

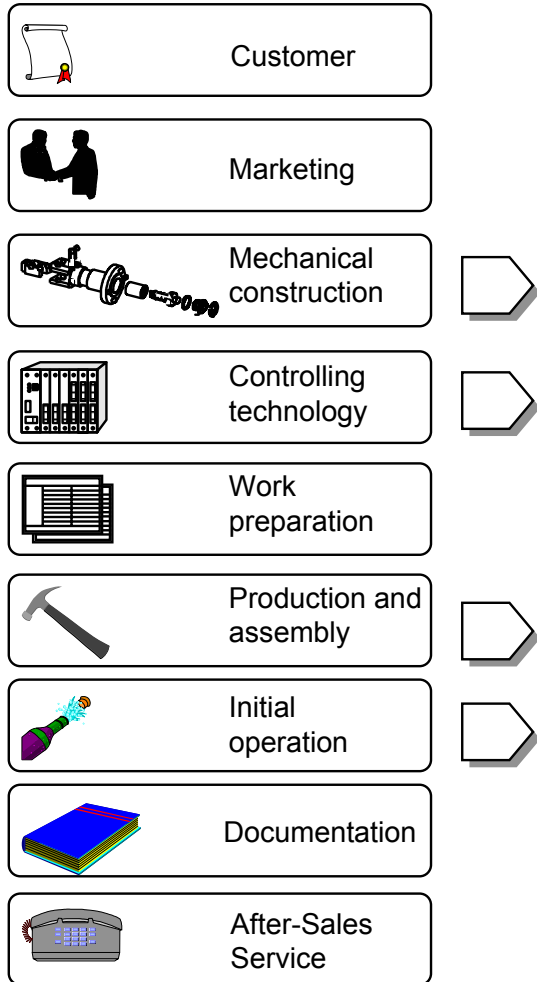
A 3D CAD model of a manufacturing system is shown in the background. It features a green frame with various components like a lathe, a conveyor belt, and a robotic arm. A small robot is positioned in the center. The model is rendered in a semi-transparent style, showing internal parts and mechanisms.

**VIRTUAL METHODS IN PROGRAMMING AND SIMULATION  
OF PROGRAMMABLE LOGIC CONTROLLED  
MANUFACTURING SYSTEMS**

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# Problems of a sequential process chain for planning of PLC software



**Difficulties in communication due to organisational and spatial separation**

**Different qualifications, ways of thinking and understanding**

**Insufficient description of functions (large number of enquiries and misunderstanding)**

**Time pressure due to numerous subsidiary tasks (e.g. offers, starting up and service)**

**Insufficient inclusion of electrical construction into concept phase (insufficient real team work)**

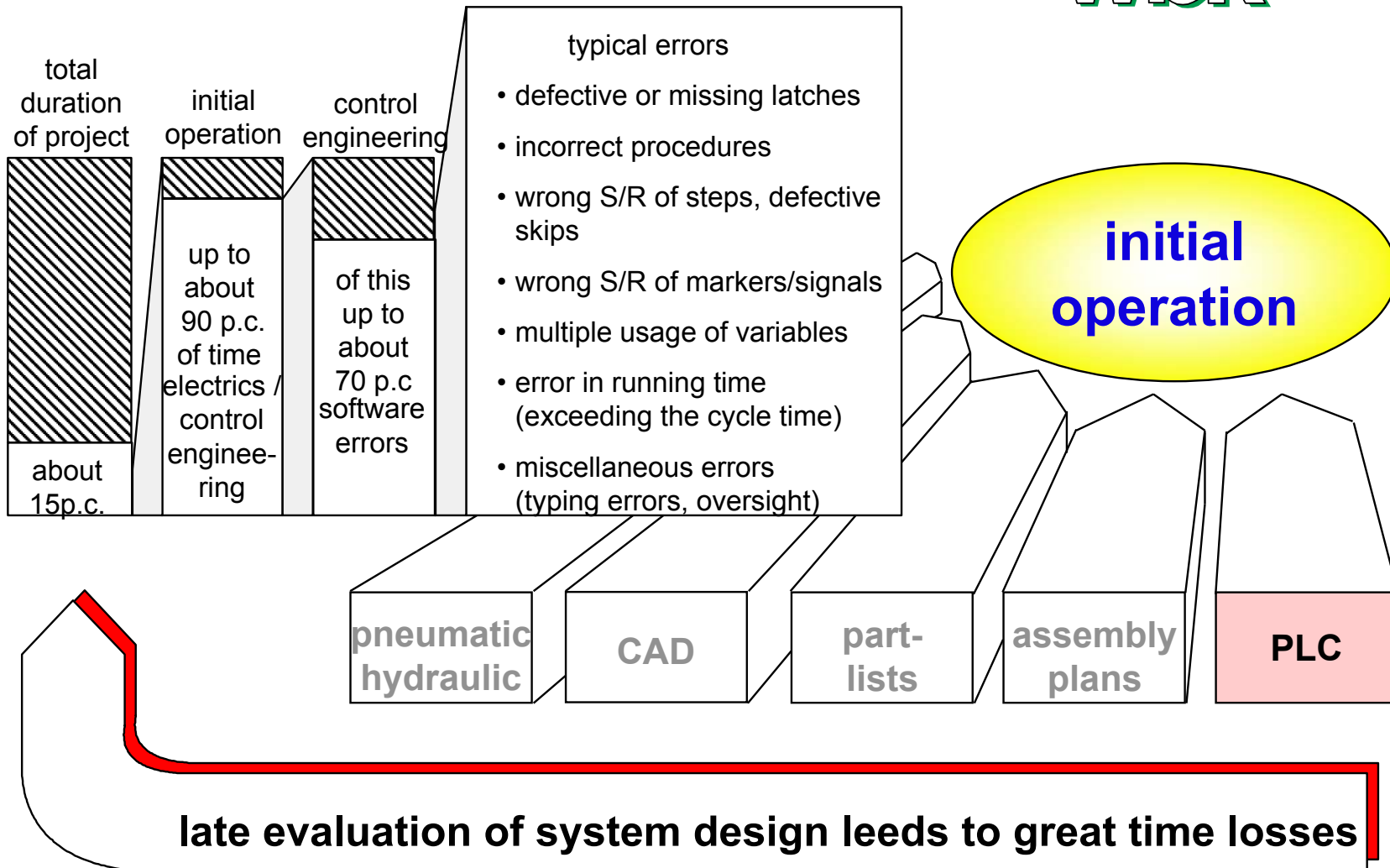
**Mechanical engineering**

**Control engineering**

**Uncontrolled storage and passing on of information**

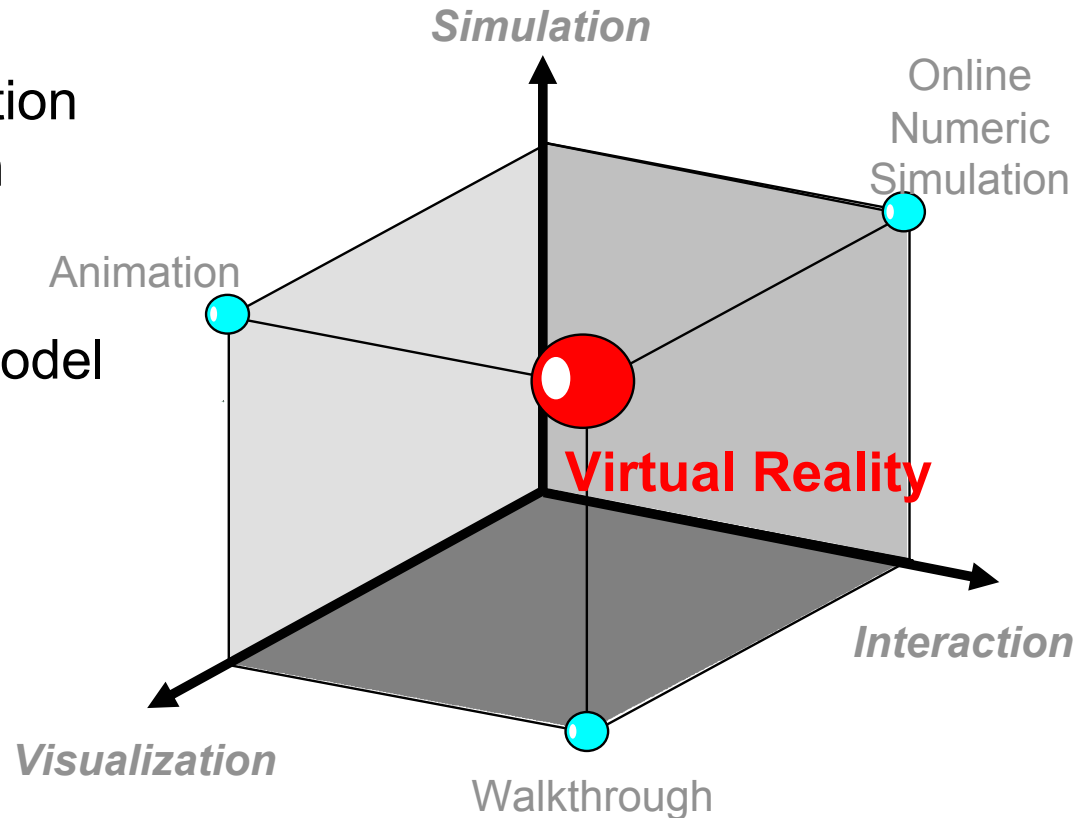
**Large number of changes and insufficient personnel to cope**


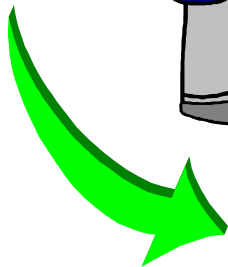
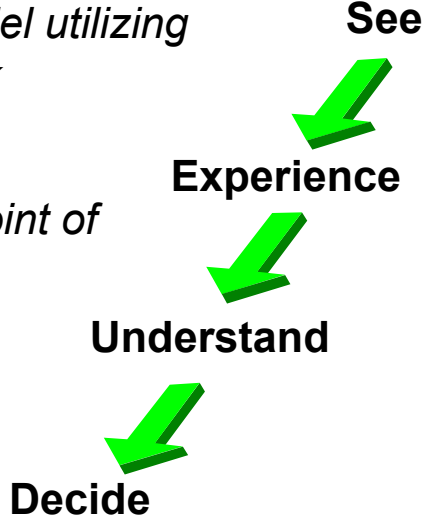
**Insufficient co-ordination of work in time and sequential working**



3-Dimensional presentation of complex systems with the possibility of

- ↻ interaction with the model
- ↻ immersion
- ↻ cooperation
- ↻ communication



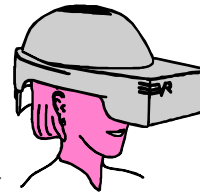
- *Increasingly complex tasks during process and product planning*
  - *Spatial distribution of planning competence*
  - *Insufficiently realized man/machine interfaces*
  - *Necessity of simulation before realization*
  - *Cessation of 3D-2D abstraction for visualisation, navigation and interaction*
  - *Direct application of heuristic problem solving behaviour*
  - *Experiencing model utilizing sensoric feedback*
  - *Observation of critical rocedures from the point of view of time*
  - *Possibility of excluding real restrictions*
- 
- 
- 
- See**
- Experience**
- Understand**
- Decide**

# Conventional programming versus VR interface and visual programming

```
1 ;
; *****
; *      OB1  Organisationsbaustein fuer      *
; *      Fischertechnikmodell                *
; *      erstellt von Bernd Zimmermann am 30.03.1994 *
; *****
; *** Einrichten des Profibus ***
L   W -EZ0,A; * Koppeladresse fuer Profibus-DP
T   W  A,-AZ0; * Koppeladresse fuer Profibus-DP
;
; *** Programmablauf ***
UN  B -M_RESET;
BAB  -INIT ;  INITIALISIERUNGSBAUSTEIN, WIRD NUR AM ANFANG BEARBEITET
-----
ZS0/OB1      PA: 4      PZ: 1      Einfügen      AWL Modus
; <F1>      ; <F2>      ; <F3>      ; <F4>      ; <F5>      ; <F6>      ; <F7>
;: Block ; Zuordnen ; Symbol ; Suchen ; Kommando ; Ende ; Wechseln ;:
SPS - Editorprogramm      Version 3.20 (c) 1987-93 Robert Bosch GmbH
```



Textual PLC programming



Verknuepfungsebene

Aktionsname: start nach\_links TBI196]

Und <input checked="" type="radio"/>	( <input type="radio"/>	Sensor:	Bedingung: 1
Oder <input type="radio"/>	) <input type="radio"/>	Sensor betaetigt LSI221	
Nicht <input type="checkbox"/>	) <input type="radio"/>	( )	Edit
Und <input type="radio"/>	( <input type="radio"/>	Sensor:	Bedingung: 0
Oder <input type="radio"/>	) <input type="radio"/>		
Nicht <input type="checkbox"/>	) <input type="radio"/>	( )	Edit

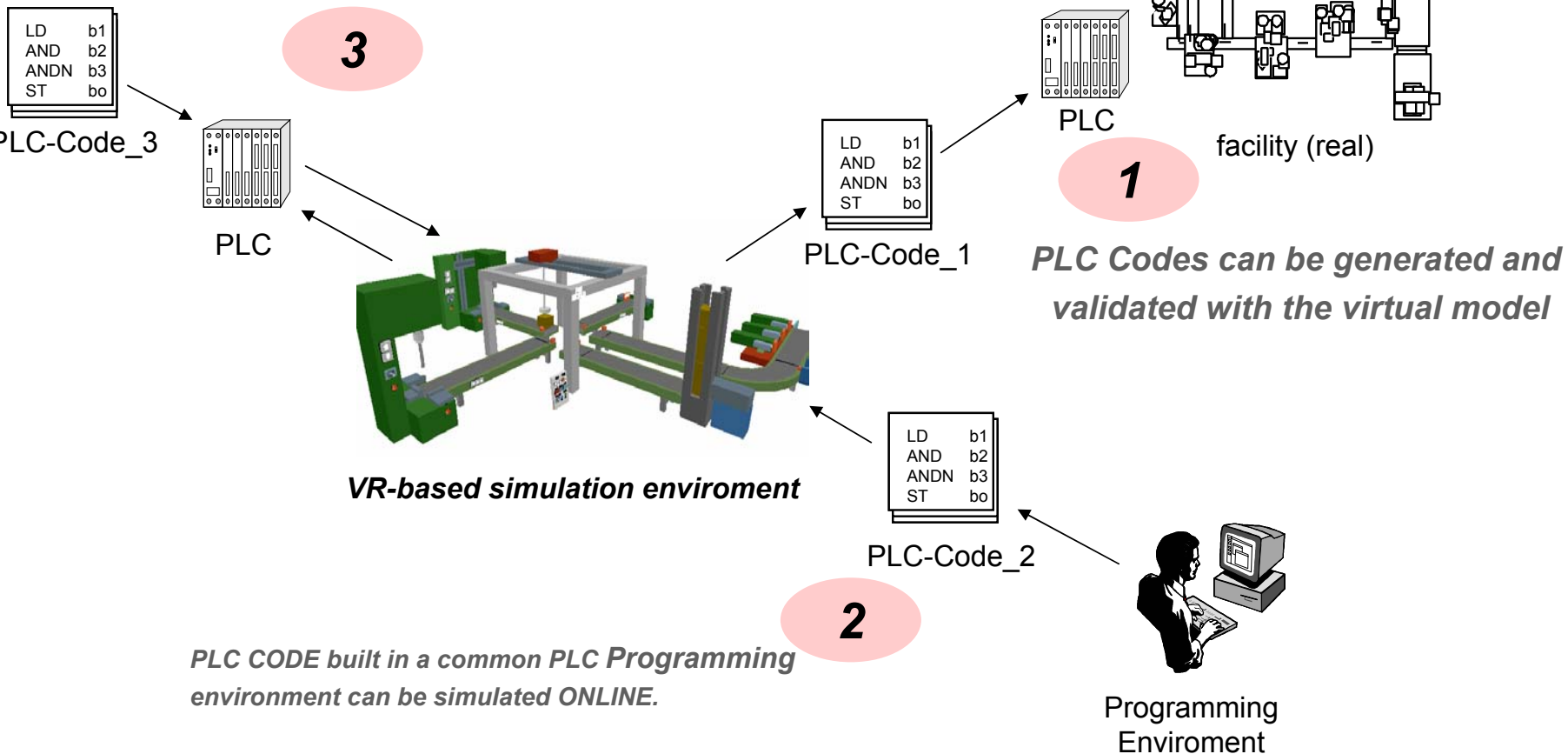
Sensoren/() erfaßt: 1 Alle löschen

Aktionen erfaßt: 1

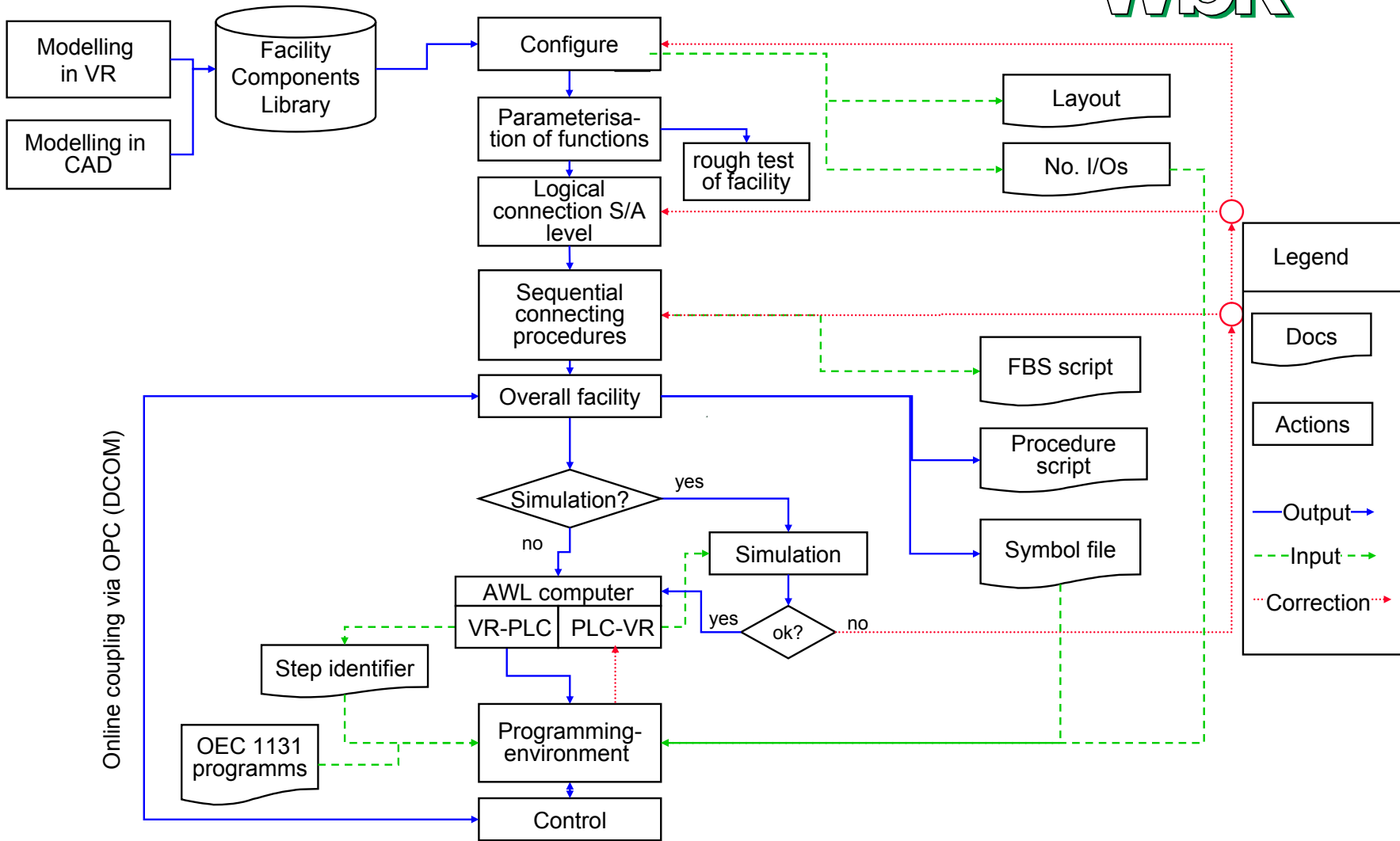
Scroll  0 OK

Intuitive connection of inputs and outputs in VR

*Existing PLC Codes can be simulated by connecting the real PLC and the virtual model*

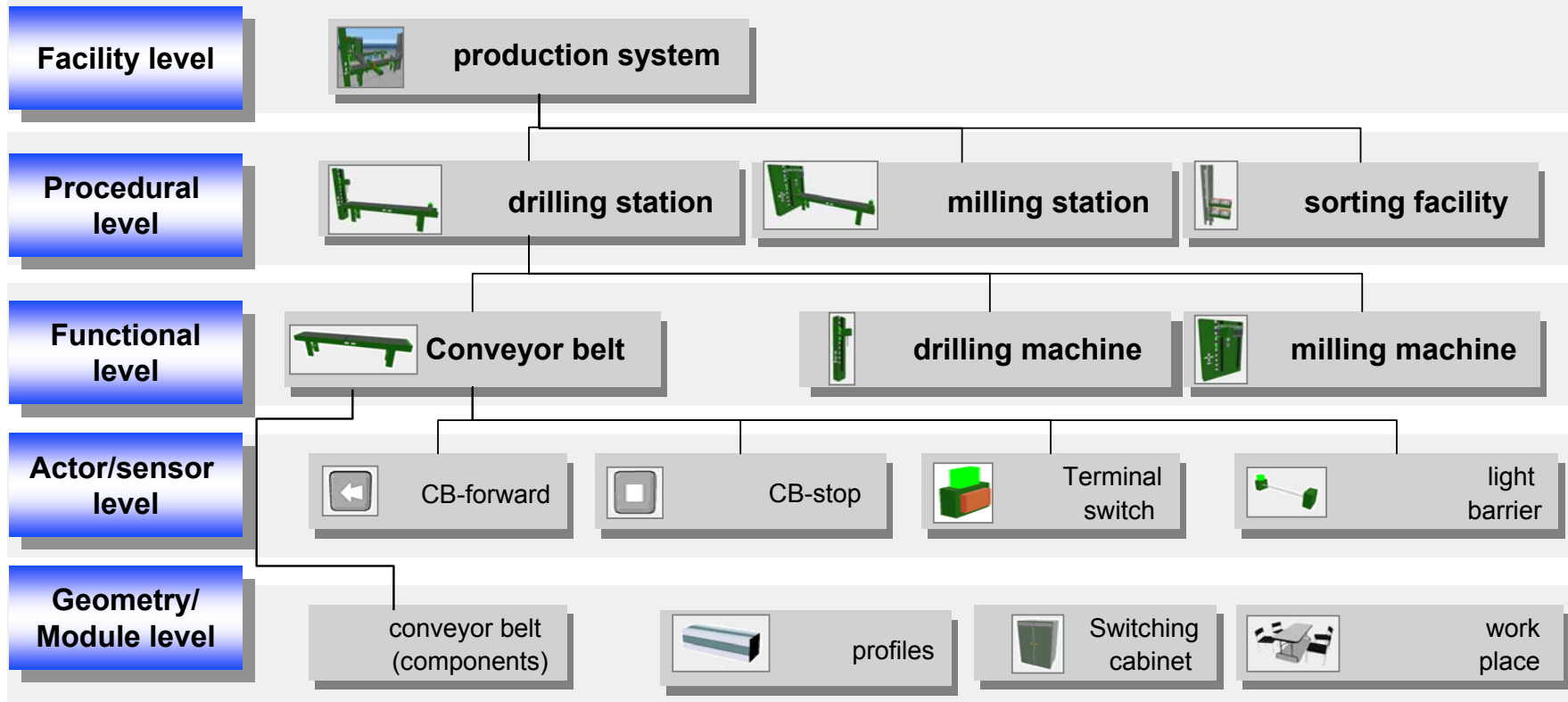


# Structure of the system





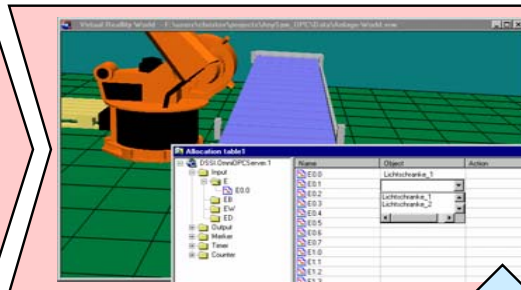
## Facility structure (geometry)



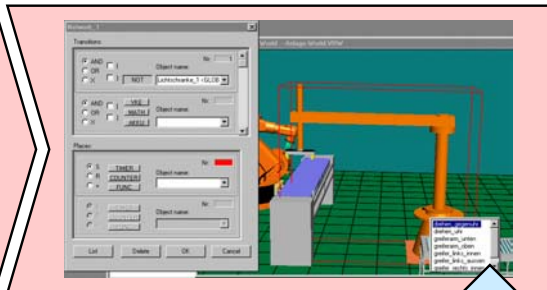
- Step 1 Configuration of the facility layout
- Step 2 Virtual Wiring  
(only needed if the PLC CODE already exists)
- Step 3 Dialogue supported programming of PLC functionalities
- Step 4 Validate the PLC-Code via OnLine-Connection



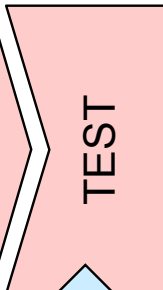
1



2



3



4

# Step1: Configuration of the facility layout

**1** Select Actors or Sensors

**2** Select geometry

**3** Arrange components

The screenshot shows the AnySIM software interface. The main window displays a 3D model of a factory layout with green conveyor belts, orange robotic arms, and a yellow pallet. An 'Add new object' dialog box is open, showing a list of objects: 'Aktoron', 'KJKA-Roboter', 'rcbater', and 'Transportband'. The 'Transportband' object is selected. The dialog box also has an 'Object name' field containing 'F87'. The dialog box has buttons for 'Probe', 'Add', 'OK', and 'Cancel'. The background window has a menu bar with 'File', 'Edit', 'View', 'Point', 'Blocks', 'Geometry', 'Kinematics', 'Simulation', 'Measure', 'Window', and 'Help'. The status bar at the bottom left says 'Press F1 for help' and the bottom right shows 'NUM'.

## Step 2: Virtual Wiring

(only needed if the PLC CODE already exists)

The screenshot shows a virtual reality environment with a 3D model of a crane and a blue ramp. An 'Allocation table' window is overlaid on the bottom right. The table has three columns: Name, Object, and Action. The 'Name' column lists I/O addresses from E0.0 to E0.7. The 'Object' column lists 'Lichtschanke\_1' and 'Lichtschanke\_2'. The 'Action' column is empty. A tree view on the left shows the PLC structure: DSSI.OmniOPCServer.1, Input, E, E0.0, EB, EW, ED, Output, Merker, Timer, Counter. Two white arrows point to the 'Name' and 'Object' columns of the table. A yellow circle with the number '4' is at the bottom left, and a yellow circle with the number '5' is at the bottom right.

Name	Object	Action
E0.0	Lichtschanke_1	
E0.1		
E0.2	Lichtschanke_1	
E0.3	Lichtschanke_2	
E0.4		
E0.5		
E0.6		
E0.7		

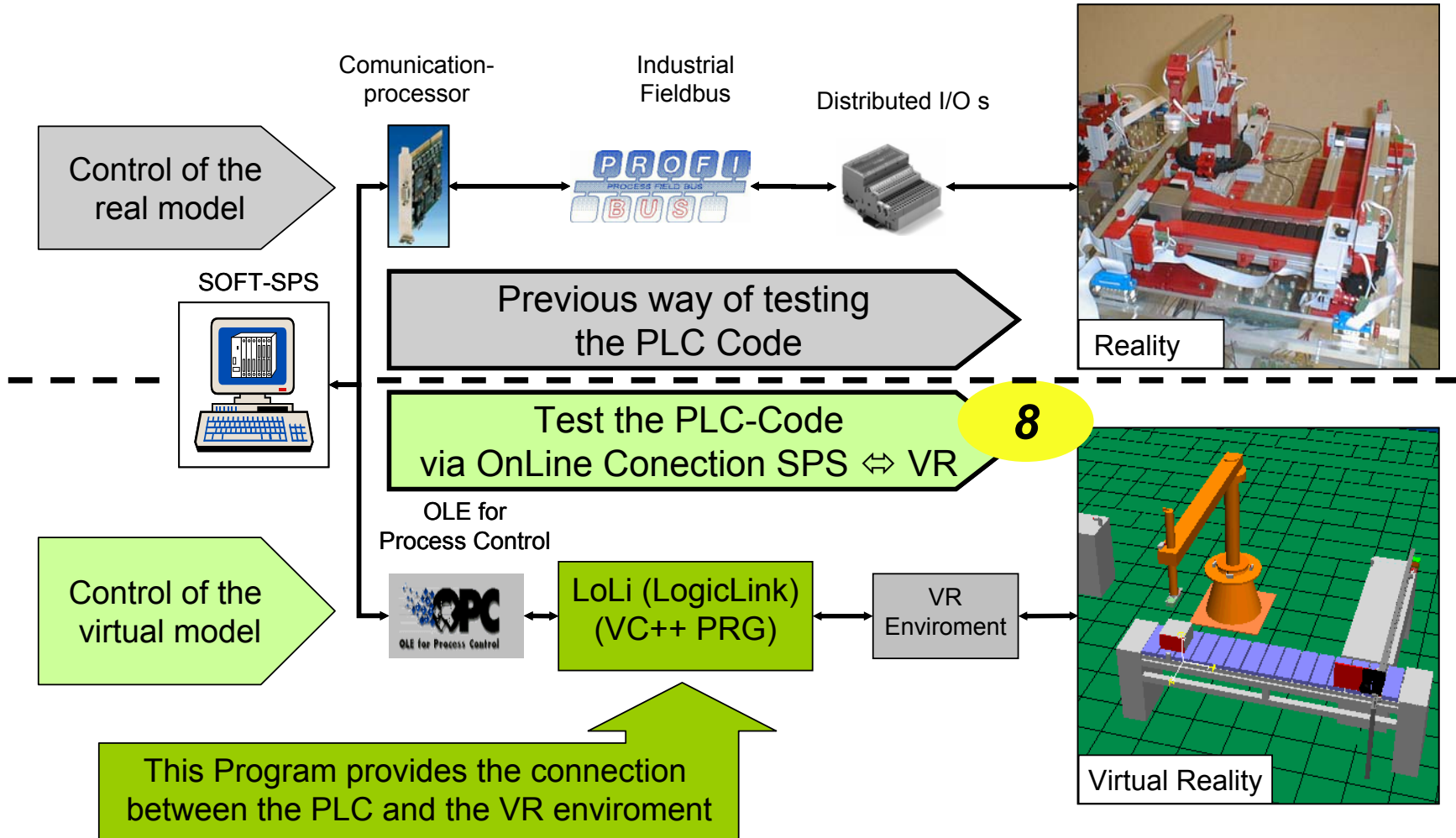
4





5

Connect I/O with virtual components

The screenshot shows a 3D simulation of an orange industrial robot arm in a virtual environment. A red wireframe box is drawn around the robot's upper arm and shoulder area. A white arrow labeled "Selected Actor" with a yellow circle containing the number "6" points to this box. In the foreground, a grey dialog box titled "Network\_1" is open. It has two sections: "Transitions" and "Places". The "Transitions" section has radio buttons for AND, OR, and X, and a dropdown menu showing "Lichtschanke\_1 <GLOB". The "Places" section has radio buttons for S, R, and =, and a dropdown menu showing "AKKU". A white arrow labeled "Define the logic" with a yellow circle containing the number "8" points to the "Places" section. At the bottom right, a context menu is open over the robot, listing functions like "drehen gegenuh", "drehen", "greifer", etc. A white arrow labeled "Selected Function" with a yellow circle containing the number "7" points to the "drehen gegenuh" option.

# Step 4: Validate the PLC-Code via OnLine-Connection



-  Further exchange of components geometry with CAD Systems
-  Create an simulate a PLC-Code for a CNC (Sinumeric 840D)
-  Evaluate the concept with a big production System of ROBERT BOSCH GmbH, Homburg, Saar
-  establishing a data structure according to DIN IEC 1131