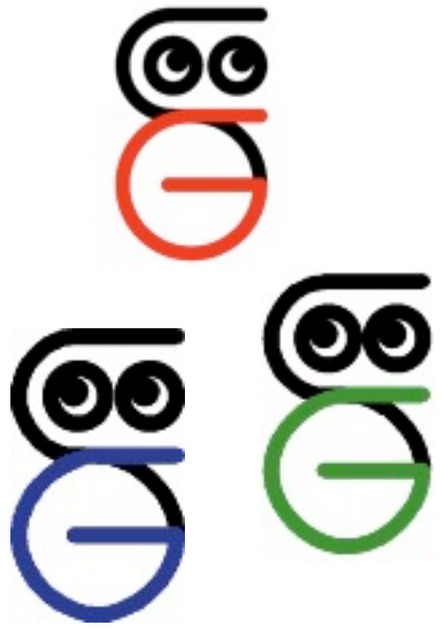
Smart Graphics: Graphics and Communication

Lecture „Smart Graphics”

Andreas Butz

26.10.2010

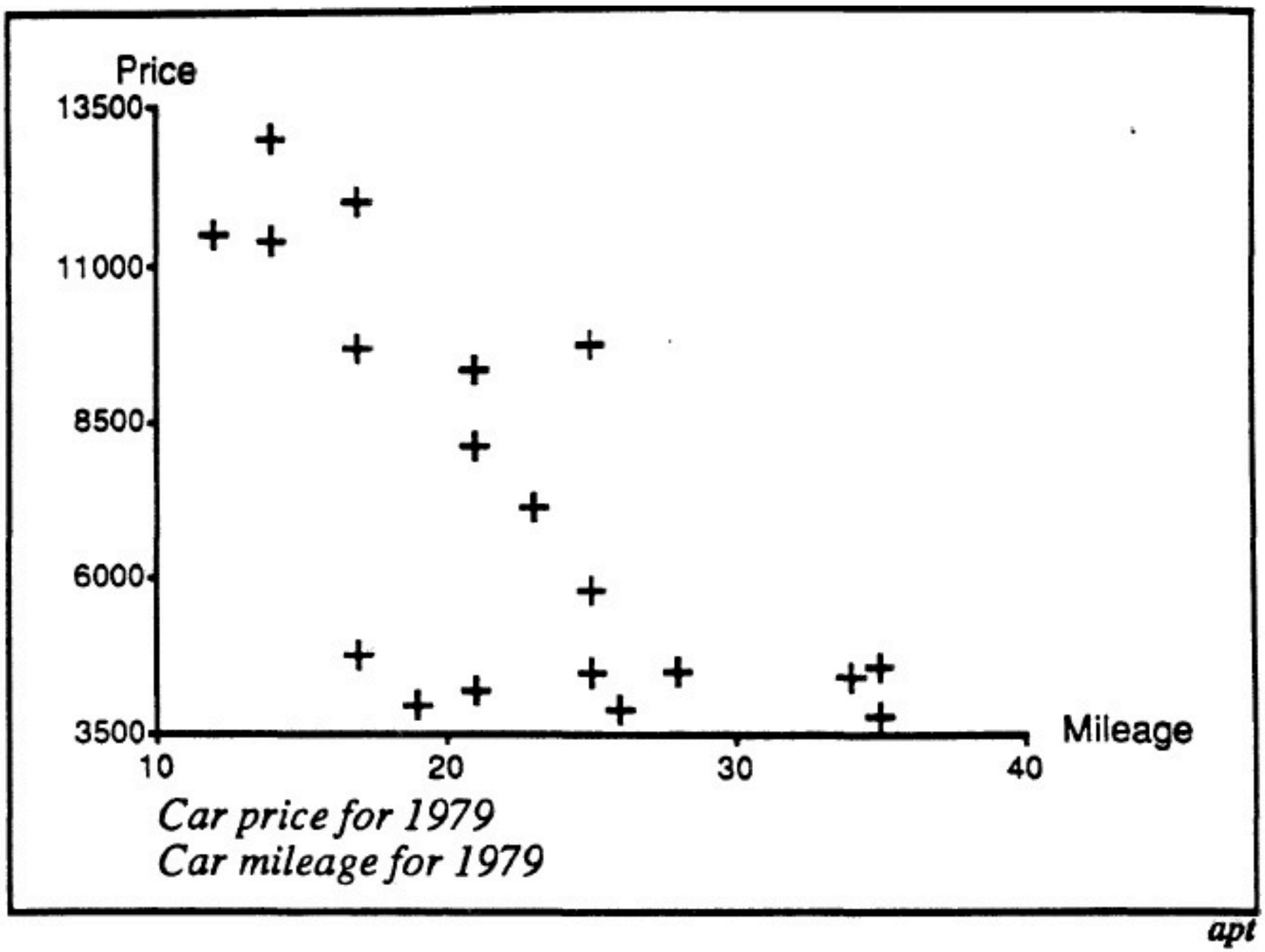


Graphik und Kommunikation

- Eine „Grammatik“ für Diagramme
  - –Syntax
  - –Semantik
- Rhetoric Structure Theory
  - –Grundidee
  - –Anwendung auf multimediale Präsentationen
- Generisches Modell eines SG systems
- Praktisches Beispiel: Generierung von 3D-Animationen
- Dabei insbesondere: hierarchische Planung

Eine Grammatik für Diagramme: APT

[Mackinlay 1986]



Ausgangsdaten

Price(Accord,5799)	*Price*(AMC Pacer,4749)
Mileage(Accord,25)	*Mileage*(AMC Pacer,17)
Weight(Accord,2240)	*Weight*(AMC Pacer,3350)
Repair(Accord,Great)	*Repair*(AMC Pacer,Terrible)
Nation(Accord,Germany)	*Nation*(AMC Pacer,USA)
Price(Audi 5000,9690)	*Price*(BMW 320i,9735)
⋮	⋮

Figure 2: Relation Tuples About 1979 Automobiles. *This is an example of a table of relation tuples that might be generated by a database system in response to a query. A presentation tool can do much better than this.*

Price :	*Cars* → [3500,13000]
Mileage :	*Cars* → [10,40]
Weight :	*Cars* → [1500,5000]
Repair :	*Cars* → ⟨Great, Good, OK, Bad, Terrible⟩
Nation :	*Cars* → {USA, Germany, France, ···}
Cars =	{Accord, AMC Pacer, Audi 5000, BMW 320i, ···}

Figure 3: Structural Properties of the Automobile Relations. *The arrow (→) indicates a functional dependency between domain sets. The square brackets ([]) describe domain sets that are quantitative ranges, the angle brackets (⟨⟩) describe domain sets that are ordered sets, and the curly braces ({}) describe domain sets that are unordered sets.*

Diagramme als visuelle Sprache

- Graphische Elemente (Punkte, Linien, ..) sind die „Worte“
- Mehrere Elemente werden zu „Sätzen“ kombiniert (Syntax)
- Worte und Sätze haben Bedeutungen (Semantik)
- Visualisierung = Generierung eines Satzes, der genau die beabsichtigten Inhalte ausdrückt

A set of facts is *expressible* in a language if it contains a sentence that:

1) encodes all the facts in the set and

2) encodes only the facts in the set.

Formale Beschreibung eines Diagrams

Encodes(*VertAxis*, [3500, 13000], *ScatterPlot*)
Encodes(*HorzAxis*, [10, 40], *ScatterPlot*)
Encodes(*Points*, *Cars*, *ScatterPlot*)
Encodes(*Position*(*Points*, *VertAxis*), *Price*(*Cars*), *ScatterPlot*)
Encodes(*Position*(*Points*, *HorzAxis*), *Mileage*(*Cars*), *ScatterPlot*)

Figure 4: The Graphical Design for a Scatter Plot of the Price/Mileage Input. *The Encodes relation indicates the relationship between graphical objects or properties and the information encoded. For example, the first line says that the vertical axis encodes the range of prices, and the fourth line says that the position of the points on the vertical axis encodes the prices of cars. The input relations are written as functions to simplify the description.*

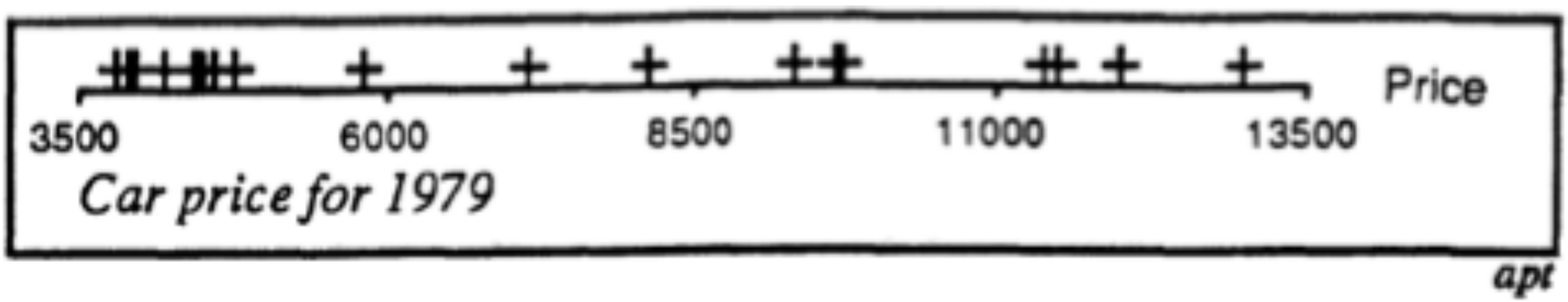


Figure 9: The Horizontal Position Sentence of the Price Relation.

Zugehörige graphische Ausgabe

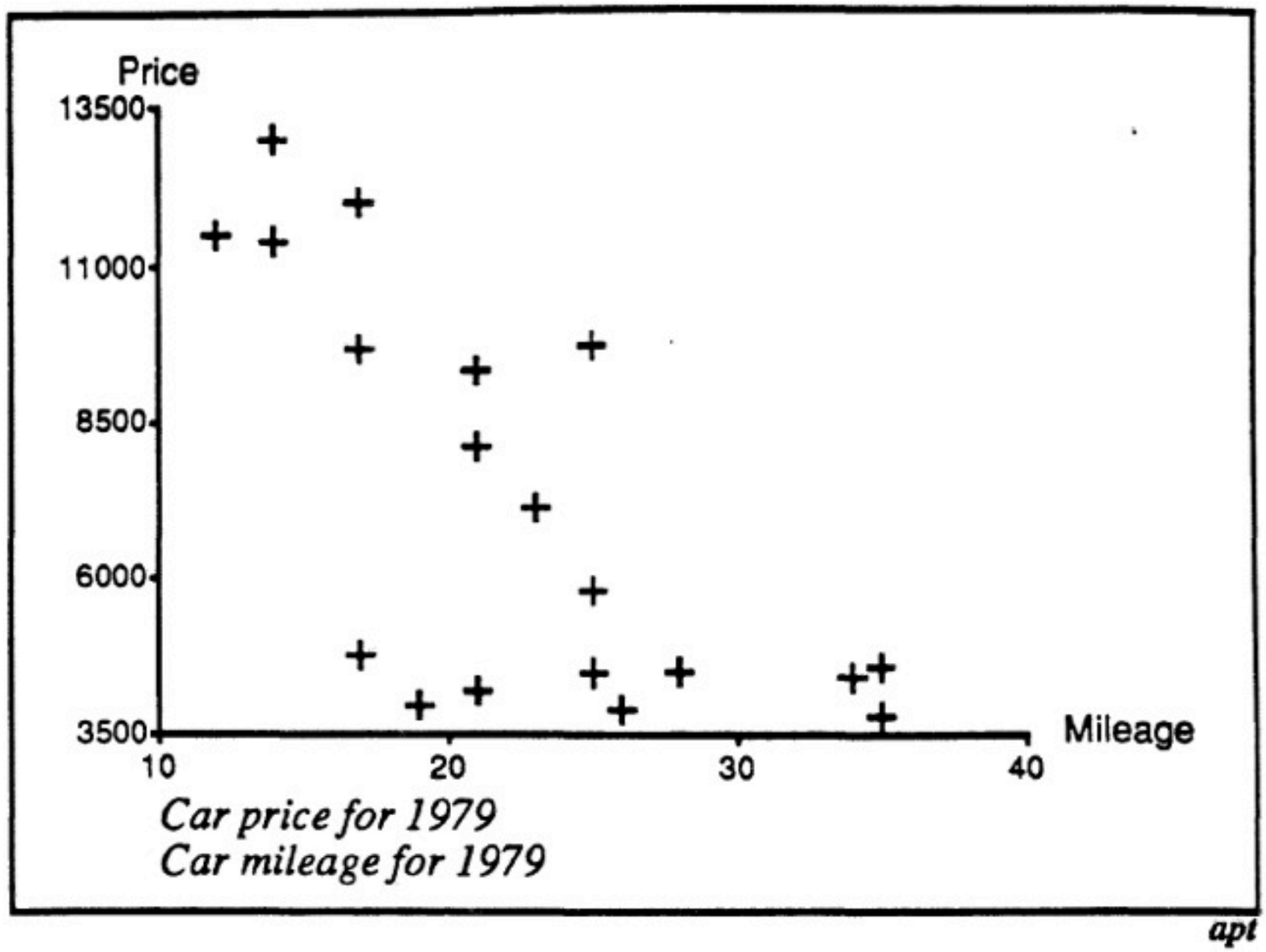


Figure 5: Scatter Plot of the Price/Mileage Input. *The graphical design for this image is in Figure 4. The design expresses the relations only if the application permits the details about the cars to be omitted. The "apt" in the lower right corner indicates that* APT *designed and rendered this diagram.*

Alternative graphische Umsetzung

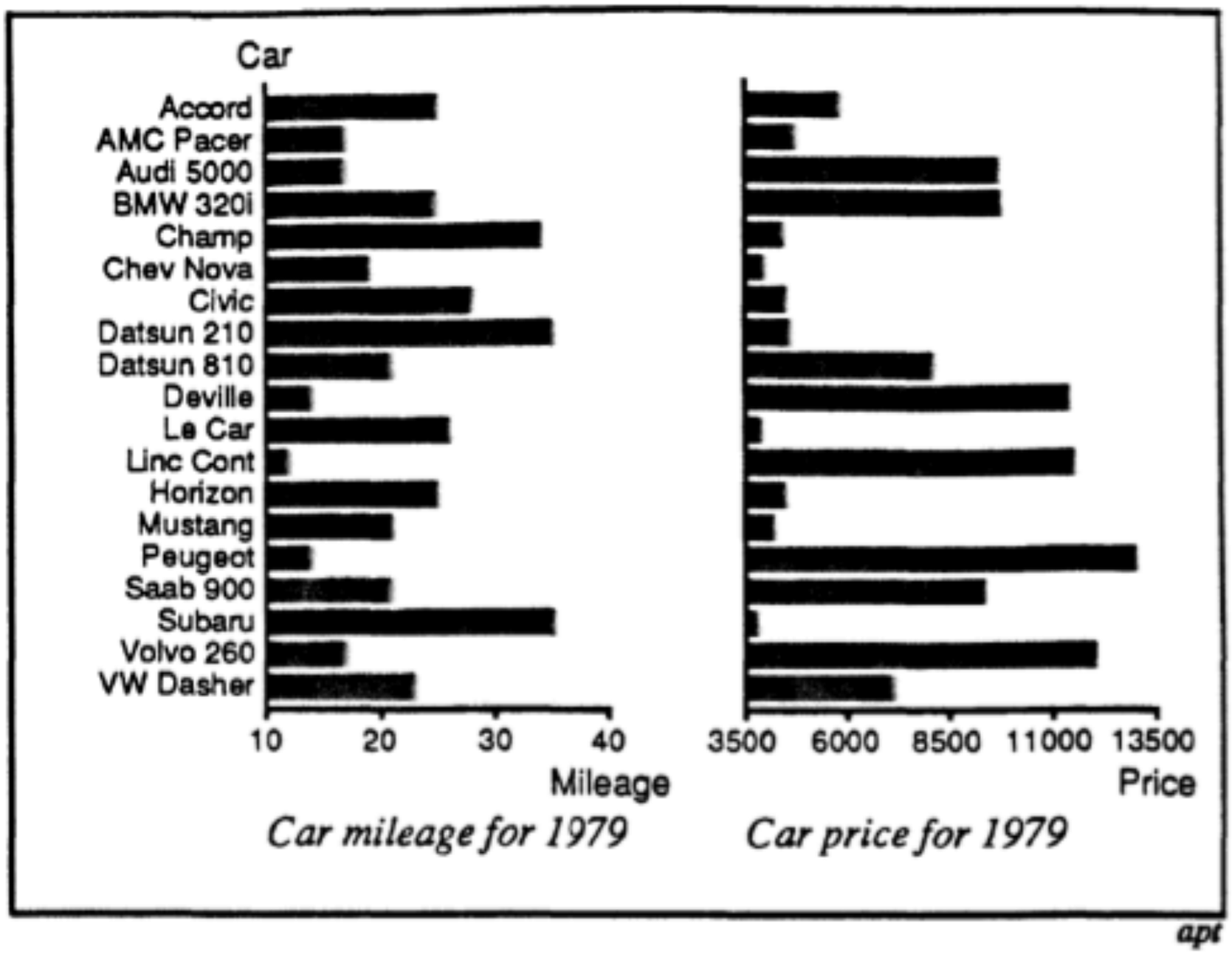


Figure 7: Aligned Bar Chart for the Price/Mileage Input. *This diagram shows the detailed properties of the cars better than a scatter plot. However, the general relationships are not as easy to see.*

Gegenbeispiel

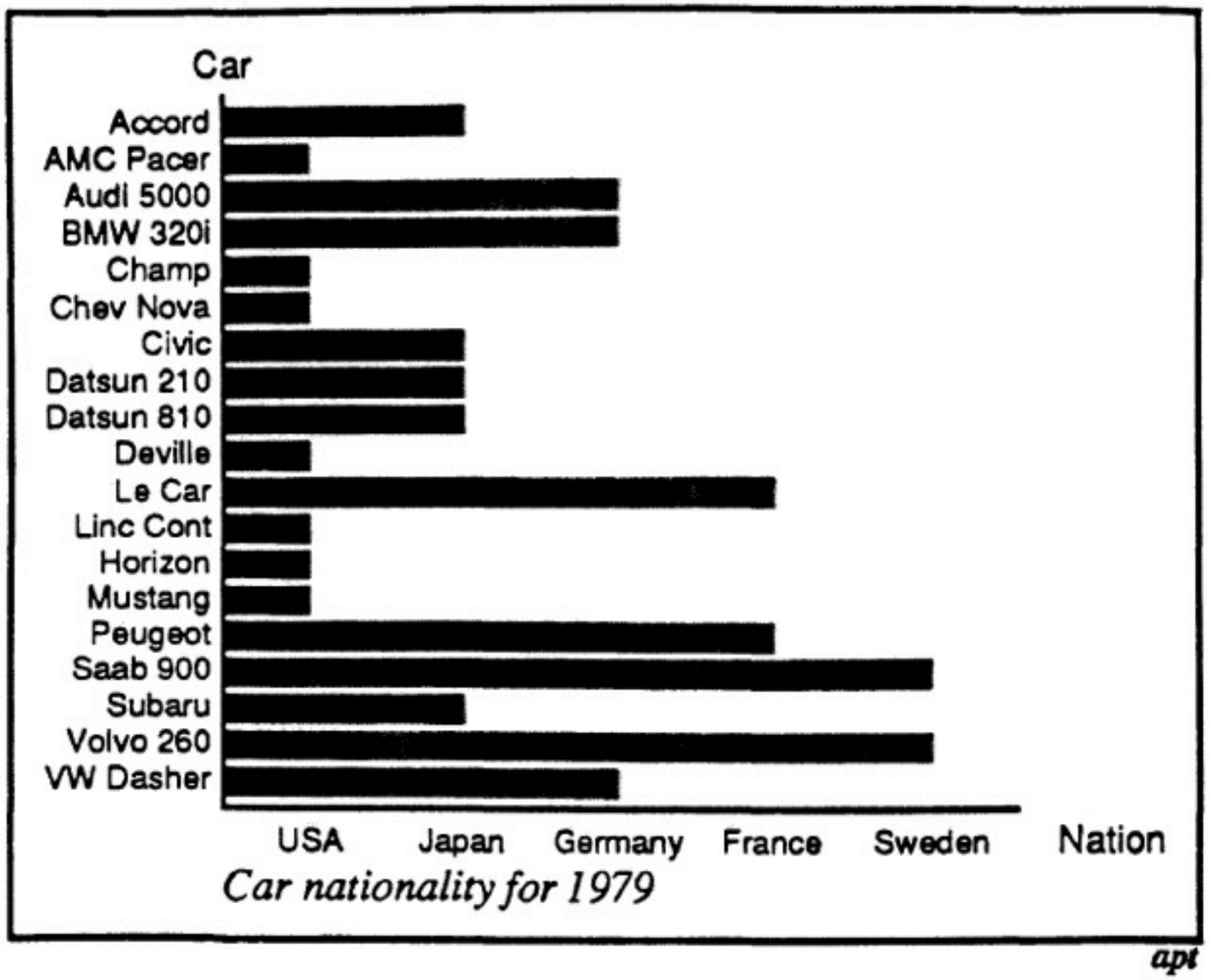
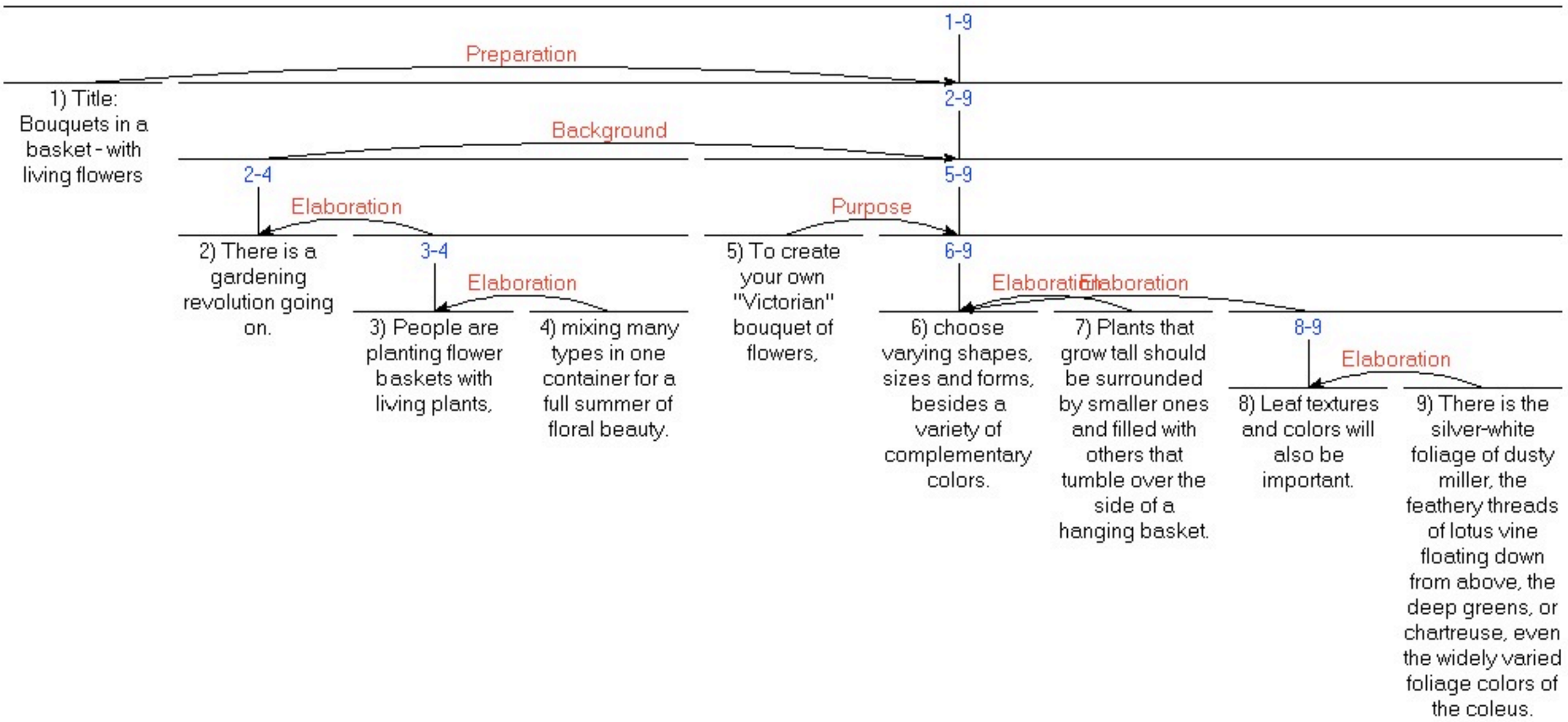


Figure 11: Incorrect Use of a Bar Chart for the Nation Relation. *The lengths of the bars suggest an ordering on the vertical axis, as if the* USA *cars were longer or better than the other cars, which is not true for the Nation relation.*

Rhetoric Structure Theory [Mann & Thompson, 1988]

- Beschreibung der hierarchischen Struktur eines Textes
- Unterteilung des Textes in logische Einheiten, z.B. Teilsätze
- Relationen zwischen diesen Einheiten
  - Nukleus – Relation – Satellit
- Insgesamt 23 Relationen
  - Preparation, elaboration, background, purpose,…
- Schemata für typische Kombinationen
- Fast jeder Text kann durch einen RST-Baum beschrieben werden

RST - Beispiel

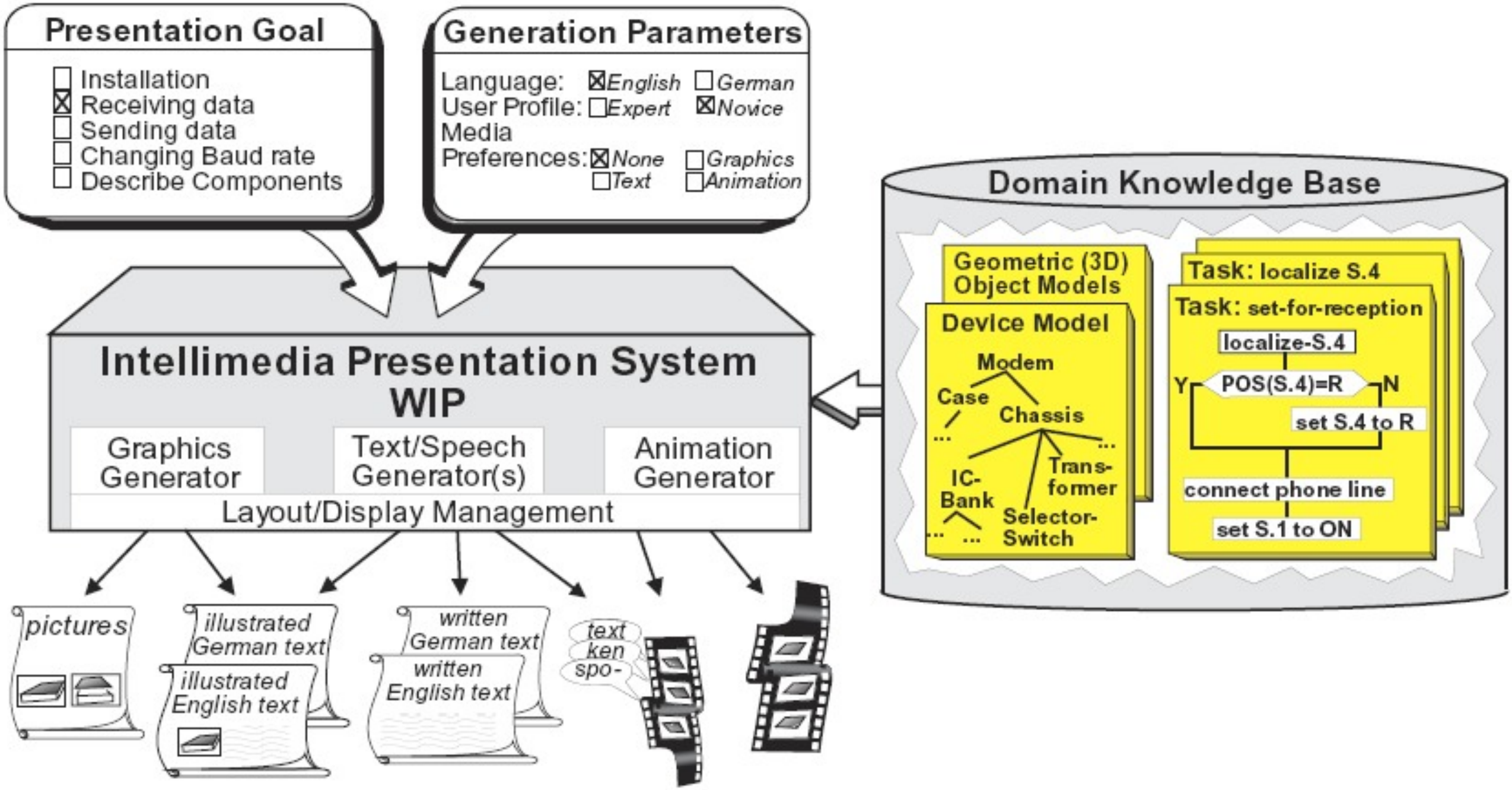


RST Multimedia Planung in WIP

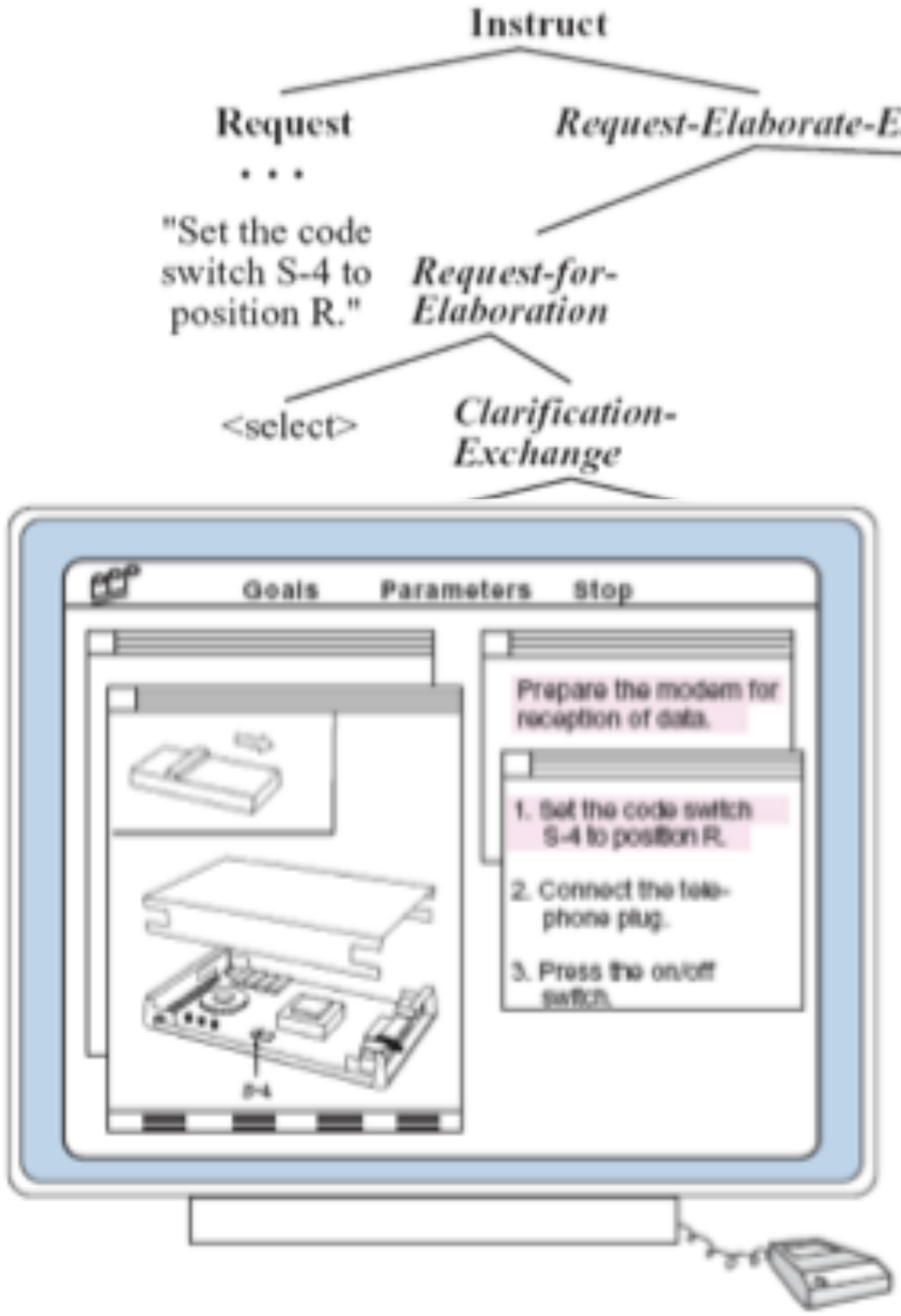
[Andre & Rist 1997]

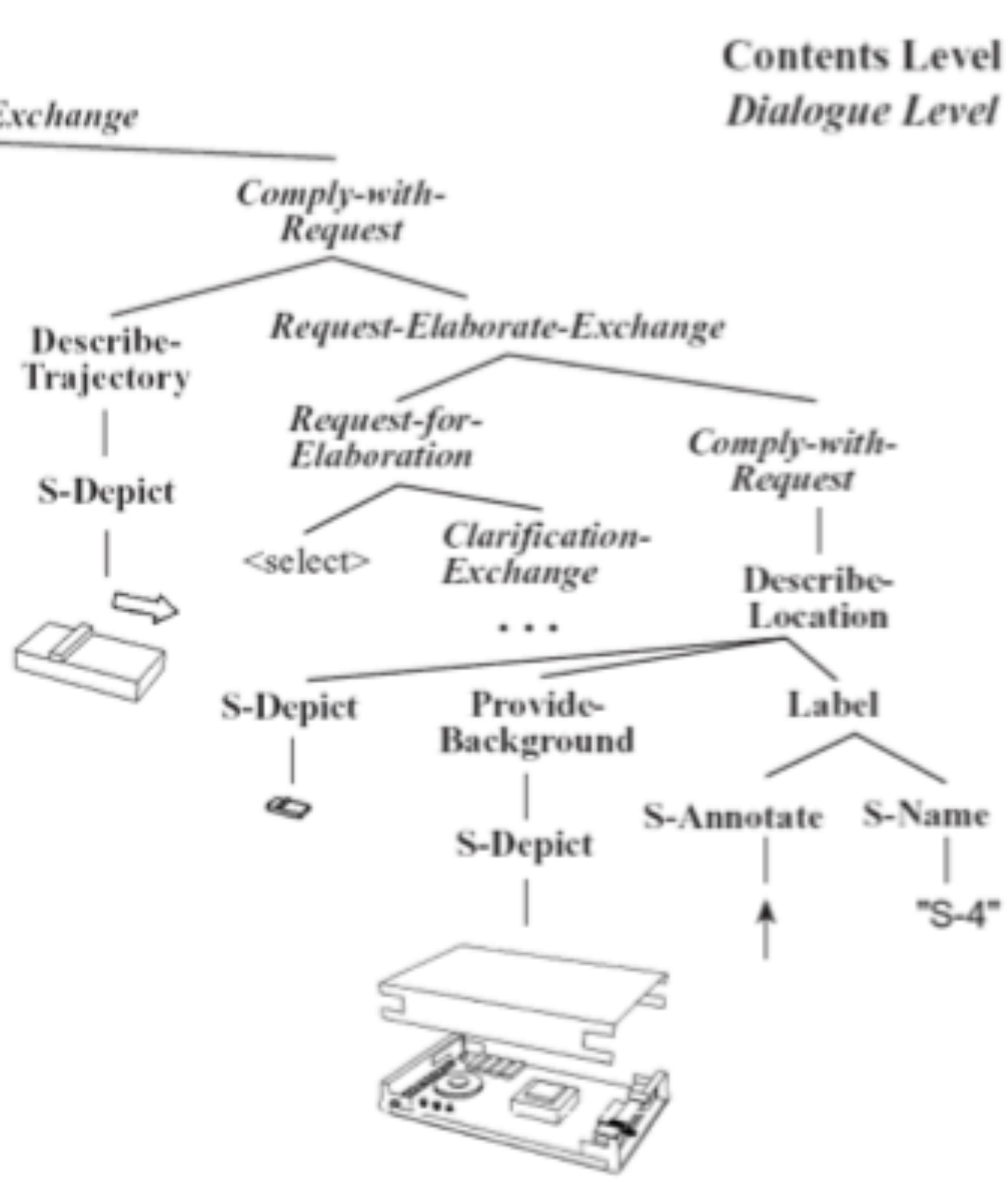
- Verallgemeinerung von RST auf Multimediale Inhalte
  - –Text, Bilder, Animationen, (Zeigegesten)
- Planung multimedialer Dokumente als hierarchischer Planungsprozess
  - –Beginne mit der Wurzel des RST-Baumes
  - –Unterteile in logische Einheiten
  - –Lege Medium für jede Einheit fest
  - –Generiere jeweilige Einheit (Text, Bild, Animation)

WIP Architektur



WIP Generierungsbeispiel

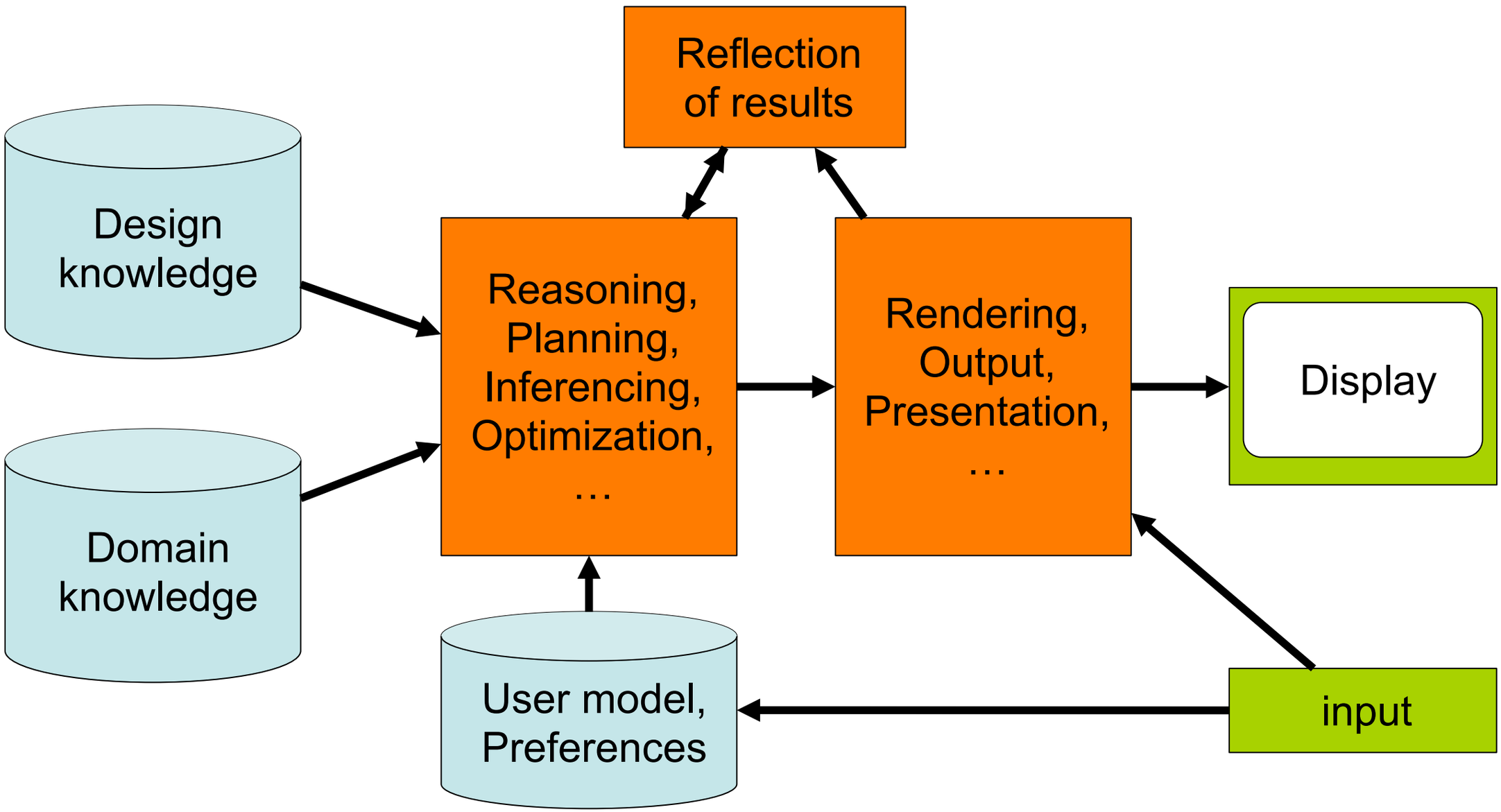




Contents Level
Dialogue Level

Some typical elements of SG systems

- Strong simplification and generalization
- Often only some elements present



Concrete example: filmmaking

- Task: create a 3D animation for the explanation of a technical device
- Starting point: communicative goal
  - –Example: show where the switch X is
- Intended result: 3D animation
  - –E.g., showing where switch X is

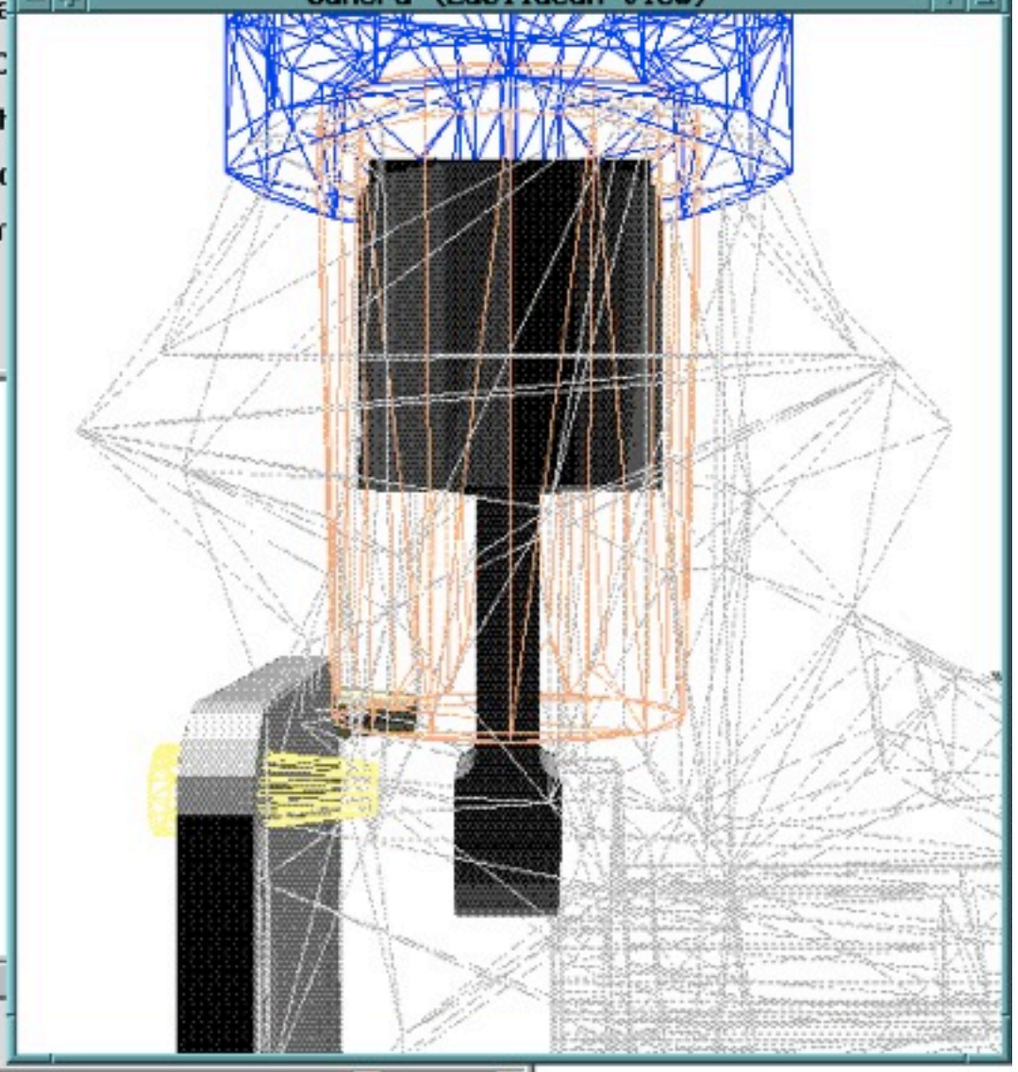
CATHI_V.1.5

Animate | Reset | Edit | Options | Domain | Grammar | Save | Goals | Exit

(ctg::localize-object :object :cylinder-group :duration 10)

Generation	Techniques	Illumination	Output	Shading mode
Incremental	Color effects	Default/No lights	Viewangle	Photorea
Adaptive	Opacity effects	Spot lights	Focus distance	Phong+C
System trace	Light effects	Point lights	Lens aperture	Phong sh
Save ASCII	Depth of field	Distant lights	Obj. opacity	Flat shac
Save GCL	Abstraction	Ambient light	Object color	Wirefram
Save Keyframes	Explosion		Object LOD	
Relative motions	Metagraphics		Dyn. Objects	

Camera (Euclidean view)



Script statistics

Presentation time
Generation time
Script time

(ctg::localize

Elementary se
Script leng

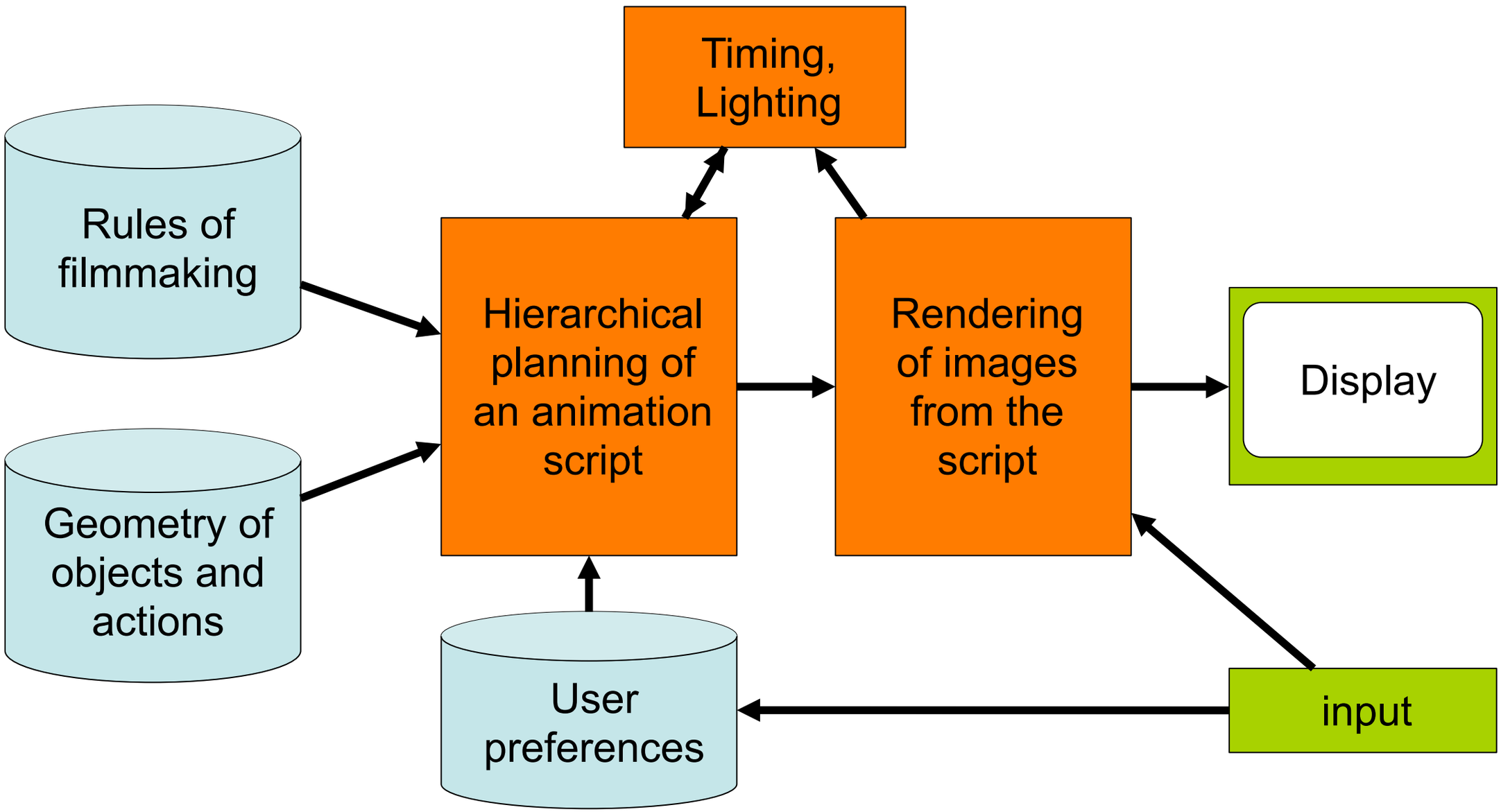
Script_Editor_V.2.3

Edit | Save | level: 5

lod	lod	k-c	vis	lod	r-c	col	col	col	col	col	col	k-c
						t-c	col	col	col	col	col	col	
vis	lod	k-f	vis	lod	f-c	k-c	k-f
						k-f	
		k-v			k-v	k-v	k-v

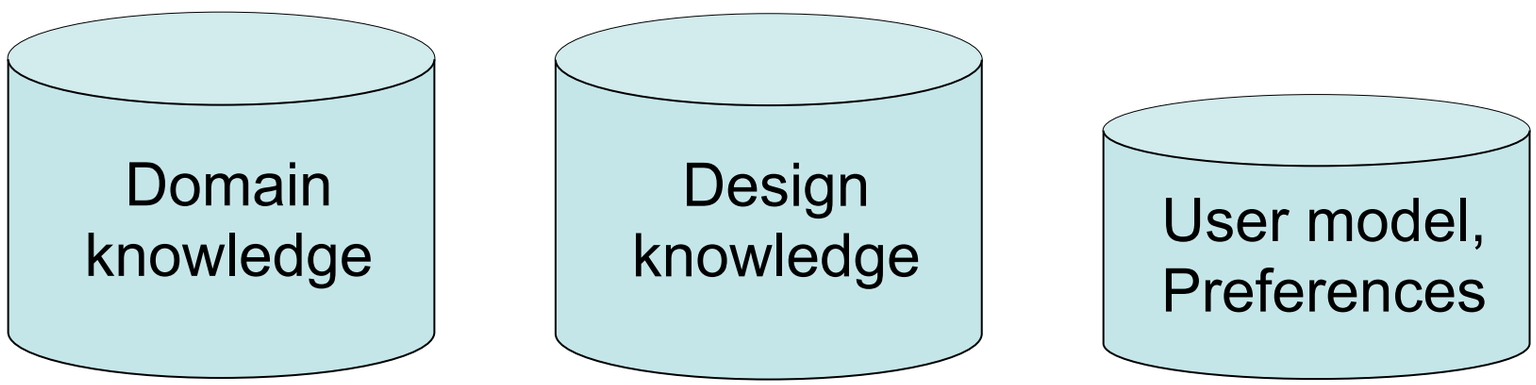
Concrete example: filmmaking

- Example system CATHI [Butz, 97]



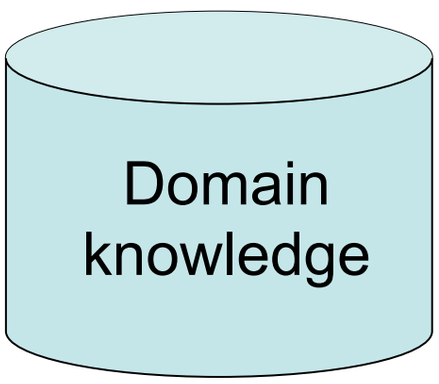
Knowledge representation

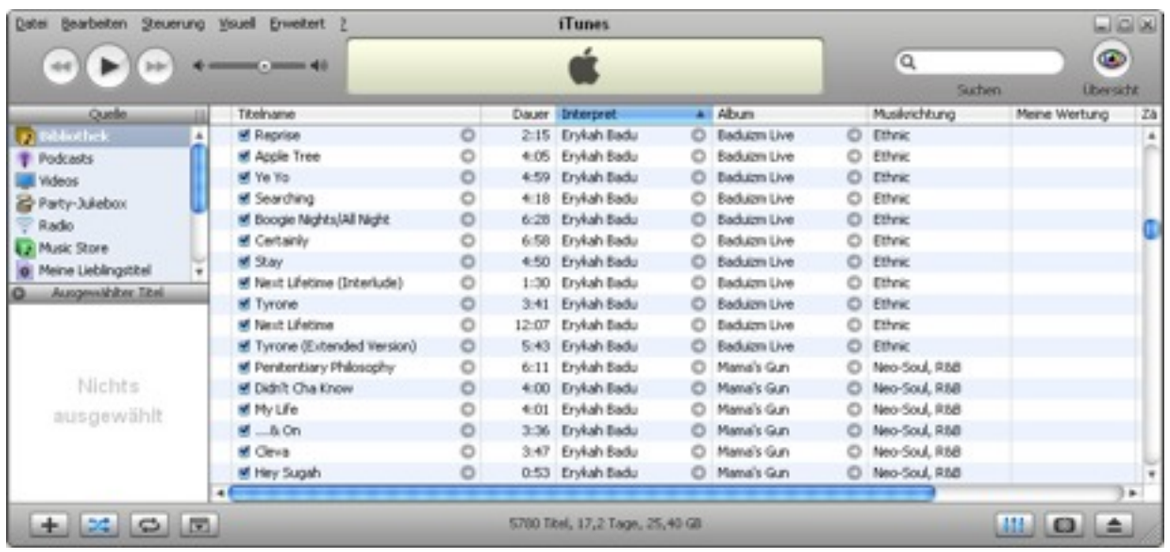
- Representations can only capture part of the reality
  - Which aspects do we need to model?
  - At which level of detail do we need to model them?
  - Do we need qualitative or quantitative knowledge?
  - How do we want to process the knowledge?
- Different kinds of knowledge must be represented
  - Domain knowledge
  - Design knowledge
  - Knowledge about the user



Domain Knowledge

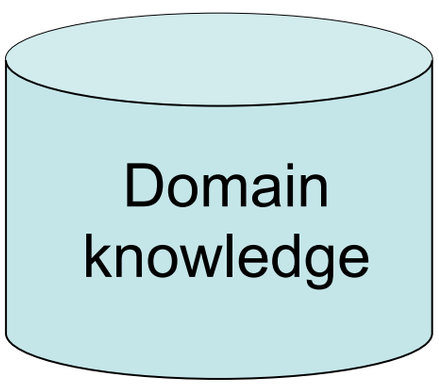
- Knowl. about things in the problem domain, e.g.,
  - Road network in a geographic database
  - Personal picture or music collection with metadata
  - Text and picture blocks for a magazine page
- Exchangeable if clearly separated from the rest
  - E.g., visualizations of different music collections
  - Route instructions in different cities

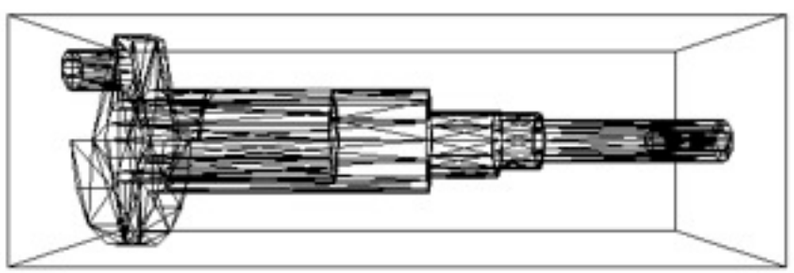


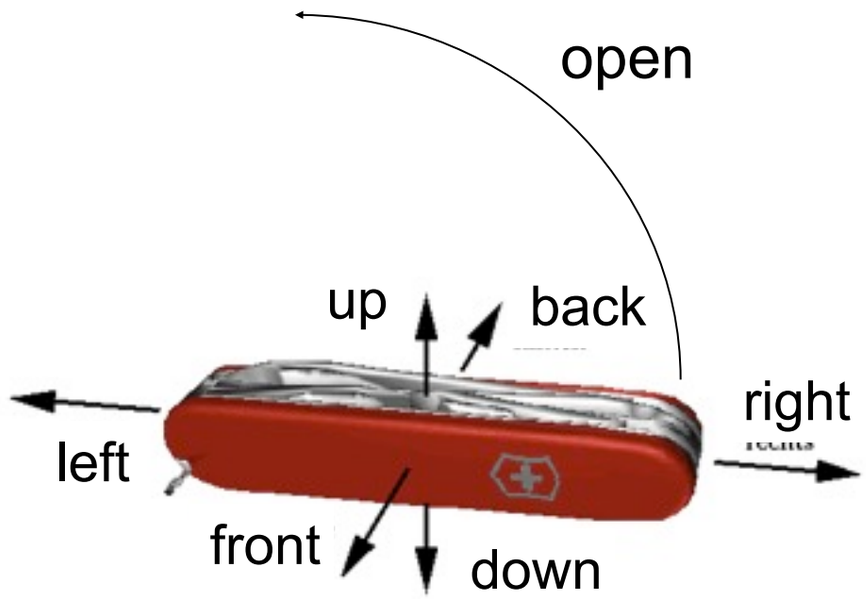


Domain Knowledge

- In the filmmaking example:
  - –Geometries of objects + bounding boxes
  - –Surfaces/colors of objects
  - –Object groups and hierarchy
  - –Preferred viewing directions of objects/groups
  - –Trajectories of movements

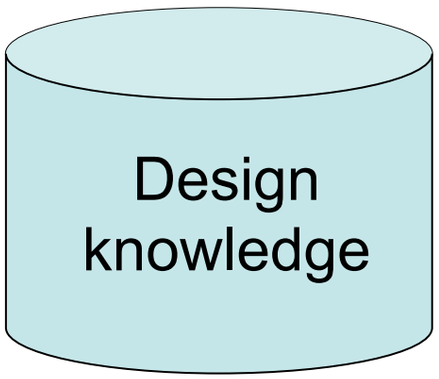


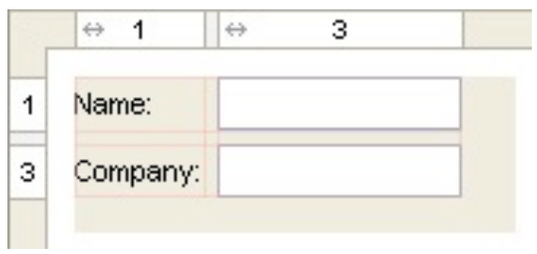


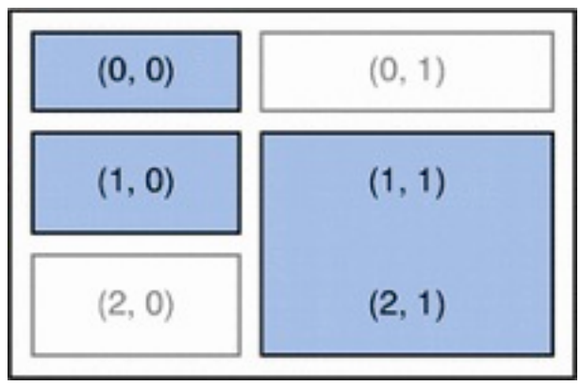


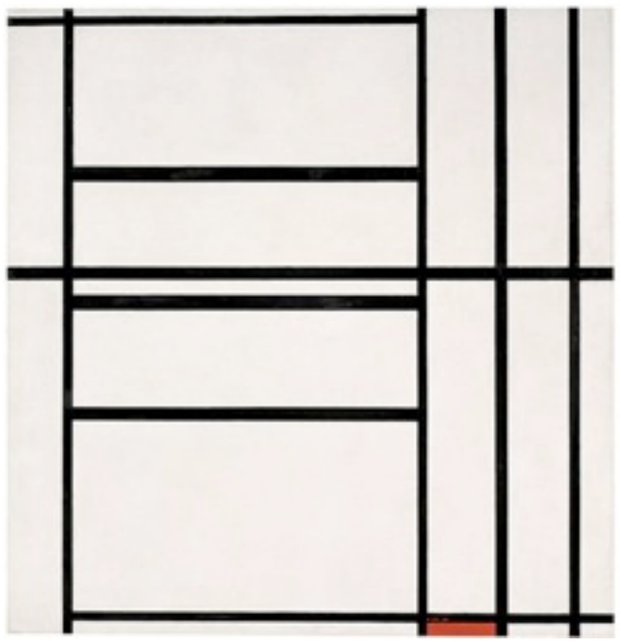
Design Knowledge

- Knowledge how to structure graph. presentations, e.g.,
  - Rules of grid-based layout
  - Rules about the composition of an image
  - Rules about the composition of diagrams
- In the filmmaking example:
  - Formal „grammar“ of the film language
  - Rules about temporal and spatial compositions of shots
- Must be formal enough to be used by a machine!
- When exchanged, changes visual style



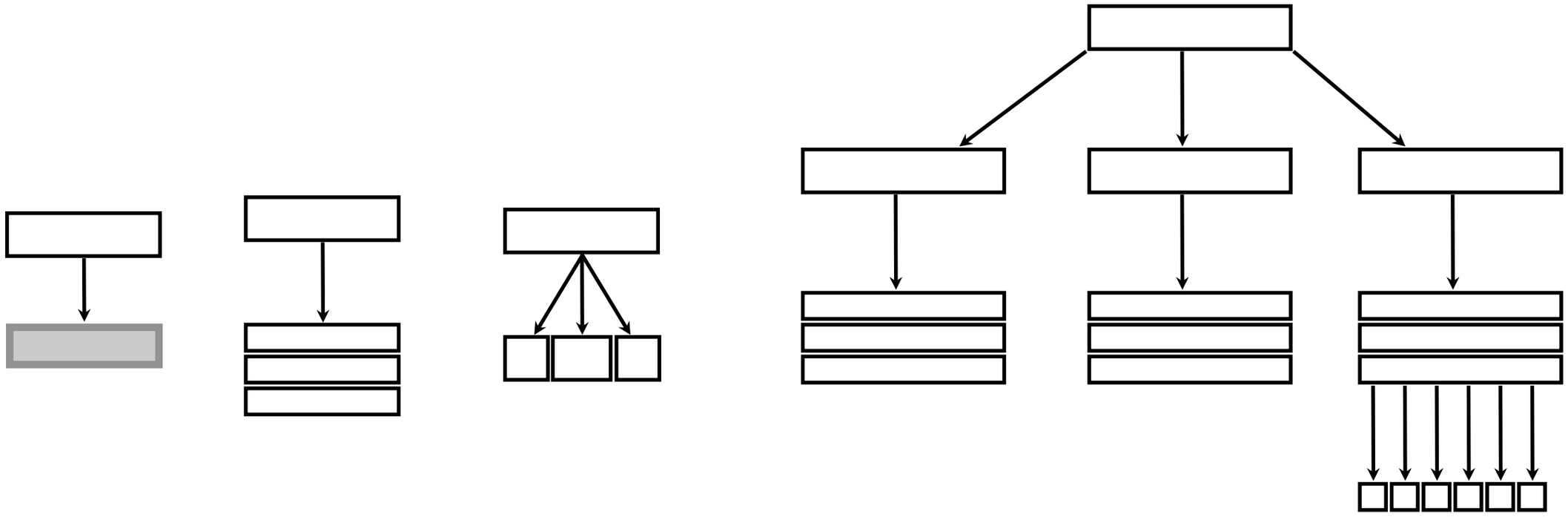






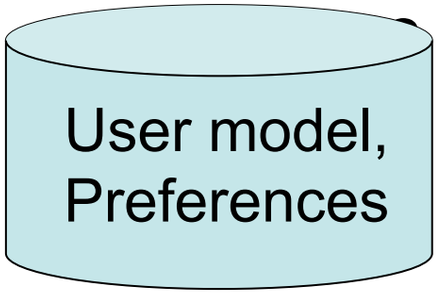
Example from CATHI:
a formal grammar of the film language

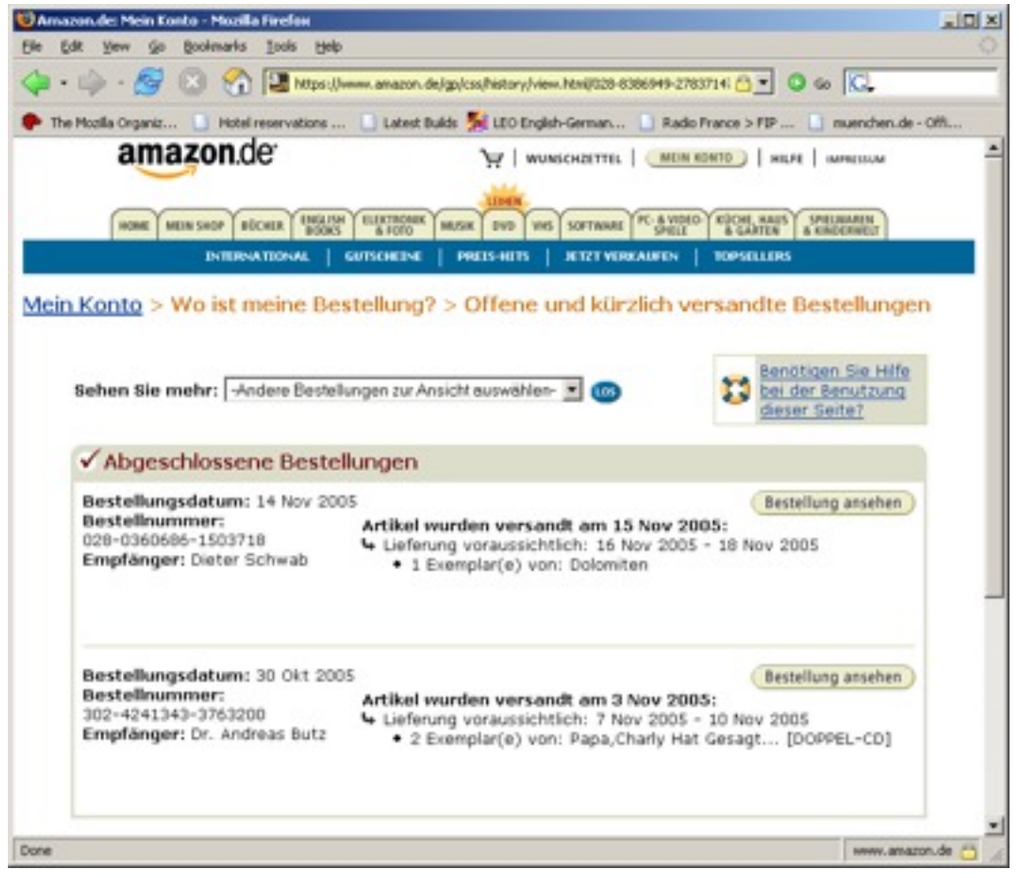
- Rules for decomposing sequences into subsequences
- Reusable in different situations
- Querying calculations in the 3D model
- Details later



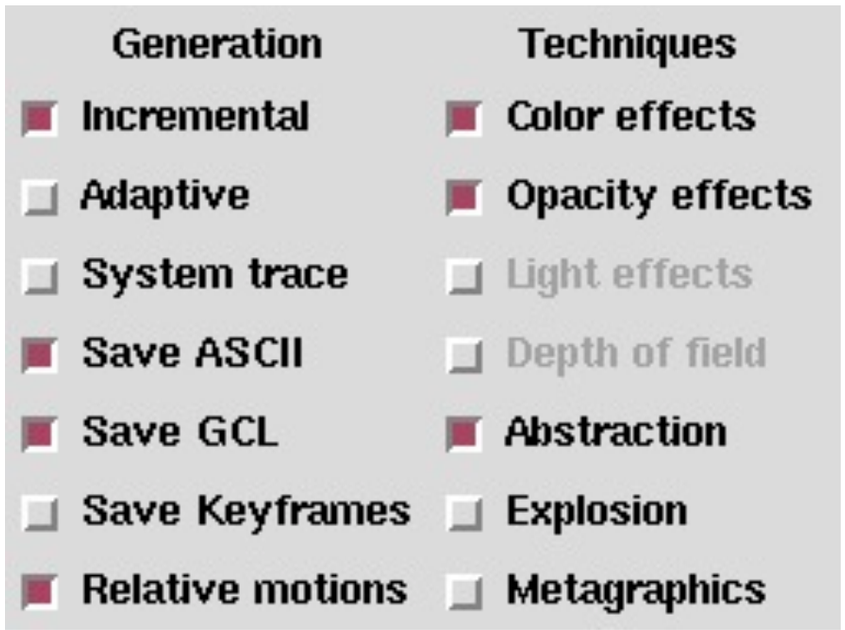
User model / preferences

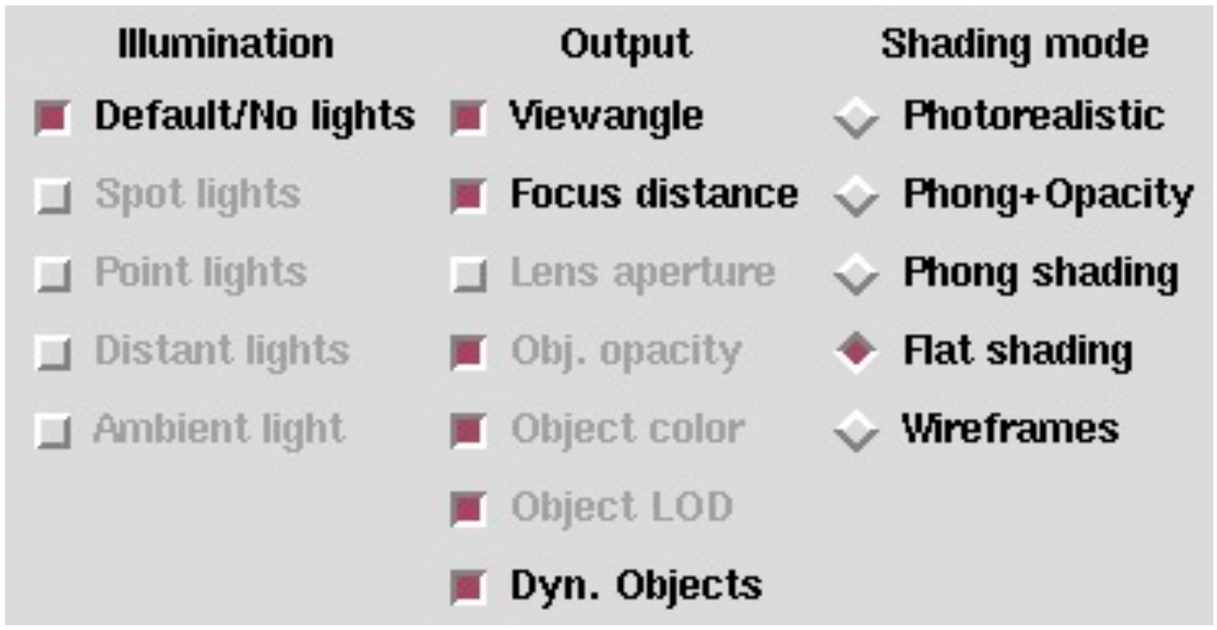
- Knowledge about the user
  - Properties, such as level of expertise
  - Preferences, given implicitly or explicitly
  - Current context of the user
  - Also: capabilities of the output medium
- Examples
  - Previously bought items
  - Personal viewing preferences
  - Current resolution of the





User preferences in CATHI





Stylistic preferences of the user

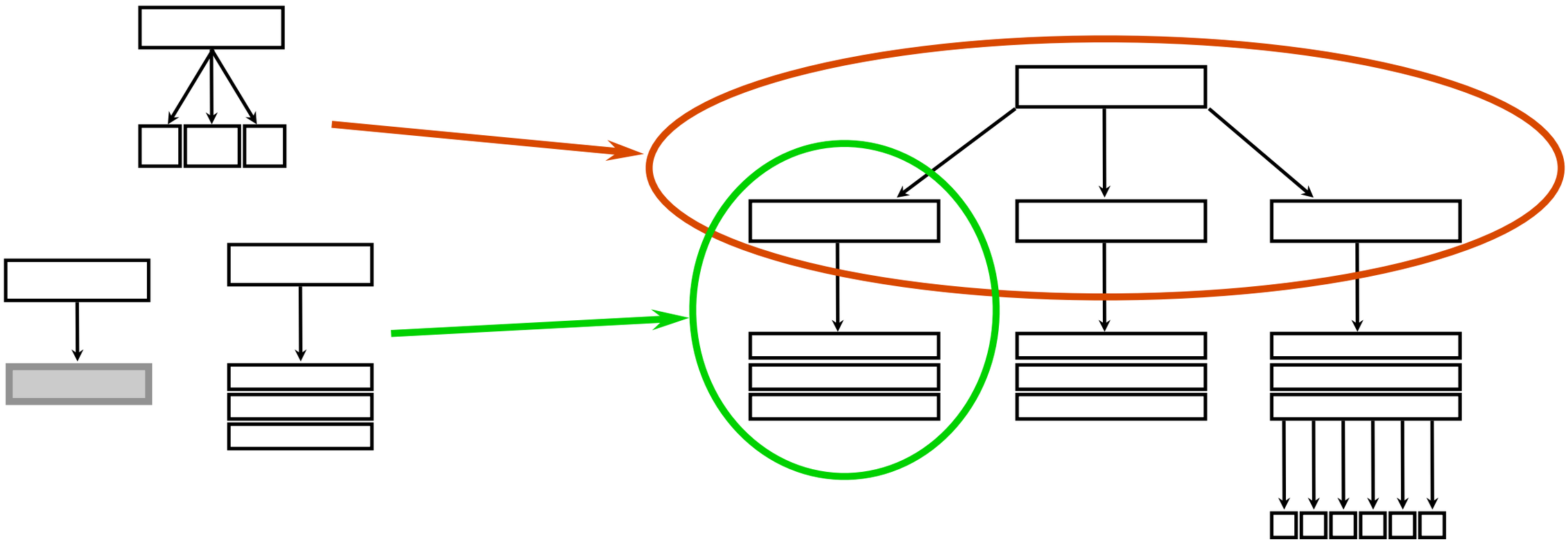
Graphical capabilities of the user‘s machine (back in 1997!)

Reasoning

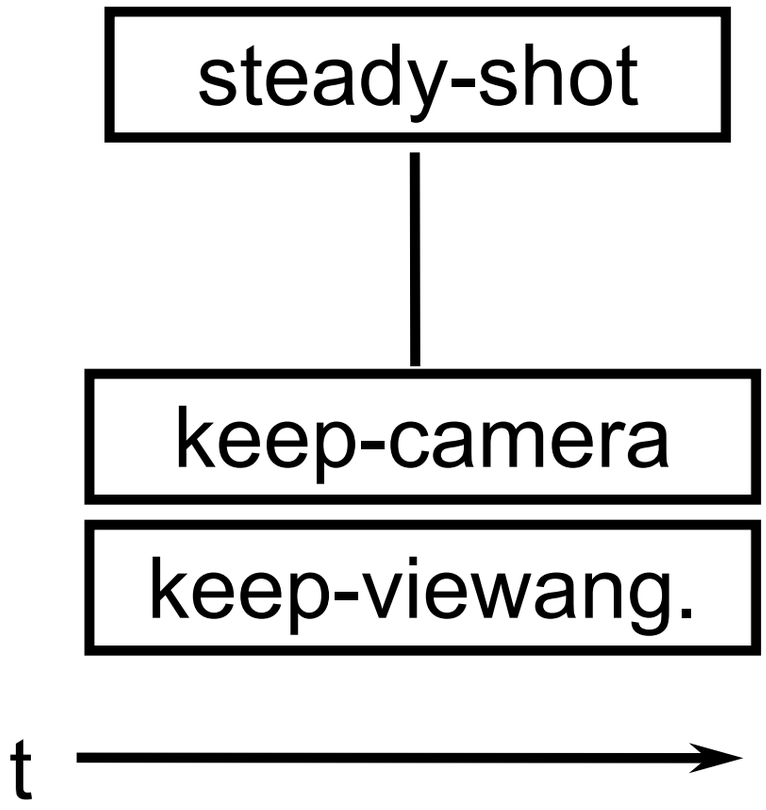
- Algorithms for:
  - Further refining the domain knowledge
  - Application of design knowledge
- Output of the reasoning process:
  - Complete structural description of the presentation
- Examples:
  - Route calculation on a road network
  - Layout of labels in a map
  - Layout of text blocks on a page
  - Specification of diagram elements
- Often the core of a SG system

Reasoning, Planning, Inferencing, Optimization, …

Example: animation scripts

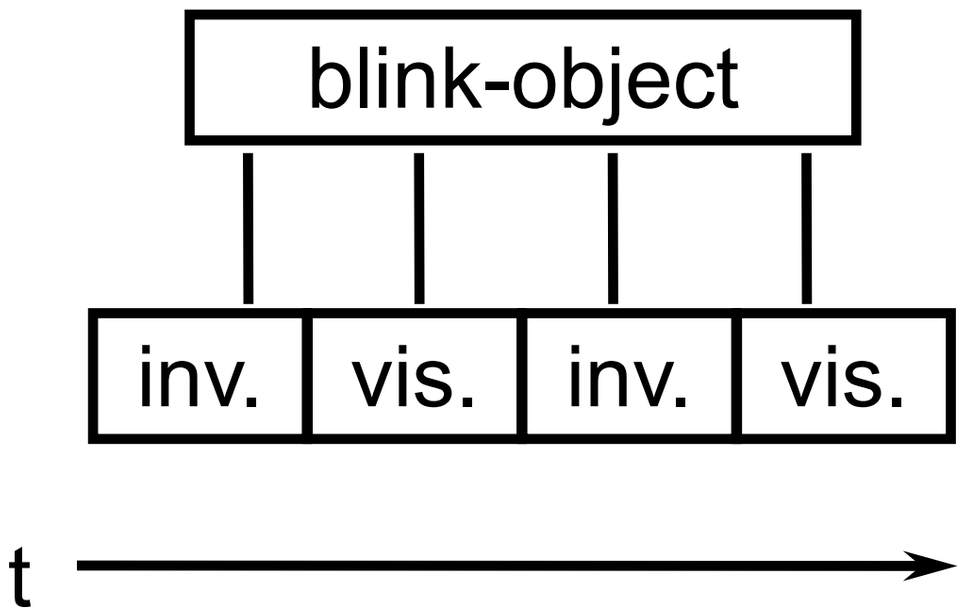


Parallel Decomposition




```
(defrule steady-shot (duration)
  (parallel
    (keep-camera duration)
    (keep-viewangle duration)))
```

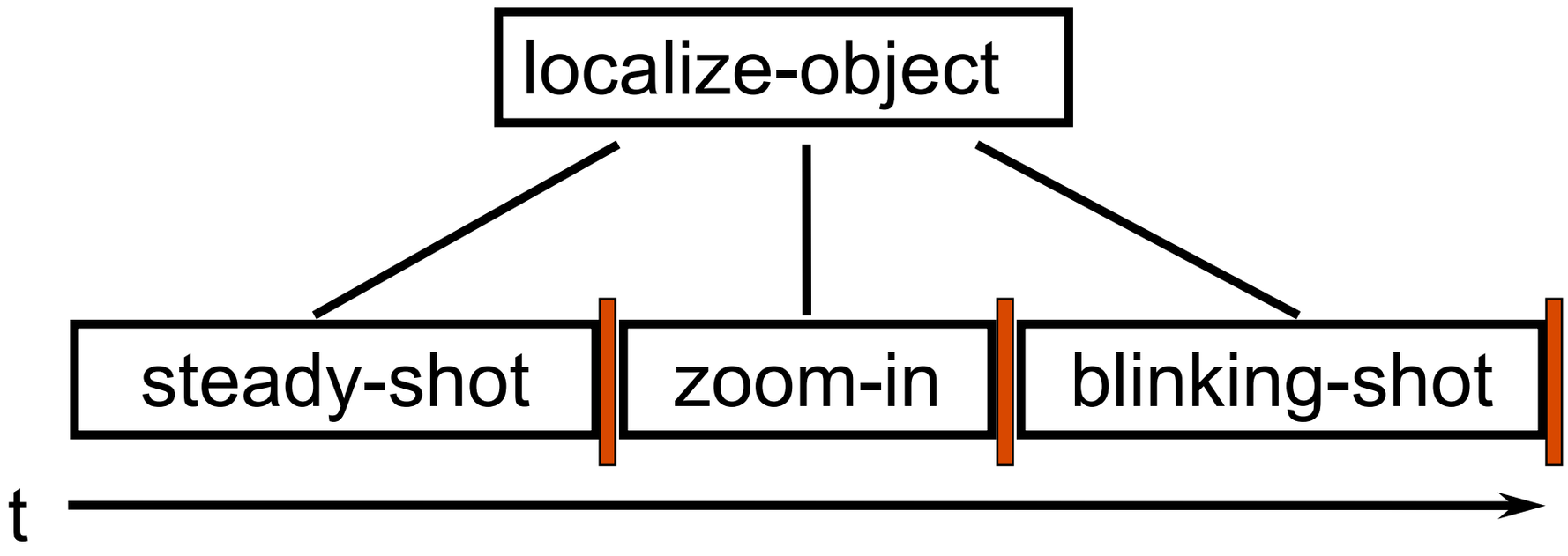
Sequential Decomposition



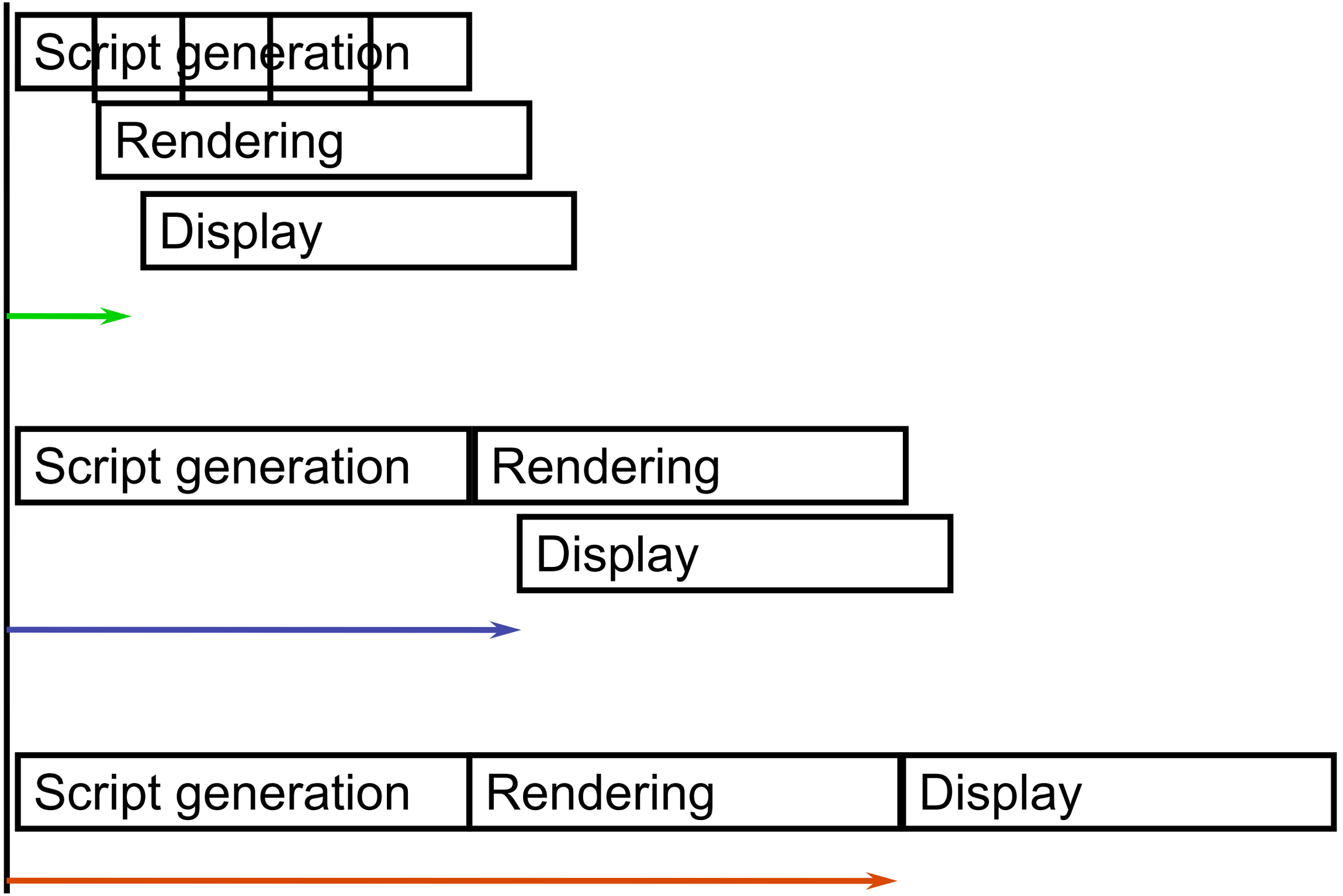

```
(defrule blink-object (object duration)
  (sequential
    (invisible object (* 0.25 duration))
    (visible object (* 0.25 duration))
    (invisible object (* 0.25 duration))
    (visible object (* 0.25 duration))))
```

Incremental Decomposition

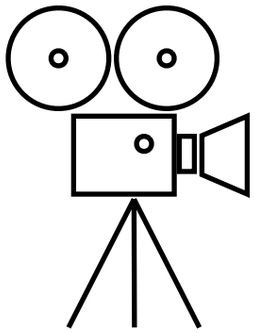
```
(defrule localize-object (object duration)
  (incremental
    (steady-shot (* 0.2 duration))
    (zoom-in object (* 0.4 duration))
    (blinking-shot object (* 0.4 duration))))
```



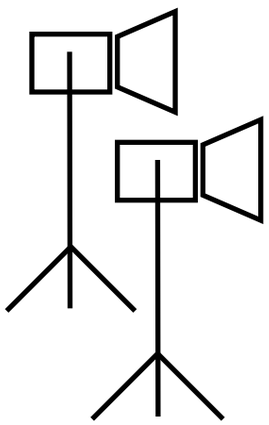
Why incremental generation?



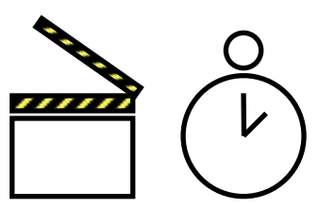
Current generation context



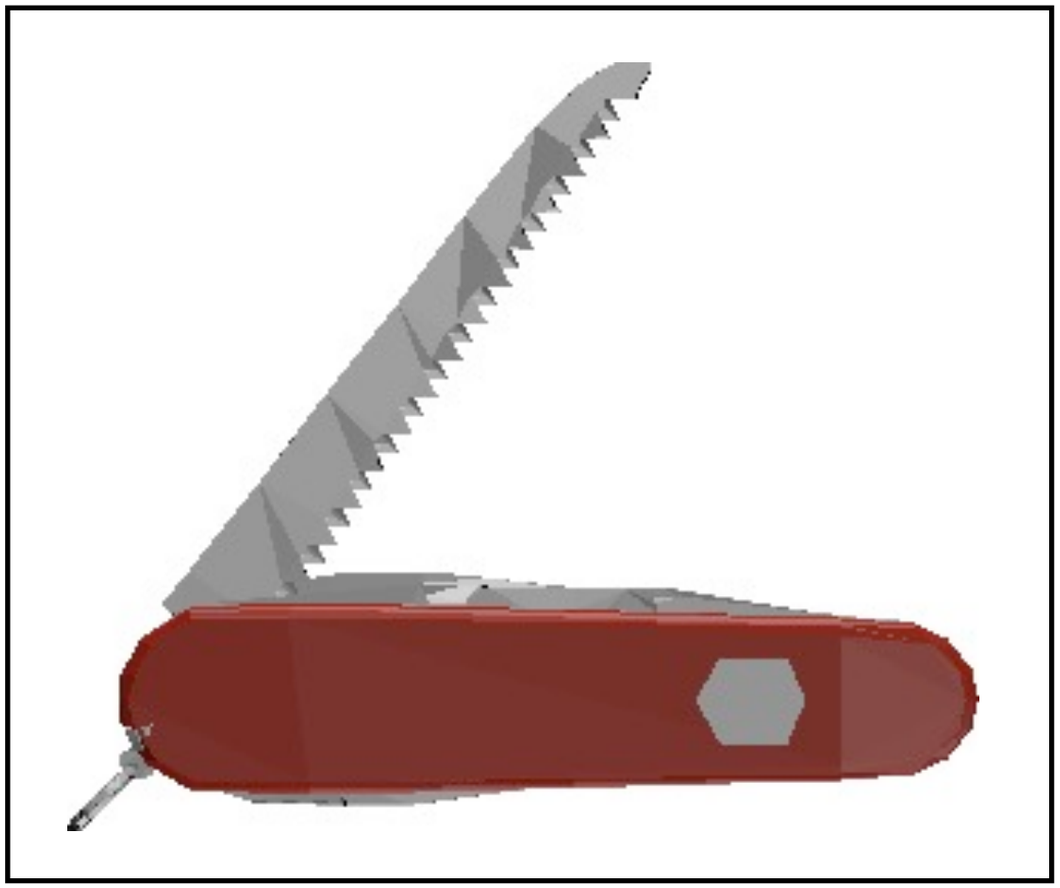
Camera position and settings



Base lighting
Effect lights



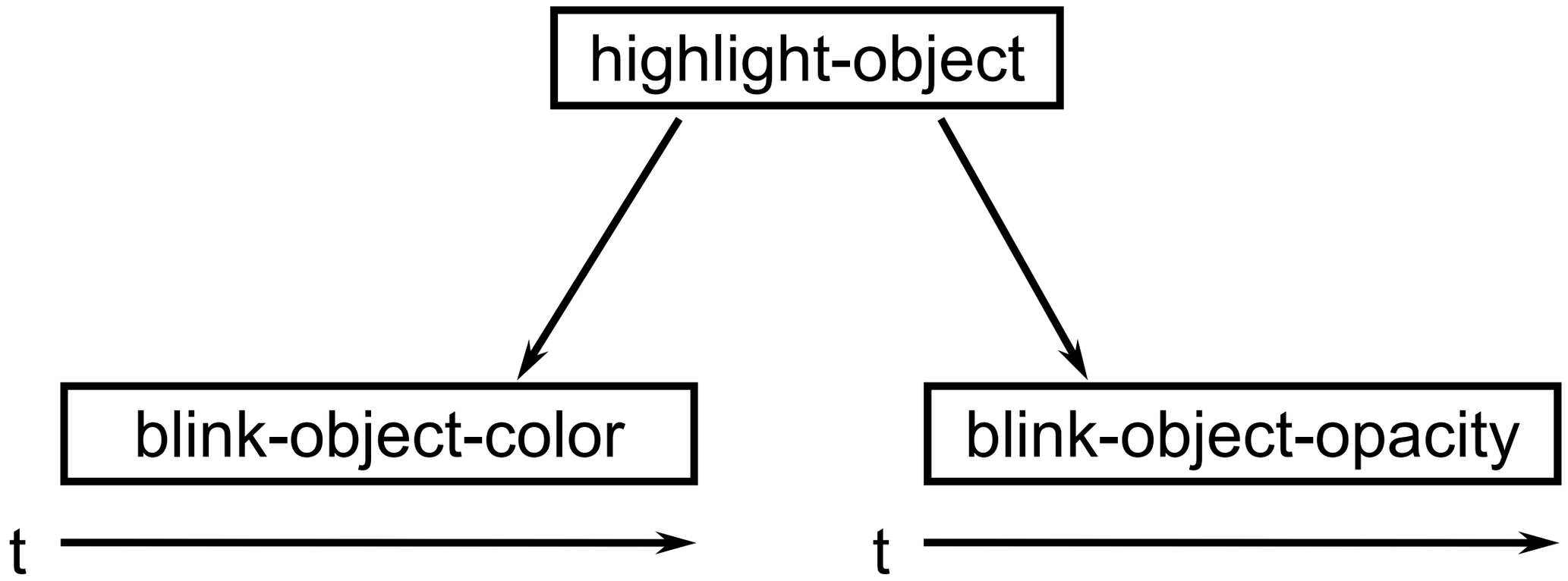
Timing of the generation and presentation



Object positions and properties

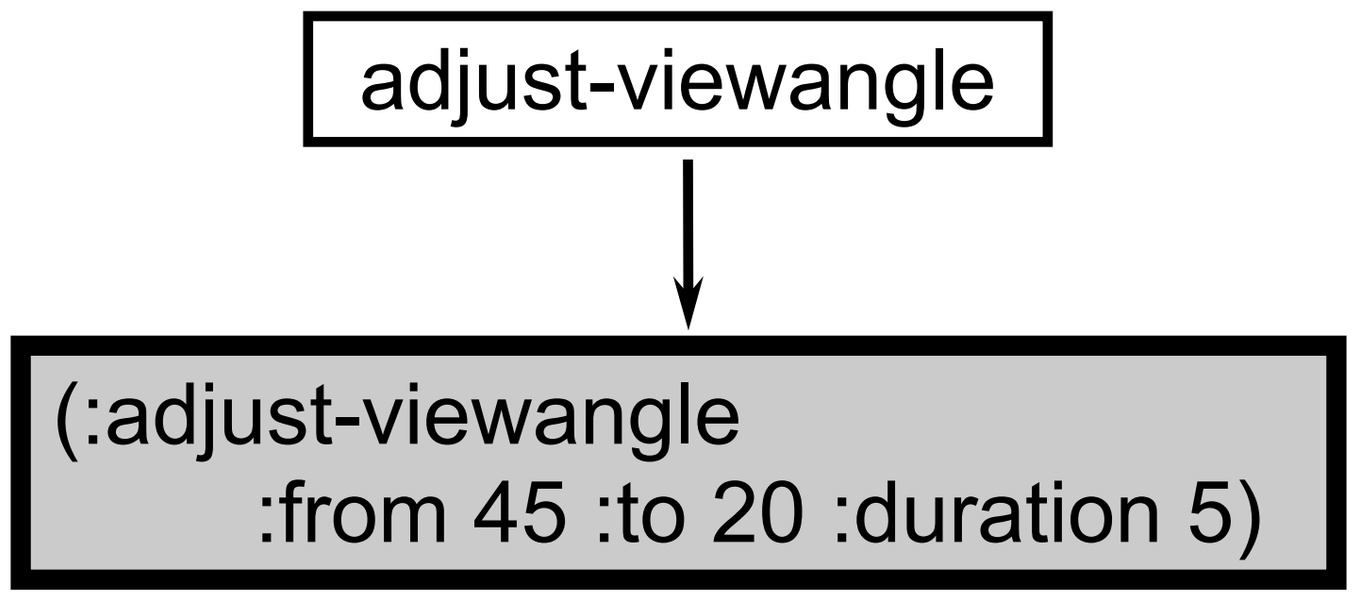
Conditional Decomposition

```
(defrule highlight-object (object duration)
  (if (feature color)
      (blink-object-color object duration)
    (blink-object-opacity object duration)))
```

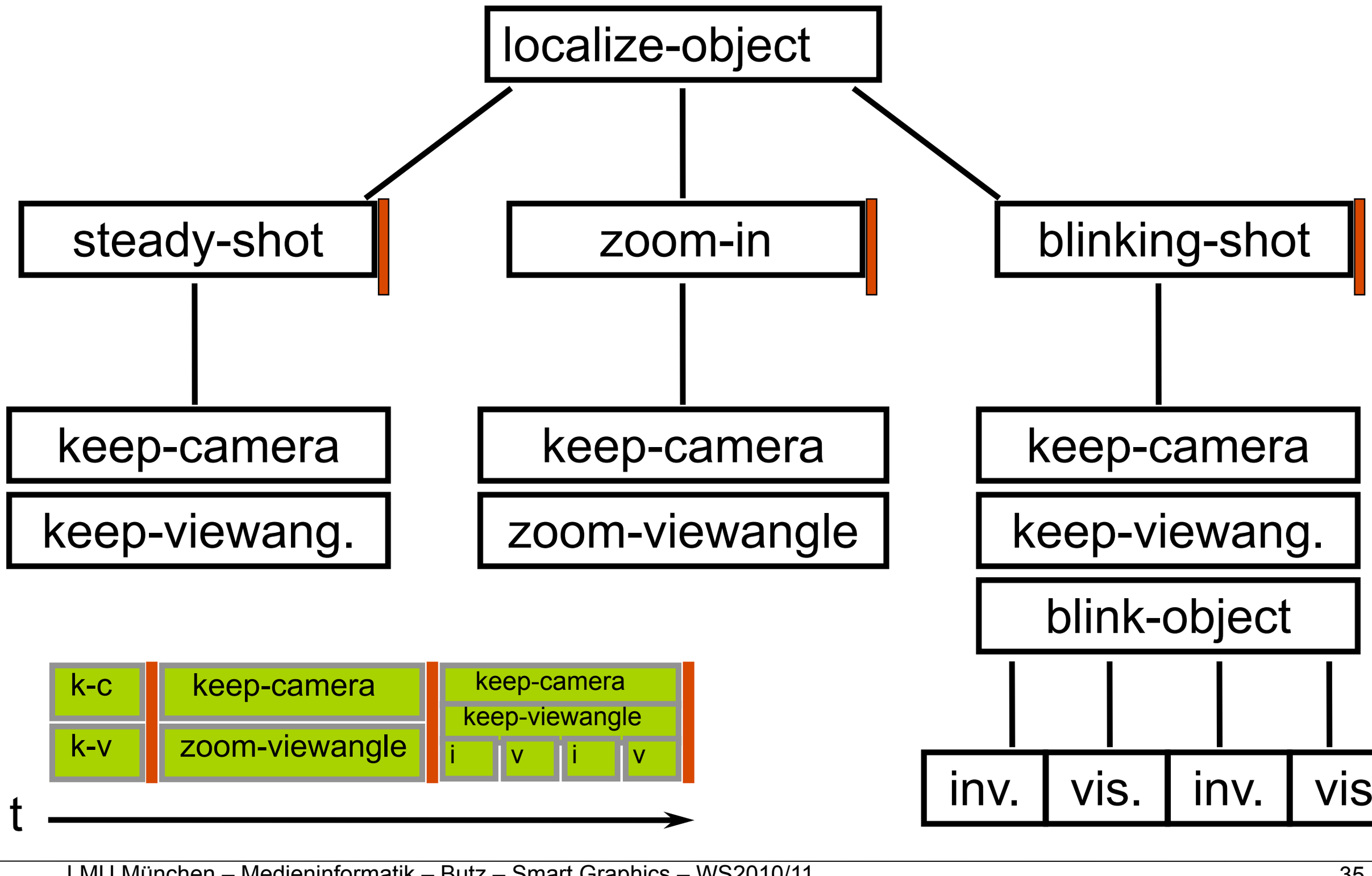


Translation of elementary sequences

```
(defrule adjust-viewangle (from to duration)
  `(:adjust-viewangle
     :from ,from :to ,to
     :duration ,duration))
```



Generierung eines Skripts

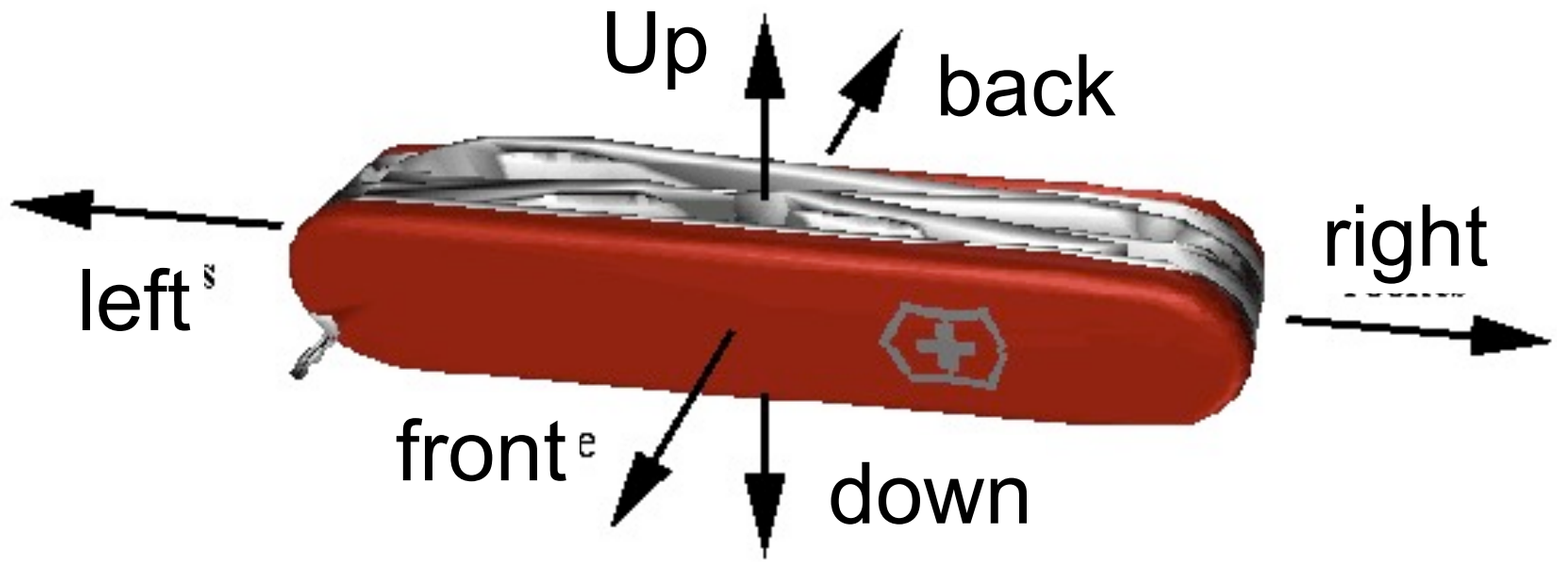


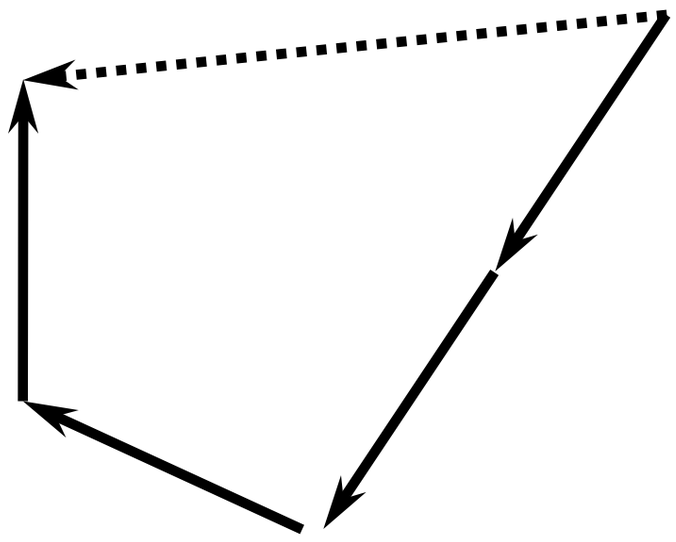
Animation scripts in CATHI

Geometrical calculations

- Calculations in the 3D model
  - Camera positions
  - Object positions and movements
  - Obstructing objects
  - Exploded views
  - Metagraphical arrows

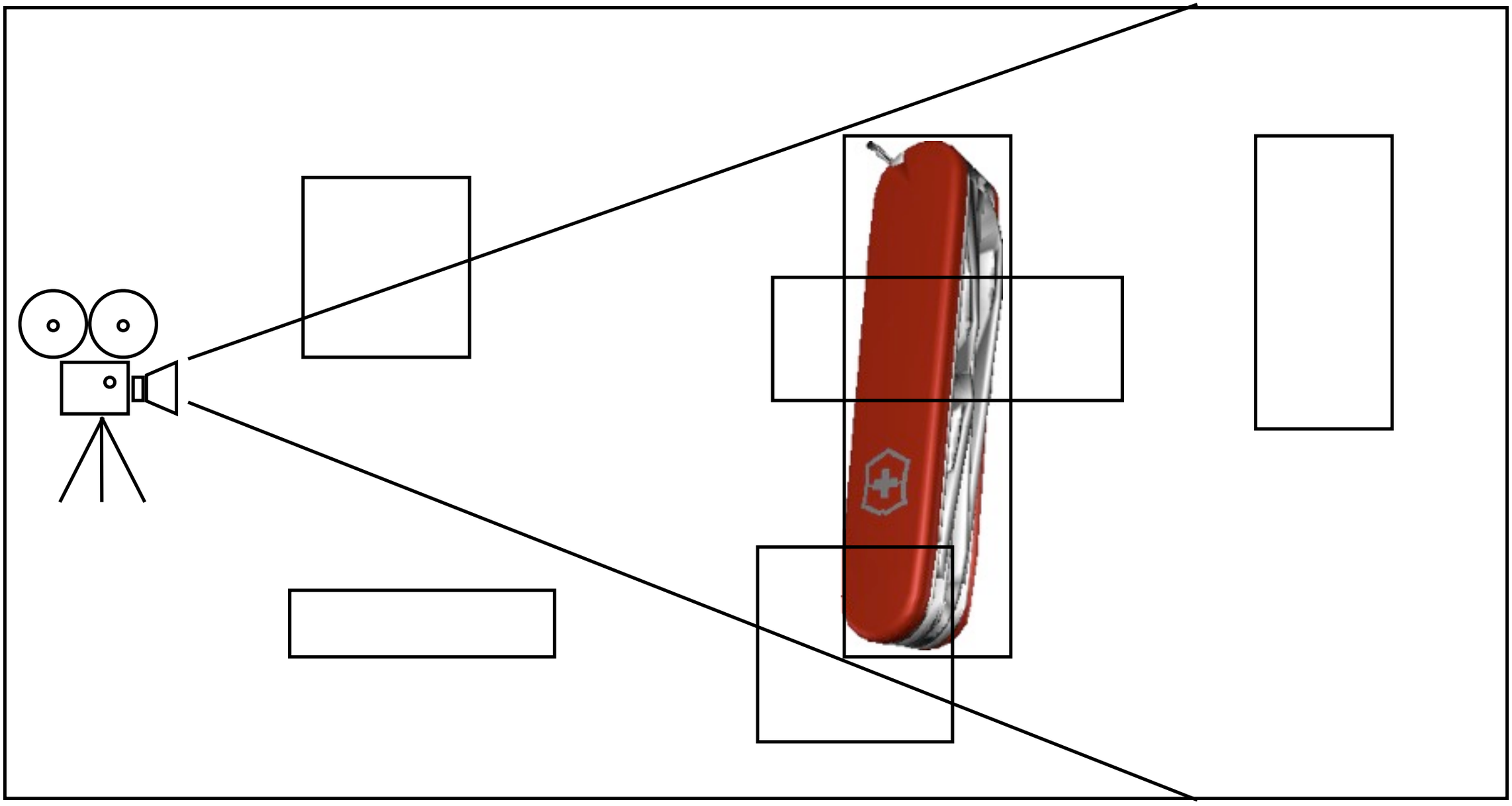
Computing camera positions



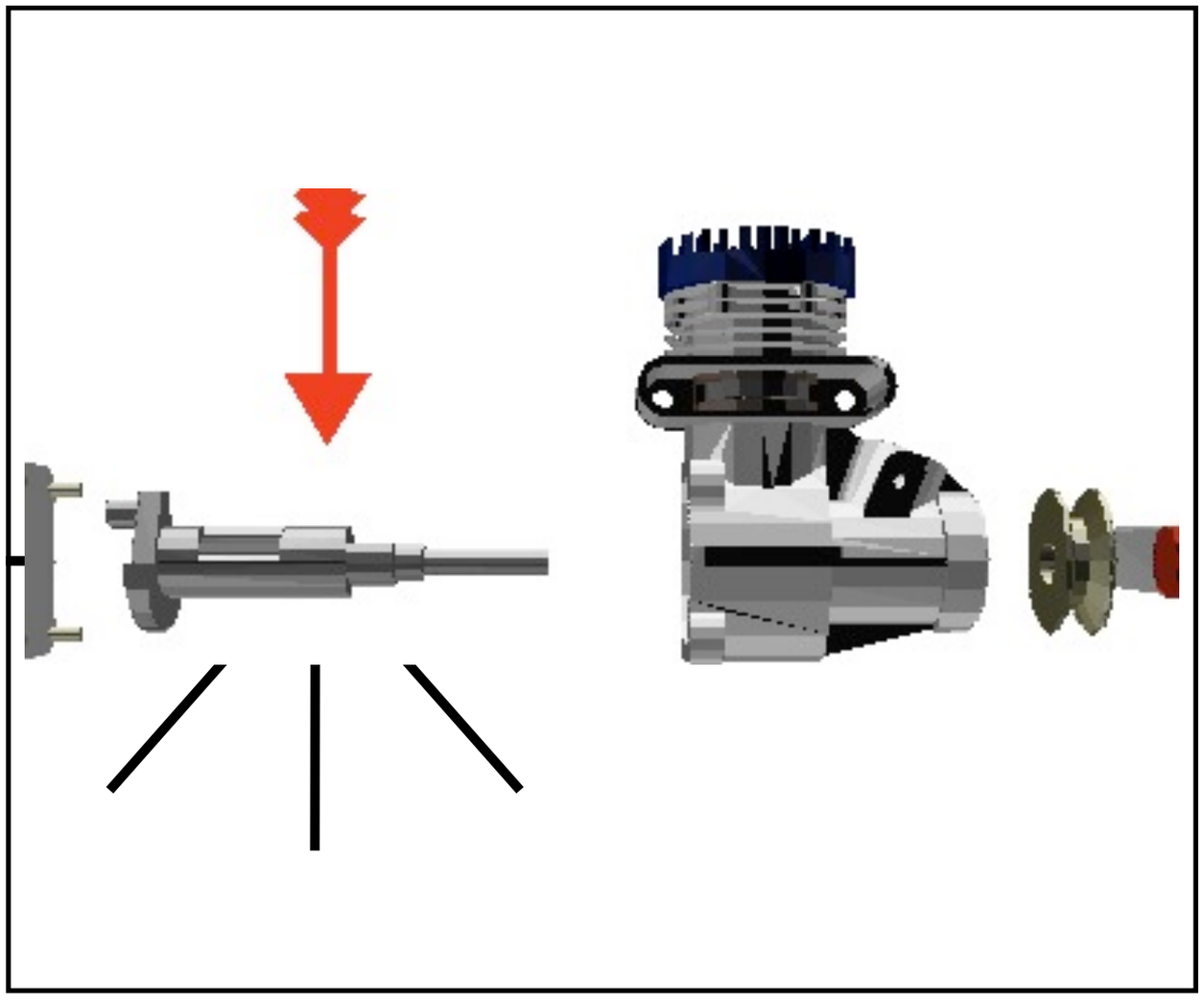


Intended viewing direction:
(front, front, left, up)

Finding obstructing objects



Positioning metagraphical arrows



Rendering

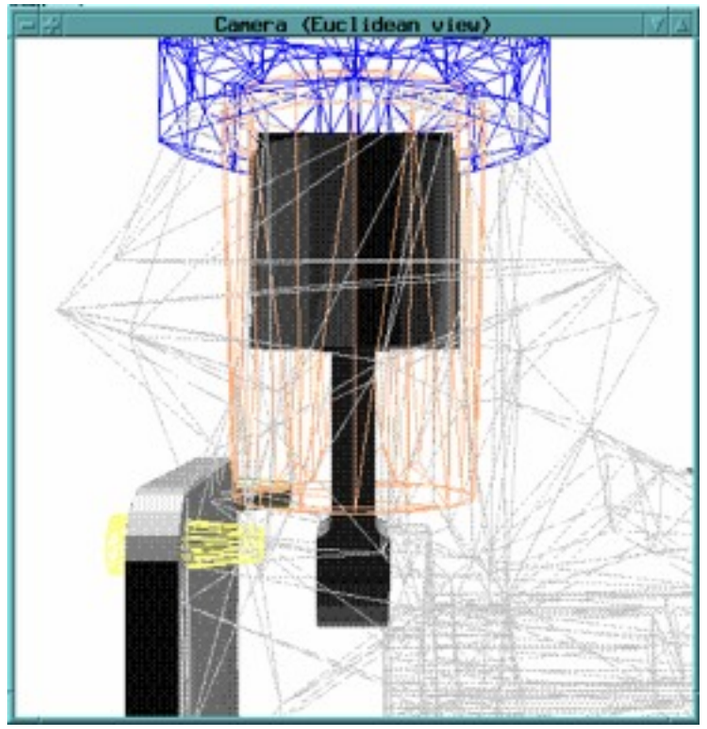
- Turn structural description into actual graphics
- Rule: no presentation without representation!
  - Structure of the output is internally represented
  - Each pixel has a “Meaning”
  - Presentation structure follows logical structure
  - User interactions can easily be interpreted
- Can be exchangeable for different output media
- Can be quite powerful
  - See NPR techniques

Rendering,
Output,
Presentation,
…

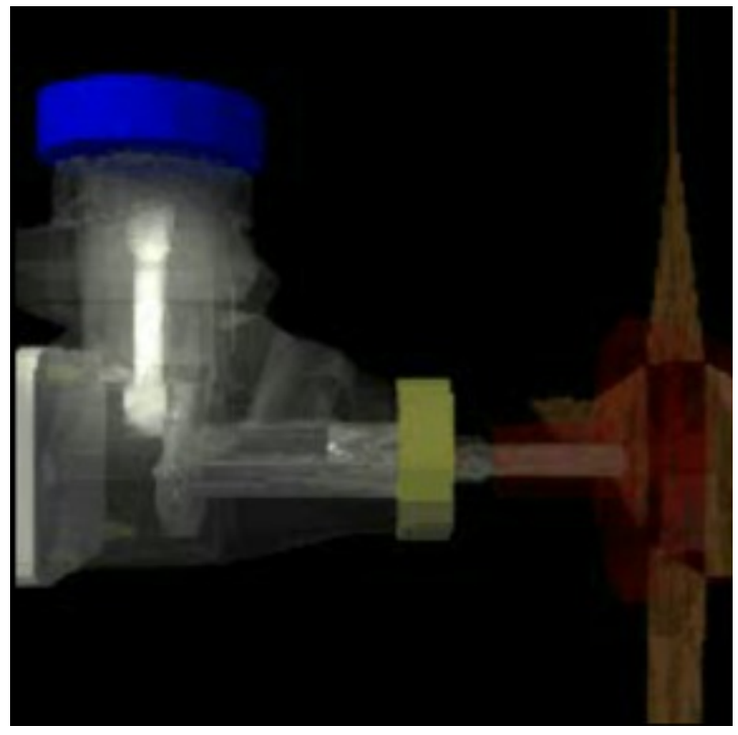
Rendering in CATHI

- Translation of animation scripts into different animation languages

- Real time output to Geomview
  - Just shaded polygons
  - Ambient, distant and point lights
  - Fast rendering enables AFL

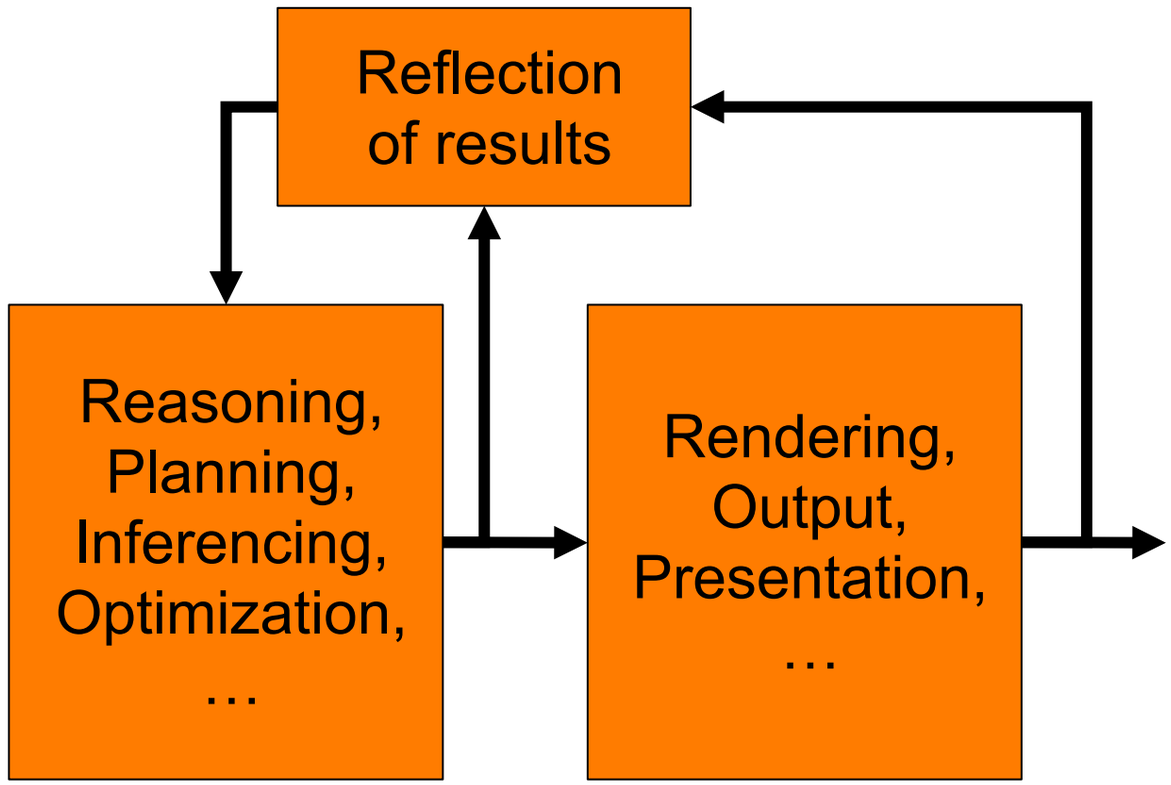


- Batch output to Renderman
  - Textures and materials
  - Spot lights
  - Depth of field
  - Nice transparency



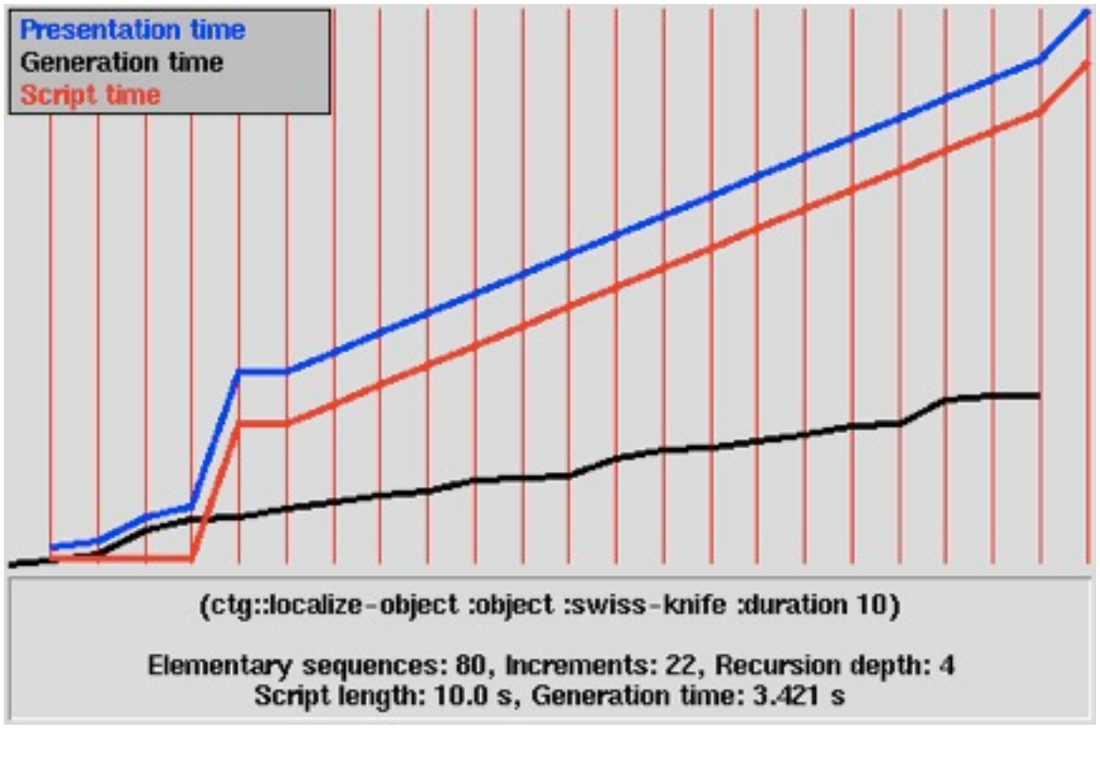
Reflection

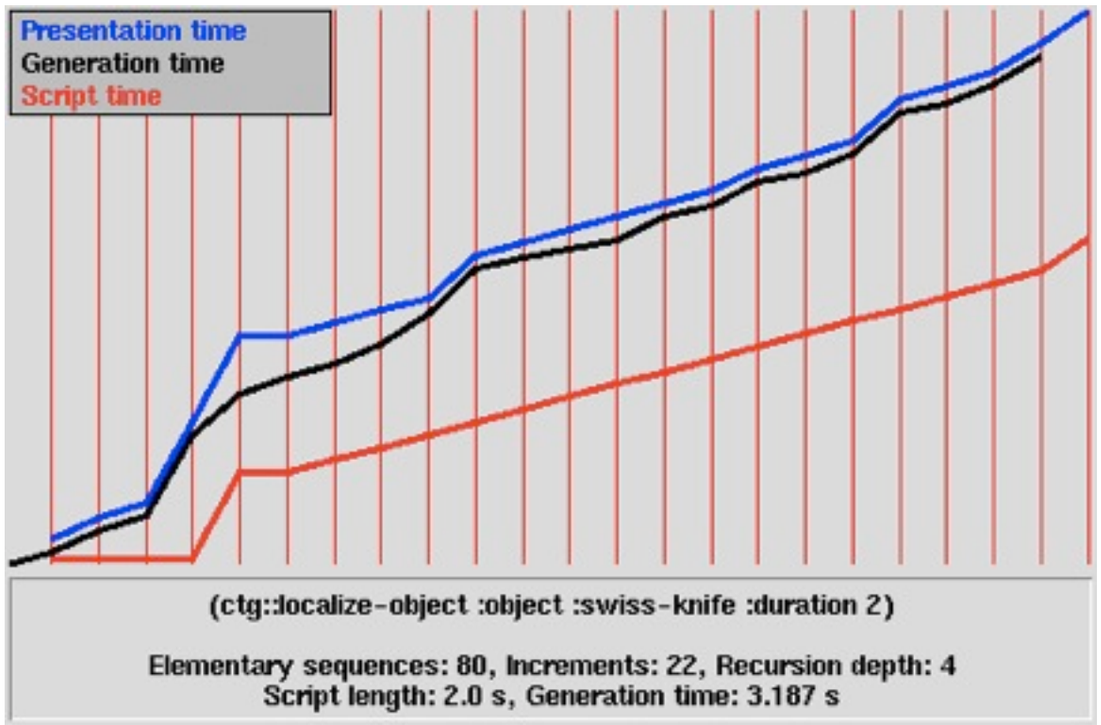
- Analysis of the generated presentation
  - Either on the structure level
  - Or after rendering
- Influence back on the reasoning process
- Anticipation Feedback Loop (AFL)
- Can find errors in output
- Self-monitoring
- Very natural for humans
  - Bike riding
  - Speaking

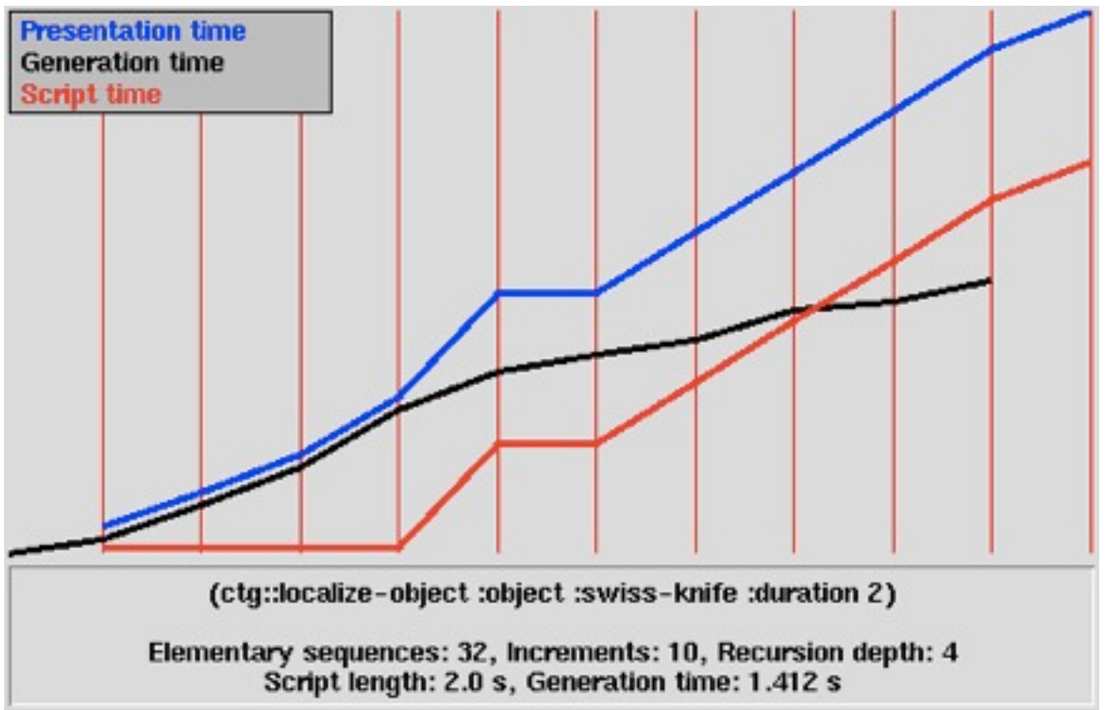


Example: Reflection on a structure level

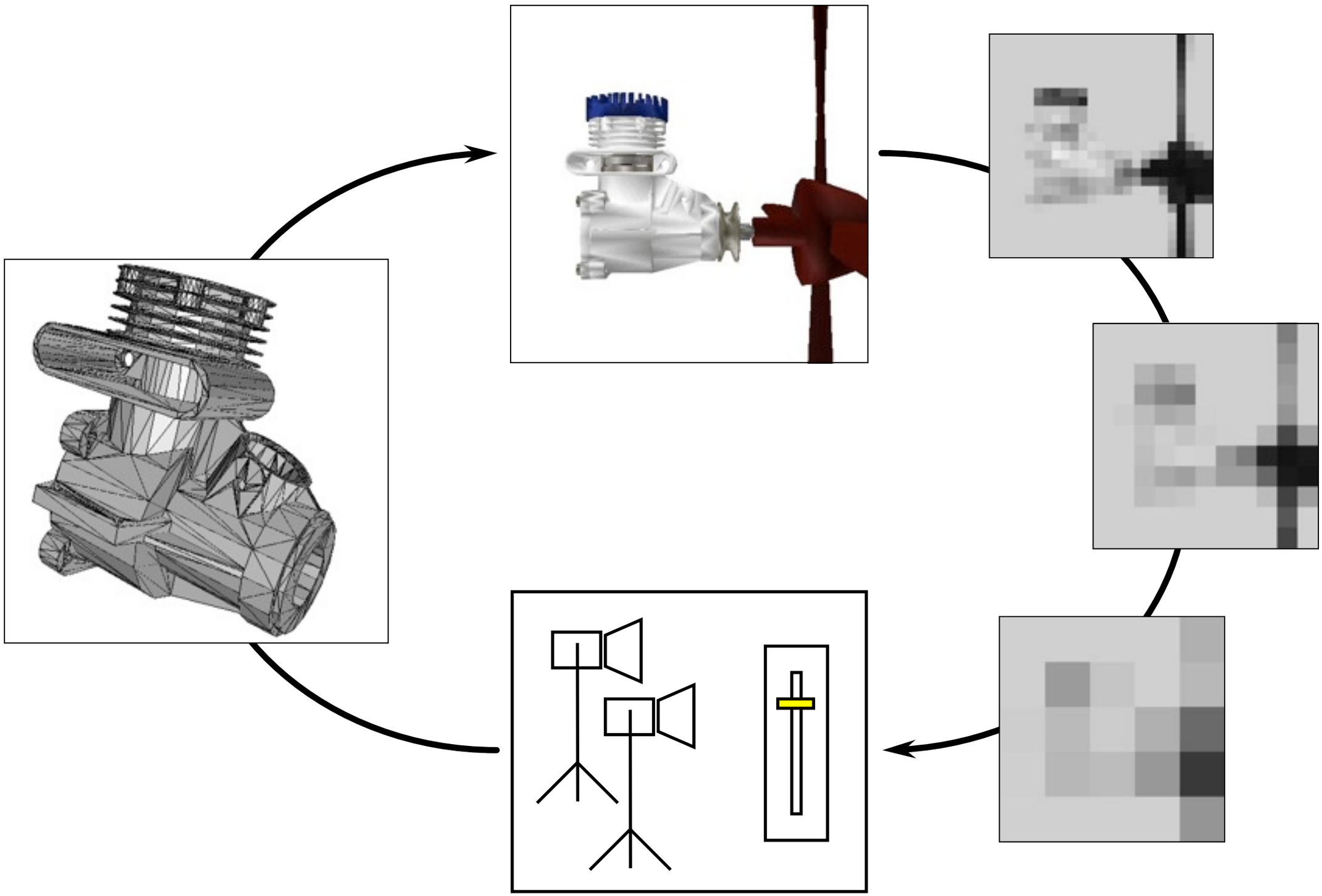
- Temporal adaptivity of CATHI‘s generation process
- Choose simpler decomposition if time is scarce





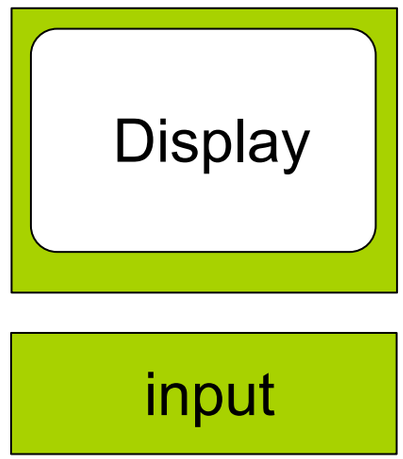


Example: Reflection after rendering

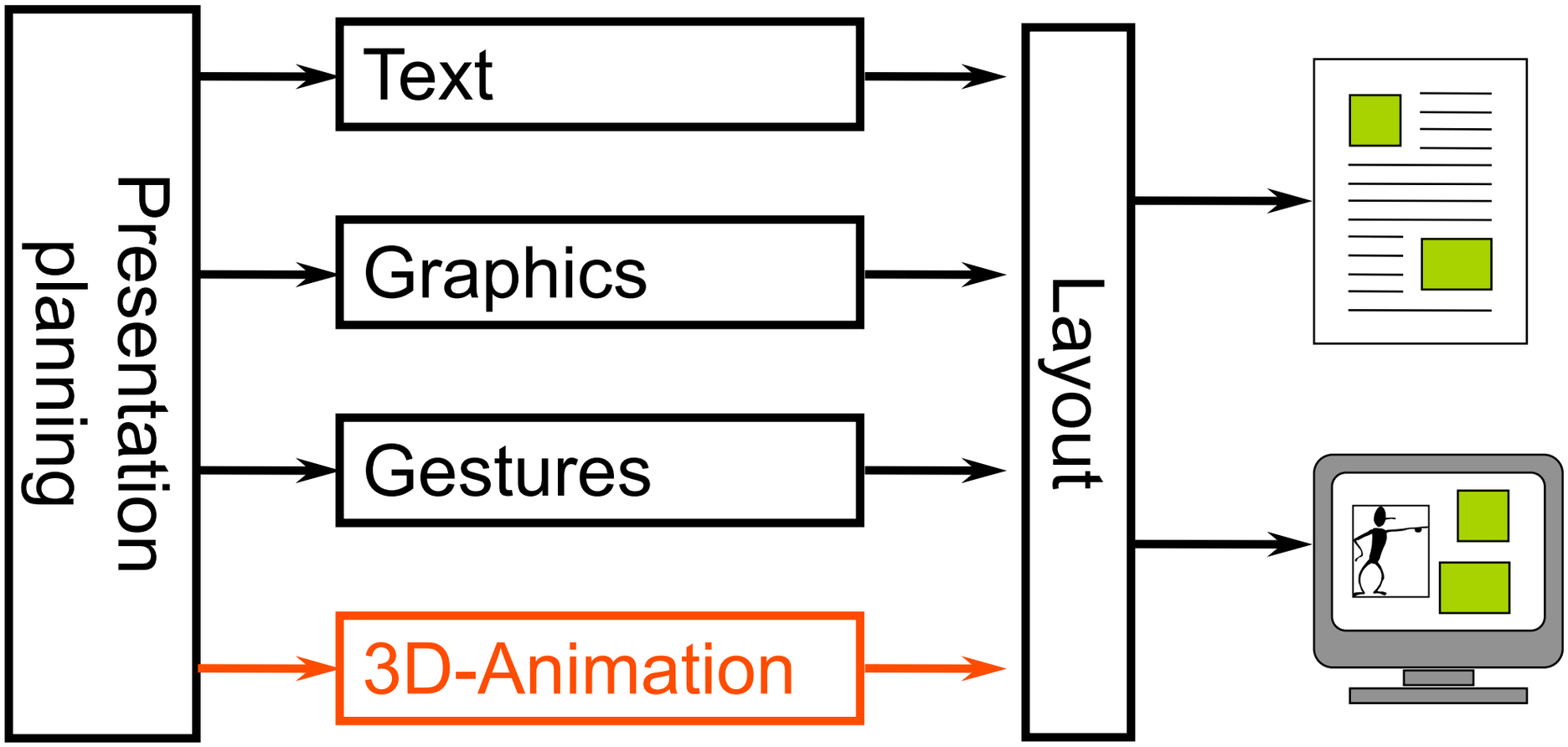


In- and Output

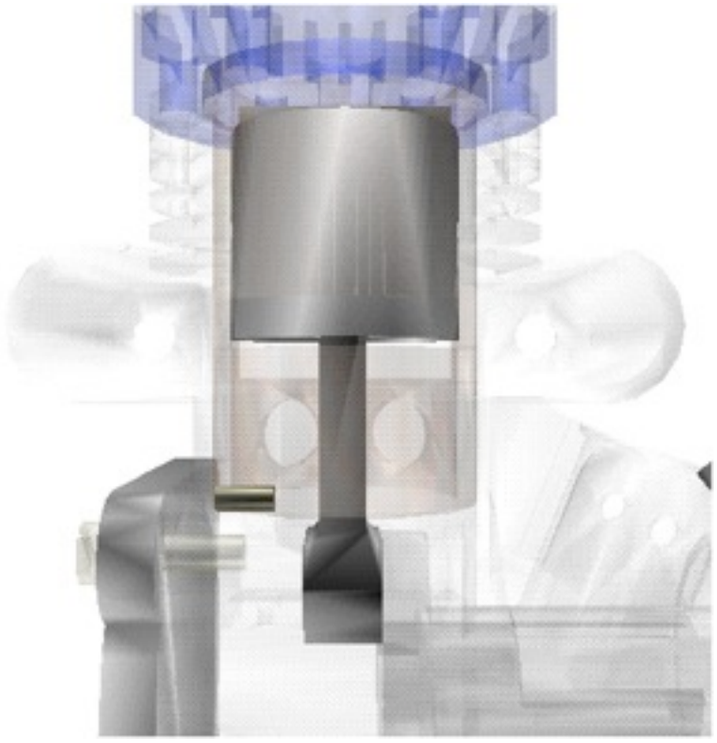
- Output can be just graphical or coordinated with other media
  - Coordination by „higher authority“
  - Integration of other media in the planning process
- Input can be explicit or implicit
  - Checking boxes, setting user profile
  - Previous interactions with the system
  - Learned profile
- In CATHI: just checkboxes

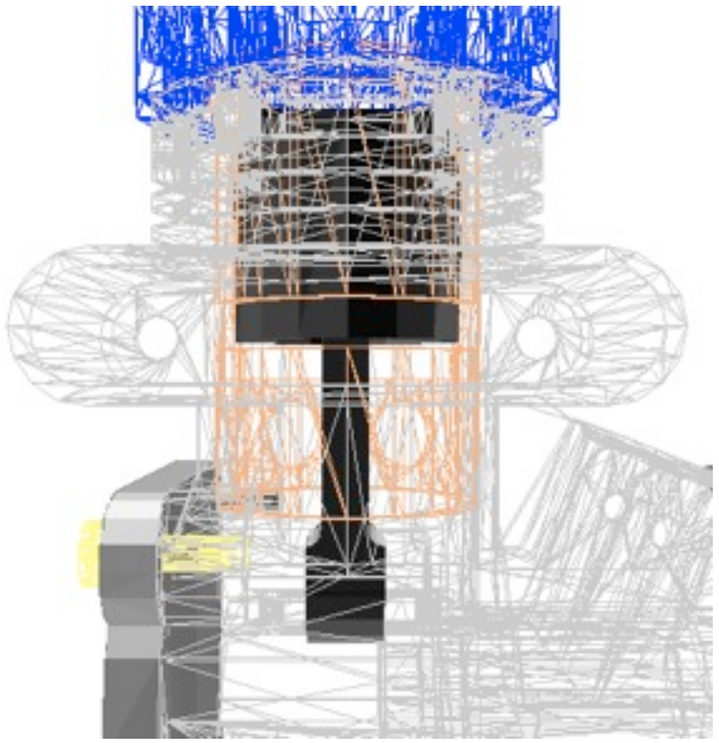


Integration of CATHI into WIP



Some example generations of CATHI





Adaptation to different capabilities of the output medium