

# Design, testing and calibration of a small syringe for use with a power injector

## Team Members

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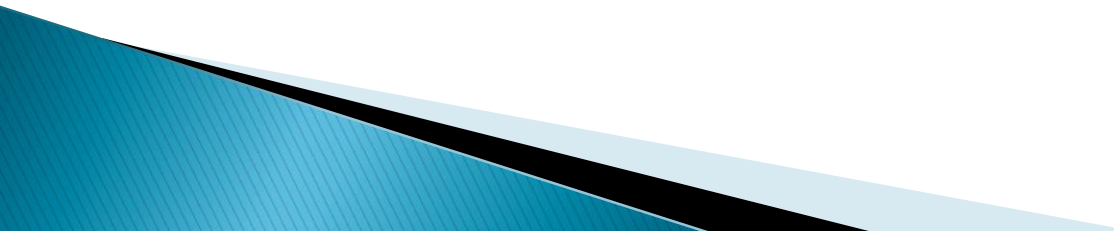
## Advisor

Professor Paul Thompson

## Client

Dr. Charles Strother

# Overview

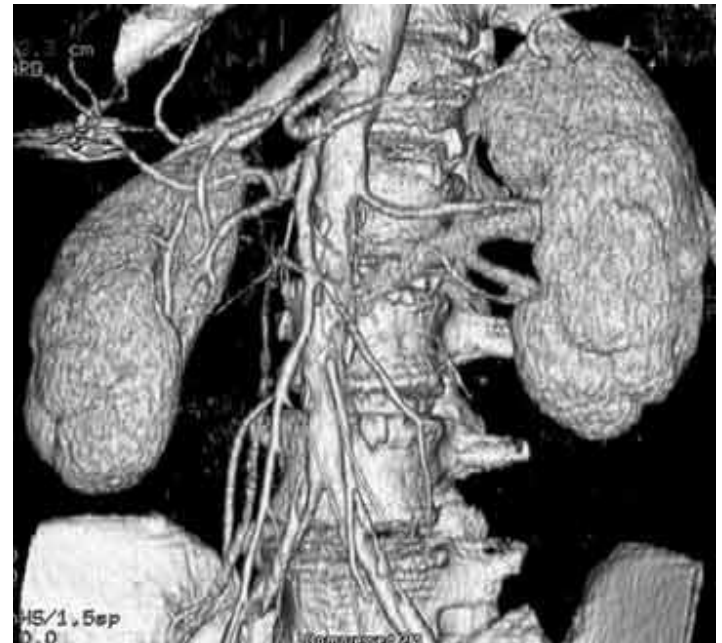
- ▶ Client Description
  - ▶ Angiography summary
  - ▶ Devices
  - ▶ Current treatments
  - ▶ Problem motivation
  - ▶ Design requirements
  - ▶ Design alternatives
  - ▶ Design matrix
  - ▶ Future work
- 

# Client Description

- ▶ Dr. Charles Strother
  - Department of Radiology
  - Angiographic research

# Angiography

- ▶ Visualization of blood vessels
- ▶ Imaging technologies
- ▶ Contrast agents
- ▶ Digital Subtraction Angiography



From: <http://radiologyinfo.org/en/info.cfm?pg=angiocr>

# Types of Angiography

- ▶ Catheter Angiography
  - X-ray imaging
  - Density variations
- ▶ Computed Tomography Angiography
  - Numerous X-ray images
  - Multidimensional views



From: <http://radiologyinfo.org/en/info.cfm?pg=angiocath>



From: <http://radiologyinfo.org/en/info.cfm?pg=angiost>

# Types of Angiography (cont.)

- ▶ Magnetic resonance angiography
  - Magnetic fields and radio waves
  - Redirection of axes of spinning protons
  - Thin slices from many angles



From: <http://radiologyinfo.org/en/info.cfm?pg=angiomr>

# Power Injectors

- ▶ Programmable for volume and flow rates
- ▶ Produces a tight bolus
- ▶ Precise timing
- ▶ Consistent results



From: <http://www.medrad.com/en-us/resources/KnowledgeCenter/Pages/WhatIsPowerInjection.aspx>

# Current Designs

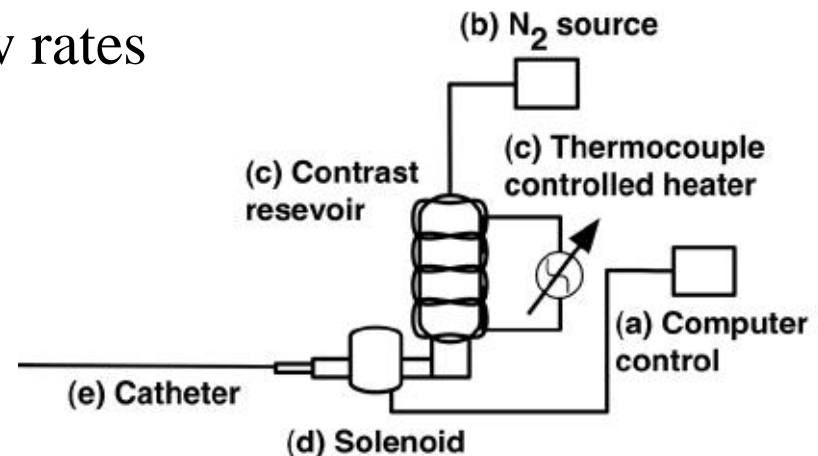
- ▶ **Hand Syringes**
  - Manually operated
  - Power limitations
  - Ease of use limitations
- ▶ **200 cc Syringes**
  - Battery operated power injectors
  - Efficient control over multiple variables
  - Too large for client's specifications





# Current Designs (cont.)

- ▶ Covidien Optistar LE MR Injector
  - 60 cc syringes
  - Volume still too large
- ▶ Digital Subtraction Angiography Micro-Injector
  - Used for small animals
  - Pressurized N<sub>2</sub> drives injection
  - Precise amounts at high flow rates

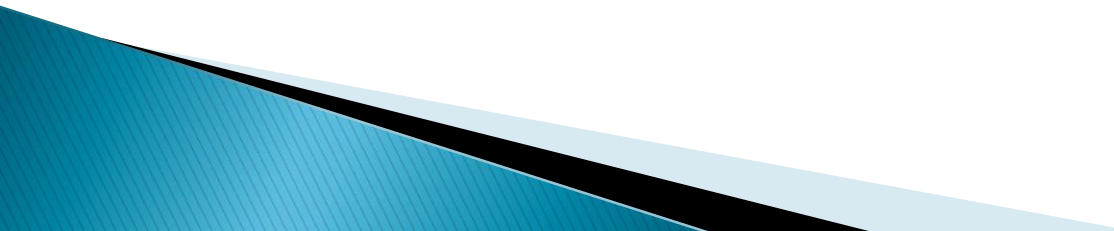


# Current Designs (cont.)

- ▶ Client Prototype
  - 1cc syringe fitted inside 200 cc syringe
  - Bubble problems
  - Lacks full range of motion
  - Not calibrated

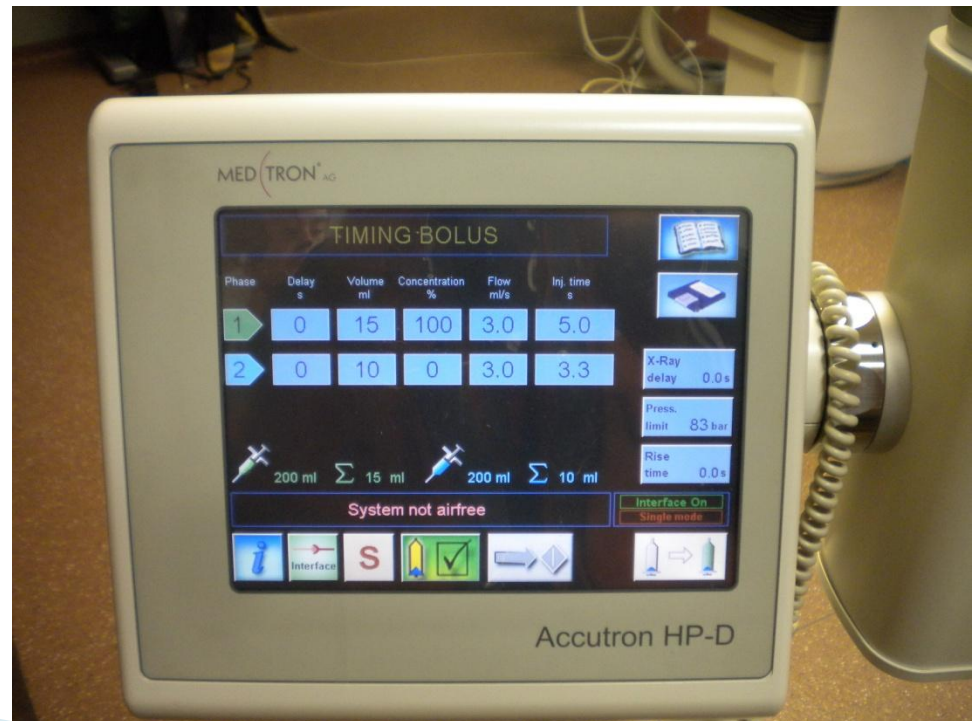


# Problem Motivation

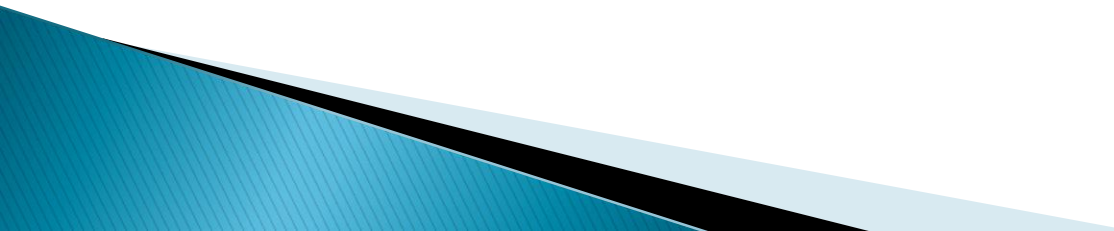
- ▶ Small animal angiography
  - ▶ Need for precision and power
  - ▶ Lack of calibration in prototype
  - ▶ Air bubbles pose threat
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# Design Requirements: Accuracy

- ▶ Margin of error
- ▶ Relation between compression and volume



# Design requirements: Utility

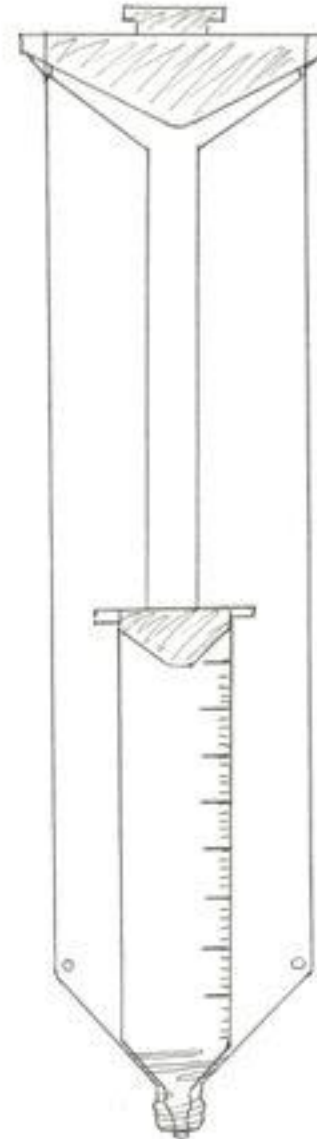
- ▶ Must be a retro-fit
  - ▶ Full range of motion for the small plunger
  - ▶ Easily cleaned, or disposable
  - ▶ Easily visible graduations
  - ▶ Air Bubbles
  - ▶ Cost
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# Design Requirements: Safety

- ▶ Latex-free
  - ▶ Safety-lock to prevent overdriving
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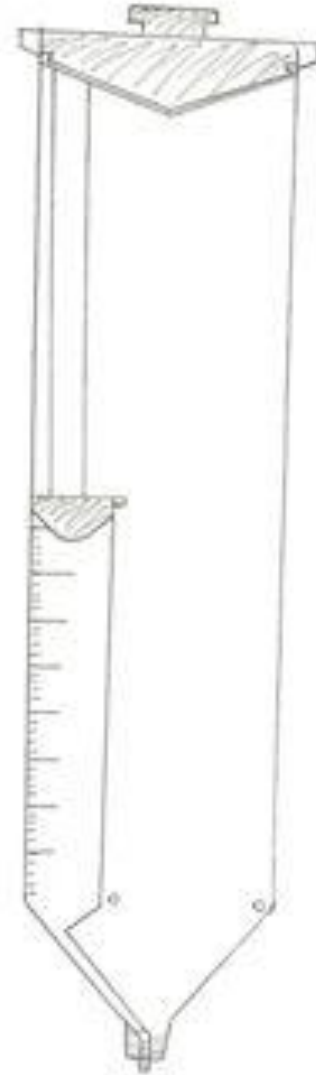
# Design Alternative: Center-Mounted Syringe

- ▶ 2 cc inner syringe
- ▶ Threaded screw-in system
- ▶ Centrally aligned
- ▶ Plunger slot mechanism
- ▶ Holes to prevent air pressure buildup



# Design Alternative: Side-Mounted Syringe

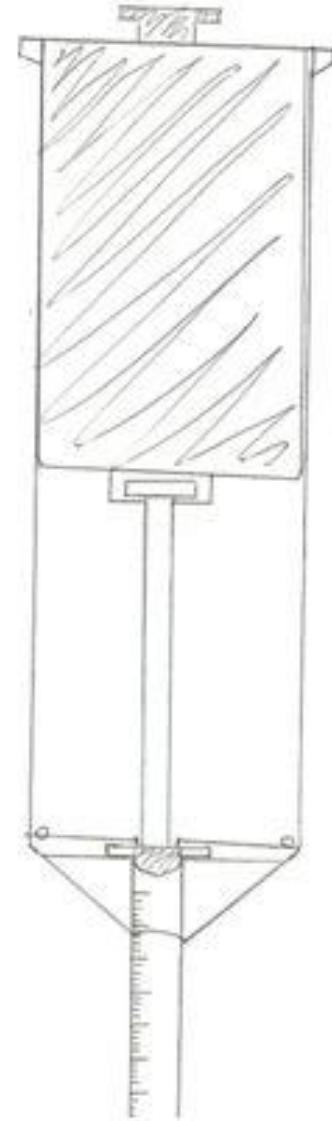
- ▶ 2 cc inner syringe mounted to side of 200 cc syringe
- ▶ Tubing connecting syringe to catheter tubing
- ▶ Slot for inner syringe
- ▶ Plunger slot mechanism
- ▶ Holes to prevent air pressure buildup





# Design Alternative: Protruding Syringe

- ▶ 2 cc inner syringe
- ▶ Protrudes from mouth of 200 cc syringe
- ▶ Twist-and-Lock mechanism
- ▶ Plunger slot mechanism
- ▶ Holes to prevent air pressure buildup



# Design Matrix

	Center-Mounted Syringe	Side-Mounted Syringe	Protruding Syringe
Accuracy (30)	22	25	29
Ease of Manufacturing (10)	8	5	5
Air Bubble Detection and Removal (25)	16	22	21
Compatibility with Machine (15)	14	10	12
Ease of Sterilization (20)	17	10	17
Total (100)	77	72	84

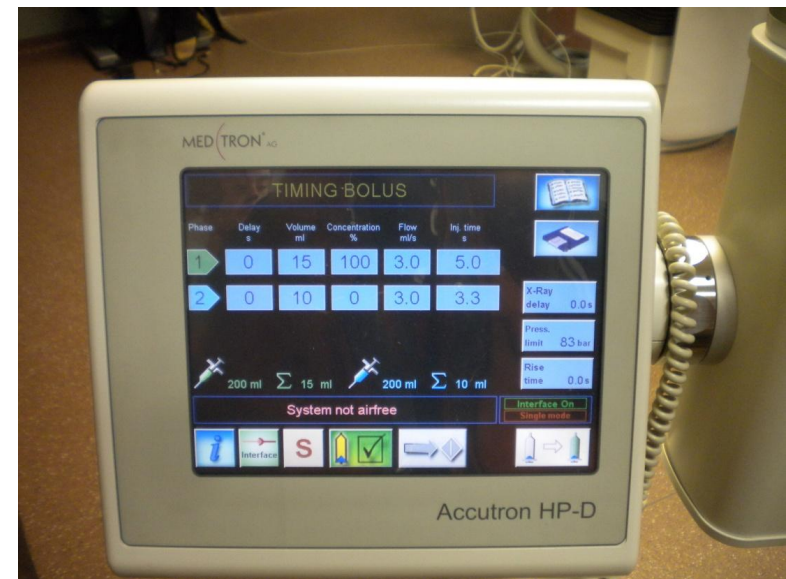
# Future Work: Materials to be Ordered

- ▶ 2cc Syringe
- ▶ Polypropylene
- ▶ Plunger adapter material



# Future Work: Calibration and Finalization

- ▶ Display reading vs. actual volume injected
- ▶ Instruction Manual
- ▶ Calibration tool or chart



# Acknowledgements

- ▶ Dr. Charles Strother
- ▶ Professor Paul Thompson

# Works Cited

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