# PhD. Proposal Outline:

**Literature Review –** reveal benefits and challenges in TEES

* Review of current instruments – challenges and advantages

**Needs Analysis Study –** survey to understand what tool functionalities are required during TEES to address these challenges (done)

**Time Flow Study –** understand the steps during surgery that take the longest amount of time and what tool limitations exist during surgery to inform the desired tool functionalities (in progress – REB is done)

* Hair trimmer – shaved just 30 seconds and this wasn’t significant enough
* Time flow of interchanging instruments and if there’s a multi-tool that could reduce this time
* Gives an understanding of the OR and surgeon’s needs and how the instruments work
* Time flow study wasn’t a feasible method of measuring cholesteatoma dissection due to many factors: patient anatomy, extent of disease, how firmly it is stuck and where it is stuck, how much bone removal necessary
* Could compare length of tympanoplasty vs. cholesteatoma surgery to show the data is heterogenous and this variance requires me to study thousands of patients in order to really show a difference
* Case volume of tympanoplasty and cholesteatoma
* Currently, use the Panetti short dissectors (left and right) and round knife, Rosen needle, Thomassin dissector

**Tool Design –** outline the design of an instrument to address these challenges (in progress)

* Tools that can reach currently on the market (ophthalmology tools)

**Tool Development/Prototyping –** outline how the tool was prototyped

* Nitinol mechanical properties that make the tip bendable

**Tool Validation –** is the instrument able to address these challenges?

* Clinical validation: survey for surgeons to evaluate the tool in a temporal bone model (in progress, (see instrument validation paper outline) REB is done for survey and using the CT scans to make models) (otology and neurotology paper)

Initial results of the surgeon survey, completed by ten participants of the TEES course in November, 2017.

* Mechanical testing – cyclic testing until fatigue, torsion testing, force to break tip (see ASME technical brief outline) (otology and neurotology paper or ASME design brief)

The following mechanical characteristics will be defined for the wrist: cyclic testing until fatigue, torsion testing, maximum force to break the tip.

Cyclic testing: as the tool is meant to be reusable, it needs to be robust thus if it can be actuated more than 10000 times without physical damage to the wrist, it is considered safe to use as a reusable tool.

Torsion testing: through the endoscopic ear surgery course in Toronto on November 30, 2017, instrument prototypes were tested in cadaveric heads by participants of the course – surgeons who wish to learn TEES skills and integrate them into their own hospital operating rooms. The instruments for the course were manufactured in house and the nitinol wrist was machined by the mill into rectangular notches, which are flexible but not as stiff as the contact aided compliant mechanism wrists.

Novel Contribution: Needs survey to understand the challenges faced during TEES, designing, building and validating a tool to address these challenge(s)

* Reaching test validation – this could be proposed as a methodology to use to test the efficacy of tools
* How are the proposed tools different/unique from current tools – in terms of functions and features
* Design for manufacturing (easier to manufacture) and design for sterilization (for reusable)
  + What is the basis for comparison between existing tools
  + This tool is different to manufacture and easier to machine?
  + How easy is it to sterilize this tool vs. current tools
  + How are current tools manufactured/sterilized and how expensive, time consuming, etc and how would the current tool do this/compare

Other Tasks:

* Provisional Utility Patent (by April 29, 2018)
* 3-4 papers
* March 12 asme conference – design of the tool + reaching test, technical description of the design (would have to see if that is public disclosure or not? Because of patent)
* OGS, NSERC