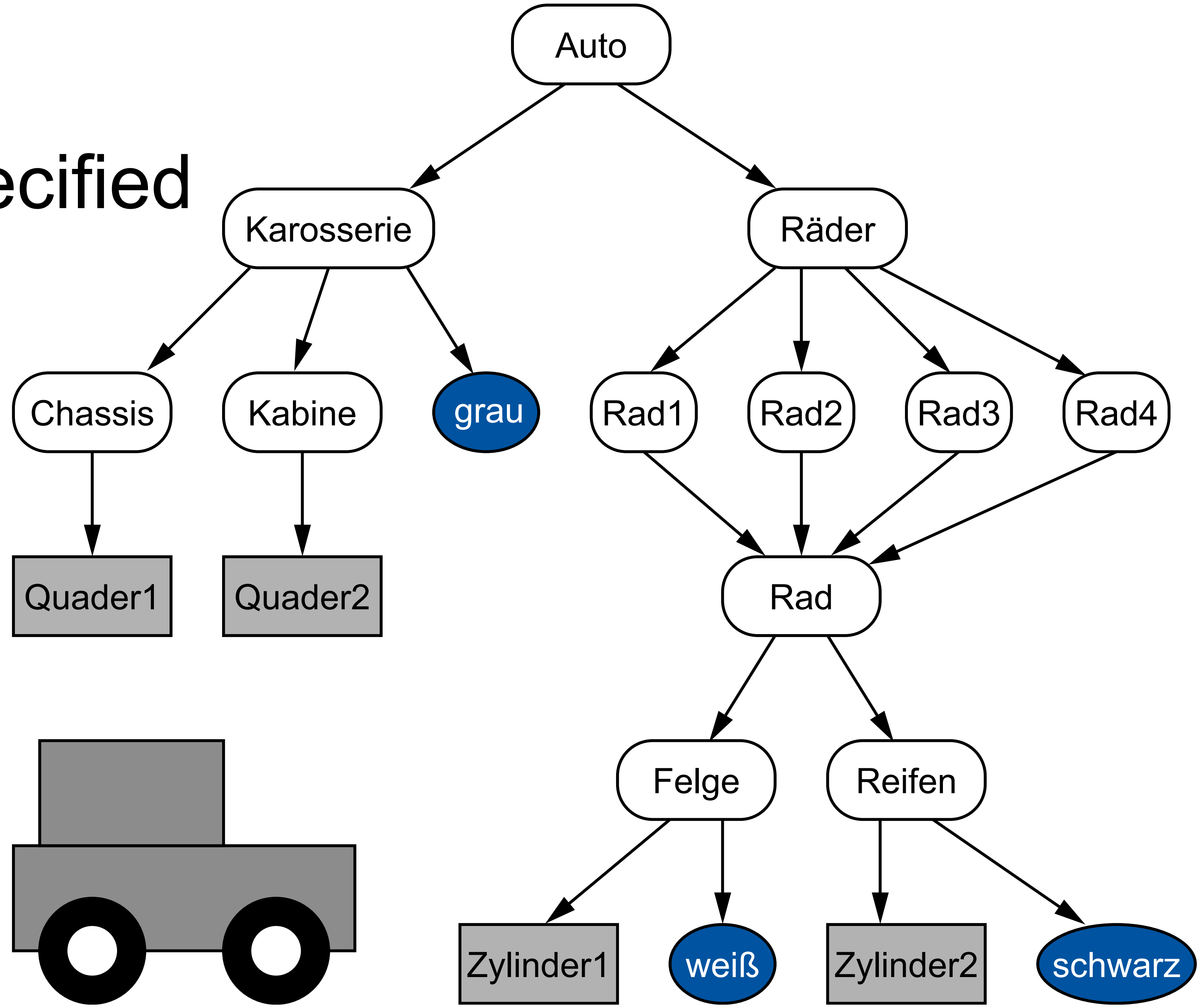
- Leafs are basic 3D objects
- Non-leaf nodes (groups) contain a ***transformation***
  - can have one or several children
  - transformation is given by a homogeneous Matrix
- Root is the entire world
- Nodes can be the child of several groups
  - not a tree, but a directed acyclic graph (DAG)
  - effective reuse of geometry



Appearance in the Scene Graph

- Scene graph also contains appearances
  - Appearance: E.g. Color, reflection, transparency, texture
    Details see next lecture
  - can be reused similarly to geometry

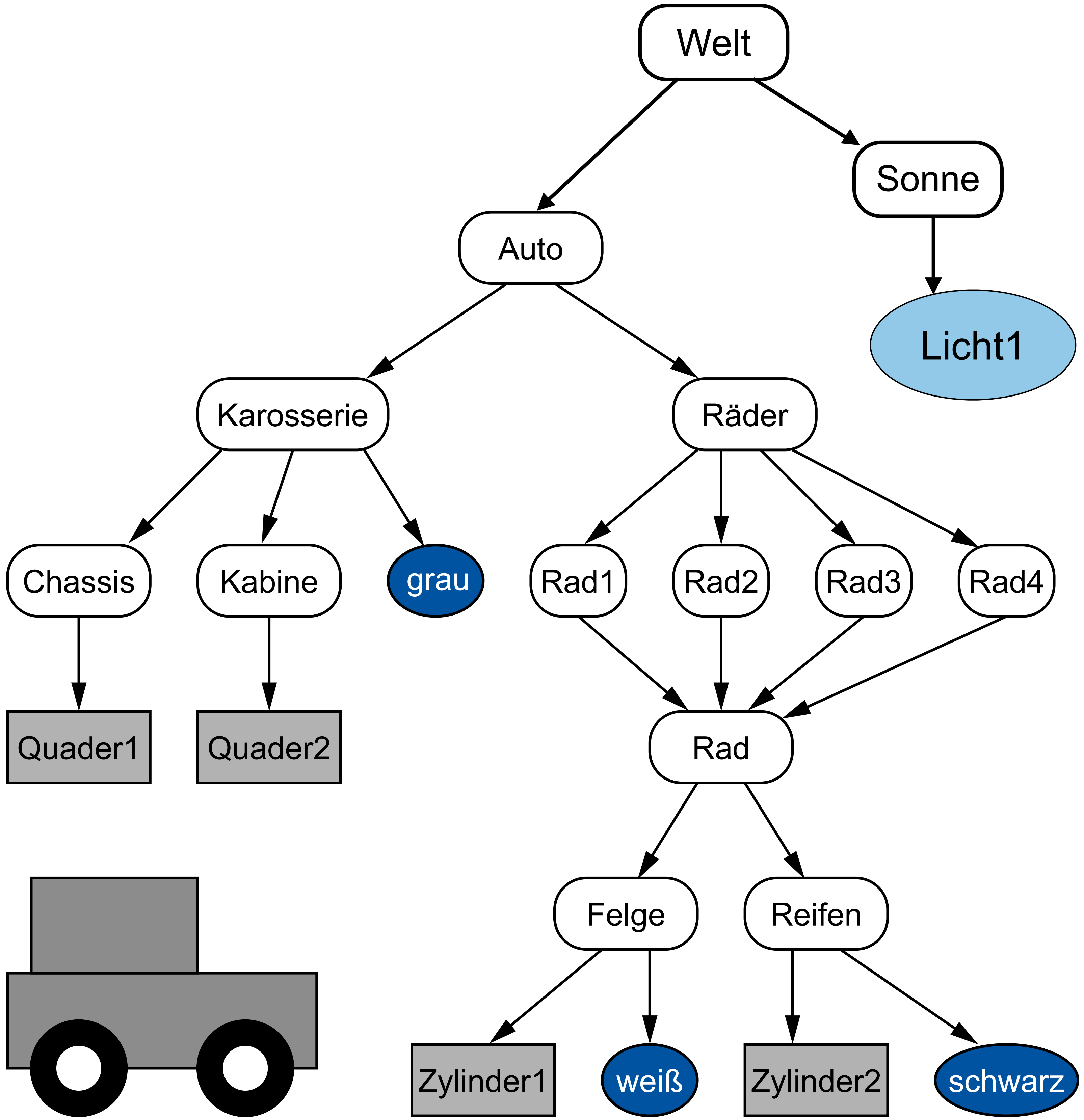
- Appearance can be only partially specified
  - unspecified values are inherited



Lights in the Scene Graph

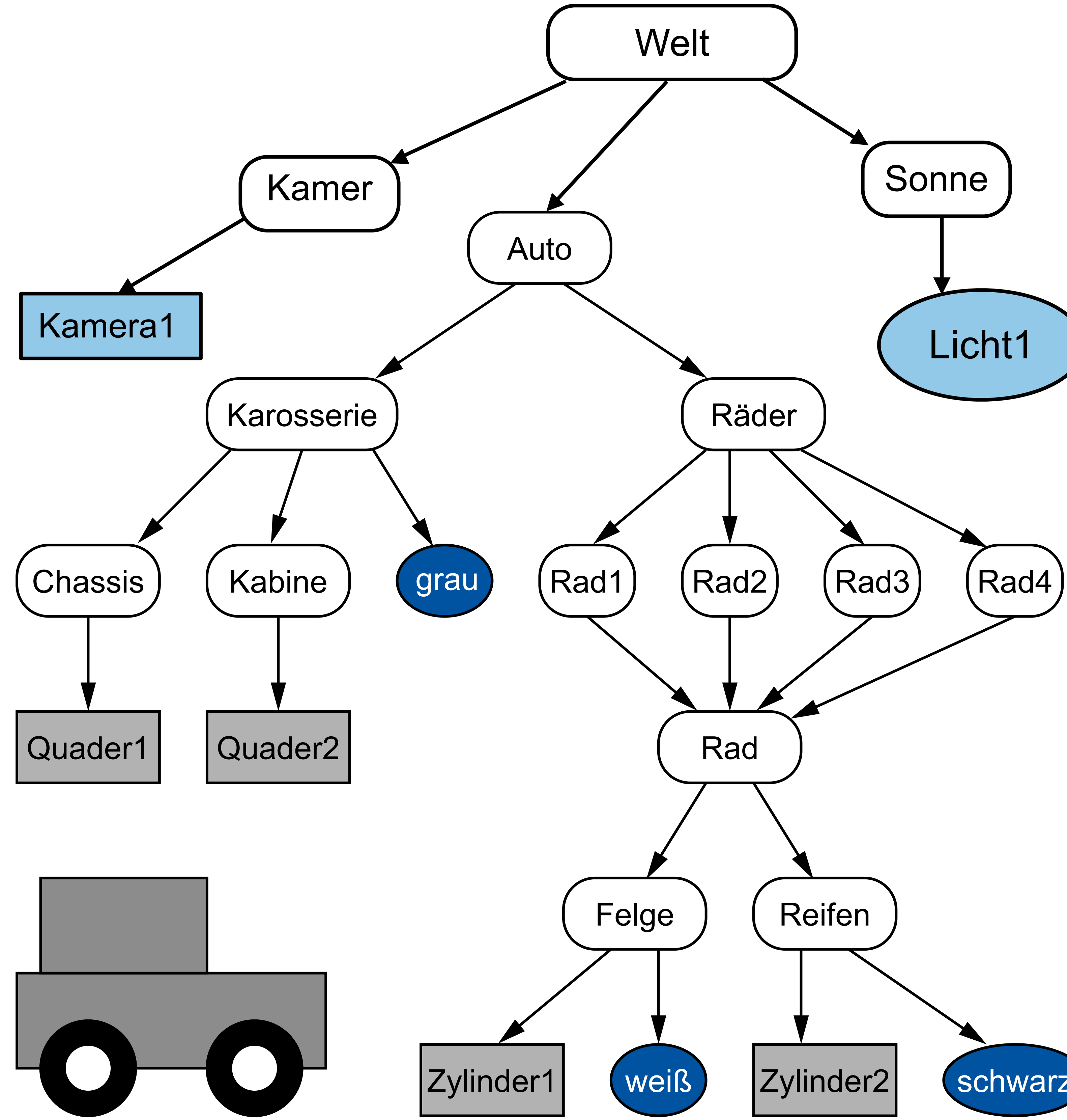
- Light sources also need a position and/or direction
  - Just include them into the scene graph
  - Can be animated just like geometry

- Lights can be in local coordinate systems of geometry groups
  - move with them
  - example: lights on a car



The Camera in the Scene Graph

- Camera also needs a position and direction
  - Just include it into the scene graph
  - Can be animated just like geometry
- Camera can be in local coordinate systems of geometry groups
  - move with them
  - example: driver‘s view from a car



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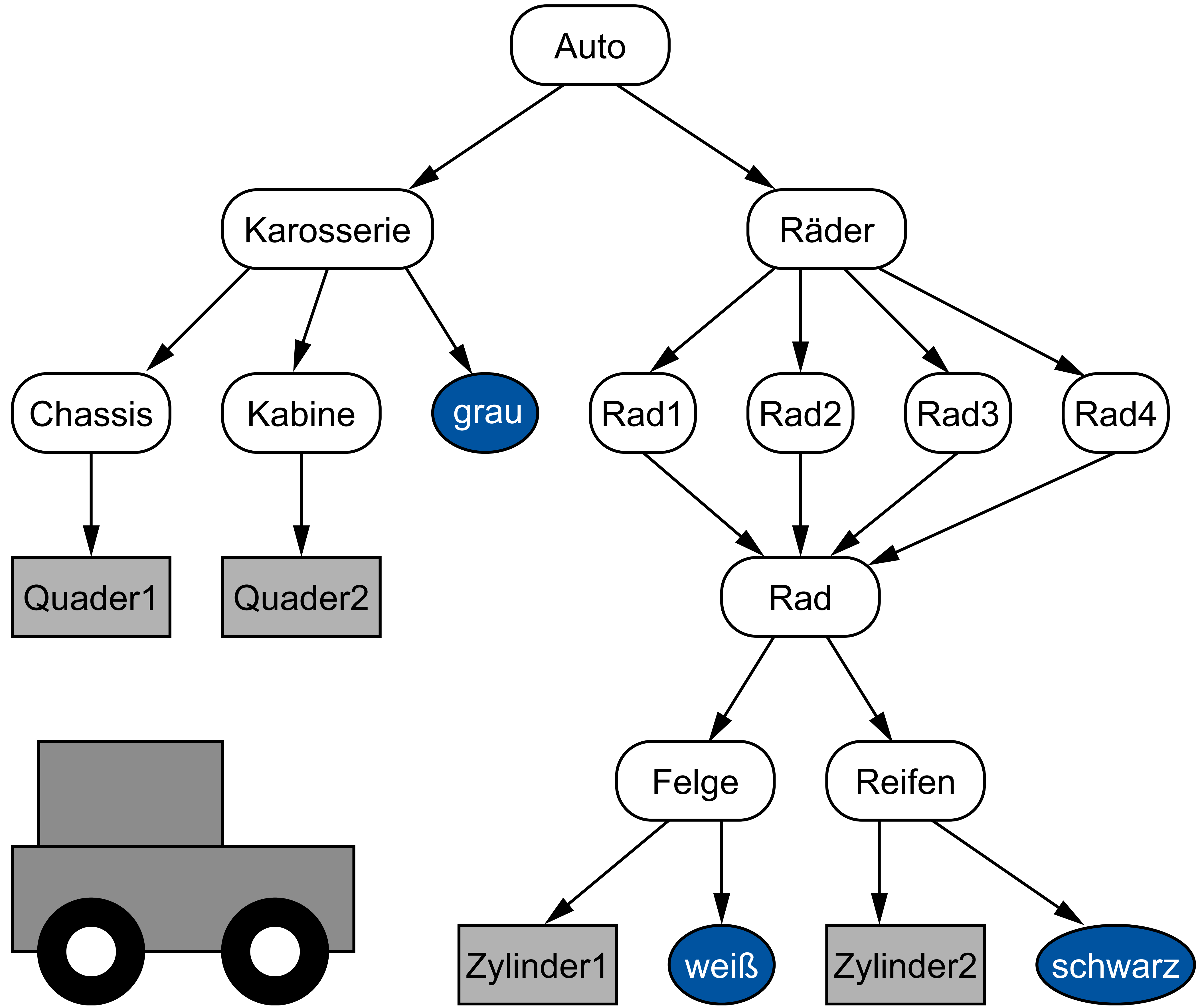
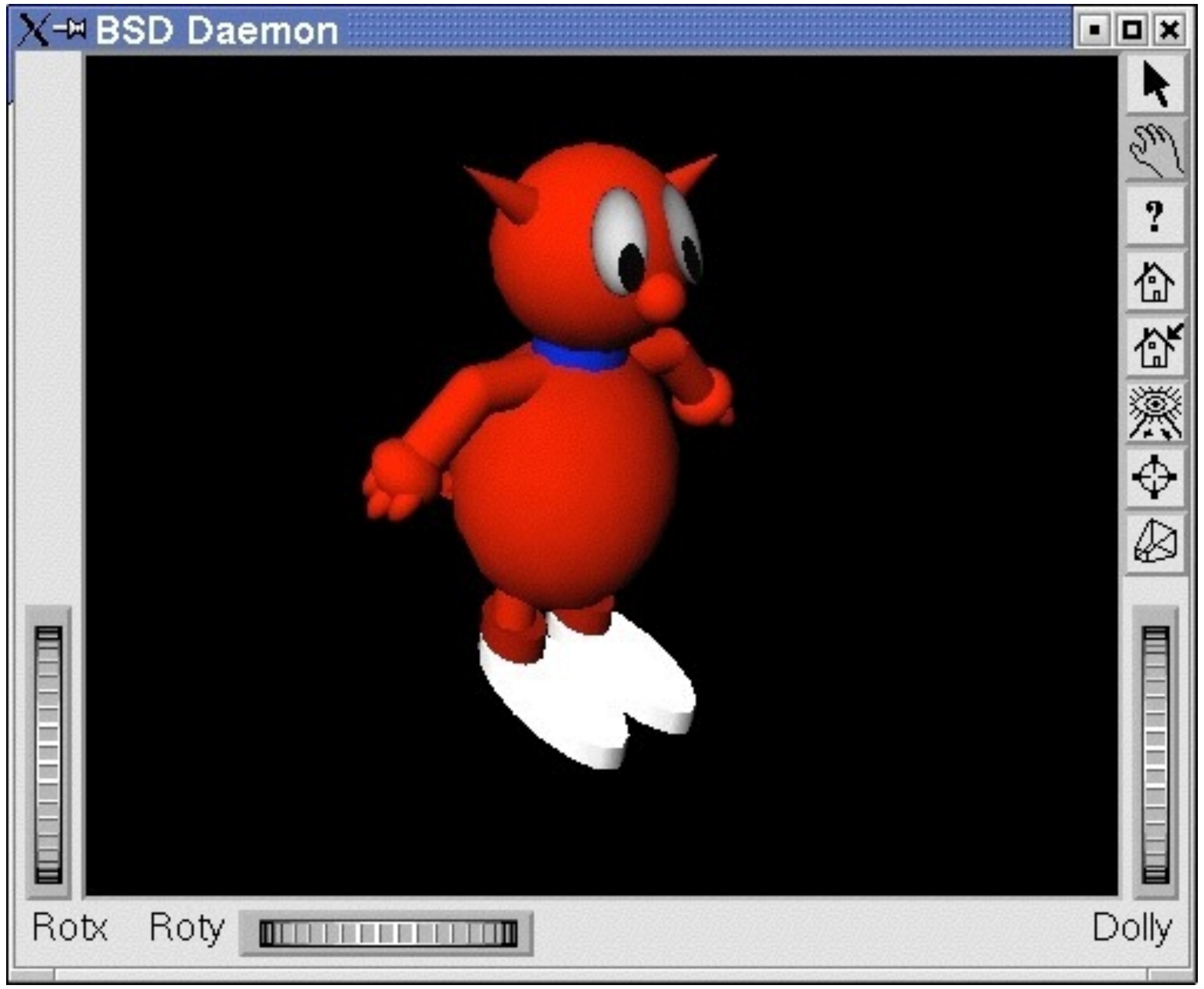
Scene graph traversal for rendering

- set T_{act} to T_{Auto}
- push state
- set T_{act} to T_{act} x $T_{Karosserie}$
- push state
- set T_{act} to T_{act} x $T_{Chassis}$
- render Quader1
- pop state
- set T_{act} to T_{act} x T_{Kabine}
- render Quader2
- pop state
- pop state
- set T_{act} to T_{act} x $T_{Räder}$
- ...



Scene Graph Libraries

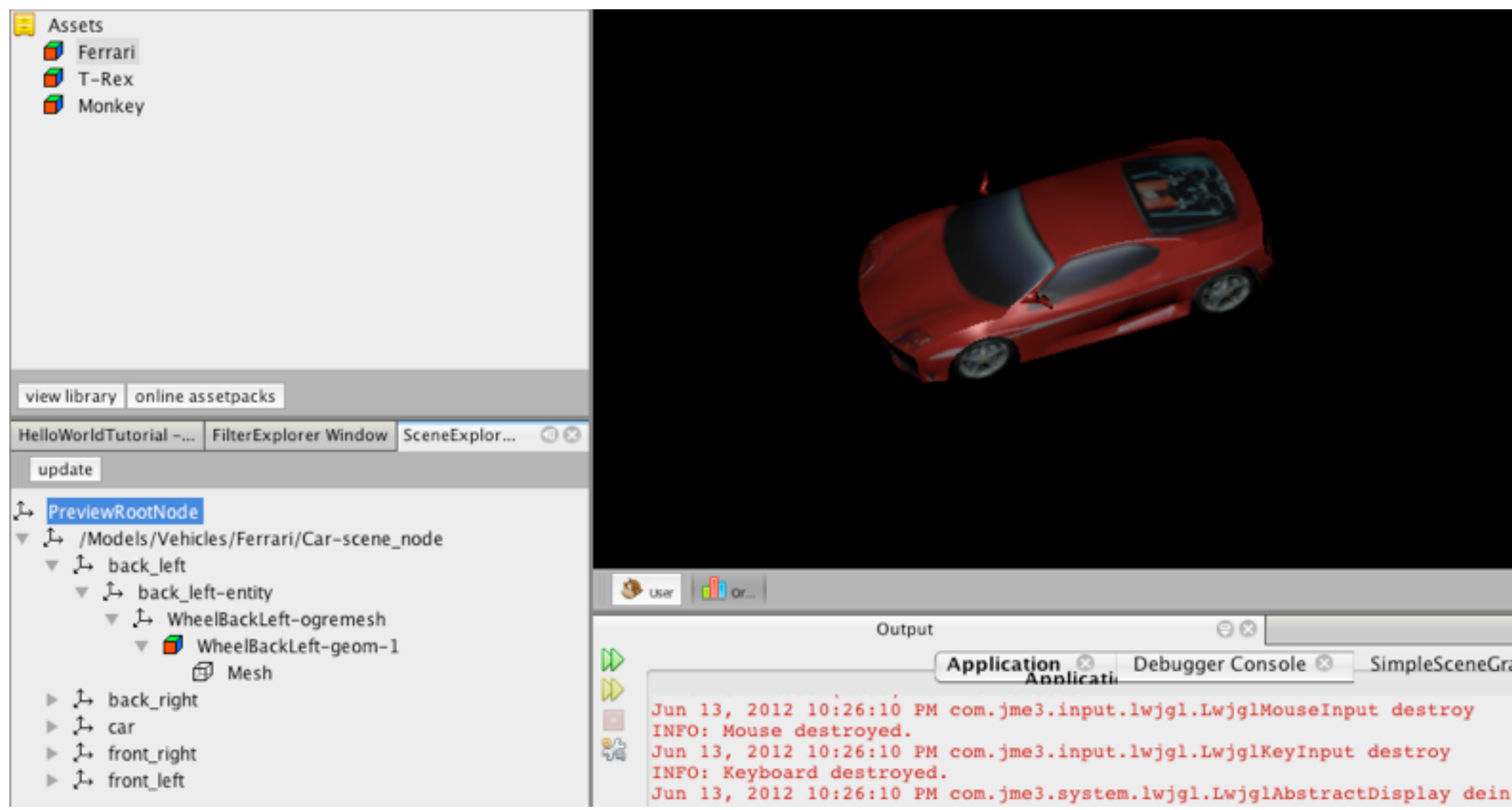
- Scene graphs exist on a more abstract layer than OpenGL!
- VRML/X3D
  - descriptive text format, ISO standard
- OpenInventor
  - based on C++ and OpenGL
  - originally Silicon Graphics, 1988
  - now supported by VSG3d.com
- Java3D
  - provides 3D data structures in Java
  - not supported anymore
- Open Scene Graph (OSG)
- Various Game Engines
  - e.g. JMonkey 3 (scene graph based game engine for Java)



http://www.shlomifish.org/open-source/bits-and-bobs/open-inventor-bsd-daemon/

Scene Graphs in Practice

- Creation of scene graphs and objects
  - Specific authoring software (e.g. Blender, Maya, 3DS Max)
- Assets (models, objects) exported to exchange formats
  - E.g. (X3D,) Wavefront OBJ (.obj), 3ds Max (.3ds), Ogre XML (.mesh)
- Objects typically are tesselated
  - Polygon meshes
  - No primitive geometric objects visible/readable anymore
- Example:
  - JME Scene Viewer / Composer



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Example of a scene graph

- Graph to be drawn together in the lecture
- VRML world linked from the class page