Methodology: Idea Generation Session

Time frame: 60 minutes total

- Present case study
- Two individual idea generation sessions with focused topics
- Present ideas and conclusions

Purpose

- Investigate the feasibility and features of a virtual heart valve implant system, including:
  - Usefulness to clinicians for finding the best transcatheter aortic valve implant model, size, position, and orientation.
  - Accessibility to engineers to develop better implants.

Sorting Ideas

Similar ideas are combined and irrelevant ideas are filtered out.

Template

Used to elaborate on each idea.

- Idea name
- A description of the idea
- Why this idea is important?
- Characteristics that highlight importance or value of an idea
- Value: Estimated user value of the idea (linear scale)

Effort:

Estimated work effort (in hours)

Prerequisites:

Requirements for realizing the idea

Simplifications: How the idea could be broken up into smaller parts

Continued refinements: How to improve the idea

Organizing Ideas

43 ideas were documented and evaluated in detail with a focus on a Minimum Viable Product.

Minimum Viable Product

- Effort:
  - A description of the idea
  - Idea name
  - Computer science
  - Estimated user value of the idea

Organizing Ideas: All ideas are connected as dependencies or contributions, showing what ideas return the most value for the least effort.

Minimum Viable Product

- Effort:
  - A description of the idea
  - Idea name
  - Computer science
  - Estimated user value of the idea

Organizing Ideas: All ideas are connected as dependencies or contributions, showing what ideas return the most value for the least effort.

Transcatheter Aortic Valve Replacement (TAVR)

Procedural option for replacing an aortic valve in high surgical risk patients

- Utilizes a thin flexible catheter to deliver the implant with access through the femoral arteries, subclavian arteries or aorta

- Self-expanding or deployed by balloon expansion

- Imaging technology is used to ensure proper placement of the device

TAVR Complications

1) Paravalvular regurgitation – ejection of blood back into the left ventricle, due to prosthesis-patient mismatch

2) Coronary artery occlusion – native leaflet is displaced and occludes a coronary ostium, reducing the blood supply to the heart

3) Stroke – caused by embolic debris

4) Cardiac arrhythmia and permanent pacemaker implantation – implanted stent may interfere with the heart's own conduction system

Conclusion

- The idea connection tree provides a roadmap to pursue simulation features.

- Simulating and evaluating the stent sealing and apposition is of direct use to clinicians during preprocedure.

- Ideas could help engineers to design better sealing implants if they had multiple models of the human aorta

Future Work

- Review work with engineers who design TAVR devices to refine value of each feature.

- Add value by conducting more idea generation sessions

- Continue work on the virtual heart valve implant system, advancing to idea S1: Implant Deployment and then further on to S2: Native Valve Leaflet Replacement.

- Identify interaction devices to move models

- Conduct user studies of alpha prototype to identify additional ideas and features to implement within application.

- Develop a user interface for intuitive interaction with the models

Acknowledgements

Jointly funded by:

- National Science Foundation (114-1251096)

- National Institute of Health (R01EB018205-01)

- Medical Devices Center

Computing resources provided by:

- Interactive Visualization Laboratory

- Minnesota Supercomputer Institute

Anatomical models provided by:

- The Visible Heart Laboratory

References


