

EXECUTIVE SUMMARY

In developing countries such as Ethiopia, Intrauterine Device (IUD) insertion training is done through the use of 2-D vaginal models. However, these models rarely provide adequate training, and medical professionals are forced to seek less reliable methods. We were tasked with creating a low-cost, anatomically correct IUD insertion simulator that accurately models the procedure.

We conducted background research with the aid of published medical papers and anatomy textbooks, in addition to meeting with physicians from both the University of Michigan and Ethiopia. We then pinpointed user requirements for our simulator. The main requirement was for the simulator to accurately represent the procedure, meaning having all organs relevant to the procedure and materials with realistic characteristics. The other main requirement was the ability to provide feedback on the placement and alignment of the IUD.

Concept generation began by first creating a functional decomposition of the IUD insertion procedure. Using this, we created subassemblies in which we could generate concepts on: the placement and alignment of the IUD, a mechanism to simulate the displacement of the uterus, the material for our simulator, and what our simulator will look like. We have generated roughly 15 concepts for each subassembly and selected 4 to 5 feasible designs. We used a decision matrix and rated each concept on a scale from 1 to 3 in regards to how well they fulfilled our weighted user requirements. These scores were summed together and an optimum design selected. We merged these concepts into one fluid design and created a rough mock up.

Using the generated concepts, we designed, built, and assembled our prototype. This prototype simulator included a see through cervix and uterus to provide visual feedback to the user. This was accomplished by using SORTA-Clear® transparent silicone as well as the use of clear acrylic for the casing. The vaginal canal was created using Ecoflex® silicone. The selected silicones' properties allowed the simulator to provide accurate tactile feedback. Through the use of springs and a guide rail system for the uterus, the insertion procedure was able to be replicated allowing the uterus to be pulled back 1 cm under 1-2 lbs of tensile force.

This prototype was then validated against the engineering specifications we had laid out earlier in the design process. This validation included having experienced medical professionals perform the procedure on our prototype and provide general feedback in a survey. We also had medical students perform the procedure and fill out their own survey. This validation process confirmed our proof of concept that the simulator accurately modeled the procedure and that the see through aspect of it provided enhanced educational opportunities. Our prototype did not meet the given affordability engineering specification. This led to changing the material of the casing in the final design to clear PVC to meet costs restraints.

The final design provided in this report is an easily mass-produced, anatomically correct simulator that is affordable and viable in developing countries. Based off of the validation surveys and feedback of numerous medical professionals here at the university, we believe this simulator exceeds our user requirements, and can be an extremely useful training tool in developing countries worldwide.