**BME 402 - Heart Phantom**

*Progress Report Week 7, 8 & 9 – 3/7/09 to 3/26/09*

*Team Members:*
Jessica Hause (Co-Team Leader)
Erin Main (Co-Team Leader)
Lacey Halfen (Communicator)
Peter Strohm (BSAC)
Fan Wu (BWIG)

*Client:*
Orhan Unal
*Advisor:*
Willis Tompkins

**Problem Statement:**

This project consists of designing a heart phantom to be used for the initial testing of a new, solenoid-tipped catheter awaiting FDA approval. This catheter will ultimately be used to treat atrial fibrillation under MRI guidance. The transparent phantom will be used to test the maneuverability of the catheter under MRI guidance as well as the high resolution imaging capabilities in the vicinity of the solenoid tip. It will consist of clear tubing of various sizes representing tortuous vasculature leading to a single heart chamber. All "veins" must terminate at one end of the phantom and be sealed so they may be filled with a saline solution in either a static or dynamic state without risk of leaking.

**Goals this Week:**

- Meet with client to discuss progress.
- Look into ordering tubing of different thickness for the large and small vessels. The larger vessels need to have tubing with a smaller thickness then the tubing that we purchased to improve flexibility and make attachment to polycarbonate easier. The smaller vessels will need to have an increased thickness to prevent kinking.
- Seal casing using acrylic glue and caulk. Also, seal all through wall connections between the acrylic and hard polycarbonate with acrylic glue.
- Connect all of the vasculature with snap-grip connectors.
- Test casing and vasculature circuit in a fluid filled static state to make sure that no leaking occurs.
- Flow and leak testing in vasculature circuit while device is connected to pump.
- Even out trim around heart by sanding. By doing this we hope that the o-rings will be able to be used to provide a leak-proof seal.

**Summary of Accomplishments:**

- Met with client to discuss progress thus far. Determined that we would need to sand down the trim around the heart to create an improved seal. A lathe could not be used because we were unable to obtain a good grip on the heart to use the equipment.
- Researched thin walled tubing for our 1'' diameter vessel (inferior and superior vena cava), however we were not able to find tubing that had a thinner wall thickness.

- Sanded down trim around heart to even out ridges in plastic from manufacturing. We were able to create a better surface so that the o-rings can be more effectively used to seal. When the seal was tested some leaking did occur on the inner o-ring. Caulk was then used on the inner o-ring to improve this seal, which when tested proved to be completely leak-proof.
- Connected hard polycarbonate to heart and sealed all connections using the acrylic glue.
- Connected all of the tygon tubing inside and outside of the casing using snap grip connectors for the small diameter vessels and zip ties for the large diameter vessels. Zip ties were used at manifold connections and quick disconnect connections. The connectors purchased for the larger vessels were too small, so zip ties were initially used. When the fluid circuit was statically filled, the zip tie connections leaked so larger diameter snap grip connecters were ordered and were used to replace the zip ties.
- Statically tested the entire circuit and casing by filling them with water. Both were completely leak proof.
- Tested our circuit in a dynamic state by hooking our phantom up to a pump. Were able to remove air from the circuit by venting through the catheter entry point. Leaking occurred at the manifold, quick disconnect and reducing connections. To remedy this zip ties used were replaced with snap grip connectors. Also, during testing some leaking did occur in the heart where the hard polycarbonate attaches to the acrylic.
- Re-glued at polycarbonate and acrylic connections. Added caulk around each of these connections to prevent any future leaking from occurring.

**Goals next Week:**

- Again test the phantom while connected to the pump to ensure that all leaks have been fixed.
- Determine the best method to remove air from the circuit. We have currently tired venting through the catheter entry point, but another method has come to our attention and we will need to look into this.
- Continue working on a way to solve the issue of kinking in the “pulmonary veins”.
- Arrange a time with client for testing in MRI.

**Project Difficulties:**

- As a result of the geometry of where the pulmonary veins enter the heart we are having issues with kinking of the tubing. Since the tubing that we are using is extremely flexible the kinks are still allowing for fluid flow, however they do prevent a catheter from passing through the area. We considered purchasing less flexible tubing (thicker walled), but we feel that kinking with this tubing could prevent fluid flow all together.

**Activities:**

| Date | Person | Activity | Time Spent |
|---|---|---|---|
| 3/10/09 | Peter, Fan, Lacey & Erin | Met with client to discuss progress and decided on method to smooth out edges around heart. | 1 hr |

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| 3/18/09 | Erin & Peter | Sanded down heart chamber, tested heart for leaks, attached polycarbonate to acrylic on heart and glued all through wall connections. | 2 hrs |
| 3/19/09 | Peter | Researched online for 1'' diameter tubing with a thinner wall. | 0.5 hr |
| 3/21/09 | Erin & Peter | Re-caulked and glued entire casing and began working out configuration of vasculature | 2 hrs |
| 3/22/09 | Erin & Peter | Connected all of vasculature using snap grip connectors and zip ties, tested circuit in a static state and found leaking at zip tie connections and ordered larger snap grips for 1''diameter connections. | 1.5 hrs |
| 3/25/09 | Team | Installed larger snap grip connectors, tested circuit with pump and added additional snap grip connectors to manifold and quick disconnect junctions. | 1.5 hrs |
| 3/26/09 | Team | Re-glued junctions between the acrylic and polycarbonate and caulked these junctions. | 1 hr |

**Team Hours:**

Weekly…….. 9.5 hrs
Total…….. 51.75 hrs

**Project Timeline:**

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|---|---|---|---|
| Jan. 18 - Jan.24 | | Project Selection | x |
| | | Contact Client | x |
| Jan. 25 - Jan. 31 | | Individual Research | x |
| | | Client Meeting | x |
| | | Brainstorm | x |
| | | PDS | x |
| Feb. 1 - Feb. 7 | | Finalize Design | x |
| | | Order Parts | x |
| Feb. 8 - Feb. 14 | | Construction | x |
| Feb. 15 - Feb. 21 | | Construction | x |
| Feb. 22 - Feb. 28 | | Construction | x |
| Mar. 1 - Mar. 7 | Midsemester Presentations (Mar. 6) | Midsemester Powerpoint | x |
| Mar. 8 - Mar. 14 | Design Notebooks (Mar.11) | Construction/Testing | x |
| Mar. 15 - Mar. 21 | Spring Break | Spring Break | x |
| Mar. 22 - Mar. 28 | | Construction/Testing | x |
| Mar. 29 - Apr. 4 | | Construction/Testing | |
| Apr. 5 - Apr. 11 | | Testing | |
| Apr. 12 - Apr. 18 | Engineering Expo | Testing | |
| Apr. 19 - Apr. 25 | | Testing | |

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| | | Poster |
| Apr. 26 - May 2 | Poster Presentation (May 1) | Poster<br>Final Report |
| May 3 - May 9 | Design Notebooks (May 6)<br>Final Report (May 6) | Final Report |
| | Peer and Self Evals (May 6) | |