AIDS Awareness: Male Barrier Demonstration Apparatus

Designed For Use in Third World Countries

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05/08/2009

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1. Abstract:

The topic of condoms has often been viewed as taboo, a critical problem in third-world countries with devastating rates of HIV infection. While there are countless advocates for their usage, there remain many misconceptions and myths about their characteristics. The client, Marge Sutinen, requires a teaching tool that demonstrates the strength of a male barrier by measuring the weight it can hold until breaking. The goal of the prototype is to disprove these myths while emphasizing the capacity and elasticity of male barriers. The final design utilizes a scale and clamp system, with copper-plated lead pellets delivered into the condom via a funnel and tubing. Upon breaking, the falling pellets are caught by a bowl lined with canvas, limiting pellet scatter. Four main categories of condoms were tested: lubricated latex condoms, non-lubricated latex condoms, lubrication-spermicidal condoms, and polyurethane condoms. The polyurethane condoms did not stretch under the weight of the pellets, and therefore were unable to be demonstrated with the device. Both latex varieties stretched the full length of the device, though the lubricated condoms didn't have a localized pellet distribution like the non-lubricated, and thus scattered more easily upon breaking. This prototype clearly and effectively demonstrates the surprising physical qualities of condoms.

2. Background:

Our client currently teaches a class at UW-Madison titled "Contemporary Issues on HIV/AIDS." She is looking for a demonstration tool that could be used to educate students about the effectiveness of condoms, stemming from a presentation that Mrs. Sutinen had earlier performed. The presentation consisted of funneling lead pellets into a condom supported by a ring clamp. The venture was rugged, as she had simply used discarded resources that were available from a friend's lab. One of her colleagues, Jenny Page, a biology teacher in South Africa, witnessed Mrs. Sutinen's demonstration and took the idea to South Africa. There, the presentation had even more of an impact, as the stigma and myths surrounding condoms and HIV are extremely exaggerated. Mrs. Sutinen plans on sharing the device with Mrs.Page to spread the message of protection to South African students at risk for HIV. Sutinen will also re-introduce her students to the demonstration using the new prototype. Even though the United States population is much more aware and informed about condoms, people are still uncomfortable talking about protection. Mrs. Sutinen believes that the demonstration tool would be an excellent way for her students to debunk myths about condom strength and encourage discussion about condoms and protection amongst their peers.

3. Motivation:

Over one million Americans are living with HIV/AIDS today; worldwide the figure tops 33 million (AIDS.GOV, 2008). In South Africa, the epidemic is extremely severe. In 2007, approximately 5.7 million South Africans were living with HIV; almost 1,000 AIDS related deaths occur every day (Pembrey, 2009). Currently, the only physical protection against the disease for sexually active individuals is male and female condoms. When using a male condom correctly, an HIV infected person has an 85% less chance of infecting his or her partner than one who does not use a condom (HSS.gov, 2001). Despite their extreme importance, there are numerous myths and taboos against condoms, especially in areas like South Africa where the disease is very prevalent (Sutinen, 2009). Although there is a great deal of effort going into educating people about condoms, there are stubborn wide-spread rumors that condoms do not help in the fight against HIV. This was made all the more obvious when Pope Benedict, addressing a crowd in Yaounde, Cameroon, announced to a crowd that not only do condoms fail to prevent the spread of AIDS, "On the contrary, they increase the problem" (The Independent, 2009). In response to such resistance against condoms, it is necessary for sex-educators to resolve social stigma surrounding condoms and dispel common myths.

4. Project Assignment:

To design a portable teaching tool to demonstrate the strength of polyurethane and latex barriers, using weights and a scale.

5. Client Specifications:

Upon meeting with our client, general guidelines were laid out to assist with the direction and focus of the project. The following guidelines can be seen below:

- Presentable –This tool needs to better teach the effectiveness of male barriers. The model will be the focal point of presentations, and for that purpose, needs to be very presentable. This includes being viewable (especially from the back of the classroom) and being aesthetically pleasing.
- User-Friendly – The students in Mrs. Sutinen's class will be the ones using this device the most – their task is to teach a presentation to the rest of the class about the strength of male barriers using our device. Some of these students may or may not have much technical experience and skill; therefore, this design

must be as intuitive and simple as possible. The possibility of this device being used in third world countries must also be taken into consideration, and provides further incentive to create a device that is easy to teach and easy to use.

- Portable – This issue was stressed by the client to be a very important feature. Making this device portable allows for its use anywhere, including outside of the U.S. For the current design, portability is necessary to allow for easy transfer to different classrooms on campus or even other school districts. This issue of portability will be discussed later in both the design constraints and design matrices.
- Affordable – Though not as important of an issue as the preceding three, cost is a limiting factor in terms of the quality of the parts purchased. For example, though a very expensive and thus very accurate scale would be ideal, the purchase choice must reflect the limited budget, which was proposed at $100.00. This figure saw an increase due to the necessary purchase of lead pellets. Overall, the cost reflects the desire to have a quality (but not extremely technical or detailed) product that could be easily reproduced if need be, a notion which summarizes the final guideline.
- Reproducible – If the client feels the for more prototypes to be used in her work, they must be made quickly and efficiently. The model should reflect this sentiment in its relatively easy and streamlined construction aspects.

6. Design Constraints:

Constraints apply specifically to three different areas of our design: the scale, the clamp, and the structure. There is some overlap between the three areas, but most constraints can be confined to just one.

- Structure: The structure has the most functionality of the three designs. First, it must be able to support the weight of the scale, clamp, barrier, and lead shot. Testing has revealed that the maximum weight a condom will hold is around eight pounds, so the structure must be able to handle this. Since this demonstration tool will be used repeatedly, the structure has to be sturdy enough to withstand this as well. In addition, the whole structure (and all parts associated) must be able to disassemble and fit in a suitcase to be transported. Similarly, we must have the structure be at least 4 ft. in length to account for the condom stretch. In short, we must have a main structural element that can reach a substantial height while still having the capability to compact and be disassembled. The assembly of the model must be intuitive, and ideally will not take much time. Finally, the structure must be aesthetically pleasing, as it will be used as the focal point in a classroom demonstration.

- Scale: The scale is more or less the most interactive part of the entire design. It is the part that students will be most able to relate to, and conveys the general purpose of the model. Because of this, it is most important that this be readable (even from the back of a classroom), and that it places an emphasis on presentation. It is not as important for the scale to be incredibly accurate, as the client is looking more for a "wow factor" than an exact, quantitative measurement. Plenty of expensive devices exist to test condoms to a high accuracy. These are mainly used to in industry, and utilize air to inflate the condom and check for perforations (T.W Hamilton, 1992). Another company, Enersol Medical, has a wide variety of machinery that tests for leaks and tests the tensile strength of condoms. (ENERSOL, 2009) However, other than statistical data, there is no real emphasis on demonstration. Our prototype fills in these gaps, giving a visual demonstration that is easy to understand, and combines both statistical data and a visual aide to convey the concept.
- Clamp: It is imperative that we make this clamp as intuitive and simple to use. Loading the lead pellets must be straightforward, meaning that it should be easy pout pellets in once the condom is attached. This clamp needs a loading mechanism so that pellets don't spill during presentation. Likewise it should be simple to clamp the barrier in place, without tearing the material and causing it to rip prematurely.

7. Ergonomics and Human Factors:

The topics of usability and accessibility do apply to many aspects of our design. The fact that our device could be used by nearly anyone (not just someone with specific training or in a specific profession) as a teaching tool provides encouragement to make it as user friendly and accessible as possible. Each of the seven principles of universal design applies to the product, some more so than others. An important focus for us is equitable use – nearly every adult should be able to use the product, as there is low physical effort required (lifting of ~10 lbs or less), and design is symmetrical in nature and easily accessible from all angles, eliminating the preference for handedness. One foreseeable problem is the height of the device. Since the barrier may stretch up to four feet, our stand includes adjustable, telescoping poles that reach this height. If placed on a table for easy viewing, it may be difficult for a very short person to access. If need be, however, the device could be placed on the floor, and this eliminates the height issue. Secondly, our design must be intuitive and simple to use. In the design matrices this aspect has high importance, and we incorporated this accordingly. Our design is intended to be portable, and will therefore require assembly. In addition, the clamping mechanism may not initially be intuitive. Our solution for this is to provide first-hand instruction to the clients, who will in turn use this device to teach classes about male barriers and the HIV/AIDS epidemic. Our hope is that assembly will take no more than a few minutes, and that we will be able to completely convey how to use this device to teachers in a similar amount of time. Finally, paramount to all other issues is that of client safety. In the early stages, there were concerns about what would happen when the barrier broke. As we found out from previous trials, the pellets more or less stay localized and do not scatter; however, later trials suggested that the barrier broke at the tip and had the potential for pellets to scatter. To counter this, a bowl lined with canvas was placed at the bottom. This aspect will receive further implementation in the future to make reducing the pellet scatter more effective. It is suggested that the demonstrators wear gloves when pouring the pellets, just as a precaution. Following these guidelines assured the construction of a safe device that is intuitive, accessible, and aesthetically pleasing.

8. Design Choices:

Since we have too many constraints to contain in just one design matrix, these three aspects instead comprise our three design matrices. The following material contains our three design matrices for the scale, clamp, and structure; it includes explanations of our options for each, as well as our final choice and reasons for this.

a. Scale Choice:

As can be seen in the design matrix below, our choices for scale include a digital display, an analog display, or a force transducer module. Our categories were weighted according to their importance: readability was our primary concern for reasons outlined earlier in the paper. Cost and portability were nearly equally important; scales can potentially be very expensive, and this weighting reflects that. Also important, though somewhat of a secondary factor, is the aesthetics of the device. In short, we wanted a scale that looked presentable. Accuracy was not a huge determining factor in our matrix, as it is not the main focus of this device. We surmised that any scale we would use would be adequate in terms of accuracy.

Digital Display:

A digital display one of the first choices to come up while brainstorming ideas. Digital displays of the scope that we needed are commonly used in fishing to weigh the fish. They are compact, and some models are not terribly expensive.

Figure 1: Digital Scale

- Pros

-Small enough to be portable
-Affordable
-Digital easier to read than analog

- Cons

-Display often too small to read from far away
-More functional than visually pleasing
-Needs batteries or other power source to run

Analog Display:

The analog display shines in the areas of cost and readability. Though some analog displays can run incredibly high, there are some models that are relatively inexpensive and perfect for our purposes. In addition, the dial and numbers of an analog scale are generally large enough to be seen from far away.

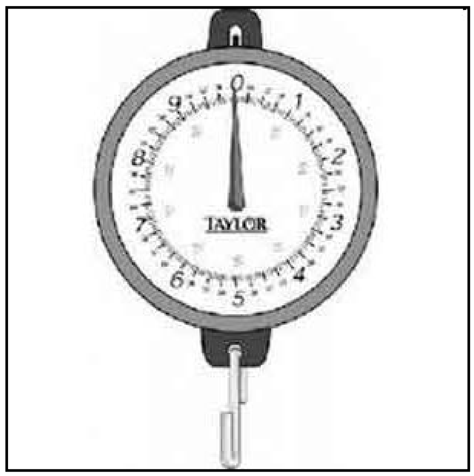

Figure 2: Analog Scale

- Pros

-Very affordable
-Easy to read from afar
-Sleek design
-No need for any power source

- Cons

-Could be cumbersome during transport
-Not as accurate as other models

Force Transducer:

The force transducer would be by far the best choice for this device, but unfortunately, the price of a force transducer far surpasses the confines of our budget, to the tune of$300.00 and up (Transducer Techniques, 2009). In general, such a sophisticated piece of machinery would not make sense with the scope and purpose of our device.

Figure 3: Force Transducer

- Pros

-Easy to read, presentable
-Very Accurate

- Cons

-Very Expensive
-Many parts; hard to transport
-Needs access to electrical power source

Decision Matrix – Scale Choice:

Scale	**Digital display**	**Analog Display**	**Force Transducer**
Cost (12)	7	**11**	1
Readability (15)	8	**11**	13
Aesthetics (8)	4	**6**	7
Accuracy (4)	3	**2**	4
Portability (11)	10	**9**	6
Total	32	**39**	31

Figure 4: Scale Decision Matrix

b. Clamp Design:

During the clamp design process, our most important objective was to ensure that the structure could securely hold a condom without creating points of concentrated strain that would lead to unpredictable ripping. Another important consideration for the clamp design involves the ease of set-up. Quick and simple assembly is required in order to cater to efficient classroom use and also to inexperienced users. Also, the clamp must be sturdy enough to undergo repeated demonstrations that involve it supported up to ten pounds.

<u>Design 1: Bicircular Clamp</u>

Our first clamp design consists of two circular shaped pieces of metal connected together by small rod that can be adjusted with a screw – type mechanism. To use this clamp, the user would insert a metal ring into the top of the barrier, align the ring with the clamp, and then tighten the structure holding the condom in between the metal pieces. Ideally, we would coat the metal pieces with rubber or a similar material in order to create a better seal to the condom and prevent tearing.

Figure 5: Bicircular Clamp Illustration

- Pros

-Tight seal around condom
-Decreased concentrated strain in condom
-Only one part requires adjusting/tightening while attaching condom

- Cons

-May be difficult to line up metal ring with the circular pieces of clamp
-Several pieces to manufacture

Design 2: Tripoint Clamp

Our second clamp design consists of a solid, circular structure that carries three small “pinch” clamps at the bottom end. These clamps would be attached directly to the condom, creating three points of contact. A hole would be drilled down the middle of the structure in order to allow for the loading of lead pellets.

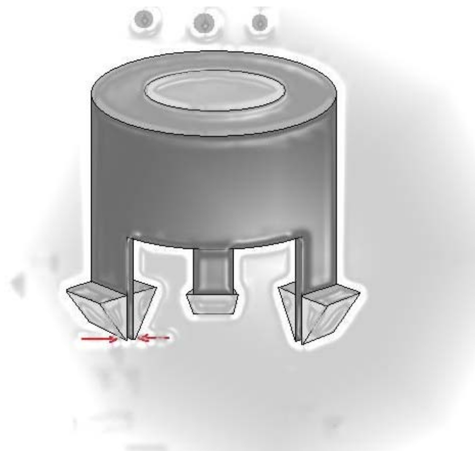

Figure 6: Tripoint Clamp Illustration

- Pros

-Easy to attach condom
-Sturdy Structure

- Cons

-Difficult to manufacture
-Produce concentrated strain on condom through points of contact
-High cost

Design 3: Monocircular Clamp

Our final clamp design consists of a single ring, made out of a slightly more pliable metal, and an adjustable screw mechanism at one point to complete the ring. Similar to the first design, the user would insert a circular, sturdy metal piece into the top portion of the condom, slip the clamp over top of the ring, and tighten the screw with the condom between the two ring structures. Again, the metal pieces would ideally be covered in a rubber – like material.

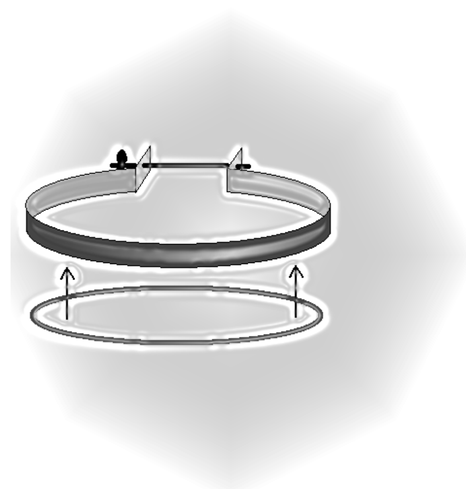

Figure 7: Monocircular Clamp Illustration

- Pros

-Decreases strain on condom
-Simple design
-Easy to assemble

- Cons

-Requires use to line up system of rings

Decision Matrix – Clamp Design:

Clamp	Bicircular	Tripoint	Monocircular
Cost (4)	3	1	**4**
Loadability (10)	9	5	**8**
Ease of Setup (12)	7	10	**8**
Manufacturability (12)	8	6	**10**
Material Compatibility (12)	10	4	**9**
Total	37	26	**39**

Figure 8: Clamp Decision Matrix

c. Structure Designs

The final component of our design to be individually analyzed is the basic structure of the apparatus. As the demonstration will likely take place in front of classrooms, the structure needs to be tall enough to be visible to all students. Also, it must be large enough to accommodate a condom that is fully loaded with lead pellets. Another important consideration in this design it's stability: it must be able to accommodate approximately ten pounds of weight that will be sitting at different points at different times during the loading process, creating different centers of gravity.

Design 1

The first design consists of a solid base and a telescoping rod. Because the rod can be compacted, it allows our structure to be more portable. The scale would be fitted to attach to the upper end of the rod.

- Pros

-Portable
-Easy to manufacture

- Cons

-Not overly stable
-Less area to attach additional features

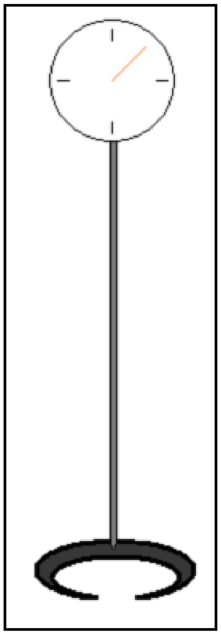

Figure 9: Single Pole Structure

Design 2

The second design is similar to the first, but consists of two telescoping rods instead of one.

- Pros

-Portable
-Easy to manufacture
-Stable from side to side

- Cons

-Could be more stable with front to back motion

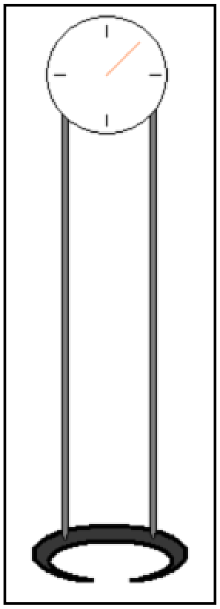

Figure 10: Two-Pole Structure

Design 3

The third design under consideration includes a Plexiglas box on which the clamp and scale would be stationed. A five sided box would be manufactured with an open top, which would be fitted with a specialized piece of material designed to house the clamp and support the scale.

- Pros

-Aesthetically pleasing
-Sturdy

- Cons

-Expensive
-Not portable

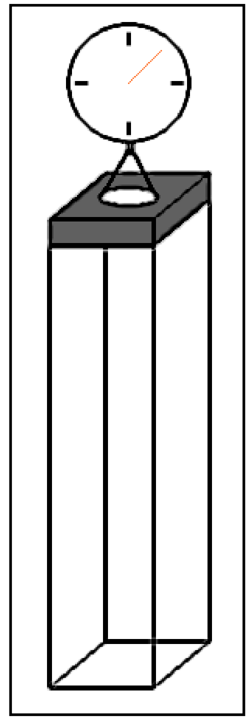

Figure 11: Plexiglas Box Structure

Decision Matrix: Structure Design

Structure	1 Pole	2 Poles	Plexiglas Box
Cost (10)	10	**8**	4
Portability (10)	10	**10**	3
Aesthetics (10)	6	**7**	10
Stability (10)	3	**7**	9
Manufacturability (10)	9	**9**	4
Total	38	**41**	30

Figure 12: Structure Decision Matrix

9. Results:

Our final design was comprised of three main features, each chosen from their respective design matrices. Based on the matrices, we chose to implement an analog scale, monocircular clamp, and a two-pole structure. These parts were then integrated using various mechanisms that would allow for portability and maintain aesthetic appeal.

Scale:

An analog scale was purchased in order to display the weight held by the condom. Although this scale had a two revolution weight capacity of 20 pounds, we only needed the maximum weight to be 10 pounds. Therefore, the audience does not need to keep track of the number of revolutions during the presentation. This scale provides a large display that would be visible from a distance (Fig 13). Compared to a force transducer or digital scale of the same size, this was a cost-effective option. This type of scale also does not require batteries or electricity, an attribute especially important as the design will likely be used in areas where electricity is not readily available.

Figure 13: Analog Scale Choice

Clamp:

A clamp of similar structure to our design was purchased. The clamp is circular and contains a screw-mechanism for tightening and loosening, with a range of ¾ - 1 ¾ inches in diameter. A large, yellow handle is present to ensure easy adjustment. The clamp is lined with a layer of rubber in order to reduce stress on the material caused by the clamp itself.

Figure 14: Clamp and PVC Tube Mount

A PVC pipe was cut, drilled, and coated with a textured paint in order to help grip the condom. The demonstrator places the pipe inside the top of an unrolled condom and tightens the clamp around the outside. Rigid wire was placed through the holes drilled into the pipe. The wire can then be hooked to the bottom of the scale, connecting the scale to the clamp system. This mechanism provides a simple, quick, and effective method for connecting the condom to the scale (Fig. 14).

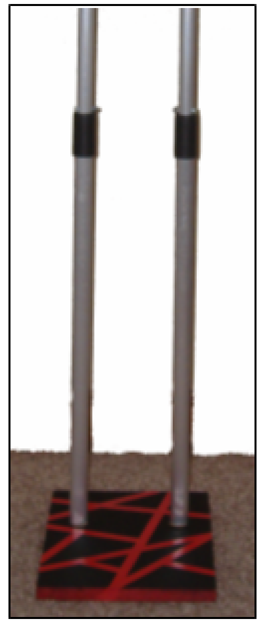

Figure 15: Telescoping Poles and Base

Structure:

The base consists of a rectangular piece of wood and two telescoping aluminum poles. The wood was cut to be 8x11 in. Two holes with a diameter of 7/8 inches were drilled 1 inch off center (at the 4 ½ inch mark) in order to account for a center of gravity which is slightly forward due to the scale and clamp placement. In these holes were places wooden dowels with a base diameter of 7/8 inches. Beyond the base, the dowels were manually sanded to a size that would fit inside the bottom of the hollow aluminum poles. With the dowels in place in the base, the lengthened aluminum poles, with a maximum height of four feet, can be slipped overtop and kept upright. This set-up allows for easy assembly and maintains portability (See Appendix B). Upon noticing a flaw in the poles that would, with time, prevent them from being extended, screws were placed half way up the poles to keep them in place. As the screws are removable, the telescoping ability is maintained.

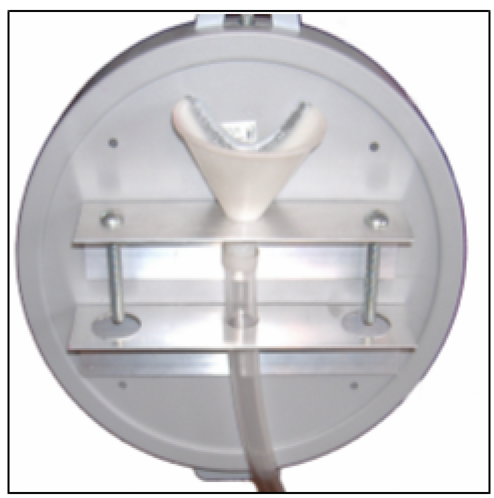

Figure 16: Loading Mechanism and L-Brackets

Integration of Scale with Structure:

A 6-foot long “L-shaped” aluminum was purchased, from which was cut two 6 ¾ inch pieces. Two holes with a diameter of .9375 inches were drilled into one of these pieces in order to allow the aluminum poles to pass through. Another smaller hole was drilled to accommodate tubing coming from the funnel. The other "L" piece was fitted with two screws, which insert into holes at the top of the poles in order to provide additional stability. Another hole was drilled to provide a place for the funnel. Both of these pieces were attached to the scale using epoxy glue. A funnel was then trimmed, fit with tubing, and glued to the scale (see Fig. 16). The result is a mechanism that allows the scale to be placed on top of the two poles, which slide through the bottom holes and fit into the screws. Lead pellets are introduced to the system through the funnel and tubing, which is placed directly in the pipe holding the clamp.

The final prototype is approximately five feet tall (see Fig. 18). It is light-weight, and as the various features can be disassembled, it is conveniently portable. A bowl, equipped with canvas to dampen pellet scatter, is placed on the base to catch pellets upon the breaking of the condom.

Item	Price	#	Shipping/Tax	Total
Alum. Poles	$7.99	2	$8.64	$24.62
Analog Scale	$33.39	1	$6.87	$40.26
10 lb. Lead Pellets	$33.69	1	$9.26	$42.95
L Bracket	$15.17	1	$0.83	$16.00
Wire	$2.29	1	$0.13	$3.42
Canvas	$2.30	1	$0.13	$2.43
Velcro	$4.29	1	$0.24	$4.53
Epoxy	$3.50	1	$0.19	$3.69
Total	-	-	-	$137.90

Figure 17: Summary of Costs

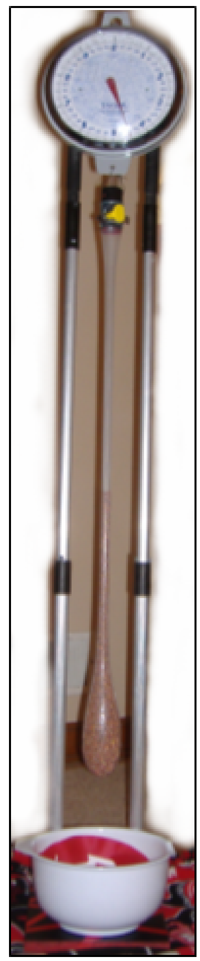

Figure 18: Final Prototype

10. Testing:

Condom Strength Test: Several different types and brands of condoms were tested using the device. Five trials were run for each specific brand or type using a new condom each time. While the majority of condoms did not break if filled slowly enough, the results were consistent, allowing useful qualitative information to be gained from testing. These results can be seen in figures 19 and 20.

Brand/Type	Approx. Weight	Approx. Length
Durex: latex, non-lubricated	6 lbs	3.5 ft
LifeStyle: latex, non-lubricated	7 lbs	4 ft
Durex: latex, lubricated	4 lbs	3.5 ft
Trojan: polyurethane, lubricated	0.5 lbs	1 in.
Trojan: latex, lubricated, spermicidal	4.5 lbs	3.5 ft

Figure 19: Results of Testing

Figure 20: Shapes of various condom types when filled.
Left to right –lubricated latex, lubricated polyurethane, non-lubricated latex.

In most cases, the rate of loading had a great effect on when the condom ruptured and if it ruptured at all. When filled at a reasonably slow rate, most condoms did not rupture but filled upwards with pellets after first accumulating at the tip (Figure 20, left). The numbers listed in the table are a result of the reasonably slow rate of fill, which was held constant during our testing. It is likely that extremely slow filling of the condoms could potentially lead to them holding the entire available 10 lbs of lead pellets. This extreme was not tested due to pellet containment issues.

There are several key points one can take away from this testing:

1. The tests demonstrate that the clamp contributes minimally to the rupture of the condom. In fact, the condom rips much later than when being held in ones hands. Almost all of the condoms that broke did so at the tip.

2. Approximate weight and length are two useful qualitative results that can be analyzed as well as the overall shape of the stretched condom which varies somewhat between types (Figures 19 and 20).

3. If one wants to gain meaningful experimental results, the condoms must be loaded at a consistent rate throughout all relevant experiments.

4. The tests definitely carry with them a “shock factor” as to the strength of the condom and its ability to stretch as determined by the reaction of various observers to the testing. This is the client’s primary purpose in building the device.

Stability Test: Throughout all testing, the structure was observed to ensure that it would not wobble in either direction during experiments. This is important because if the device were to fall over, it could break or injure students. It successfully stood upright with adequate stability under almost 10 lbs of loading and showed no signs of failure.

It was also shown that the structure is securely held together even though it can be easily disassembled. While conducting frequent and repeated testing, no part of the structure became loose.

Pellet Containment Test: The device did not contain the lead pellets as successfully as was hoped. Difficulties developed from pellets climbing up the condom before breaking it which caused them to fall from a greater height. Also the continued pouring of lead pellets through the device as the condom ruptured caused some scatter. Improvements in this area must be made and will be addressed in the Future Work section.

11. Difficulties Encountered:

During the design and building process, several previously unforeseen difficulties arose. During initial testing, condoms tended to stretch to lengths less than four feet. Telescoping poles of this length were then purchased. The mechanism manufactured to attach the scale to the poles, however, did not conserve the poles' entire height. Upon final testing, the condoms stretched to the ground with the shorted ground-to-clamp height of 3 ½ feet. The situation was remedied by using the remaining wooden dowels to create extensions placed in the top of the aluminum poles. With these extensions in place, the ground-to-clamp height of four feet was restored.

Other difficulties encountered stemmed from the inability to obtain lead pellets early in our design process. Initially, the client believed pellets could be acquired at little to no cost. After it became clear this wasn't the case, it took time to find ten pounds of pellets at an acceptable price. Because preliminary testing had to be conducted with miscellaneous metal materials or with manual stretching, the results were skewed and not as representative of the actual weight and length of condoms before their breaking point. With more accurate preliminary testing, the primary design would have been able to accommodate the variability of condoms, a feature that wasn't realized until the majority of work on the prototype had been completed.

As preliminary testing could not take place with pellets, the problem of pellet scatter was not immediately recognized. When a condom breaks at the tip, the majority of pellets fall straight down. The demonstrator, however, likely will not instantly stop pouring pellets at the time of the break. Any pellets poured into the funnel past the time of breaking are not as easily recovered. Also, some types of condoms reached a stretching capacity and then started to fill towards the clamp. When these condoms broke, the pellets located towards the top of the apparatus tended to fall in a less predictable manner. The short-term answer to this problem was to acquire a tall graduated cylinder, which was more likely to catch pellets falling from higher elevations. More permanently, future plans include implementing a transparent plastic sheet that would be curved into a circle and surround a stretched condom from clamp to floor. This way, pellets would be contained independent of where the condom ripped or when the pellets cease to be poured.

12. Future Work:

Potential Improvements:

Most importantly, a taller pellet containment system must be put in place to more adequately seal the pellets from escaping. It may by possible for the design team to accomplish this quickly before the semester ends. Currently, the leading design idea is to purchase a flexible, clear plastic sheet, cutting it to the desired dimensions. It would be wrapped into a cylinder and held into the bowl with Velcro. Of secondary importance is the addition of more height to the poles while maintaining stability. While the device has always been tall enough to accomplish the necessary testing, more height would allow for better visibility and would accommodate any condom that stretches to a surprising length

Experimental: Again with the help of the client's students, a procedure will be developed to run experiments with the device. It is anticipated that this responsibility will be undertaken mostly by the client's students, after they are instructed on how to use the device. This will involve the implementation of safety protocol. The design team recommends that goggles be worn by whoever is operating the device, not only for this person's safety, but also to reinforce the idea of wearing a protective barrier.

13. Conclusion:

The finished prototype includes all the selected components of the mid-semester design: an analog scale with a sizable display, a hose clamp altered to resemble the monocircular clamp design, and a two-pole body that supports the condom testing apparatus. Also included are some additional features, specifically a system that makes it easy to deliver the lead pellets into the condom.

There are some ethical concerns surrounding our project, namely the issue of safety for those operating and observing the demonstration, its suitability in public classroom use, and its sturdiness and resilience over multiple demonstrations. By constructing a plastic confinement for the base, any safety issues involving pellet scatter should be resolved. Because this device does not contain a realistic phallic model, it is suitable for a greater range of classroom use. After one of the poles showed wear of the tightening mechanism, screws were added to increase stability and allow for a more robust method of tightening that will not wear or break as easily.

The prototype is effective for its intended purpose and has met the client's needs as a portable and durable teaching tool to demonstrate the strength of latex male condoms.

The client intends to use the prototype in the fall semester in her class on HIV/AIDS as she continues her fight against the growing epidemic.

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Acknowledgements:

Special thanks to Mrs. Marge Sutinen, Professor Kreeger, the UW College of Engineering Student Shop, and Eric Bachman.

Appendix A: Product Design Specifications

Team Members:

Nick Balge – Team Leader

Terra Gahlman – Communicator

John Cheadle – BWIG

Whitney Johnson – BSAC

Function: To demonstrate to classrooms with students of various ages the strength of latex and polyurethane male barriers. This will be accomplished by inserting lead pellets or a different dense material into the barrier and displaying the resulting weight it can hold.

Client requirements:

portable
classroom and user friendly
inexpensive
reproducible

Design requirements:

1. Physical and Operational Characteristics

a. *Performance requirements*:

Able to withstand repeated demonstrations (approx. weight ~10 lbs.)
Must clearly and accurately display weight
Stable structure
Able to secure latex and polyurethane in place

b. *Safety*:

Must prevent pellets from scattering upon barrier failure
Must prevent latex/polyurethane from scattering
Barrier clamp must not be dangerous

c. *Accuracy and Reliability*:

Should provide repeatable results
Accuracy to the nearest .1 lb would be desirable

c. *Life in Service*:

Must withstand repeated use
Average number of demonstrations during which the tool will be used in its lifetime has yet to be determined.
Should be designed to last a number of years before becoming dysfunctional

e. *Shelf Life:*

Some components may require a dry space for storage
Scale may require the tool to be used and stored at room temperature away from heaters or air conditioners.
Scale may require batteries of standard shelf life

f. *Operating Environment*:

Classroom environment will prevent the device from operating under adverse conditions
Students may handle device, should be durable
Must be tolerant of dust if stored

g. *Ergonomics*:

Height and shape must allow for easy placement of lead pellets into the barrier.

h. *Size*:

Height must be approximately 4.5 to 5 feet.
Floor space will be minimal
Will likely be able to be disassembled
Must remain small enough to be portable

i. *Weight*:

Light and easily portable
No quantitative data is yet available
Must be able to withstand 10+ pounds of strain easily

j. *Materials*:

Must be able to be handled by students (nothing fragile or harmful in any way)

k. *Aesthetics, Appearance, and Finish*:

Sleek and professional appearance
Should focus attention to condom and weight reading
Must have a clear casing, if any, to ensure condom visibility

2. Production Characteristics

a. *Quantity*:

One unit is currently required with possible future reproducibility being a primary design concern

b. *Target Product Cost*:

Should be relatively inexpensive
Around $100 total

3. Miscellaneous

a. *Standards and Specifications*:

none

b. *Customer*:

Small
Inexpensive
Liked the idea of lead pellet use

c. *Patient-related concerns*:

Device needs in include additional male barriers/storage area for additional demonstrations
After barrier breaks, students should be shielded from possible scattered pellets
Large enough display to read from a reasonable distance

d. *Competition*:

There are commercial products that test the strength and effectiveness of male barriers, but we are not aware of any devices specifically for classroom use.

Appendix B: Structure Assembly and Dimensions