Evaluating Knowledge-Based Assistance for DIY*

M. Schiller[1], G. Behnke[1], P. Bercher[1], M. Kraus[2], M. Dorna[2], F. Richter[1], S. Biundo[1], B. Glimm[1] and W. Minker[1]

*Special thanks to: M. Dambier[2], J. Rose[2], M. Schmautz[1] and C. Zhu[1]

[1]Faculty of Engineering, Computer Science and Psychology
Ulm University, Ulm, Germany

[2]Corporate Research
Robert Bosch GmbH, Renningen, Germany

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A digital companion for DIY


- Support novice users with setting up DIY tools and completing DIY projects
- The DIY domain
  - requires proficiency with electric and manual tools, attachments and different materials
  - different possible courses of action towards a goal
  - unforeseen events during task execution (e.g. mistake, tool breaks, etc.)
- We combine
  - (hierarchical) AI planning
  - ontology-based knowledge modeling
  - multimodal human-computer interaction

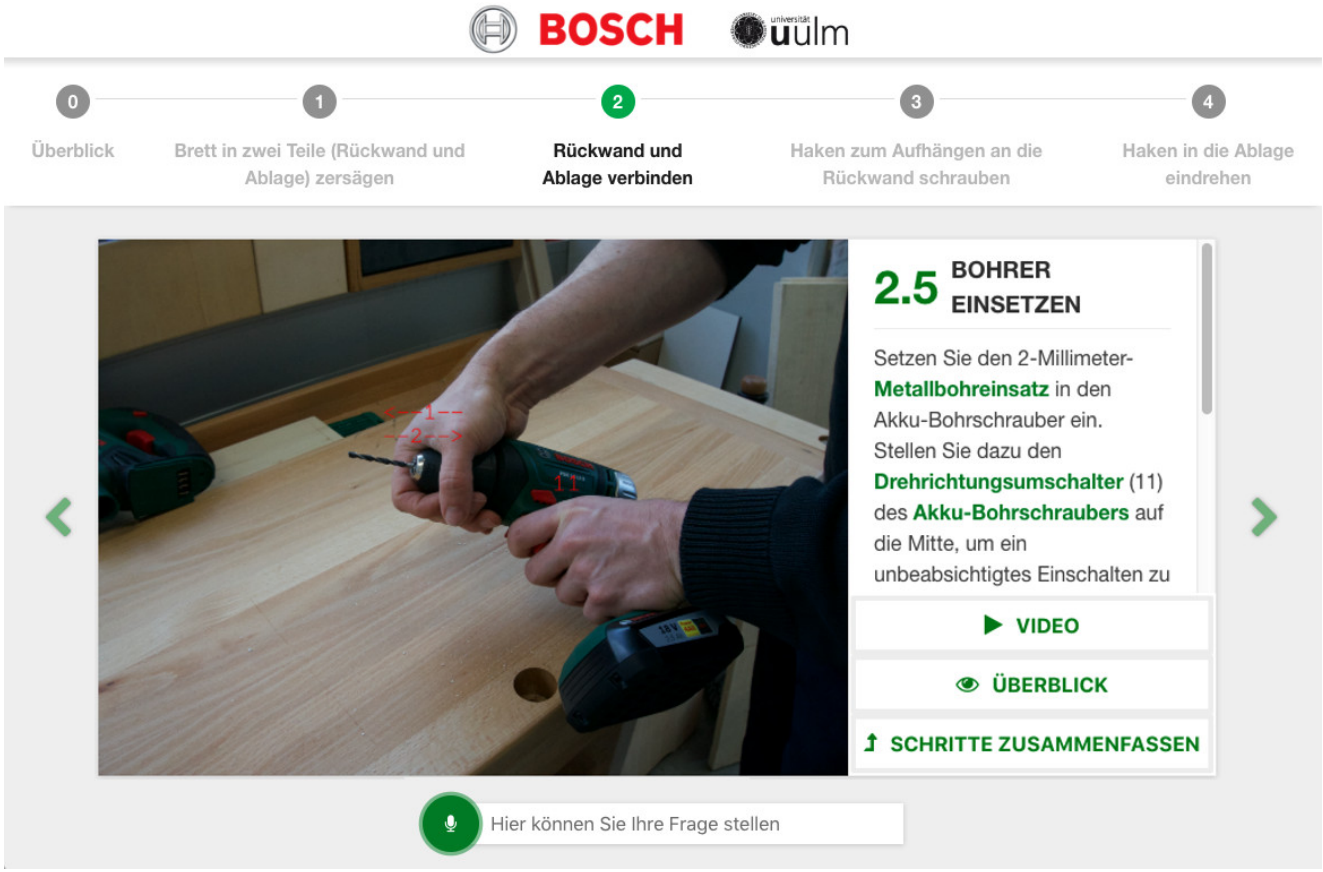
Application scenario

- Step-by-step instructions to enable users to achieve different tasks

  Planning $\rightarrow$ adapt to individual situation & preferences

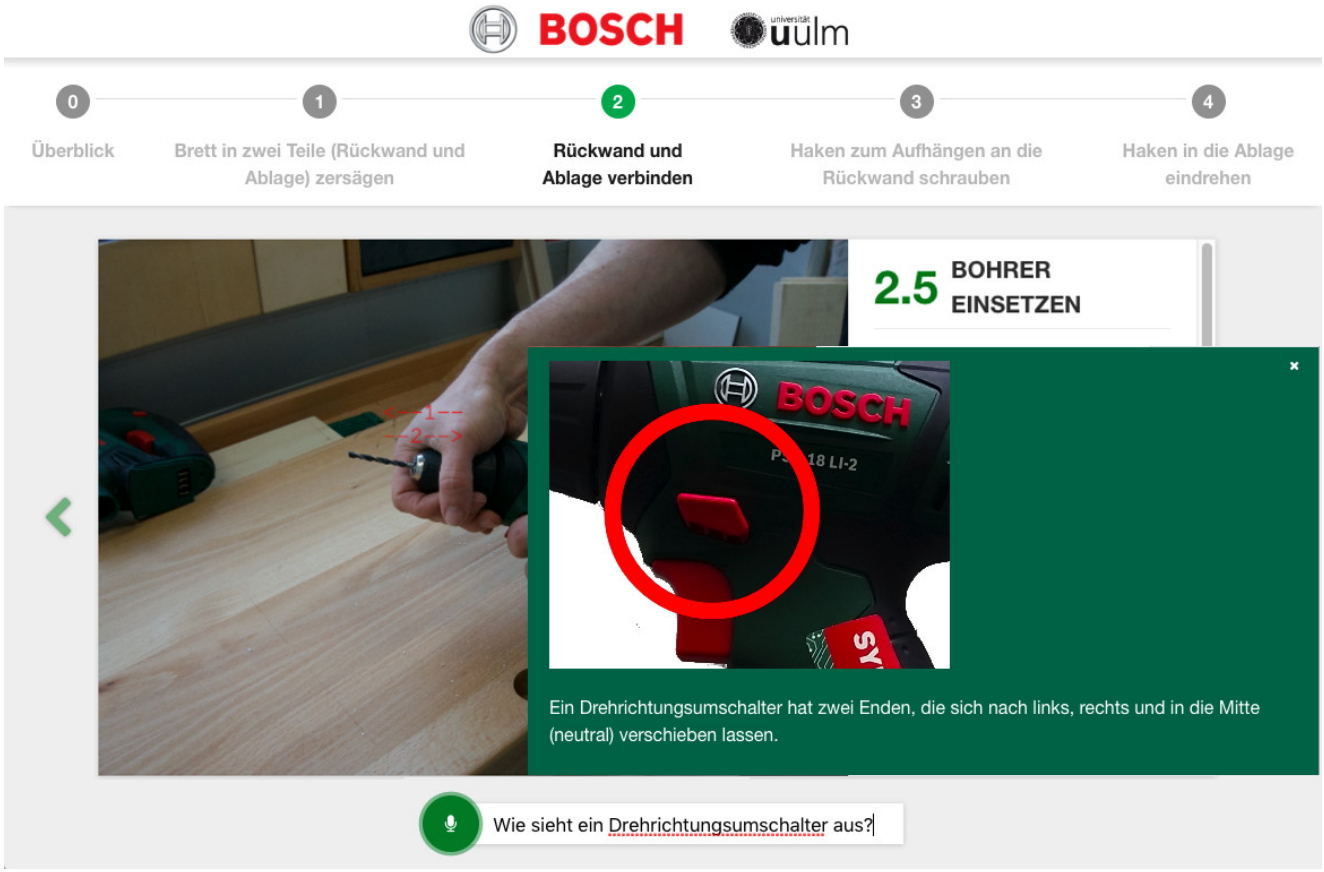
- Enable users to learn about device(s) while using them
  - What device can be used for what task?
  - What settings, what equipment, etc. are needed to perform a task?
- Enable users to learn about the application domain:
  - How are devices and objects in the domain distinguished?
  - What characterizes them?

Step-by-step assistance



- Each step illustrated by text, image and video
- Speech, text and touch commands for navigation and information requests
- Questions about concepts, appearance of objects, etc. supported

Step-by-step assistance



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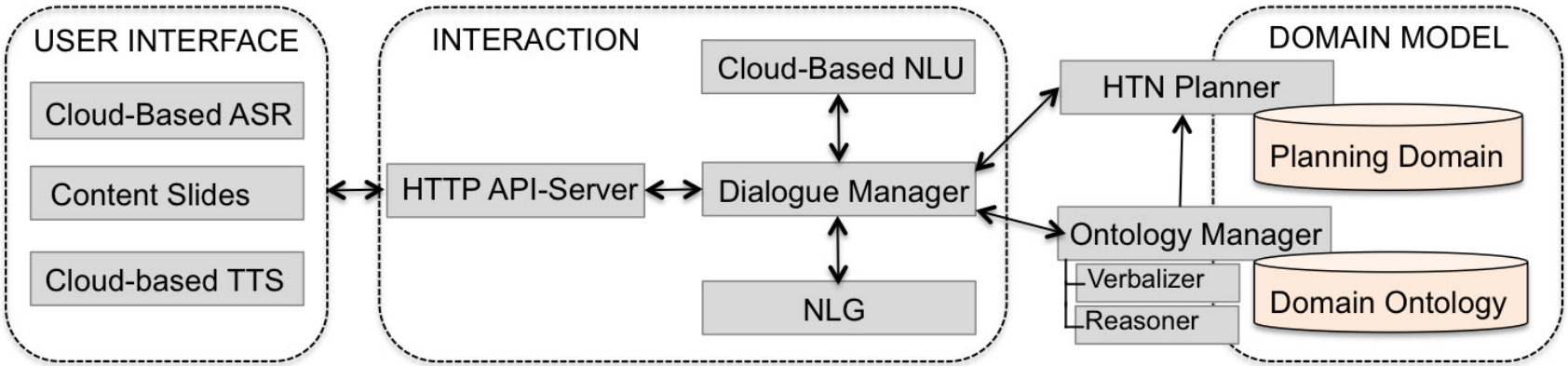
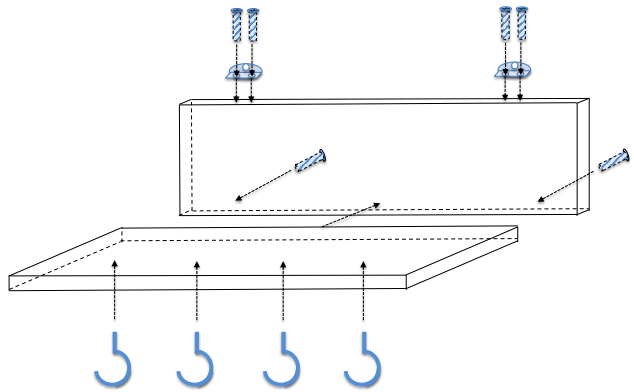
System outline



- Integration of procedural knowledge (planning domain) and declarative knowledge (domain ontology)
- Ontology as (unified) underlying knowledge source for planning and dialogue
- Interaction realized using dialog manager (Information State Update approach) and:
  - *annyang* – speech recognition
  - Microsoft LUIS – NLU
  - *Vue.js* – multimodal GUI

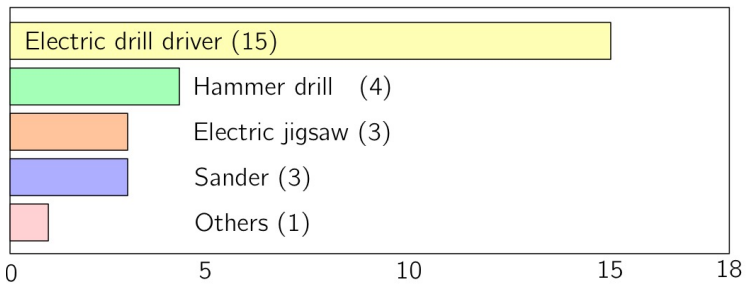
User testing



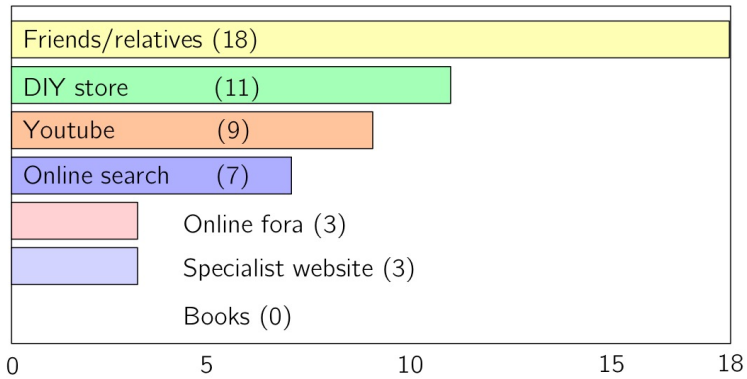
- Participants: 18 DIY novices (10f/8m)
- Experimental task: construct wooden key rack while using assistant
- Power tools: electric drill driver, electric jigsaw, optionally: sander
- Two experimental groups
  - full assistance ($n = 13$)
  - baseline assistance ($n = 5$): only one level of instruction, no interaction, no videos
- Assessment: pre- & post-test questionnaire, observation + video

Participant characteristics

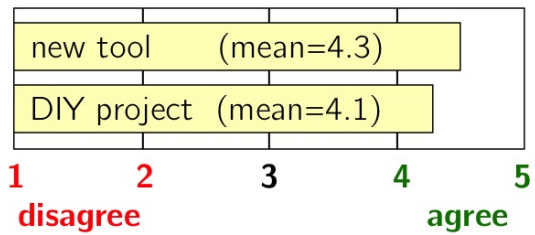
- Project experience mostly limited to assembling furniture ('Ikea'), attaching pictures
- Prior experience with electric tools



DIY help-seeking

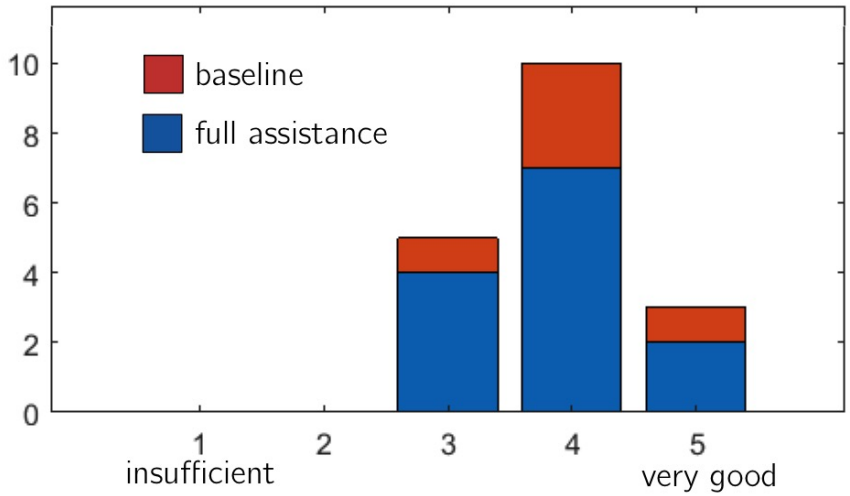


- Would participants like to receive digital assistance for a new tool/a DIY project?

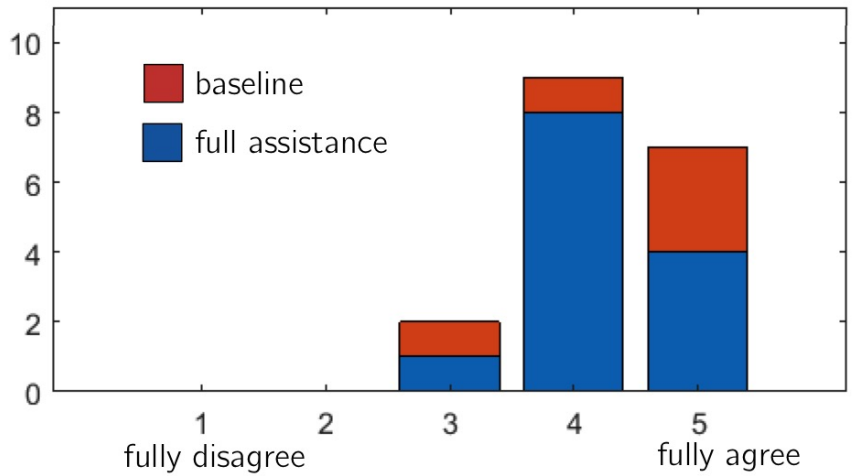


Main post-test questionnaire results

- How would you judge the app overall?



- I have learned something about DIY while interacting with the app.



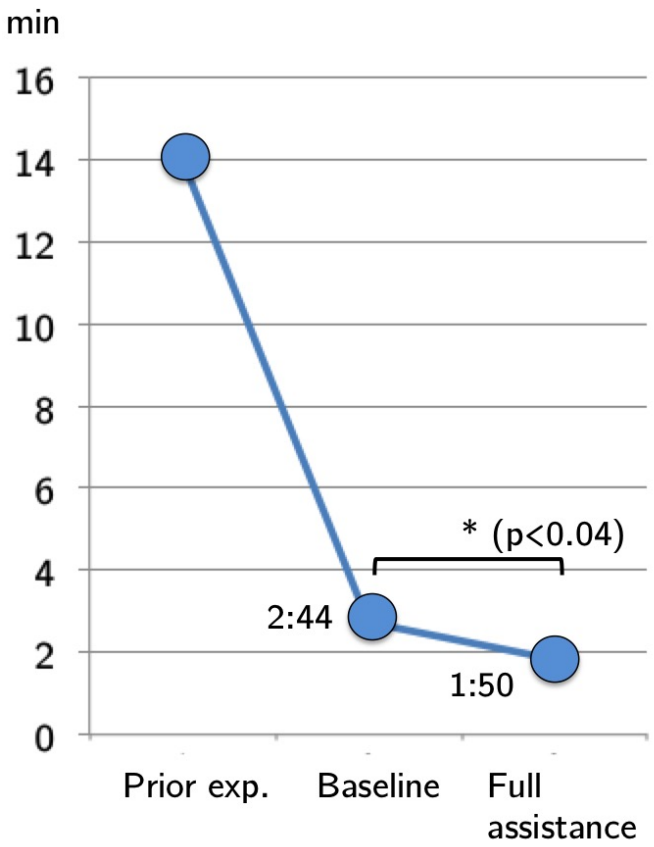
Users' comments (full assistance condition)

- problems with speech interaction (5)
- videos were silent (3)
- instructions not precise enough (4)
- instructions too obvious (3)
- explanations not helpful/too obvious (4)
- intermediate steps not detailed enough (2)
- too much jargon (2)

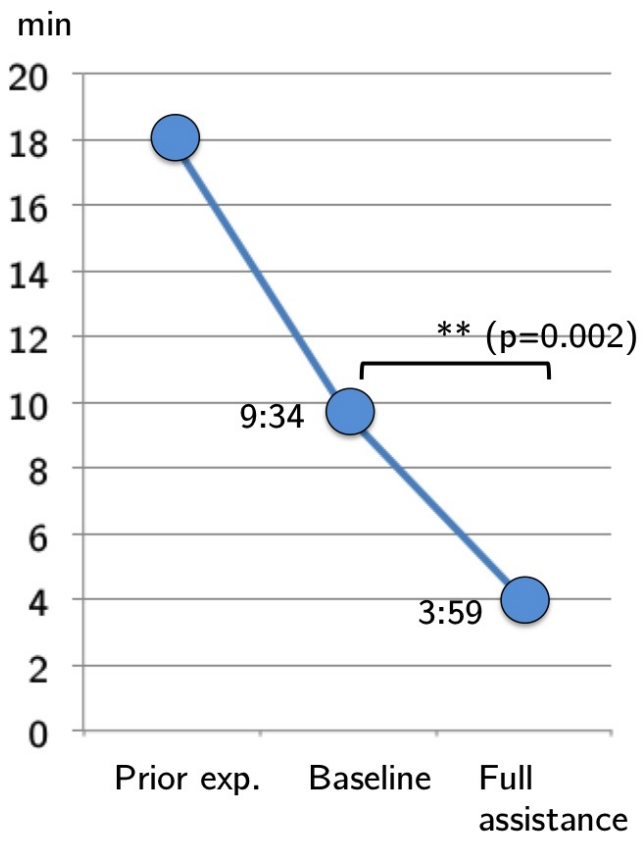
Tool setup with/without assistance

- Time to operation: time users spent setting up the electric tool (insert attachments, battery, adjust settings) until operable

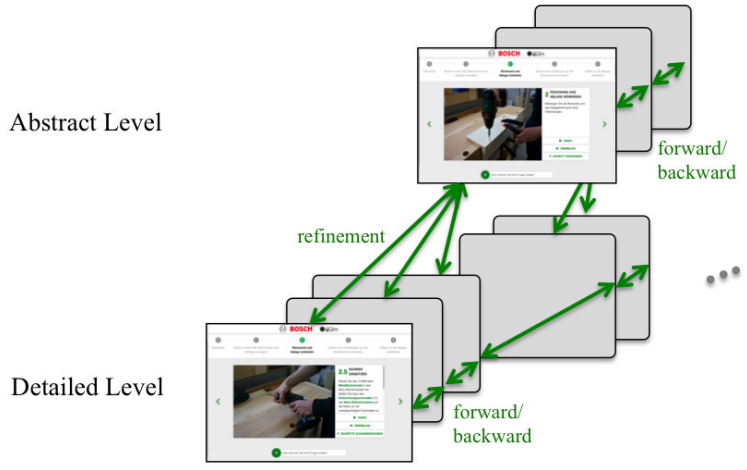
Electric drill driver



Electric jigsaw



Challenges/observations



- Conveying the hierarchical structure of instructions to users
  - First tests: users stayed on top level, rarely navigated to detailed level
  - Remedies/parameters: tutorial video, adjusting default presentation sequence (e.g. starting the instruction at the lower level vs. top level), clear wording of buttons
- Animating users to interact and discover system's abilities
  - Small inconveniences (misunderstanding, latency) discourage users
- Some users had difficulties with even the simplest tasks (e.g. marking plank to be cut in half)

Conclusion

- User testing highlighted remaining challenges: making system's capabilities transparent to users (e.g. hierarchical organization of instructions)
- Importance of user modeling becomes apparent (different kinds of help required)
- Future work: incorporate more pro-activity