ACROBA

connect & produce through agile production

Task planner

Thomas Ribeaud, Berner Fachhochschule

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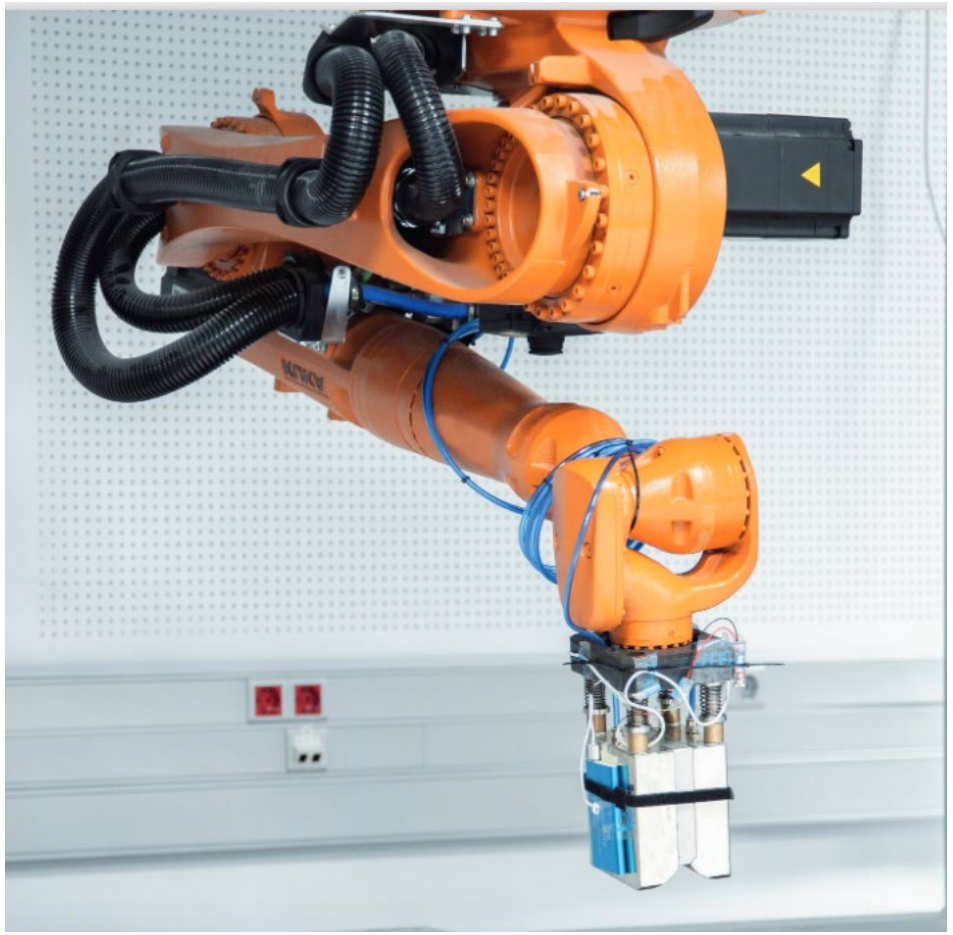
Plan

- ACROBA Architecture
- Plansys2
- Use cases
- Task Planner architecture
- Questions/Inputs

ACROBA Architecture

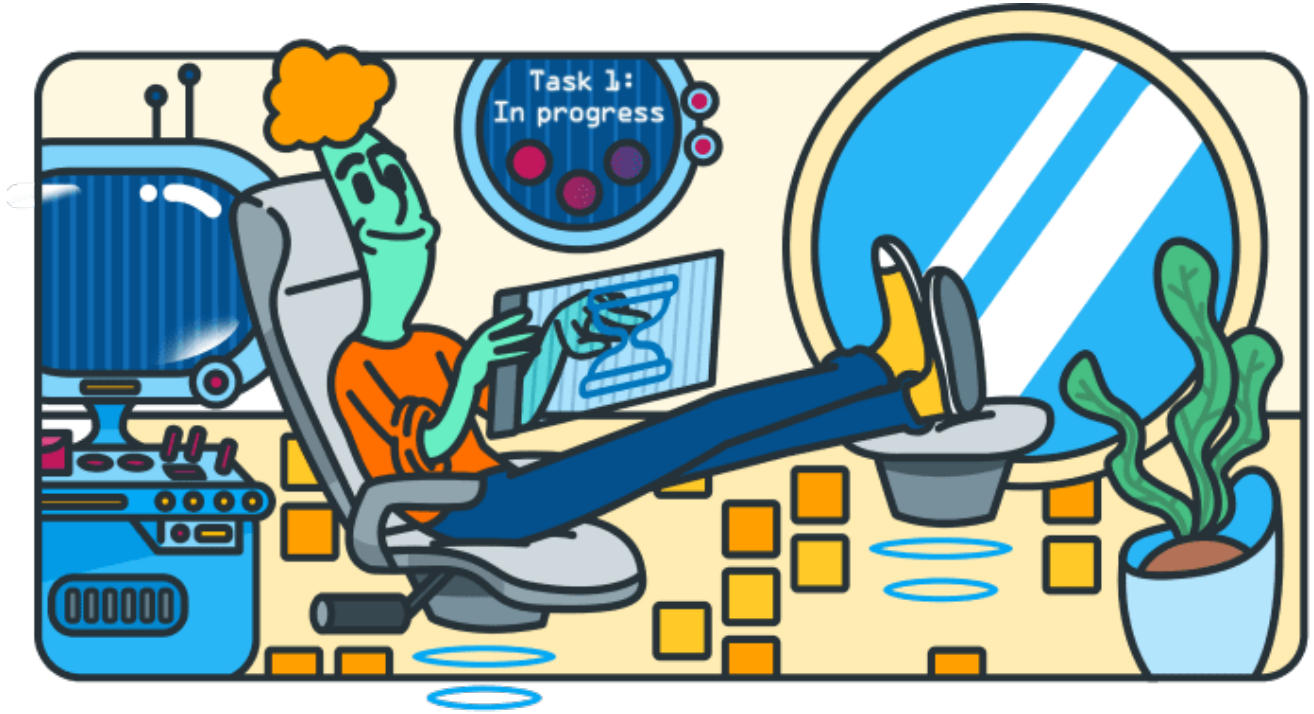
- AI-Driven Cognitive Robotic Platform for Agile Production Environments
- Flexible production solution for mid-range companies
- Modular collaborative or standard platform



ACROBA Cognitive module

ACROBA Task Planner

- Executor of the task
- Help to design the task
- Task optimization
- Online re-planning
- High level of automation



BehaviorTree.cpp

- Library to handle behavior trees from MOOD2Be project: Models and Tools to design Robotic Behaviors (2019)

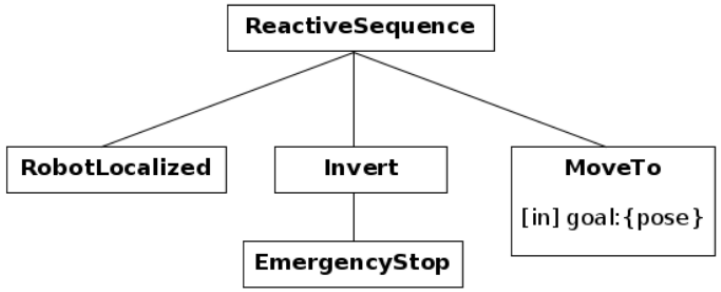


Figure 8: Check if robot is localized and emergency stop is pressed.

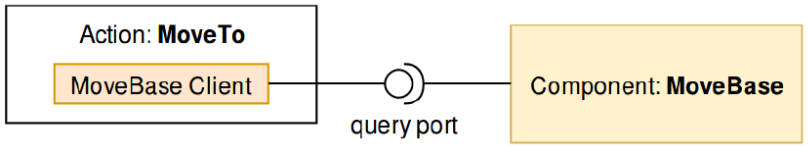


Figure 2: Relation between an Action of the BT and a service-oriented component.

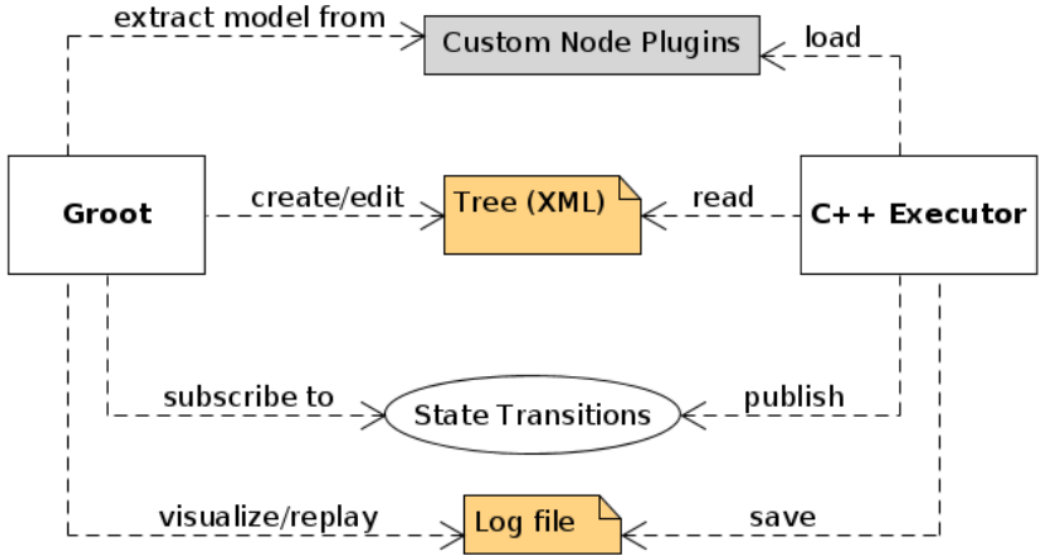
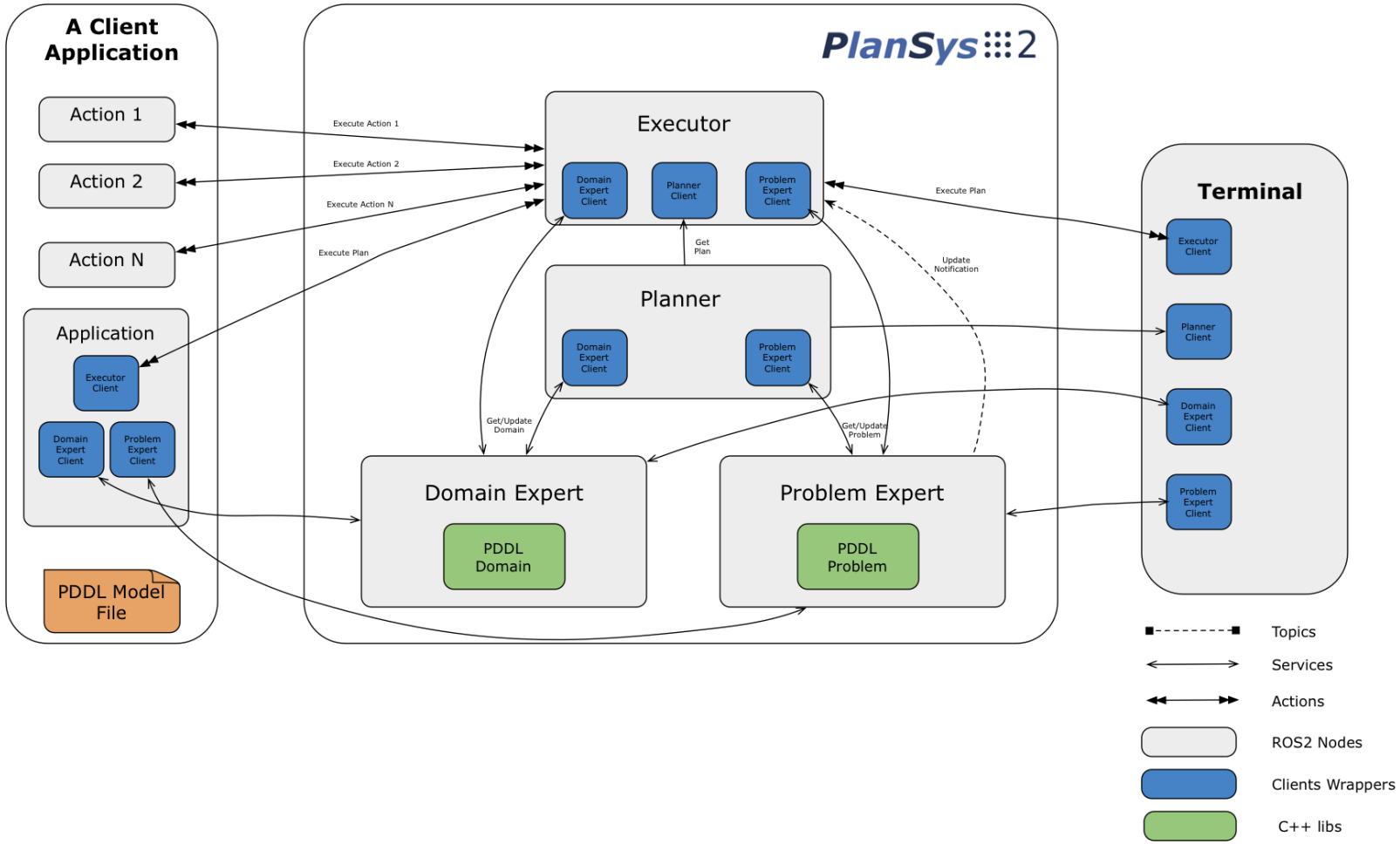


Figure 10: Relation between Groot and the C++ Executor

Plansys2

- ROSPlan for ROS2
- Can generate, execute and display Behaviour trees
- Generation from PDDL with several solvers available



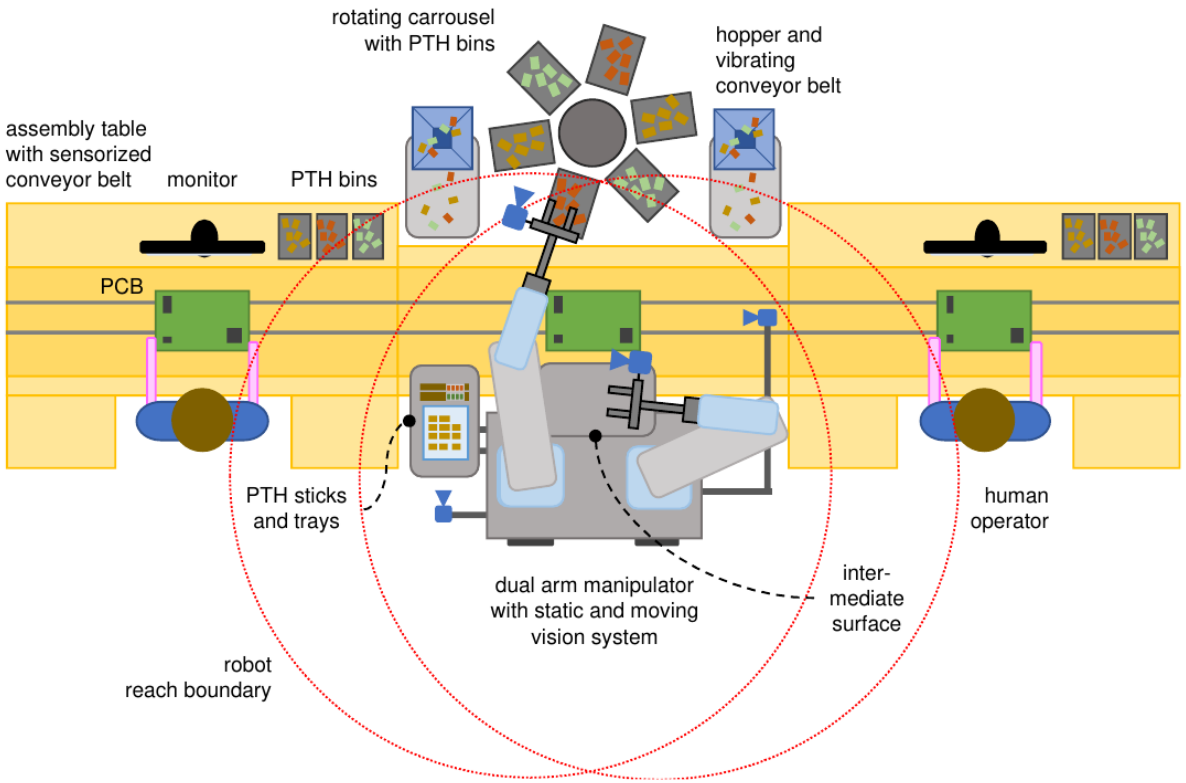
PDDL

- Planning Domain Definition Language
  - Domain -> Predicates (properties) and operators (Actions) = Robots/Tools/Parts and Robot skills
  - Problem -> Goal = Domain state to reach by using actions
- Evolution of PDDL over time

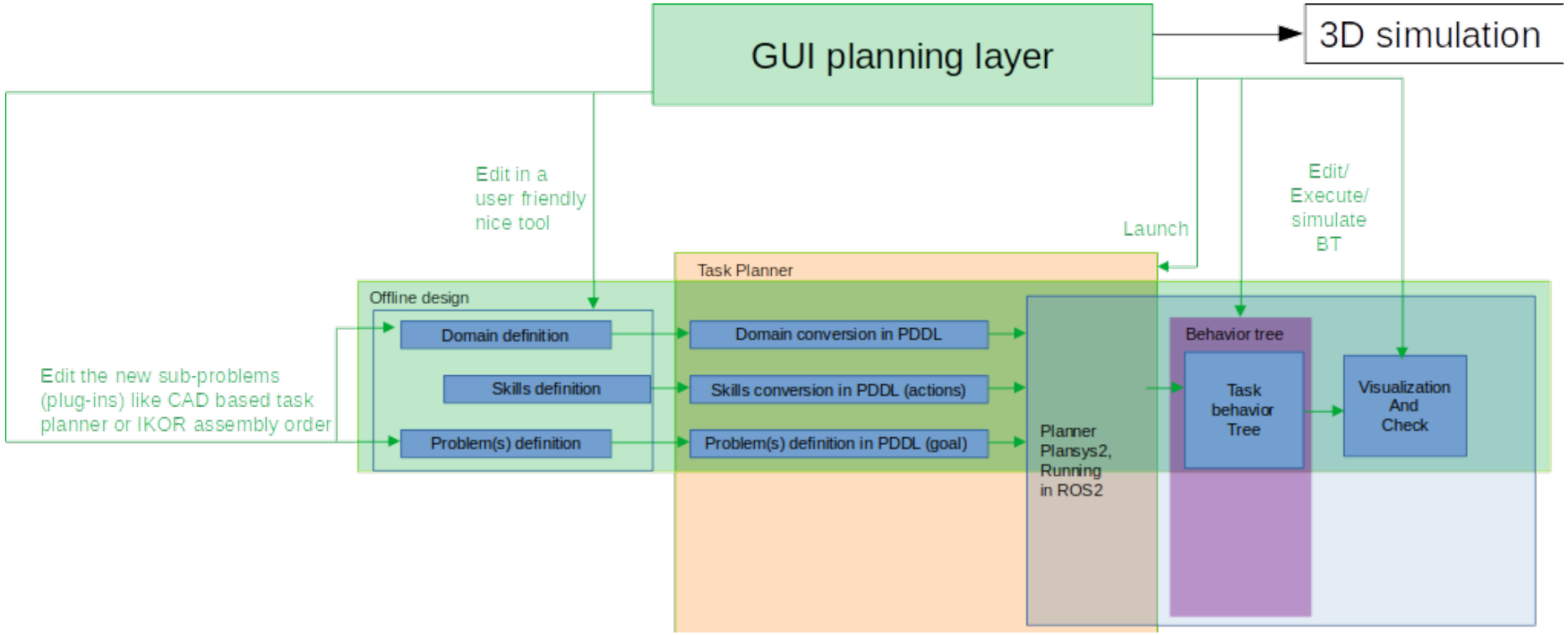
```
(define (domain factory)
   (:requirements :strips :typing :adl :fluents :durative-actions)

   ;; Types ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
   (:types
      gripper piece zone
   );; end Types ;;;;;;;;;;;;;;;;;;;;;;;;;

   ;; Predicates ;;;;;;;;;;;;;;;;;;;;;;;;;
   (:predicates

      (piece_at ?p - piece ?pz - zone) = true if part p is in zone pz
      (gripper_at ?g - gripper ?z - zone) = true if gripper g is in zone z

      (gripper_free ?g - gripper) = true if gripper g doesn't hold a part

      (gripper_has ?g - gripper ?p - piece) = true if gripper g holds part p

   );; end Predicates ;;;;;;;;;;;;;;;;;;;;

   ;; Actions ;;;;;;;;;;;;;;;;;;;;;;;;;;;;
   (:durative-action pick
      :parameters (?g - gripper ?z1 - zone ?p - piece)
      :duration ( = ?duration 4)
      :condition (and
         (at start(gripper_at ?g ?z1))
         (at start(piece_at ?p ?z1))
         (at start(gripper_free ?g))
      )
      :effect (and
         (at start(not (piece_at ?p ?z1)))
         (at start(not (gripper_free ?g)))
         (at end(gripper_has ?g ?p))
      )
   )
```

Use case example

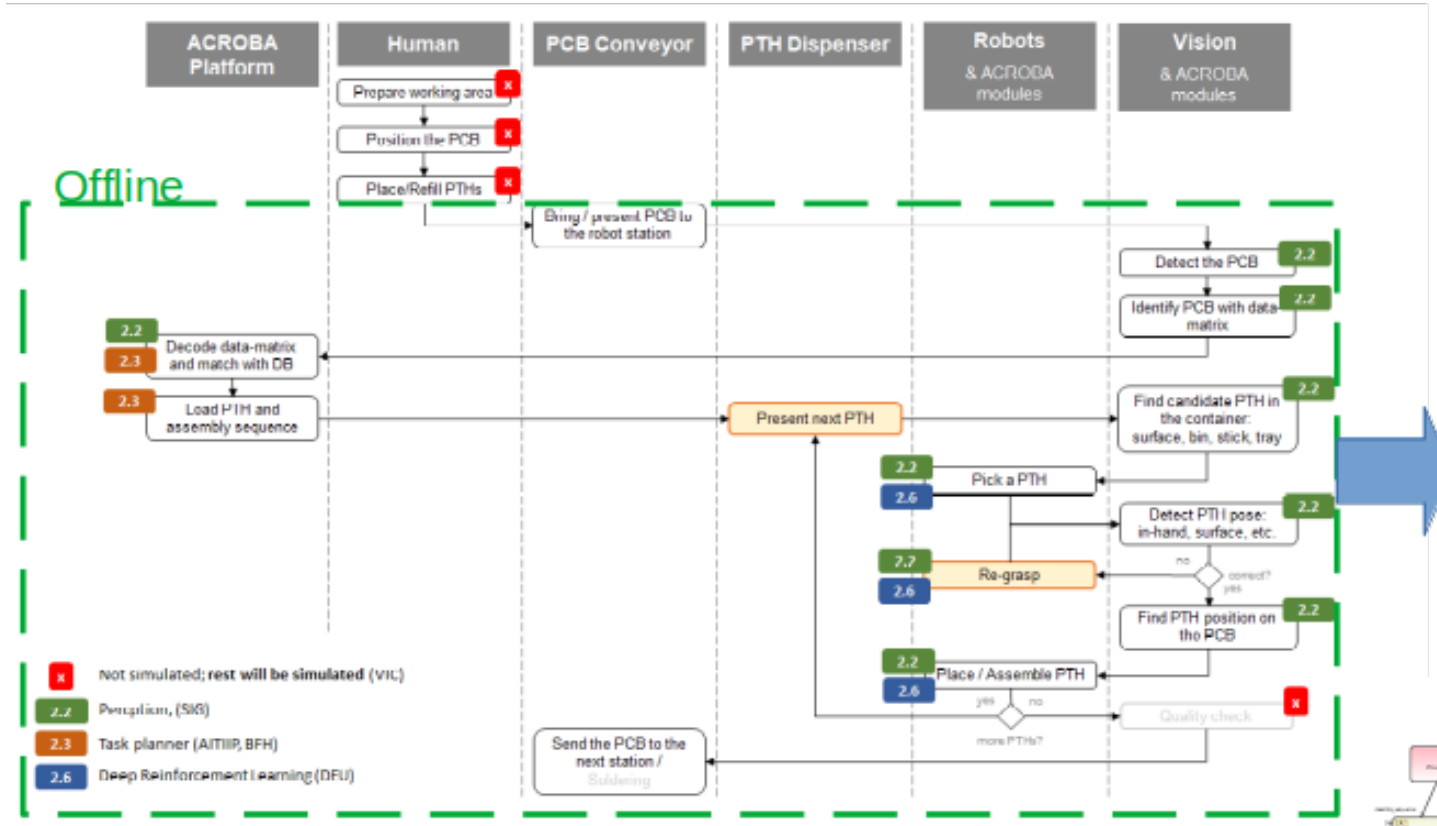
- 5 use cases
  - Collaborative assembly lines
    - IKOR: PTHs on PCBs
    - ICPE: Electric motors parts
  - Light out manufacturing
    - STER: Processing of medical 3D printed parts
    - CABKA/MOSES: Defects removal and QC
- Let's use IKOR as support for presentation

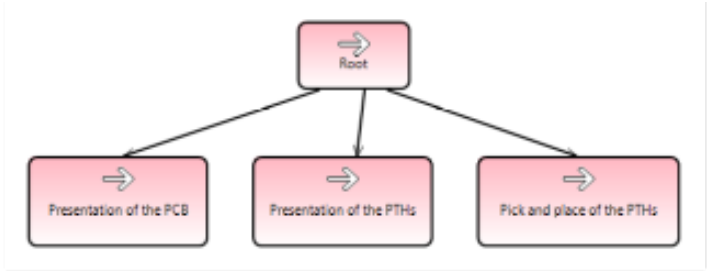


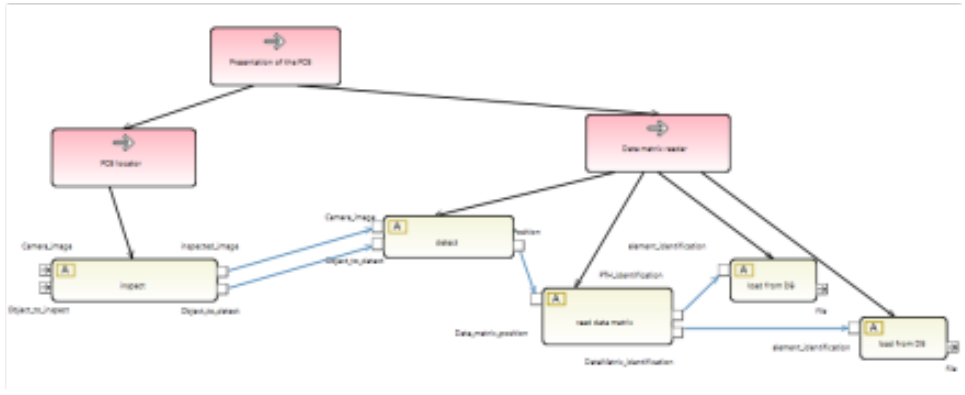
Task planner at engineering time



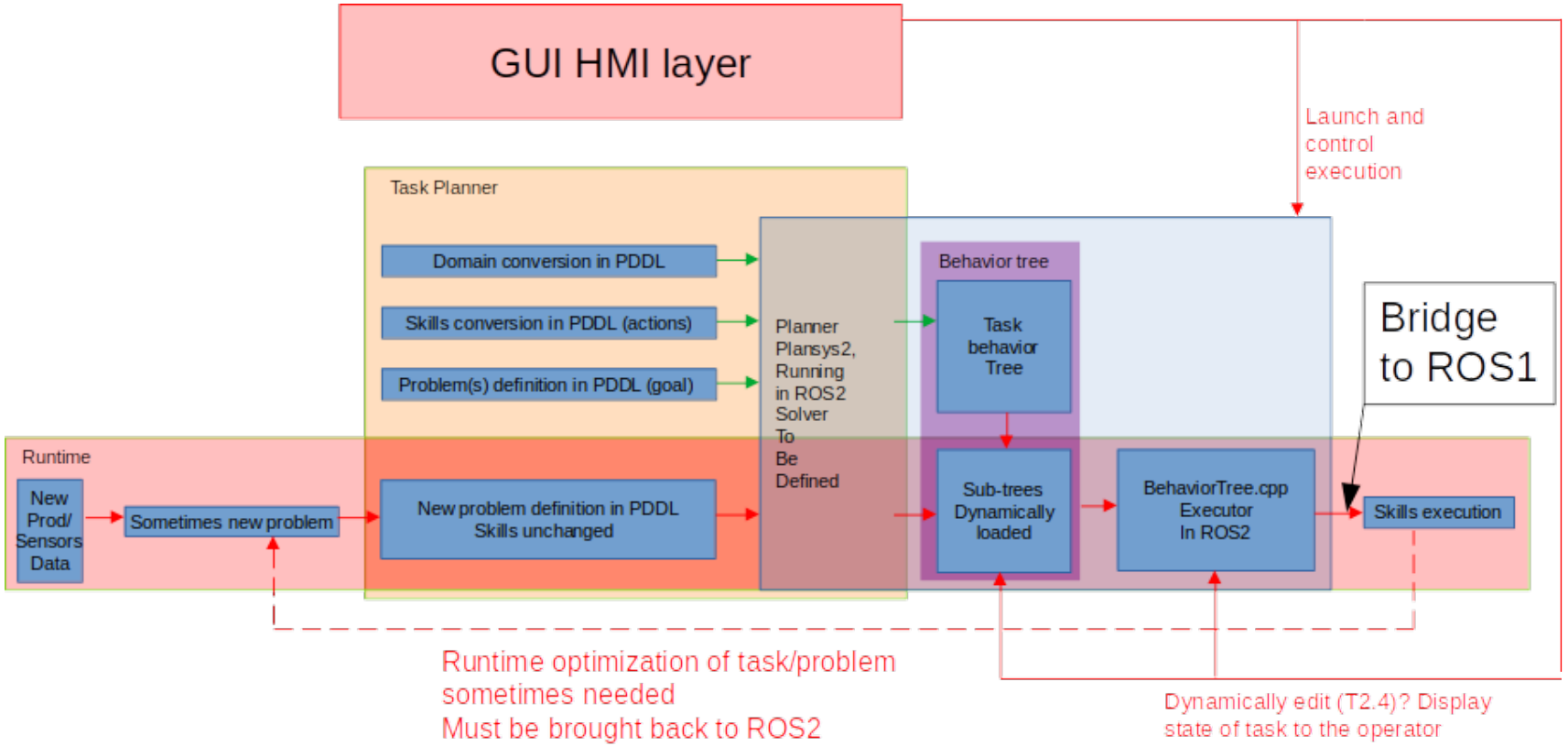
Task planner at engineering time





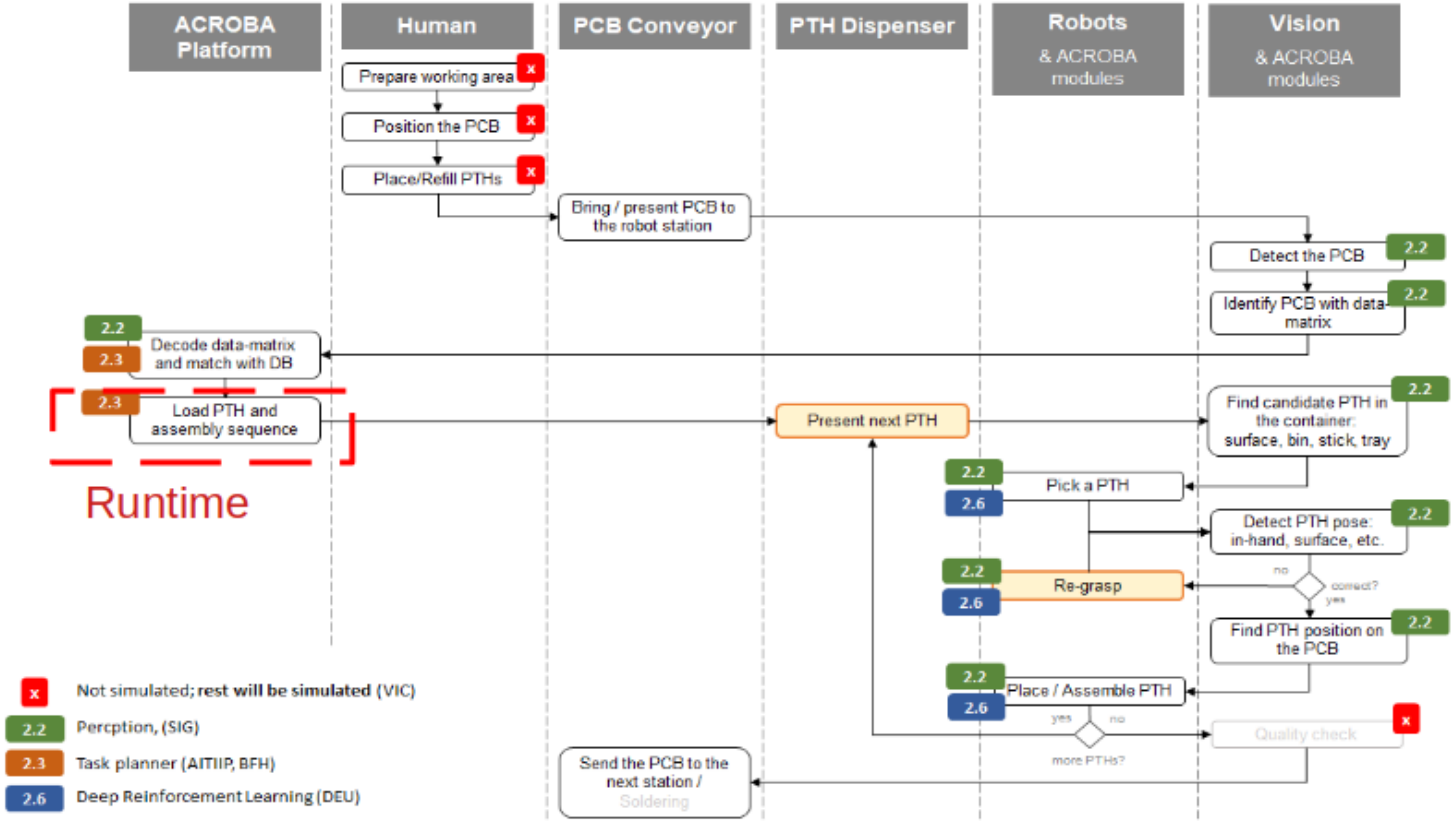


Task planner at runtime

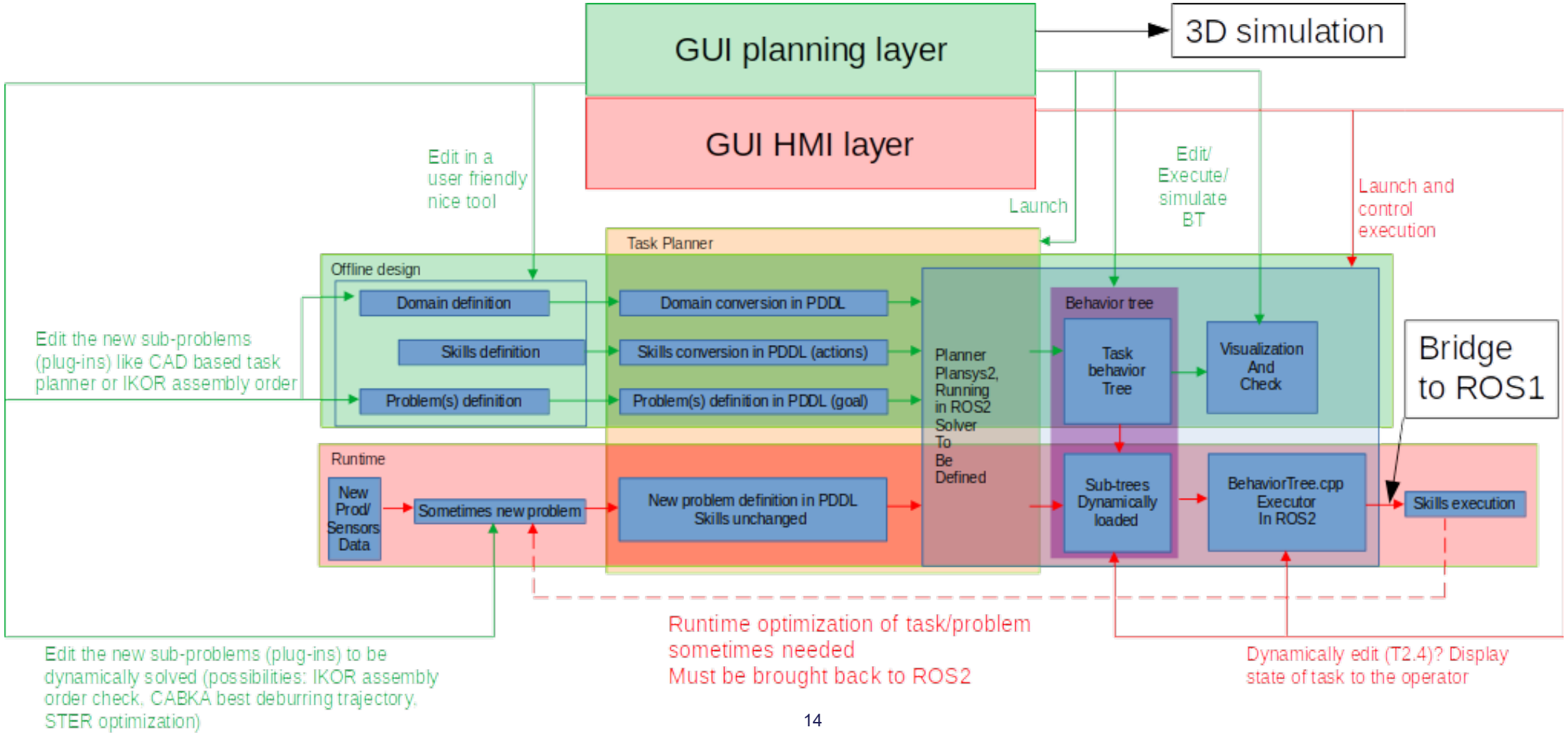


Task planner at runtime

- Online re-planning in case of human operator perturbation

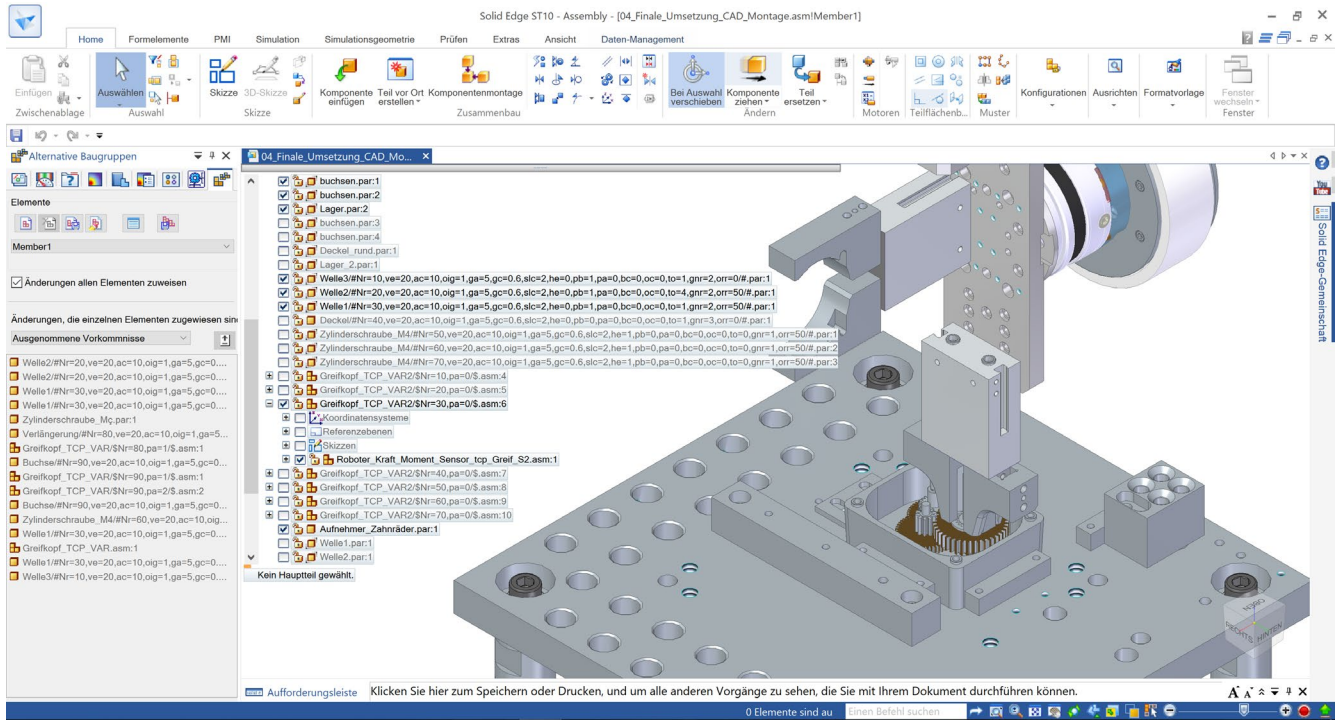


Task planner overview

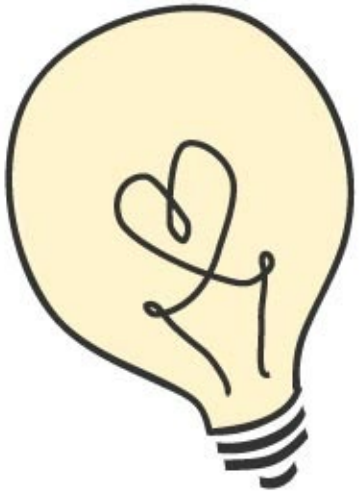


CAD based task planning

- Plug-in for the task planner
- Step files
- Info needed:
  - Relative positions of the parts
  - Relative direction of the parts
  - Movement type of assembly
  - Assembly order
  - Where to find the parts
- GUI or other way for the designer to give order of assembly



Questions/ Remarks /Inputs



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