INSTRUCTIONS FOR ASSEMBLY & USE
LAPARODOME: LOW-COST LAPAROSCOPIC TRAINING DEVICE

April 2020

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LASER CUTTING SETTINGS

Purpose: to laser cut one complete *Laparodome* set from chipboard sheets

Materials Needed:

- 2 sheets of 26” x 38” chipboard 0.05” thickness
- Pattern files on Adobe Illustrator (V14.ai)
- 40 by 28 laser cutter

Instructions:

The following settings were used to cut the pattern files linked above onto the 0.05” thick chipboard by an Epilog Laser Cutter.

Cut Type	Power	Speed
Vector Cut	70	15
Raster	50	40

Please note that these settings were used on an older version of a 40” by 28” Epilog laser cutter. Since different laser cutters have different settings, it is recommended to construct test cuts when first configuring the device and prior to cutting the *Laparodome*. These settings were optimized given the equipment used but can be modified by increasing power and decreasing the speed or vice versa to account for differences in equipment abilities. Because of the differences between laser cutters, test cuts are recommended before the *Laparodome* is cut.

When performing test cuts, the success of the cut can be determined by vector cuts cutting all the way through the material in question with minimal scorching and raster creating markings that are dark enough to read clearly in room lighting. Vector cuts will be used to release the design from the chipboard sheet and to provide perforations on which the device will be folded. These will occur along the solid lines and dashed lines of the pattern file. Raster is used to create alphanumeric labels that will aid in assembly, and these will occur where the numbers and letters appear in the pattern file.

INSTRUCTIONS FOR ASSEMBLY

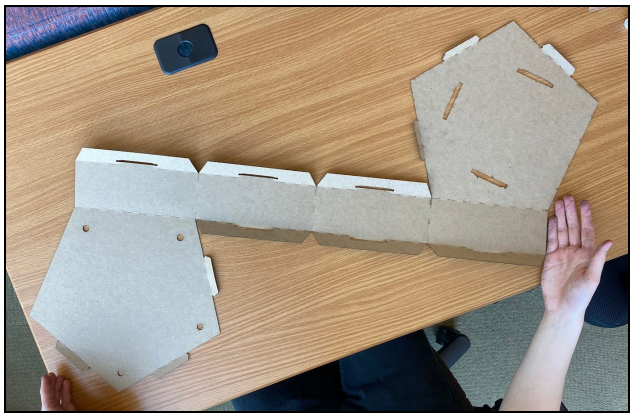
Purpose: to assemble a complete *Laparodome* device from laser-cut chipboard sheets and included components

Materials Needed:

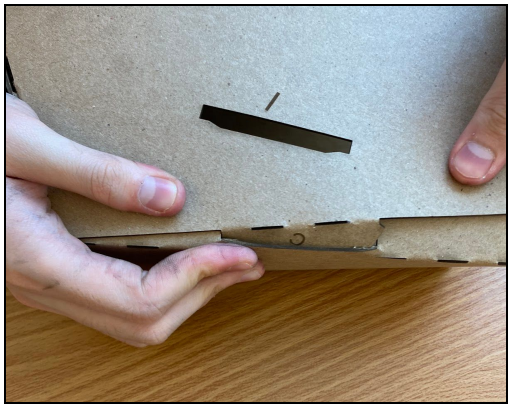
- 1 complete laser cut *Laparodome* cardboard sheet, including:
    - Sheet with dome, phone holder and task boxes pattern
    - Sheet with base pattern
- 5 suction cups
- 4 grommets
- 4 strips of velcro: 2 long strips of one texture, 1 long strip of compatible texture, 1 short strip compatible to penrose drain velcro
- 1 set of tasks assembly components, including:
    - 1 cardboard peg board
    - 1 cardboard task platform
    - 12 pegs / wooden dowels
- For task component creation (please see BOM for links to recommended products):
    - 100 mm x 100 mm (4 in. x 4 in.) 2-ply (or more) gauze
    - 2+ triangular pencil grips
    - Dark thin tipped marker
    - Penrose drain
    - Velcro with adhesive backing
    - Scissors / blade

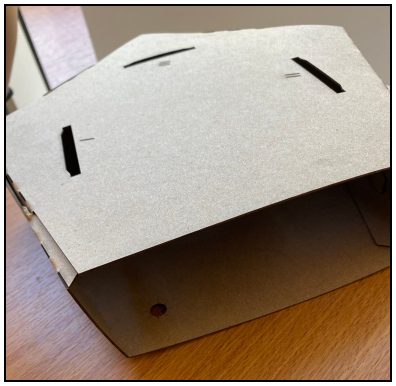
Instructions for Laparodome Assembly:

1. Push out all cardboard components from laser cut sheets.
2. Start folding the base and drawer pattern by laying it flat on the table with the side with **labeled tabs face down** (left image). Fold all of the components up along the dotted lines (right image). Making all the folds first will make the assembly process easier in other steps.

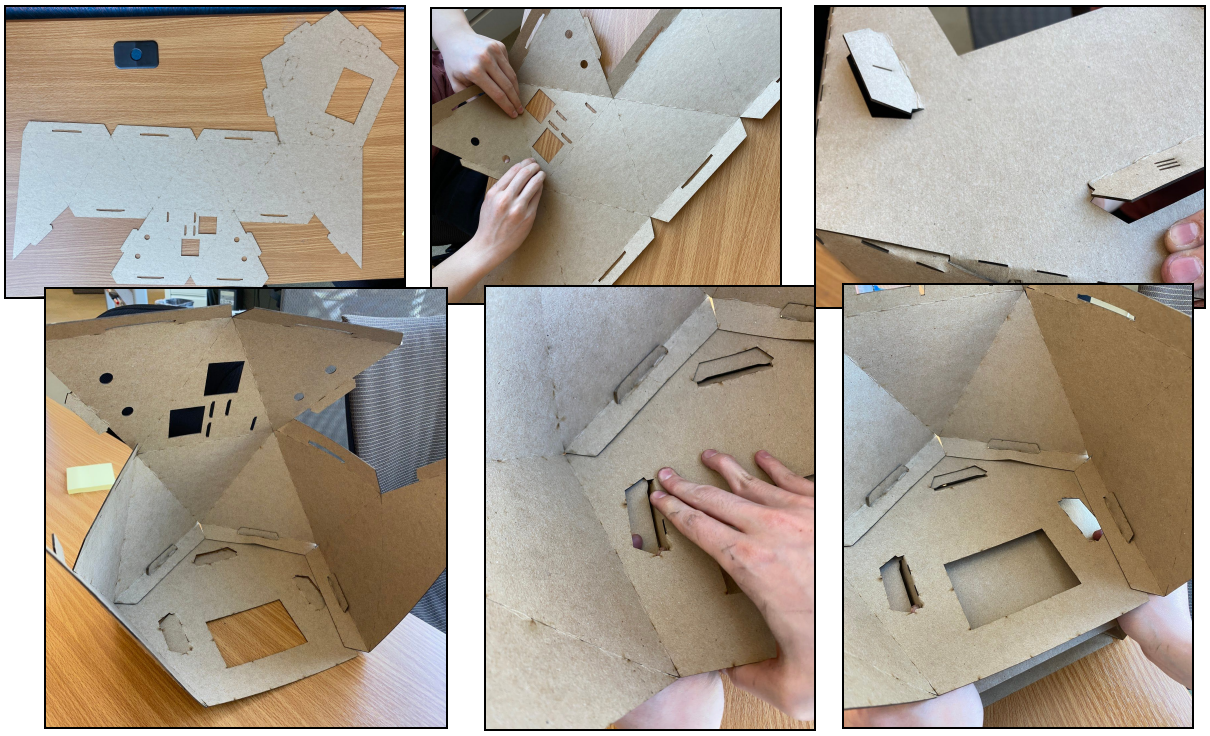


3. Next, insert the tabs on the pentagon shapes into the slots with the corresponding letter (top row of images). The order in which the tabs are inserted does not matter. Inserting later tabs may be facilitated by pulling the tab from inside the drawer that forms as you fold the base (bottom row, left image). The final product should look like a pentagonal box with one side open (bottom row, right image).



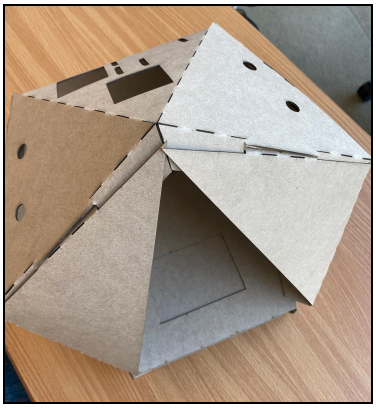


4. On the dome pattern, lay the cardboard sheet flat on the table with the **labeled sides face down** (left image), and begin folding along all dotted lines by creasing the cardboard up (center image). However, the tabs on the pentagonal shape labeled I, II, and III should be folded by pushing them down (right image). Making all the folds first will make the assembly process easier in other steps.

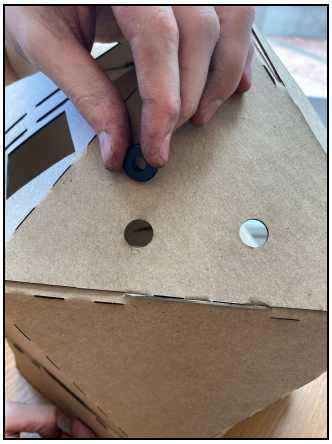
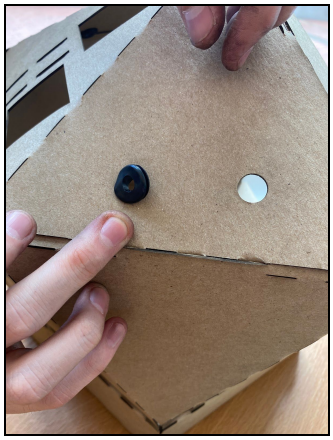
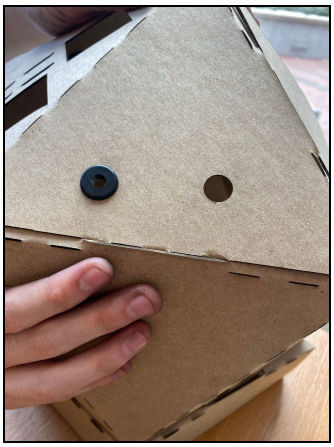


5. Insert tabs labeled with 5, 6 and 7 into the corresponding slots by matching up the respective numbers (left image). Before inserting the other tabs, connect the dome to the base structure by aligning the pentagon shapes and the tabs on the pentagon of the dome with the slots on the base. To secure, push the tabs of the base pentagon into the slots on the platform (center, right images). It may be helpful to secure the two structures by pulling on the tab from inside the drawer.
6. Then, insert the tabs on the dome labeled 1, 2, 3 and 4 into the matching slots with the respective numbers (left, center images) to close the dome structure (right image).

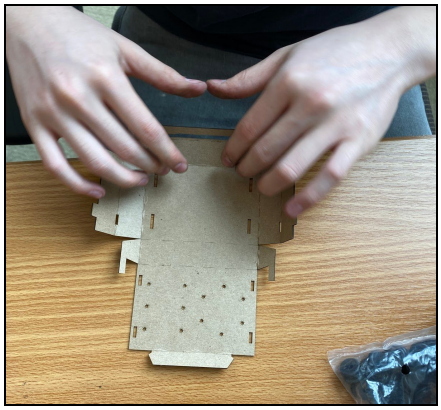
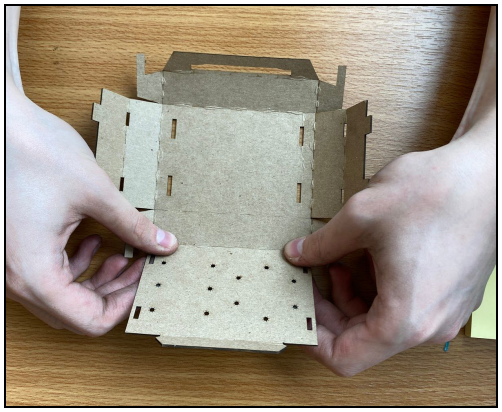




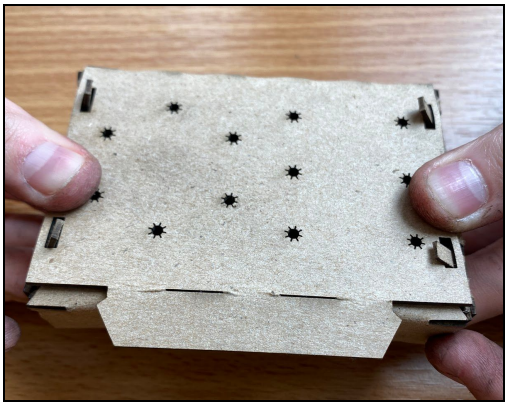
7. Insert grommets into the 4 circular holes on the top of the dome structure.

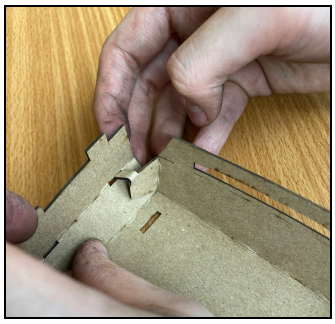
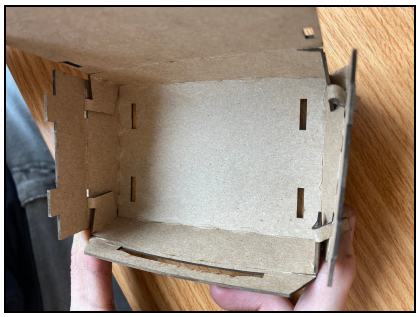
8. On the bottom of the base, push the suction cups into the cut holes so that the cup can be secured to the table.
9. Fold boxes that will serve as the peg board and the suturing platform (only pegboard shown for reference). Begin by laying the cardboard flat on the table and creasing all dotted lines up. It does not matter which side is facing up.

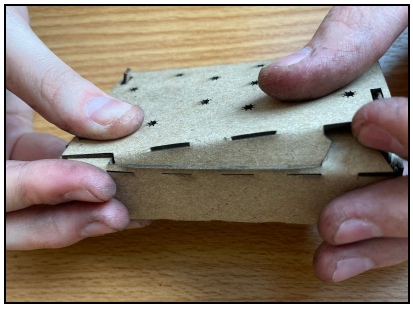
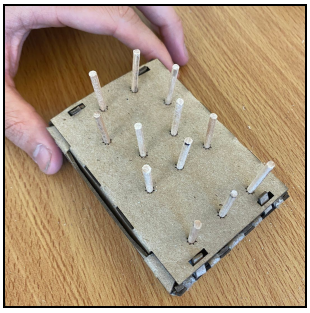
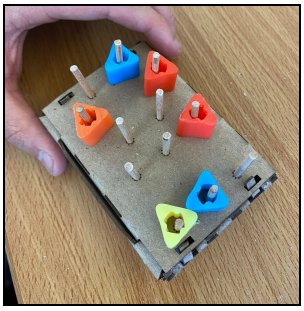
10. Insert the L-shaped tabs into the slots on the sides adjacent to them so that the tab extends through the hole (left, center images) and the side they are attached to is now perpendicular to the side wall and the bottom of the box (right image). Repeat for all L-shaped tabs.

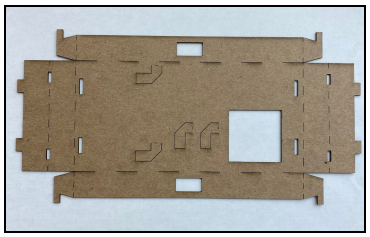
11. Fold the walls of the short sides down so that the tabs are extended straight up through the holes (left image). Then, fold the lid of the box down and insert the tabs through the holes on the top (right image).

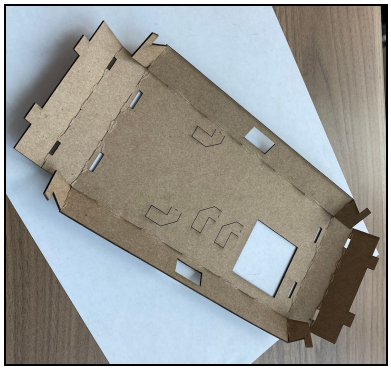




12. Insert the tab on the lid into the slot on the base (left image). For the pegboard, push the 12 wooden dowels into the holes cut into the pegboard platform and through both sides (center and right image).

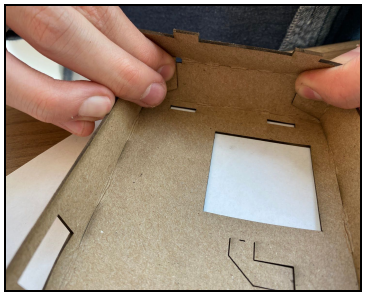
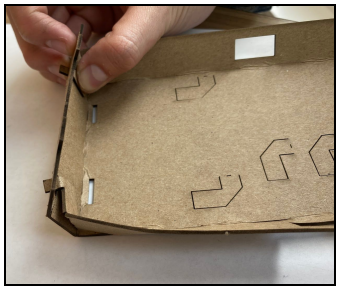
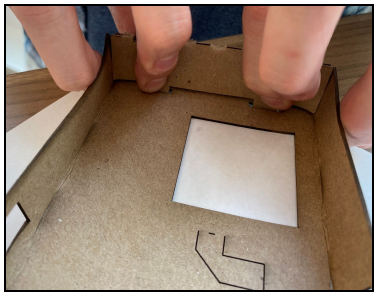




13. Fold the phone holder similarly to the task platforms by laying the pattern flat on the table, matching the orientation shown in the image below. Crease along the dotted lines up (center, right images).

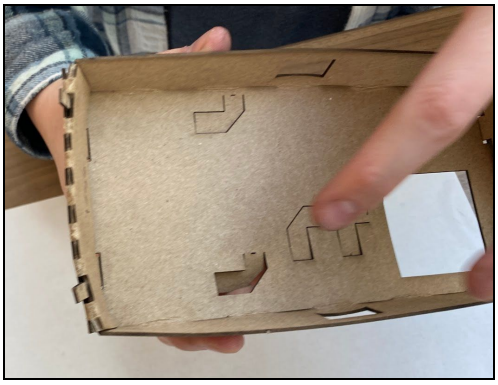




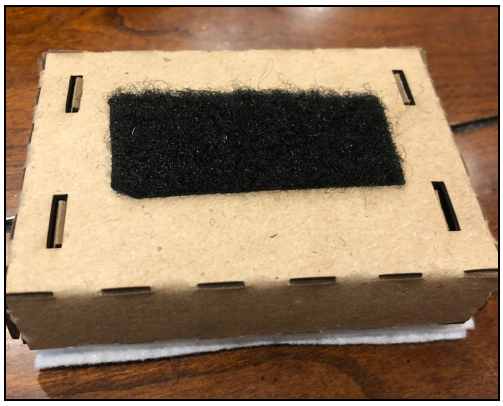
14. Insert the L-shaped tabs into the slots on the sides adjacent to them so that the tab extends through the hole (left, center images). Repeat for all L-shaped tabs and then fold over the small side and tuck the tabs into the slots on the largest rectangle (right image).

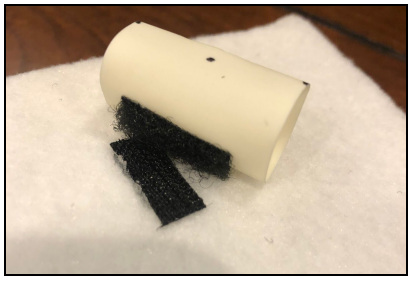
15. Push the hooked tabs as seen in the image below in order to secure it to the top of the dome in either horizontal or vertical orientation.



16. Place one long strip of velcro on the bottom of each task platform (side without tabs sticking up from the top). This velcro should be the same texture type. Additionally, place the compatible textured strip of velcro within the rectangular area on the platform of the dome and the opening.



17. Place the short strip of velcro on top of the task board without the pegs. The penrose drain will be secure to this for the suturing tasks.



For Task Component Assembly:

1. To create additional objects for the Peg Transfer task, use a blade to cut each triangular pencil grip lengthwise into pieces that have a height of 14 mm (0.5 in.). The triangles should be equilateral triangles with a side length of approximately 16.5 mm (0.65 in.) and a hole in the center of approximately 7.8 mm (0.3 in.).
2. With the pencil grips linked in the document, 3 objects were able to be created from each pencil grip.
3. To create additional pattern cut templates, a circle approximately 65 mm (2.5 in.) in diameter should be drawn on a piece of 100 mm x 100 mm (4 in. x 4 in.) 2-ply gauze. This can be done using a 3D printed ring, the bottom of a cup / mug / pint glass with the approximate diameter, a water bottle, etc.
4. For additional penrose drains for suturing tasks, cut standard penrose drains with a diameter of 10 mm (0.4 in.) into 25 mm (1 in.) segments. On each segment, a slit of 12 mm (0.5 in.) should be cut in the center of the segment.

5. Two black dots should be placed in the center of the penrose drain segment lengthwise and on either side of the cut slit. The dots should be placed 4 mm (0.1 in.) from the slit.
6. A small strip of Velcro should be placed on the non-slit side of the penrose drain. The texture should be used so that it can be secured onto the Velcro strip on the task platform.

INSTRUCTIONS FOR USE

Purpose: to perform all laparoscopic tasks using a completely assembled *Laparodome*

Materials Needed:

- 1 fully assembled *Laparodome*
- Either 1 webcam and monitor OR 1 mobile phone with camera ability
- 1 complete set of laparoscopic tools, including:
    - 1 pair of endoscissors
    - 1 grasper with locking ability
    - 2 needle drivers
    - 2 Maryland dissectors
    - 1 open-ended knot pusher
    - 1 closed-ended knot pusher
- 1 complete set of tasks, including:
    - 6 pencil grips
    - 1 cardboard peg board
    - 1 cardboard task platform
    - 12 pegs
    - 1 chip clip with Velcro strip
    - 1 sheet of gauze with pattern drawn
    - 2 penrose drains (prepared with dots)
    - 1 ligating loop foam organ (prepared with line)
    - 1 ligating loop / endoloop
    - 2 silk or sofsilk suture at least 90cm in length, taper SH or V-20 curved 26mm needle

General Instructions:

1. To complete each laparoscopic task, insert the necessary tools into the two grommets located closest to the center triangle for the standard position OR, for a more angled and challenging approach, insert one tool into the grommet closest to the center on one side and the grommet farther from the center on the other side.
2. Prepare the necessary task components and insert this into the task platform area inside the device.
3. If using a cellphone, launch the camera app and place the phone into the phone holder. Position the holder using the hooks so that the camera aligns with one of the rectangular openings on the center triangle of the dome. Ensure that the field of view contains the entire task platform. The phone may be oriented either vertically or horizontally.
4. If using a webcam, connect the webcam to a laptop or monitor and position the webcam in the largest opening on the center triangle of the dome.
5. Complete each task per instructions listed below. Read the instructions for each task carefully before beginning the task as timing and materials differ between tasks.

Task Instructions:

Task One: Peg Transfer

- *Tools: Two Maryland dissectors*
- *Materials: one cardboard pegboard with pegs inserted, six rubber pencil grip objects*
- *Maximum time to completion: 300 seconds, Proficiency time limit: 48 seconds*
- *For video explanation and more tips, see: https://www.youtube.com/watch?v=gAQPXHWqdXQ*

1. Center the pegboard on the Velcro strip in the center rectangular area on the platform of the device. All six colored objects should be aligned on the six pegs on the same side of the board as your non-dominant hand. Note: It does not matter which peg pattern-parallel or circular- is on the left or right side of the test taker.
2. Adjust the camera as necessary to make sure the field of view is centered on the pegboard and the entire pegboard is visible.
3. Timing for this task begins when you touch the first object. Timing ends upon the release of the last object.
4. To perform this task, grasp each object with the tool your non-dominant hand, and transfer the object mid-air to the tool in your dominant hand. You will then place the object on a peg on the opposite side of the pegboard. There is no importance placed on the color or order in which the six objects are transferred. Each transfer must be mid-air without using the board or pegs for assistance.
5. Once all six objects have been transferred to the opposite side of the board, reverse the process and first grasp each object with the tool in your dominant hand, transferring mid-air to the tool in your non-dominant hand, and placing it on the original side of the pegboard.
6. A penalty is assessed if an object is dropped outside of the field of view or if you can no longer retrieve the object. You will not be allowed to retrieve the object if it is dropped outside of the field of view. If this occurs, continue the task with the remaining objects.
7. There is no penalty for dropping the object within the field of view, unless you are not able to retrieve it. If you can retrieve it, pick the object up with the hand it was dropped with and continue the task. The drop cannot be picked up with the tool in the opposite hand from which it was dropped.

Task Two: Precision Cutting

- *Tools: One Maryland dissector, one pair of endoscopic scissors,*
- *Materials: one chip clip with Velcro, one 4x4 piece of gauze with a pre-marked circle*
- *Maximum time limit: 300 seconds, Proficiency time limit: 98 seconds*
- *For video explanation and more tips, see: https://www.youtube.com/watch?v=mUBZoSO3KA8*

1. Place the two-ply piece of gauze with a single marked circle into the chip clip. The circle pattern should be facing up, with the open edge inside the jumbo clip, and the folded edge on the opposite side, closest to you. Make sure that the entire marked circle is outside of the clip.
2. Place the clip with the gauze onto the Velcro strip located on the rectangular area on the platform of this device.
3. Make sure the camera is centered on the gauze so that the entire piece of the gauze is in the field of view.
4. You must start cutting from an edge of the gauze and you may switch hands with your instruments at any time during the task.
5. Timing for this task begins when the gauze is touched. Timing ends upon the marked circle being completely cut out from the gauze piece.
6. Using the Maryland dissector in one hand, you will provide traction to the gauze, placing it at the best possible angle to the cutting hand.
7. Using your endoscopic scissors in your other hand, you will cut into the gauze and then along the pre-marked circle until it is completely removed from the 4x4 gauze piece.
8. The gauze is multi-ply; however only the top marked layer needs to be cut, so, cut the bottom layers of the gauze can be cut as much or as little as desired.
9. The objective is to complete the task accurately in as little time as possible. A penalty is assessed for any cuts deviating from the line demarcating the circle, whether made inside or outside the marked circle.
10. If gauze comes out of the clip during the task, you must continue the task without reaffixing the gauze.

Task Three: Suture with Extracorporeal Knot

- *Tools: Two needle drivers (or choice of one needle driver and one Maryland dissector), one knot pusher (either open or closed), one pair of endoscopic scissors*
- *Materials: one 2-0 silk suture of 90cm or 120cm length, one penrose drain with marked targets, one cardboard task platform with Velcro strips on top and bottom*
- *Note: self-righting needle drivers and hemostats are not permitted.*
- *Maximum time limit: 420 seconds, Proficiency time limit: 136 seconds*
- *For video explanation and more tips, see: https://www.youtube.com/watch?v=ie0o6_xt5ec*

1. Place the cardboard task platform onto the Velcro strip in the rectangular area on the platform of the device, so that the Velcro strip on the platform is horizontal.
2. Center a penrose drain securely onto the Velcro strip on the task platform, so that the slit in the penrose drain is vertical. Adjust the camera as necessary so that there is equal viewing area on all sides of the task platform.
3. Timing for this task begins when your first instrument is visible on the monitor. Timing ends when you have cut both ends of your suture inside the trainer.
4. Introduce the suture into the device with the needle driver to begin the task. The suture must be grasped by the thread and NOT the needle when introducing it into the trainer.

5. In this task, you will place a long suture through the two marks in the penrose drain and then tie three single throws of a knot, extracorporeally, using a knot pusher to secure each throw onto the penrose drain, thus, closing the slit. Once inside the trainer, the needle may be placed through the drain in one motion, or two or more motions.
6. Once all three throws have been secured onto the penrose drain, exchange one tool for the endoscopic scissors and cut both ends of the suture inside the trainer. The ends may be cut together or separately and the tail length is not important for this task.
7. Penalties are assessed for any deviation of the suture material from the two marks on the penrose drain, for not properly closing the slit in the drain, and for a knot that slips or comes apart when tension is applied to it.
8. Do not pull the penrose drain from the task platform as this is an automatic failure of the task.

Task Four: Suture with Intracorporeal Knot

- *Tools: Two needle drivers, one pair of endoscopic scissors*
- *Materials: one 2-0 silk suture of 15 cm length, one task platform with Velcro strips on top and bottom, one penrose drain with marked targets*
- *Note: self righting needle drivers are not permitted*
- *Maximum Time Limit: 600 seconds*
- *For video explanation and more tips, see: https://www.youtube.com/watch?v=hAzhqYid5jc*

1. Place the cardboard the platform onto the Velcro strip in the rectangular area on the platform of the device, so that the Velcro strip on the task platform is horizontal with the foam side up.
2. Center a penrose drain securely onto the Velcro strip on the task platform, so that the slit in the penrose drain is vertical. Adjust the camera as necessary so that there is equal viewing area on all sides of the task platform.
3. Timing for this task begins when your first instrument is visible on the monitor. Timing ends when you have cut both ends of your suture inside the trainer.
4. Introduce the suture into the device with the needle driver to begin the task. The suture must be grasped by the thread and NOT the needle when introducing it into the trainer.
5. For this task, you will need to use the needle drivers to place a short suture through the two marks in a penrose drain and then tie three throws of a knot intracorporeally, in order to close the slit in the penrose drain. Once inside the trainer, the needle may be placed through the drain in one motion, or two or more motions.
6. The first throw must be a surgeon's knot or double throw, followed by two single throws. You must exchange hands with your needle, or needle end of the suture, between each throw to ensure you are tying each throw with the opposite hand. You may start tying with either hand.
7. Once all three throws have been secured onto the penrose drain, exchange one needle driver for the endoscopic scissors and cut both ends of the suture inside the trainer. The ends may be cut together or separately and the tail length is not important for this task.

8. Penalties are assessed for any deviation of the suture from the two marks on the penrose drain, for not properly closing the slit in the drain, and for a knot that slips or comes apart when tension is applied to it.
9. Do not pull the penrose drain from the task platform as this is an automatic failure of the task.