How Much Do Specialists Have to Learn from Each Other When They Jointly Develop Radical Product Innovations?

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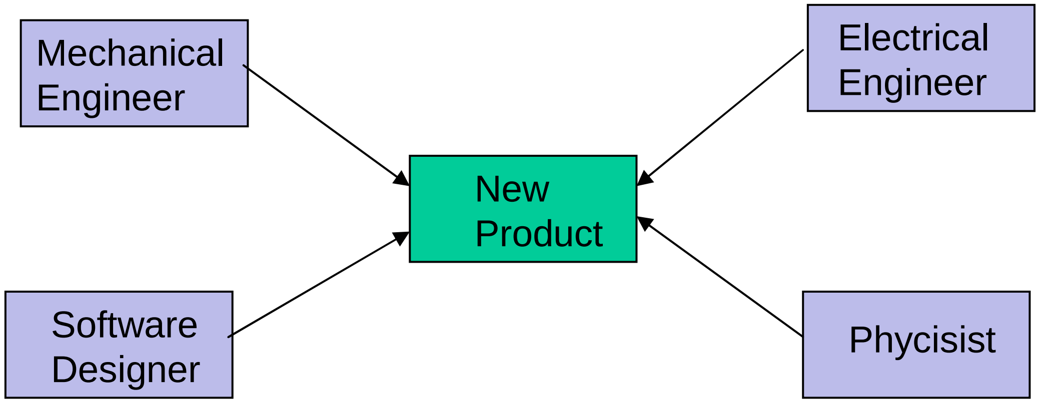
1. The problem: How do specialists integrate knowledge while avoiding cross-learning

Product innovations require knowledge integration:



Problems:

“Different percepts and different attitudes shaped by practice make interchange […] remarkably difficult, and thus they invisibly pressure disciplines to work among themselves rather than to engage in cross-disciplinary research.”
(Brown and Duguid 1998)

Approaches to Knowledge Integretation

Argyris and Schön, Nonaka: intensive cross-learning

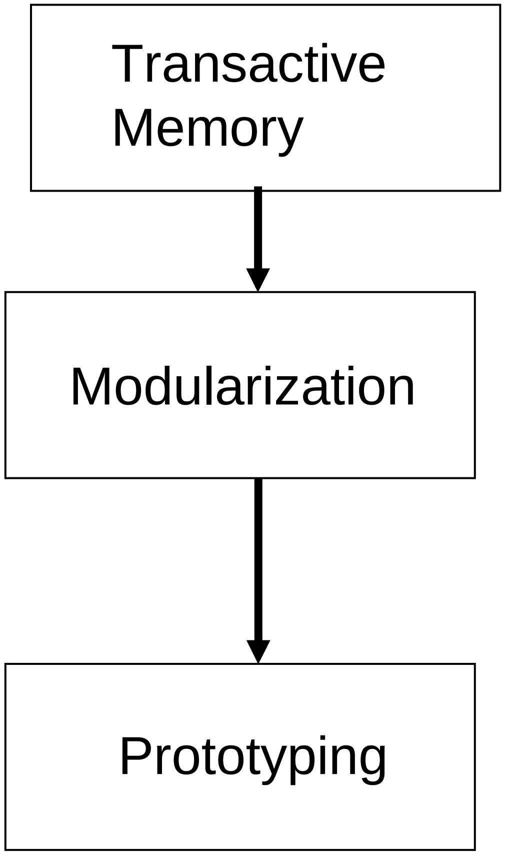
Brown and Duguid (1990): enabling architecture - organizational translators, knowledge brokers, boundary objects

Trans-specialist learning is inefficient:

“Although knowledge can be learned more effectively in a specialized fashion, its use to achieve high living standards requires that a specialist somehow uses the knowledge of other specialists. This cannot be done only by learning what others know, for that would undermine gains from specialized learning.” (Demsetz 1991)

“[T]ransferring is not an efficient approach to integrating knowledge. If production requires the integration of many people’s specialist knowledge, the key to efficiency is to achieve effective integration while *minimizing* knowledge transfer through cross-learning by organizational members.” (Grant 1996)

2. The concept of Transactive Organizational Learning (TOL) 1



Localization of relevant specialists

Specialists concentrate on the design of modules; coordination between modules through joint definition of interfaces

Joint definition of interfaces through prototyping
Forms: mental, virtual, rapid and real prototyping

2. The concept of Transactive Organizational Learning (TOL) 2

Advantages of **Modularization** for organization learning:

- Other components can be treated as black boxes (up to a certain extent)
- Parallel development of modules
- Possible to detach learning at the architectural level from learning at the component-level
- Possible to separate learning at the product architecture level from learning for modular innovati

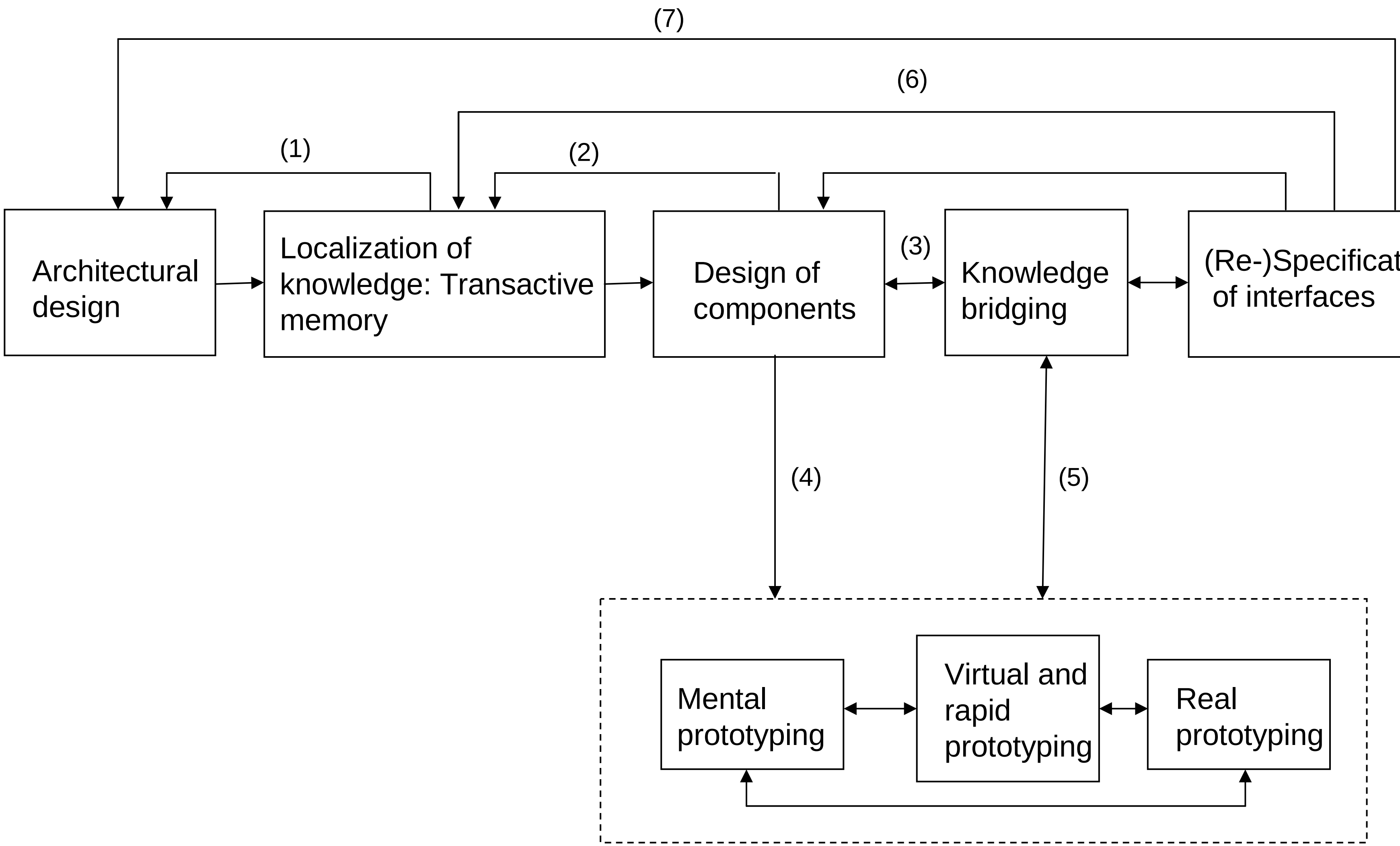
Advantages of **Prototyping**:

- Prototypes are boundary objects
- Identification of problems encountered in tests allow problem-oriented communication

Advantages of **Transactive Memory**:

- Speedy identification of experts

2. The Concept of Transactive Organizational Learning (TOL) 3



3. Research Questions

Q1: To what extent and in which ways do specialists from different domains share (or do not share) knowledge in electrotechnical product innovation projects?

Is knowledge sharing reduced through transactive memory, modularization and prototyping? Which factors influence intensity of knowledge transfer and in which forms does knowledge exchange take place in different phases of the project?

Q2: **Do processes of modularization and prototyping, if applied, differ between incremental and highly innovative product innovations?**

Are highly innovative product innovation projects characterized by a higher degree of knowledge sharing than incremental product innovation projects? If yes, in which ways is this knowledge sharing achieved?

4. Research design

Qualitative study: single-case-embedded design

Radical vs. incremental product innovations

Scale of innovativeness: four dimensions:
(1) technological innovativeness for the company
(2) technological innovativeness for the industry
(3) market innovativeness for the company
(4) market innovativeness for the industry

Plus qualitative analysis

35 semi-structured interviews

ATLAS.ti

Projects

	DNS	M	CF	BMI	BM2	RI	WLM
Degree of Innovativeness	High	High	High	High	Low	Low	Low
Kind of Product	Hard-ware	Hard-ware	Hard-ware	Soft-ware	Soft-ware	Soft-ware	Soft-ware
Professions involved	Electr. Eng. CN-Engin. Physics	Mech. Eng. Physics Chemistry Electr. Eng.	Mech. Eng. Physics Electr. Eng.	Electr. Eng. IT	Electr. Eng. IT	Mach.Build. Physics Electr. Eng.	IT Process Eng. Software Electr. Eng.
Number of Project Teams	3	1	1	1	1	4	1
Number of Project Members	15	10	9	3	5	11	11

DNS – proximity switch; M – measuring instruments for chemical industry; CF – measuring instrument for production facilities; BMI – software for production systems; BM2 – softwareplatform; RI – process automation equipment; WLM – software for waterworks

5. Results

Transfer of knowledge between specialists takes place in form of knowledge bridging in response to emerging problems, not ex ante.

Modularization, prototyping and transactive memory reduce cross-learning for incremental as well as for highly innovative projects.

Concerning transactive memory: personal networks are more relevant than " electronic yellow pages.

Modularization: early specification of interfaces often not possible, especially not for highly innovative projects.

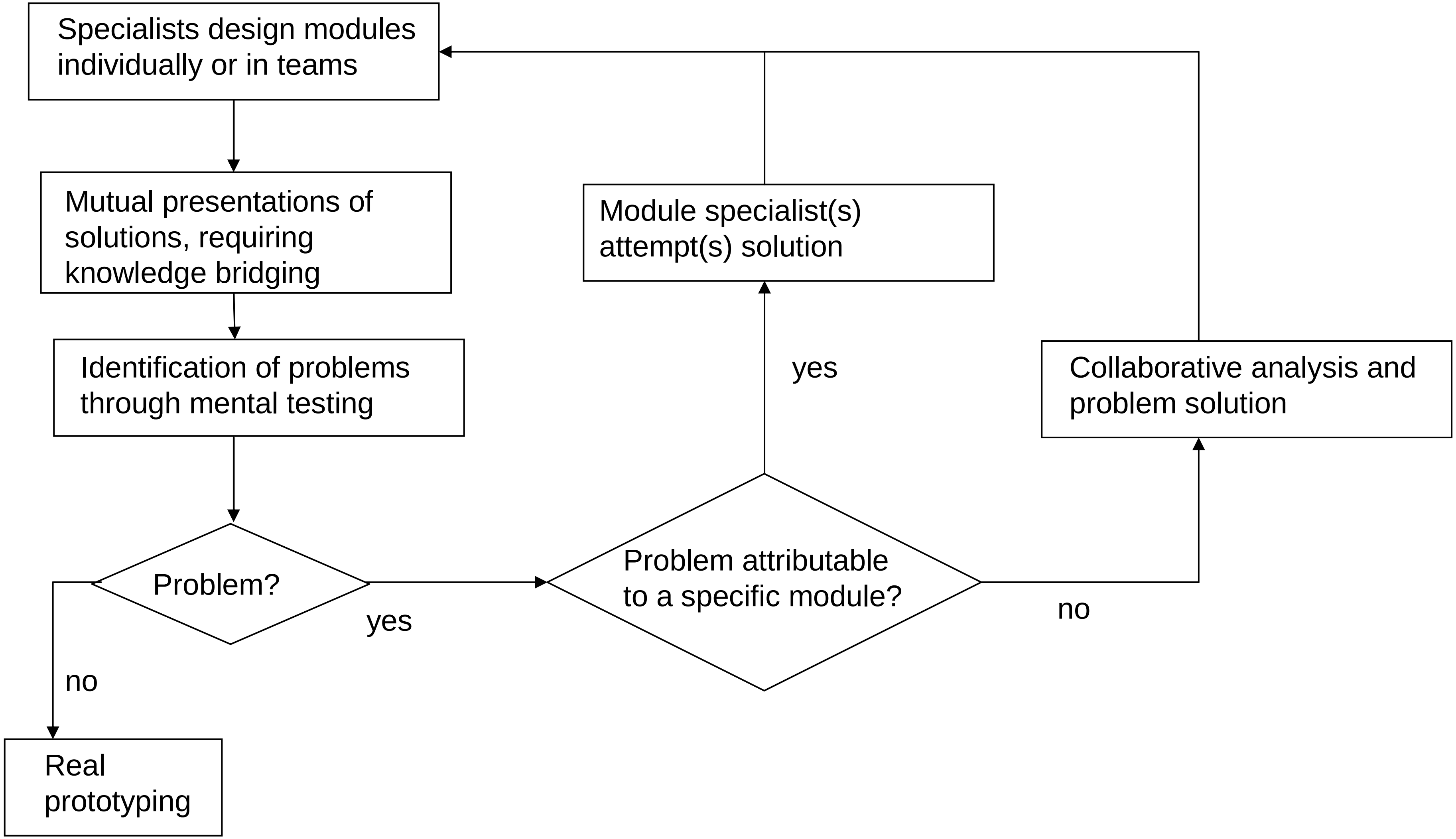
Mental prototyping: P6, DNS: I do not need precise information on the theory [the technology of component A]. But I need information on: what influence will [the technology of component A] have on [component B] once it is implemented. If the requirement is that [component A] has a quick response time I have to know that this will aggravate the requirements [for component B]. (Q 6:39)

Highly innovative product innovations require more frequent and more consequential iterations.

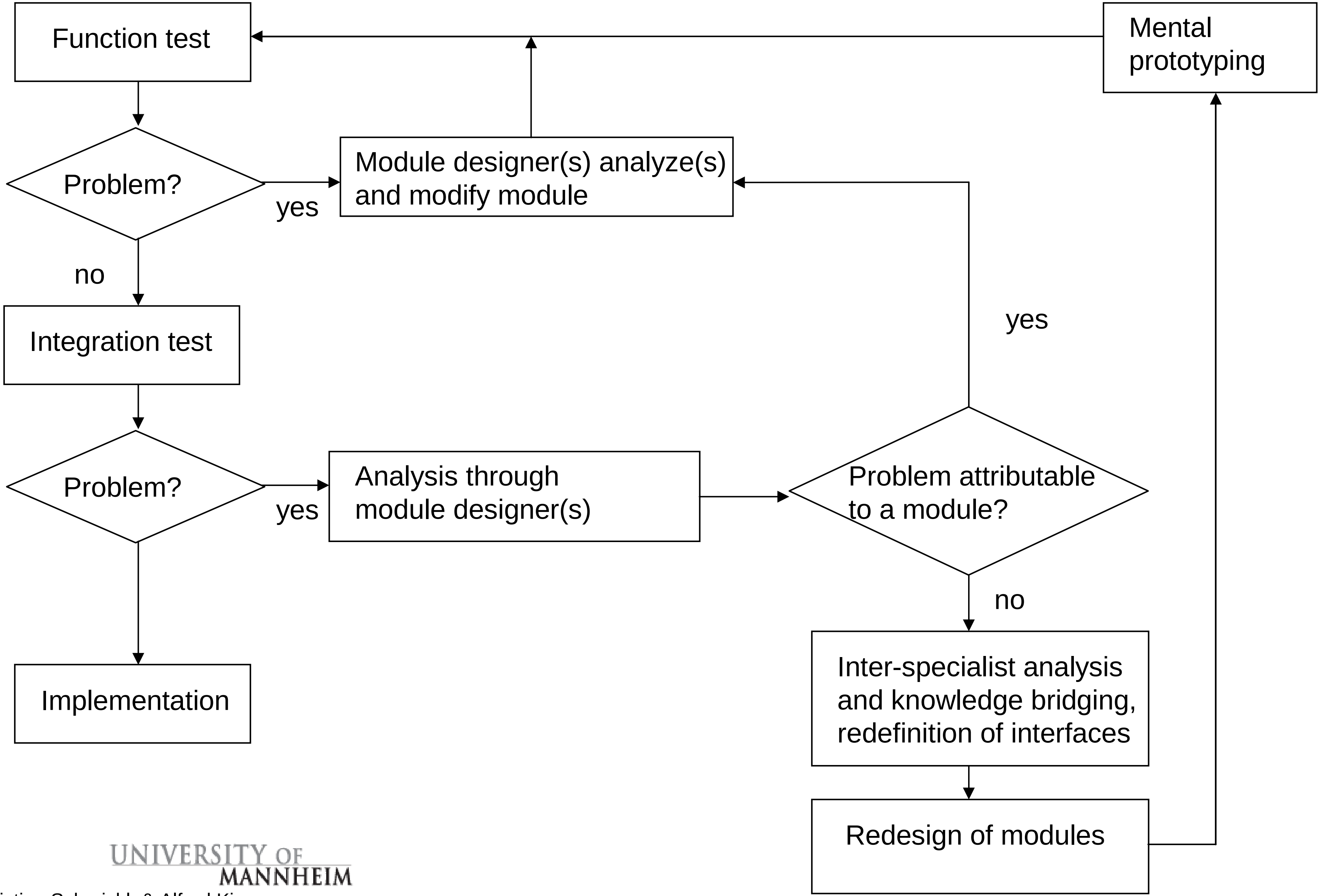
"One does not yet see [in the beginning of a project] so many things that might possibly cause real problems."

*"*We had some very, very tough requirements but we were not bound to existing solutions or existing components or standards or anything. From that perspective it was much freer, starting with a much more open solution space. Therefore I think we had more iterations and more tracks to investigate than would be normal."

Mental Prototyping



Virtual and Real prototyping



Interdisciplinary knowledge transfer is more comprehensive in highly innovative projects due to incomplete interface specifications.

"The interface has been defined from our side in such a way and it [our component] fulfils it [the interface requirements], the others have to be the cause. Such an approach does not make much sense since the interfaces are fluctuating anyway."

"Well, we agreed upon the subtasks and the interfaces. Then we provided [component B] and the frame. And the corporate Research Center provided [component A]. This we knocked together and we watched: are there any problems? And then we jointly solved the interface problems … . ***We discussed interfaces in depth: How can we integrate component A into the frame?*** *…. [T]he measurement engineers and … the designer were involved. And then we played around with different possibilities.*"

Interdisciplinary knowledge exchange is manageable through a trade-off between depth and breadth of knowledge.

" … if a problem pop up, one has to drill rather deeply [into the other developer's knowledge domain]."

6. Discussion and conclusion

TOL supported for highly innovative inter-disciplinary product innovations

However, some differences due to degree of innovativeness

Limitations:

- Small number of projects

- Only one company

- Concentration on generation of technological knowledge; neglect of innovations in functions like marketing or HR