

Study Participants & Data Collection

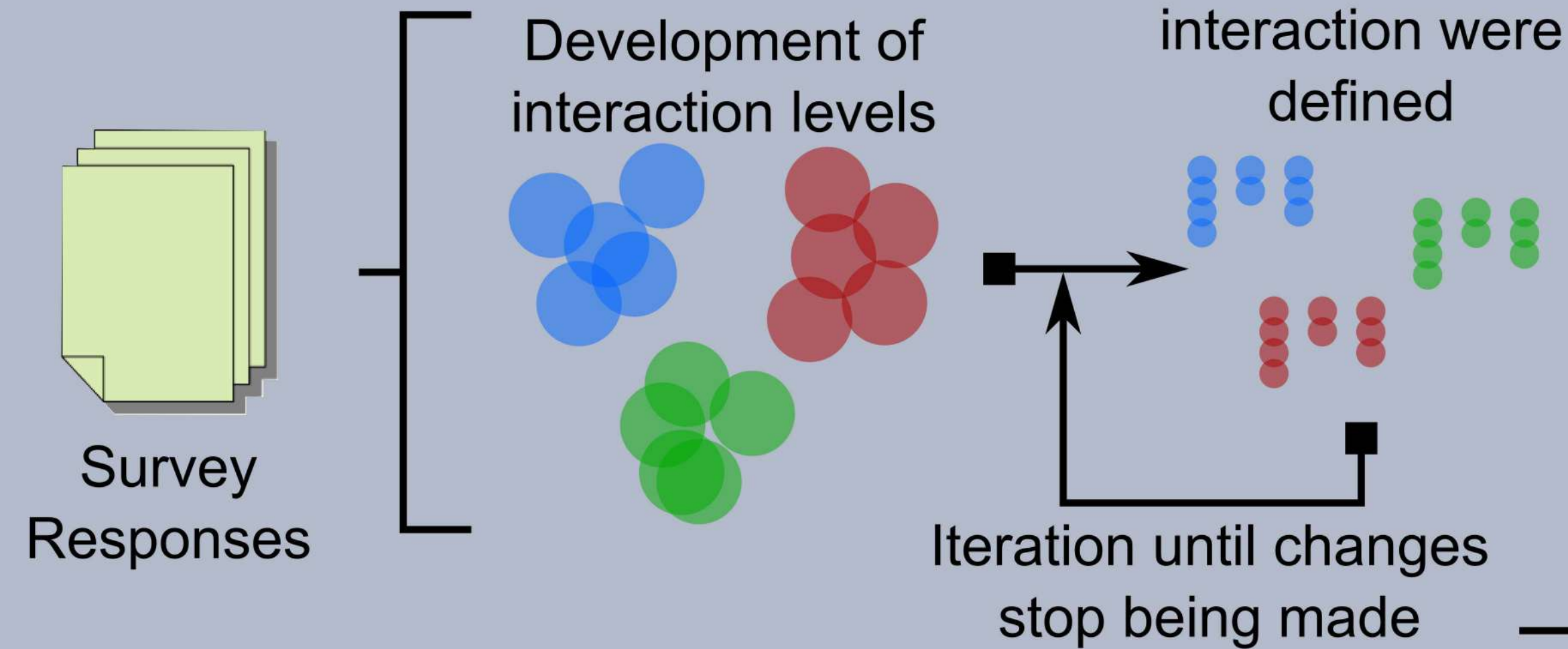
- Pre- and post-course open-ended surveys
- Four semi-structured in-depth interviews per team
- Eight senior capstone design teams were interviewed during the course of the semester
- Design teams consisted of between 4 and 5 senior engineering students (27 mechanical engineering and 1 biomedical engineering)

Design Teams			
Team 1	Team 2	Team 3	Team 4
Designed biomedical research equipment. Sponsored by professor.	Designed medical device for rural setting. Sponsored by professor's laboratory.	Designed mechanical engineering research equipment. Sponsored by professor's laboratory.	Designed consumer medical device. Sponsored by medical school doctor
Team 5	Team 6	Team 7	Team 8
Designed a medical training simulator. Sponsored by professors and medical doctors.	Designed a consumer medical device. Sponsored by professors and medical doctors.	Designed a diagnostic medical device. Sponsored by professor and NGO	Designed consumer product. Sponsored by company.

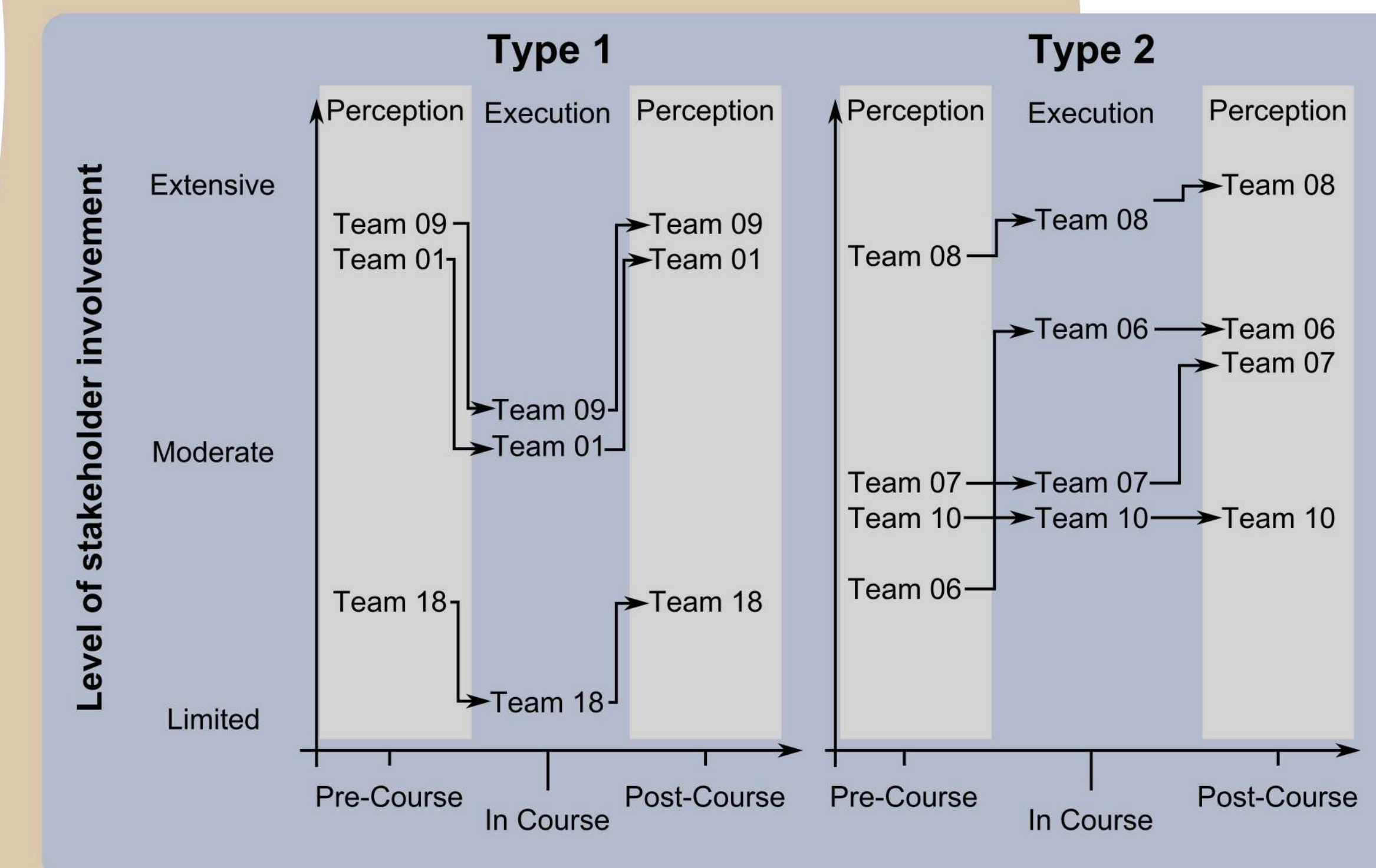
Example Survey Questions:

- What role do you think stakeholders should have during product design?
- Identify benefits to interacting with stakeholders when designing?
- Identify challenges to interacting with stakeholders when designing?

Data Analysis



Level:	Definition:
Limited stakeholder interaction	Students described a small role for stakeholders during design. Students mentioned few, if any, benefits to interacting with stakeholders during the design process.
Moderate stakeholder interaction	Students mention that interacting with stakeholders is beneficial during the design process. Students mention one to three specific design phases where stakeholders should play a role.
Extensive stakeholder interaction	Students describe a large role for stakeholders during the design process. Students did not restrict stakeholders to specific design phases, but describe their involvement as continuous during the design process.



Type 1: Students' interactions with stakeholders did not meet their pre-course expectations. Their perception of the appropriate level of stakeholder interaction during design remained unchanged.

Type 2: Students' interactions with stakeholders met or exceeded their expectations. Their perception of the appropriate level of stakeholder interaction during design tended to increase (3 of 4).

Team 1

Pre-course survey:
"I think stakeholders should play a pretty large role when it comes to product design. They are the ones who have the idea in mind of what the product should look like so it is important that they play a large role."

During course:
"A lot of it...was easy because [our sponsor] had a very clear idea of what exactly she wanted. She was pretty solid on her input of requirements."
"...there was some stuff that [the lab] kind of thought of late...they didn't really tell us about [it] until way into the designing process."

Post-course survey:
"It is important that all parties are on the same page when prototyping begins so that there are no unnecessary design changes that could waste time and money."

Team 7

Pre-course survey:
"[Stakeholders] should have primary input on user requirements. They should also be in an advisor role as the project progresses, giving feedback on if the engineering specs developed by the team satisfactorily fulfill the user requirements."

During course:
During the course, the team's concept was dramatically redesigned after obtaining feedback from end-users and proxy end-users on their original design. This feedback caused dramatic changes to their prototype and project plan.

Post-course survey:
"When a prototype is developed, it should be presented to stakeholders to determine its efficacy...Checking in with stakeholders during the design process ensures that the product is on track with their needs."

Team 6

Pre-course survey:
"Stakeholders should provide the requirements and some specifications of what they want in their design. They should be able to have input on design selection but should not have a say in between iterations of potential designs."

During course:
During the course, the team interacted frequently with their end-user and sponsor in order to guide their project. Their end-users included several graduate student researchers with conflicting wants/needs. The team used increased interaction to overcome these challenges.

Post-course survey:
"they should be able to have input on design selection ~~but should not have a say in between iterations of potential designs~~ and should be able to refine their expectations throughout the design process."

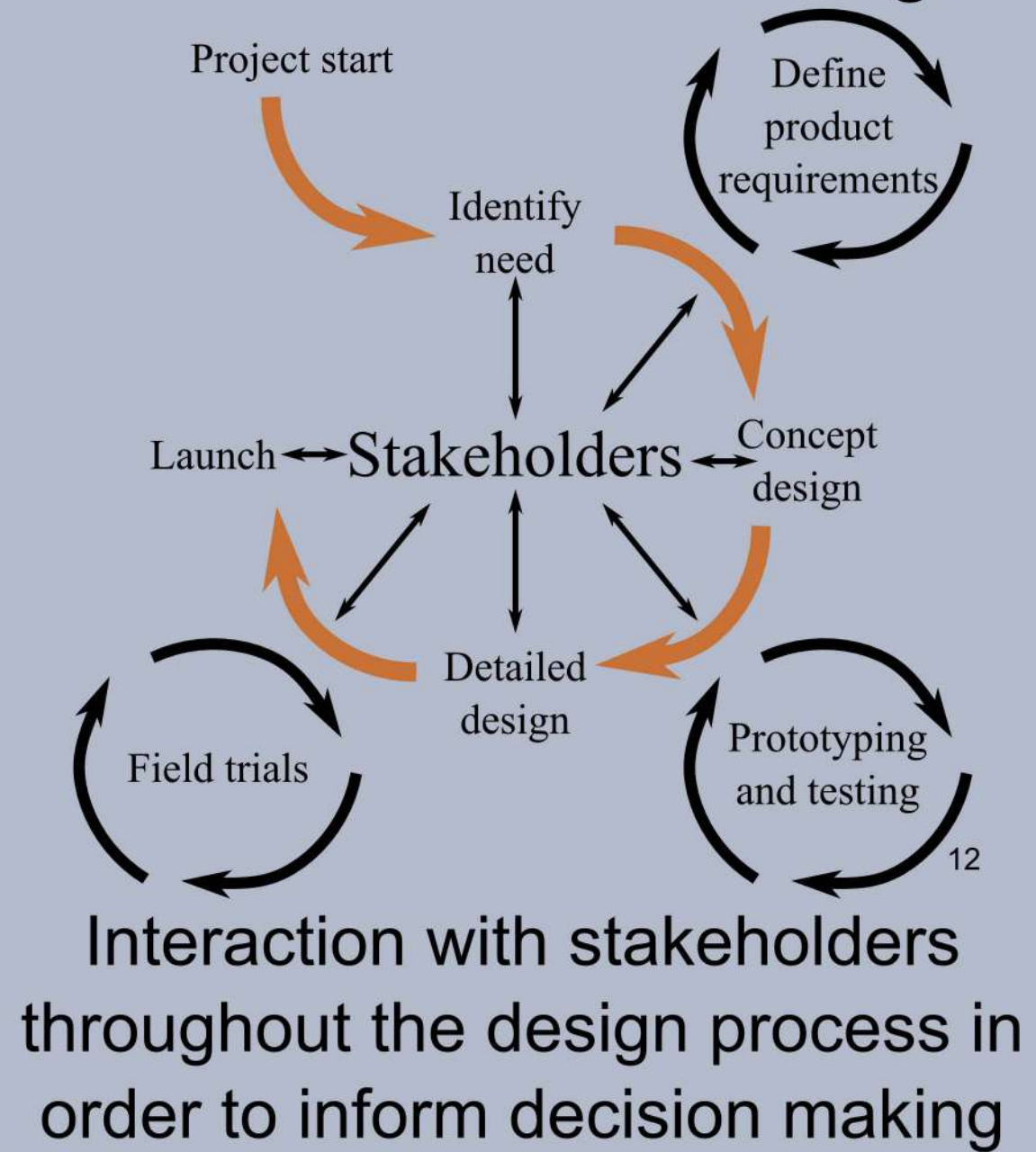
Research Questions

- 1) How do student perceptions of stakeholders differ before and after their capstone design experience?
- 2) How do factors related to students' design projects and their interaction with stakeholders during the design experience influence changes in their perceptions?

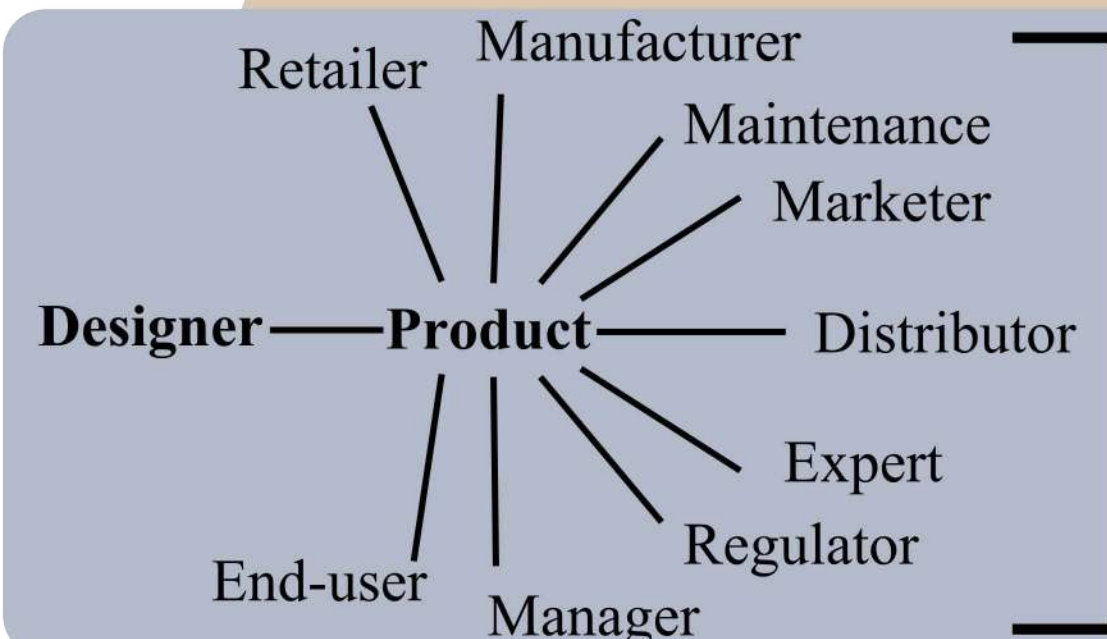
Stakeholder Interaction Methods:

- Interviews^{1,2,3}
- Focus groups^{1,2,3}
- Observations^{1,2,3}
- Surveys^{1,2,3}
- Quantitative data (e.g., sales data)^{1,2}
- Codes / standards^{1,2}
- Focus group brainstorming^{4,5}
- Consensus-building workshops^{4,5}
- Design ethnography⁶

Human-centered design



How can designers incorporate the needs/wants of diverse stakeholder groups?



Student perceptions of stakeholders during capstone design

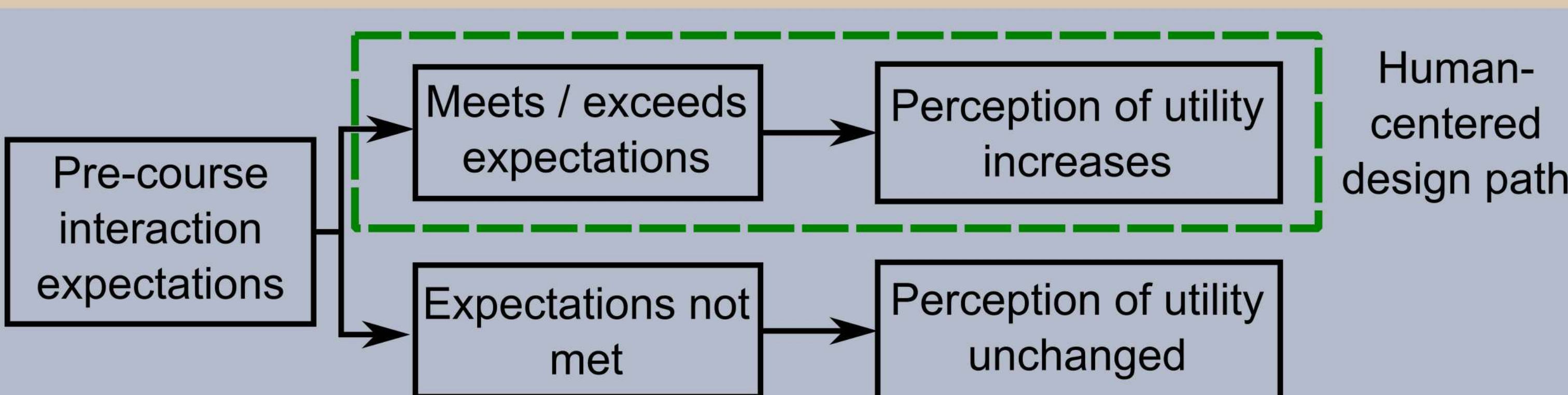
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How can design projects be formulated to guide students along this human-centered design path?

Project Attributes:

- Easily accessible stakeholders
- Clearly defined stakeholders
- Multiple key stakeholders
- Proxy-stakeholders
- Availability of end-user context
- Under-defined project

These project attributes were associated with design teams who interacted more extensively with stakeholders



Human-centered design path

References

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