Red Case

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An ambulance simulator for training in various situations

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INTRODUCTION

This project was realised with the help, time and kindness of the London Air Ambulance (LAA) and Dr Samy Sadek working at Royal London Hospital (RLH).

The LAA performs emergency surgeries on sites of accidents. Thus, training on past cases and life-like situations is very important to train future crews. The objective of this project is to make props to simulate possible accidents and provide ideal terrain. This should help trainees believe and understand the constraints of a particular scene. After an introduction to the LAA by Dr Samy Sadek, access to moulages provided a greater understanding of potential areas of study. One clear problem was the accuracy of a scenario; the tension and actions during training do not always match that of the scene of an accident.

The LAA services show a great deal of creativity and resourcefulness to train their staff regularly. Providing realistic scenarios and creating tensions are paramount to be ready in any situation. Dr Samy Sadek provided insight into their daily lives but also on their moulages, which are re-enactments of medical cases encountered by the LAA. Such cases usually present a challenge such as: medical decision, outcome that could be avoided or difficult procedure. By familiarising trainees with those, they hope to share the knowledge and experience they gathered as a team.

The LAA is a charity but their medical staff are paid by the NHS. They are part of Helicopter Emergency Medical Services (HEMS). Their moulages are adaptable and creative. The crew rearranges the mannequins to be able to support different surgical techniques as they are not designed for some of those scenarios. For example, a mannequin was opened to insert a tube mimicking the aorta, the tube is filled with water and is long enough so the mentor can create a pulse.

CURRENTLY

The moulages provide training on several cases that the paramedics have experienced or specific areas that are important like prioritisation and communication. The more realistic a moulage is, the better. At the moment, the mentors need to vocalise a lot, including the situation where the patient is found and their state. They will also correct the behaviour of their trainees and increase tension when needed, by acting like the public or other emergency services.

The problem identified was how realistic a situation could be. Limitations like the space given to work, the potential dangers and communication of the scenario are key to make it real life-like. One of the scenarios included a tube station and a patient under the train. This was represented by rails, a sheet on the rails to hide the patient as a carriage would and a sign indicating the name of the station. This scenario shows some constraints. The trainees cannot walk on the tracks before the current has been stopped, they need to lay on the tracks or the side of the platform to communicate with the patient and be able to drag them out. However, those things are not an instinct, the trainees would start talking as we would, standing up on the "platform". The mentor would have to vocalise the impossibility of this action which can break the tension that has been carefully crafted.

For a moulage using an ambulance, a sheet of white fabric taped on a barrier was placed facing the arriving trainees. It represented the front of the ambulance implying the trainees would make their way to the back of it to enter the vehicle. This technicality had to be reminded to avoid mistakes and the system was quite precarious.

Another scenario presented a cyclist under a bus. This shows a prop setting a scenario rather than being an active component. A printed sheet was taped to a nearby frame, a wheel is placed to add dimension. It gives a more realistic and visual approach. However, the wind can be impractical and make the scenario harder.

BRIEF

Technique, prioritisation and communication are topics that are explored in moulages. They gather the paramedics' experience to train other paramedics. The more realistic a moulage is the better. The mentors will correct the trainees' behaviour and increase tension when needed by taking on various roles. However, by having to vocalise the situation where the patient is found and their state, the mentors cannot fully observe the trainees.

The cases used in training were gathered up, to make sure the most needed prop is designed for those training sessions: the ambulance. It would need to be weatherproof, robust, weighted-down, recognisable, accurate and see-though for the mentors to look in. The LAA crew trains underneath the helipad on the 17th floor of the RLH. This area has stones under a net, ventilation and tiles giving a very difficult space to work on or to set anything on. This is also an open space with a lot of wind and possible rain.

RESEARCH

Observing moulages by the LAA helped to identify some problems. Trainees did communicate several difficulties in training that could be changed to make the whole process more realistic. The issue that was chosen was then presented to Dr Sadek to ensure the problem was relevant. The cases used in training have been compiled, to ensure the optimal prop can be designed for those training sessions.

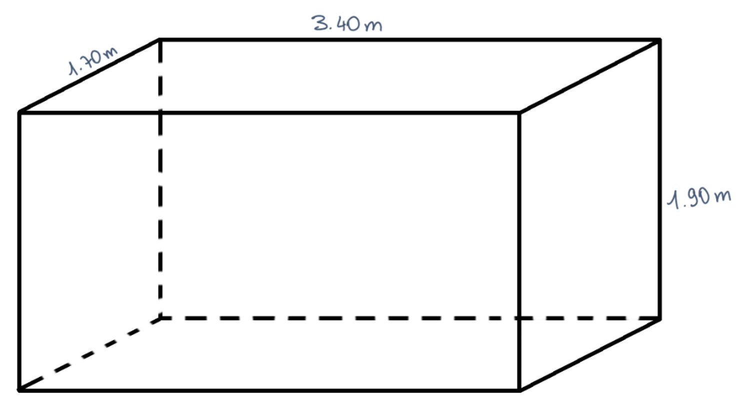
Documentaries and lectures on the air ambulance services are also a useful insight in this line of work. These helped to understand the numerous cases and infinite combinations that the LAA can stumble upon. A lecture by Cliff Reid showed that emergency services can use a printed banner hung up and weighted down to mimic an ambulance or bus in Australia which was later witnessed at the LAA.

Open-air theatres were contacted in the hope of understanding more about their material selection and regulations for safety and realism. Research was made on different structures such as tents, pop-up structures and frames. Different materials were explored and manufacturers were contacted to find out more about them. The research directly impacted the work and ideation that took place.

The dimensions of the ambulance were measured a few times for accuracy. The inside space is about 3.40m by 1.70m. To mimic the space and add various levels of tension, research into exposure therapy, claustrophobia and various subjects was conducted. This led to the development of visual cues to help imagine a scenario but also adding auditory overload for an accurate depiction of the scene.

IDEATION

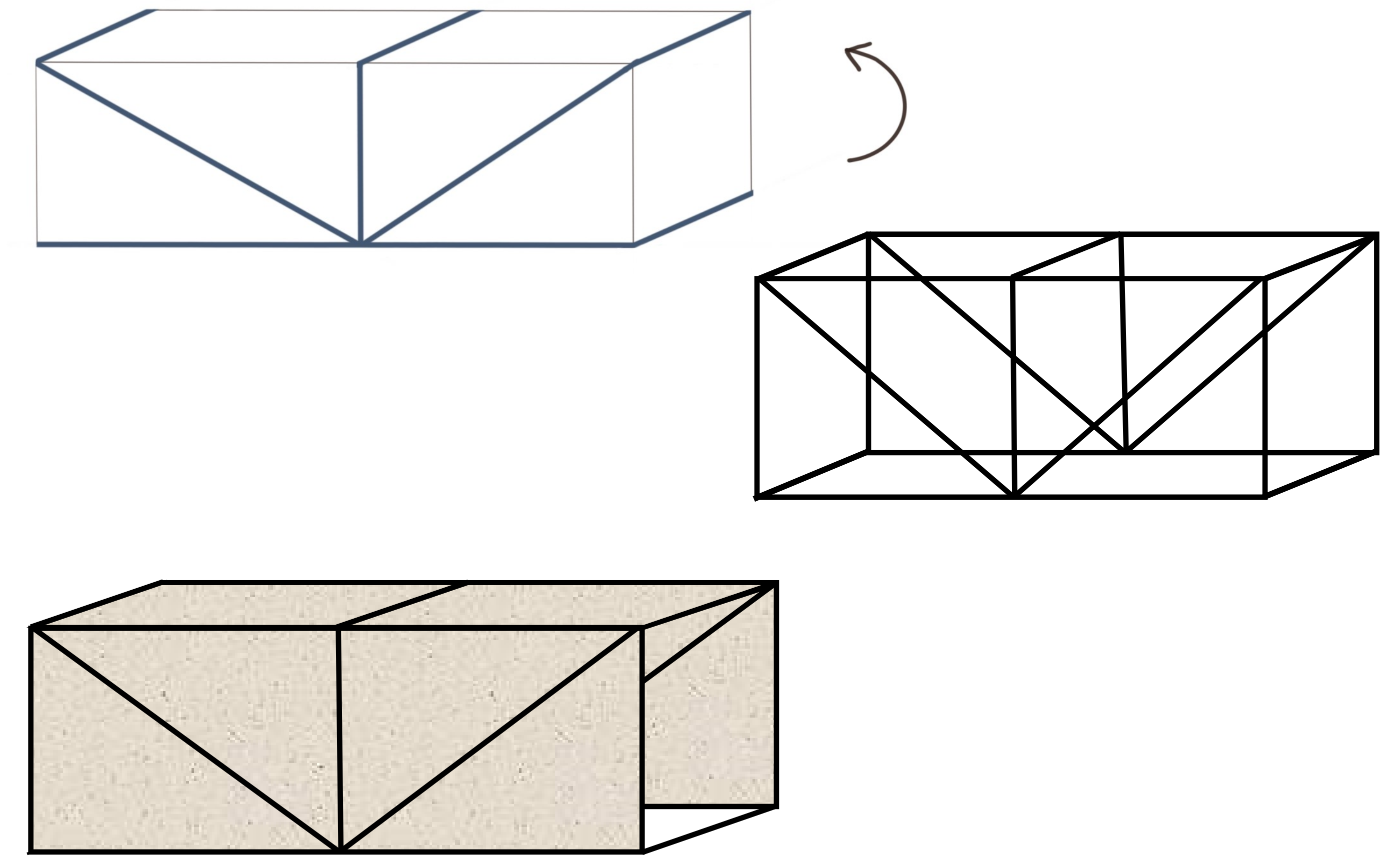
Dimensions of the ambulance were taken multiple times to ensure accurate measurements. Interaction with the paramedics confirmed their knowledge of people overestimating the size of an ambulance and the need for a flexible transparent ambulance for training purposes. A variety of materials were used to prototype a possible mechanism for deployment and rapid storage. This involved a criss-cross pattern and a tent-like frame.



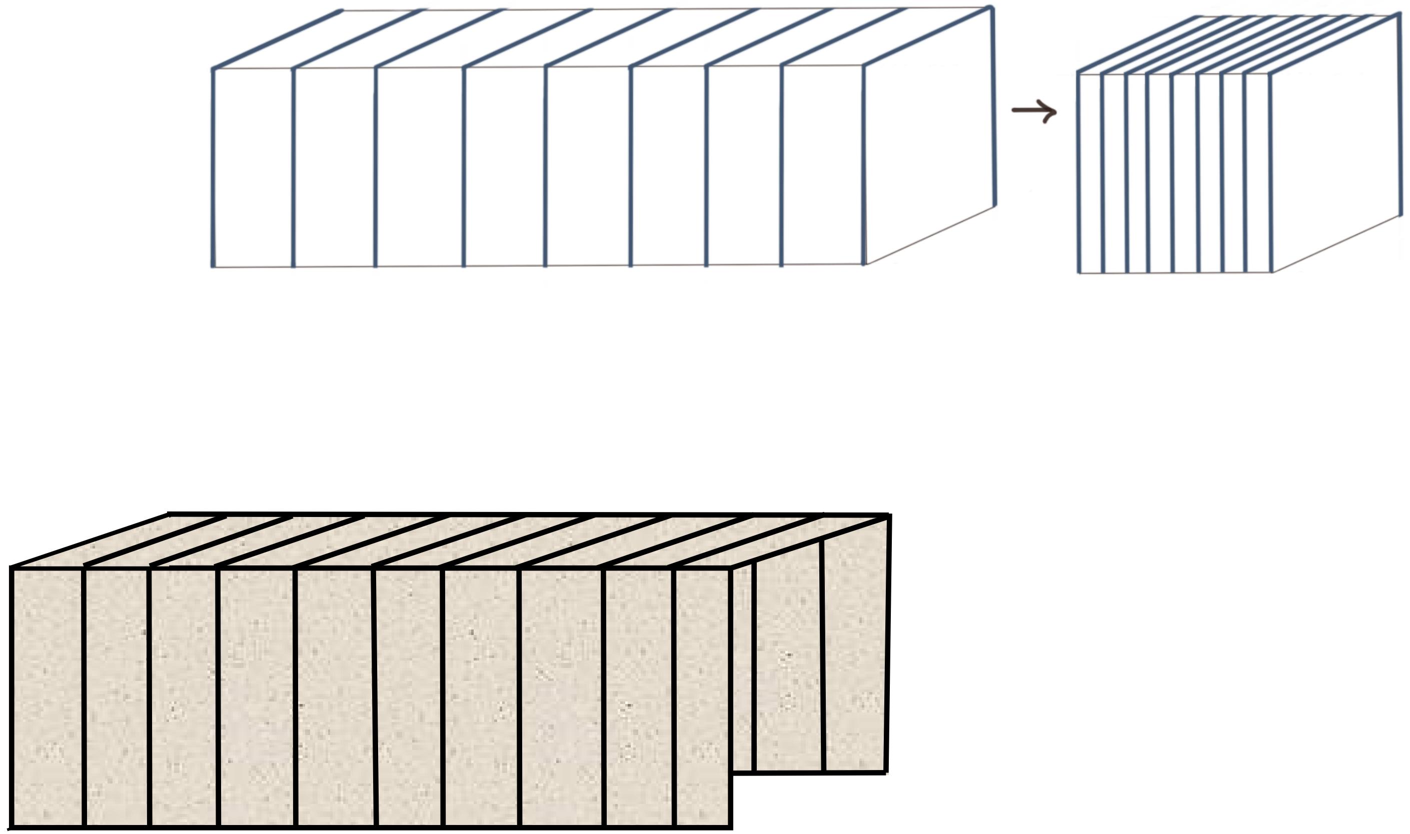
Those mechanisms were tested with wire, paper and cardboard. The tent-like frame showed problems of weight support which led to a simplification of the idea.

Foldable panels became the next idea with a bamboo frame. This was then prototyped with cardboard and wire. The bamboo frame panels are light and easy to move due to the central cross. Since the structure is light, weights are attached to the bamboo feet to provide stability and weight.

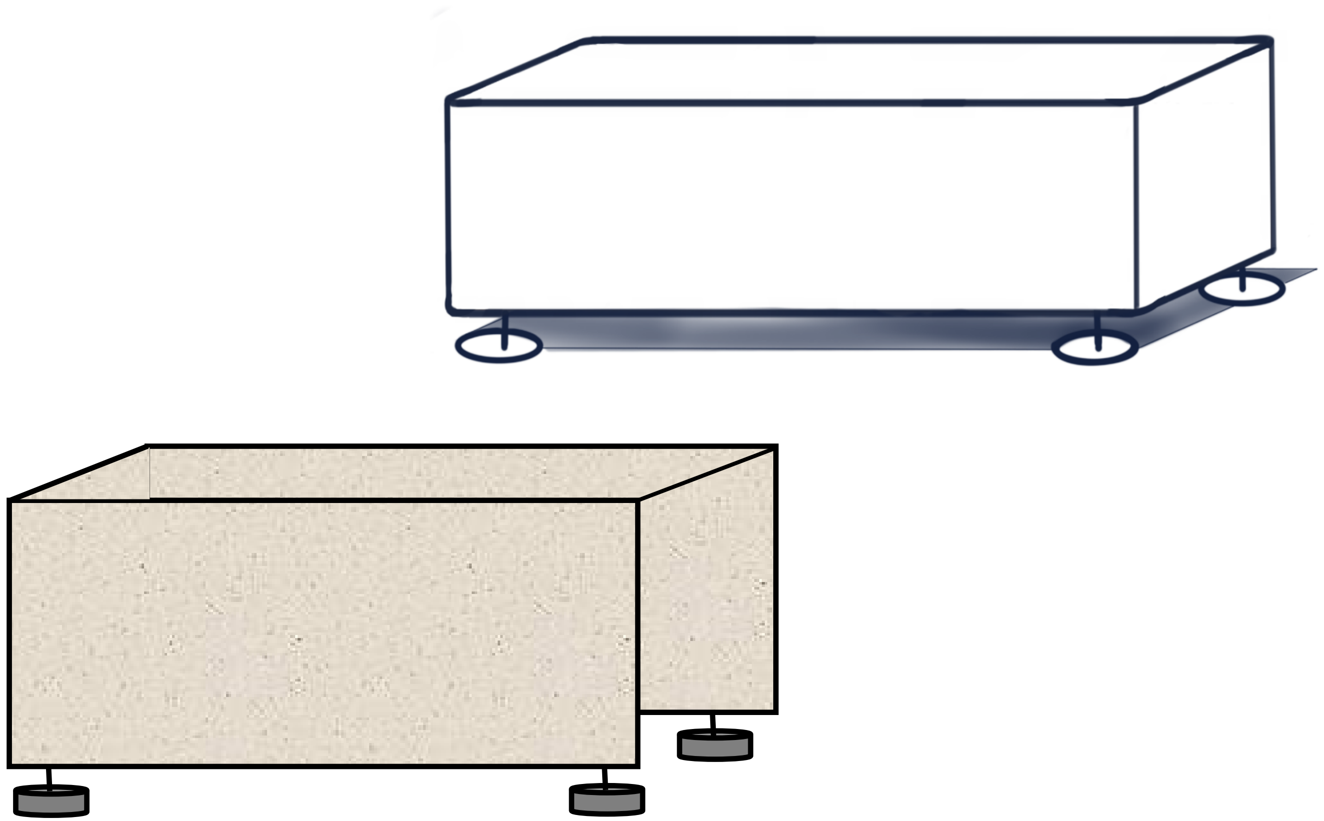
The connectors for the different parts provided a challenge as they need to be an ideal diameter and have enough surface area for glueing to provide ideal bonding between the rods.



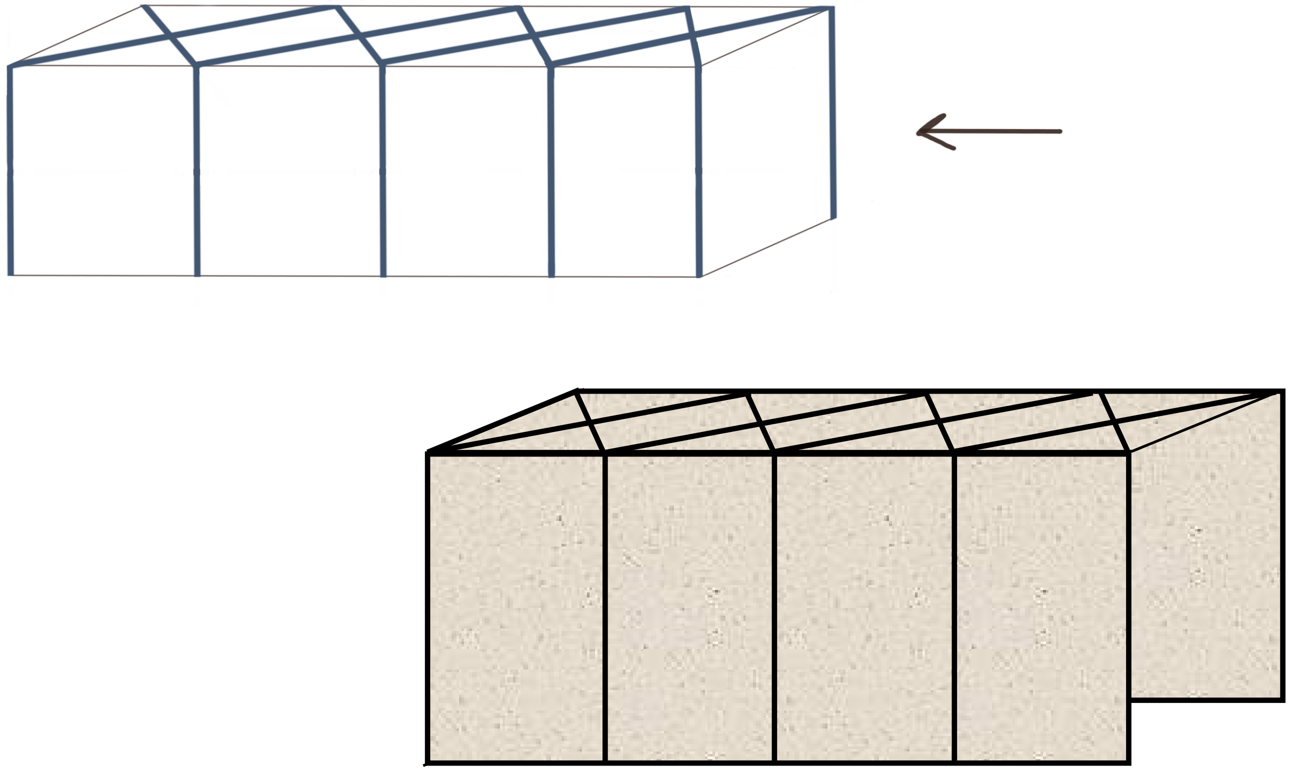
This spring steel design was inspired by tent mechanisms, the system would have been a pop-up structure for easy deployment and disposal. However, the size of the frames would have been far too large, making the system a potential hazard if not given enough space.



Using arches and spring steel wire, this would require minimal deploying. The user would tie down the structure to weights then drag to extend it. This could be made faster by using a self-extending rod. By using compression, when released the rod would expand thus extending the sheet too. This would help ensure the dimensions are maintained.

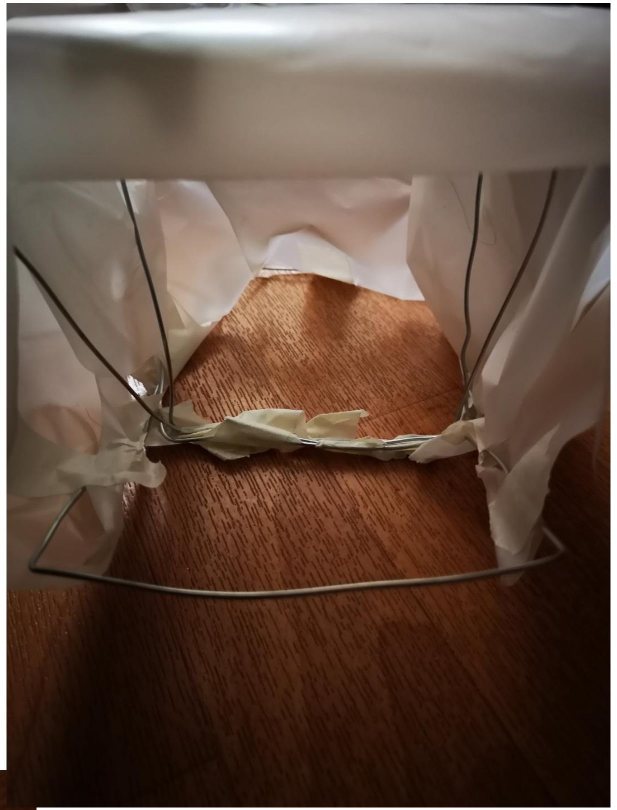


Another idea was a blow-up structure. This encompasses pop-up tents and printed sheets observed both at LAA and through a conference. This idea raised the issue of weights and reliable ties, movement due to changing weather and potential holes deflating the structure, questioning its durability.

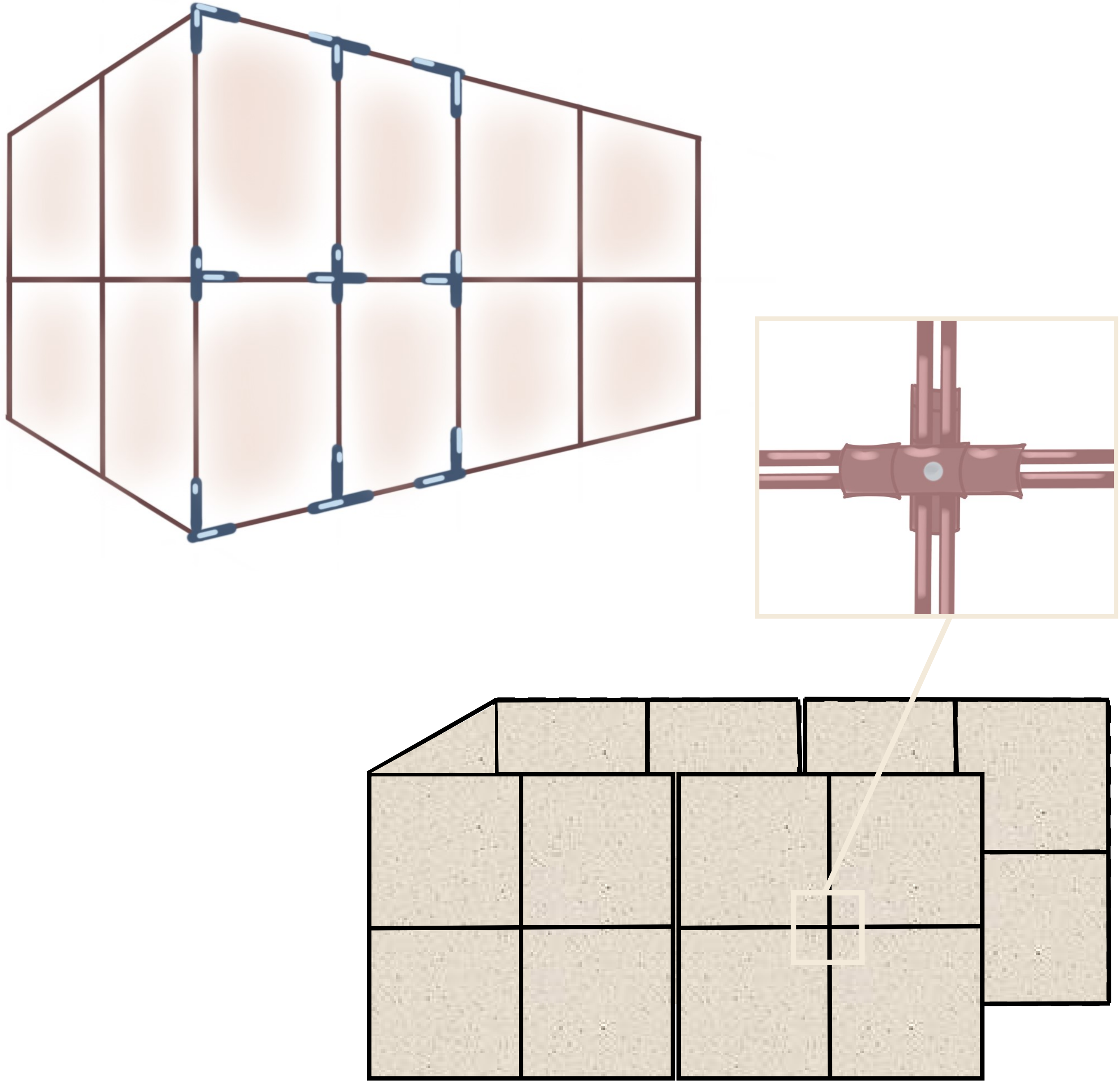


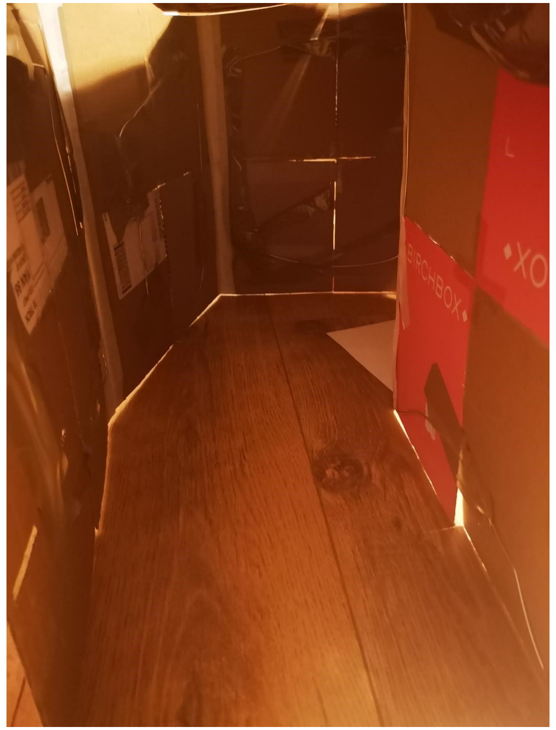
Creating dependent arches that move each other would be a very intuitive and simple product. The user would need to fix one end of the structure down, then move away to drag the rest. The articulated arches would then extend the structure. Creating the right angle and depth proved quite an issue due to the dimensions. A lot of fabric would be left to accommodate the change from deployment to being put away.

This low-fi prototype of the tent-mechanism (p.13) explored the frame sizes and the deployment mechanism. This showed a difference in frame size due to the angles. This would only be enlarged at a bigger scale. Folding it would be unpractical.

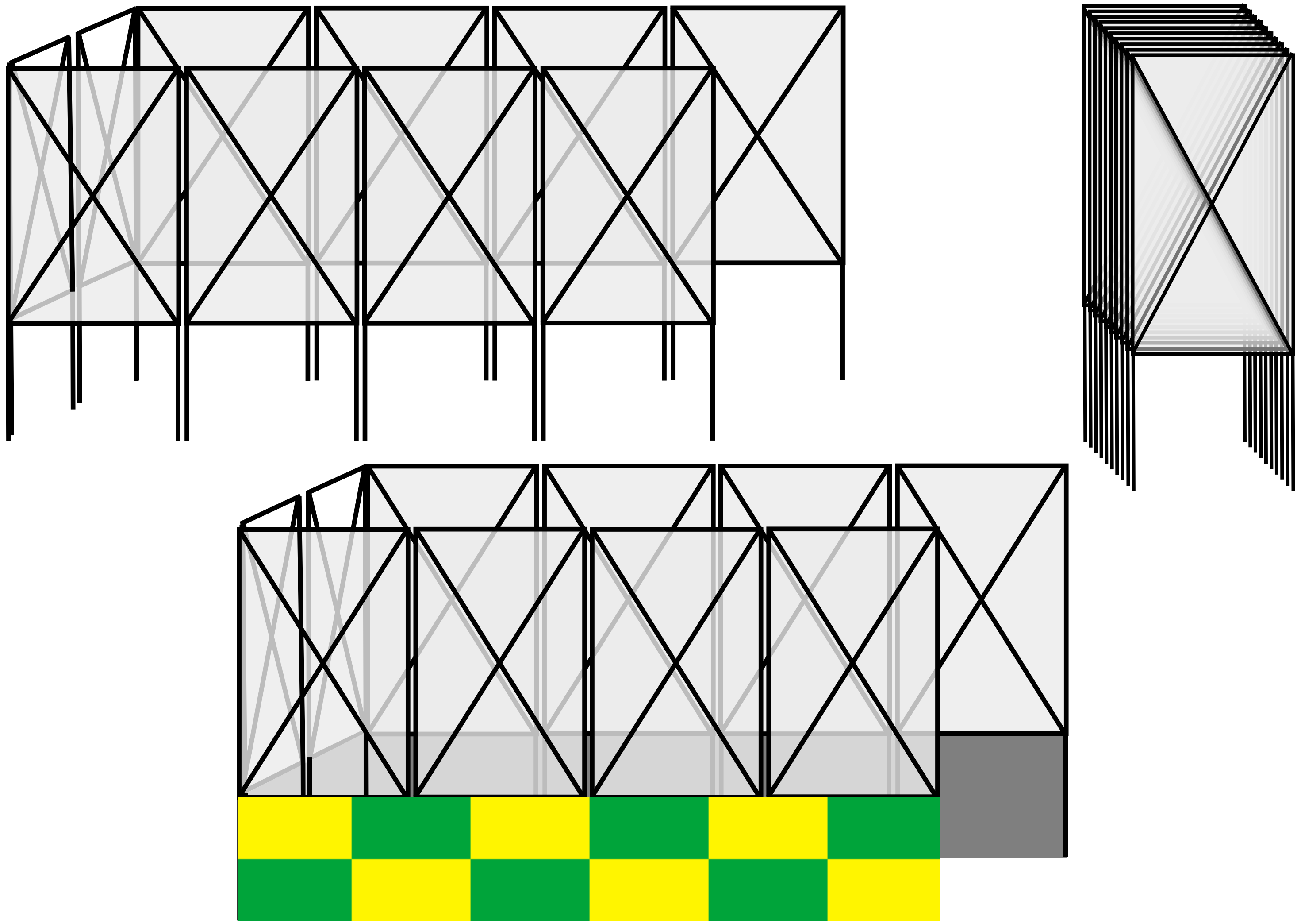


One of the issues mentioned before (p.16) with this structure would have been the extra fabric to accommodate the frame size difference when closed and opened. The entire structure would also be very mobile due to the interdependency of the frames.

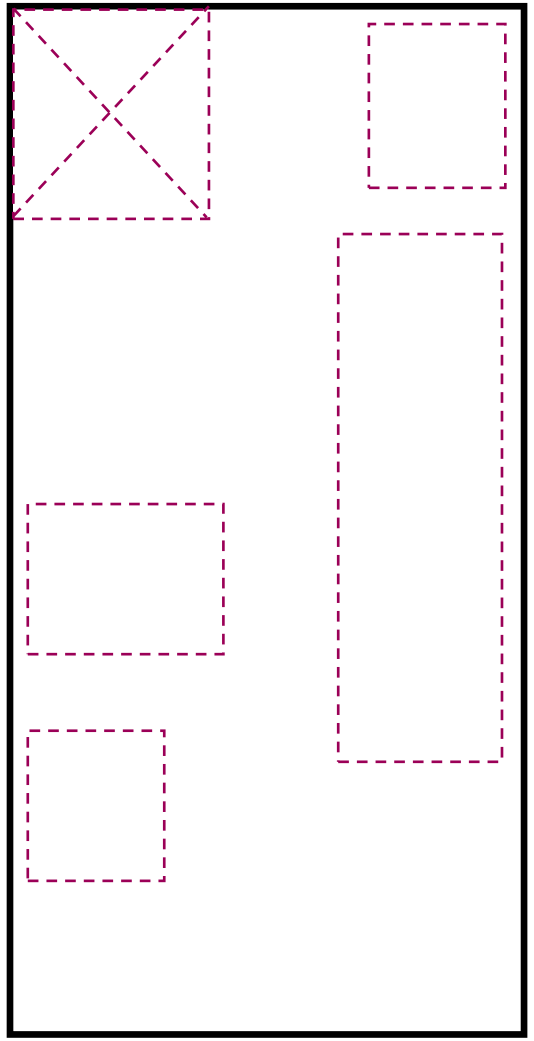


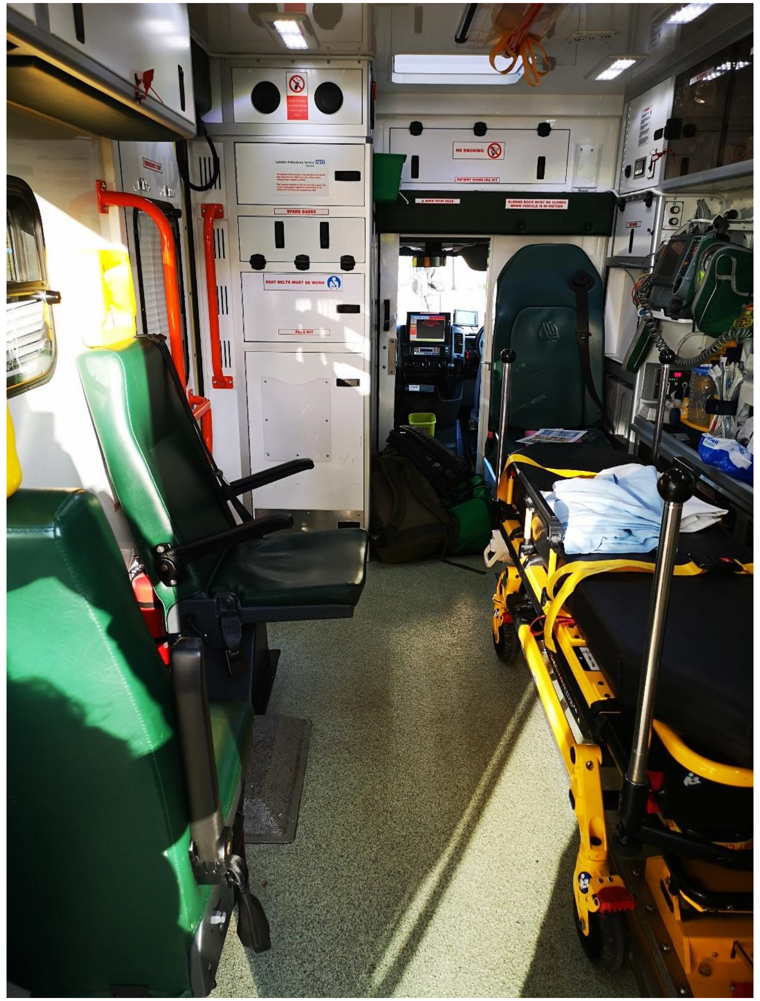


To create a window effect, small bamboo frames with clear plastic were thought of. This would have been easy to fold and dry but also repair due to an interlocking mechanism if one of the frames were damaged. When prototyping out of cardboard and wire, it became evident that the structure was highly unstable due to the number of interdependent elements.

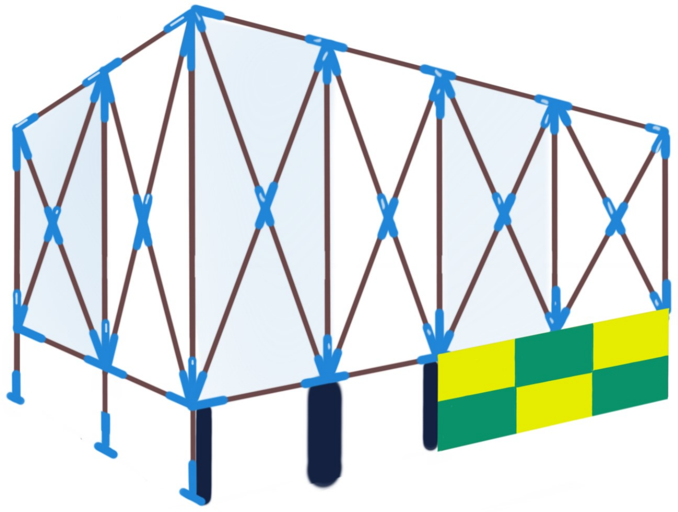


A simulation of the 10 panelled-shape was created to explore the shape and the look of the structure. This was to make sure the triangles would allow appropriate visibility and grip for the user.



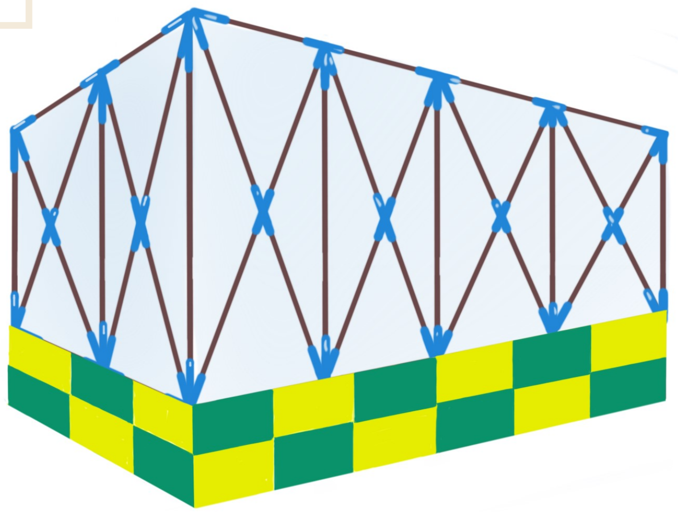


Above is a representation of the usable space in an ambulance at a scale of 1:25. This includes an oxygen and shelf space indicated by the cross, three seats for paramedics and passengers and a stretcher for the victim.



The 3 states of the structure are represented here with the option of removing the mesh. The first one represents the frame and joints. Weights are then placed by adding water bottles in a belt secured by hook-and-loop fasteners at the feet of the frame. This can be added to all the feet or only to the corners of the structure.

The yellow and green band is finally affixed to the weights to complete the ambulance. By adding the band, the structure further resembles an ambulance, making the scenario more intuitive.



Those are the elements required to make the structure from scratch. The joints and foot stand can be 3D printed. The fluorescent bands are optional and a smaller amount of weights can be placed in good weather. The hook-and-loop fastener can be put around the folded structure to help transport to the bag. The handles of the bag ensure a better grip.

Necessary elements

- 20 x Bamboo (2m)
- 30 x Bamboo (1.80m)
- 40 x T-joint
- 18 x Hinge
- 10 x X-joint
- 20 x Footstand
- 1 x Gorilla Glue
- 5 x Tarpaulin Mesh Sheet (1.5x1.8m)
- 20 x Tarpaulin Bungee Balls
- 4 x Weights and Bottles (1L)
- 11 x Weights and Bottles (1L)

Optional elements

- 2 x Fluorescent Bands (3.40m)
- 1 x Fluorescent Band (1.70m)
- 4 x Hook-and-Loop Fasteners
- 1 x Bag with Handles

PROTOTYPES

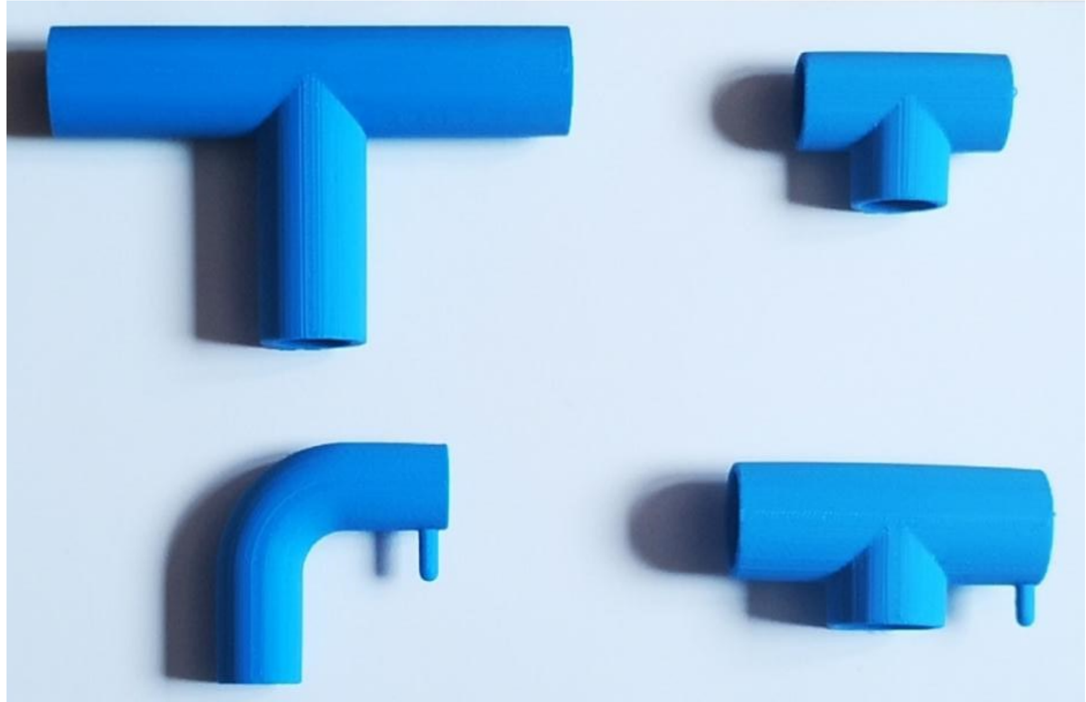
The idea of the structure changed after considering several ideas: tents, sheds, gazebos and pop-up systems. In the end, the triangle formation was opted for to prevent torsion and possible breakage of the structure.

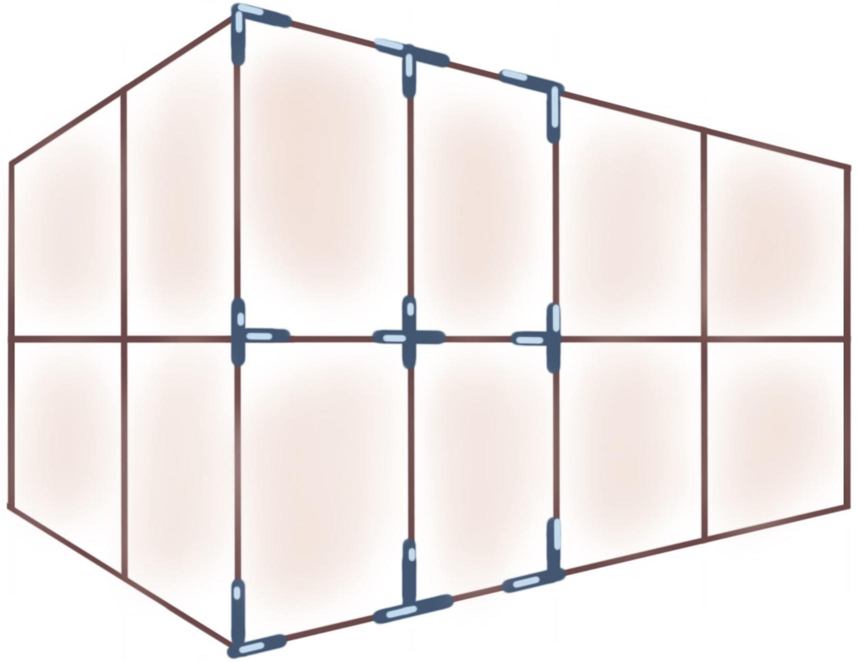
Bamboo was selected due to the material's good strength and low weight. It can also be found easily for a relatively low price and can be changed to metal rods. This allows the structure to be easily moved around and used in different weather for an extended period of time. The transparent mesh tarpaulin provides visibility for anyone outside the structure but creates walls for trainees. The angularity of the joints was tested repeatedly to fit the bamboo's irregularities and provide good grip for the user.

ABS was used for the joints to provide structure and easy handling. The user can replace it with ASA to provide UV protection. The plans for the joints can be found on the website created for this project.

The materials and elements purchased[1] for this project are weights, bamboo rods, tarpaulin mesh and tarpaulin bungee balls with glue. 3D printed connectors were created. Transparent tarpaulin was used and was going to be tested. One of the features of the product was to allow visibility for mentors from the outside of the structure but provide a wall-like feeling from inside.

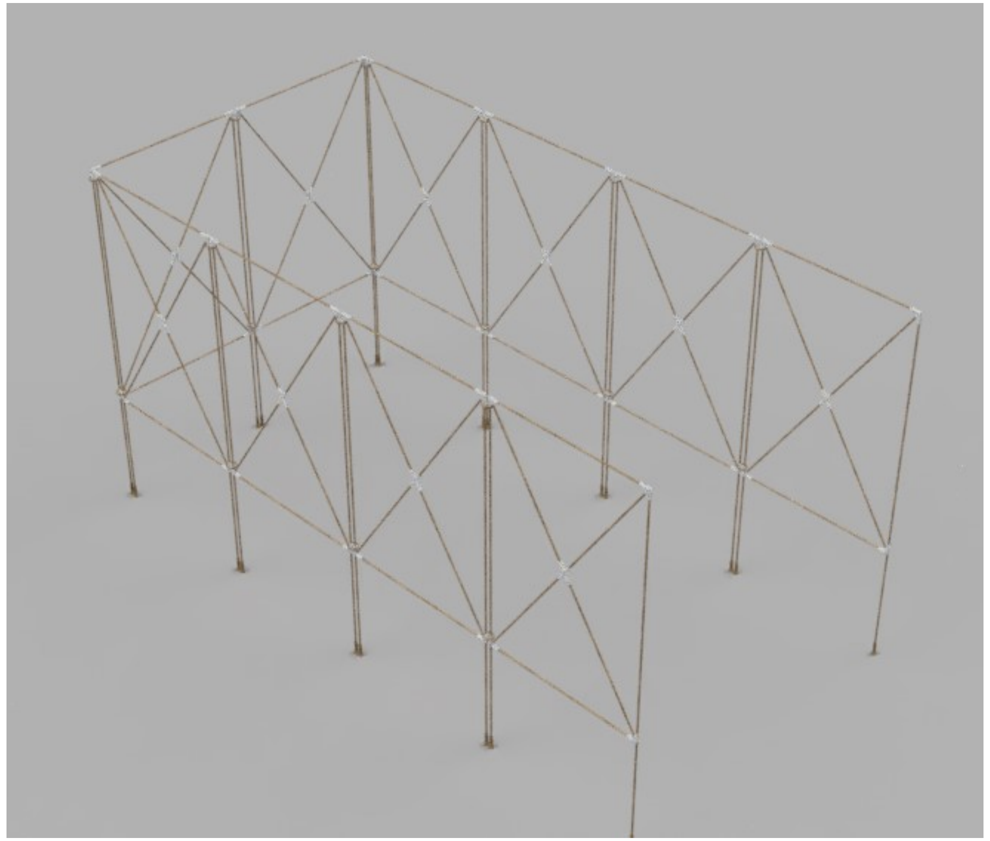
Polarising film, one-way privacy filter and privacy blinds were studied and considered. Polarising film would have been fitted on glasses worn by the user and to the walls of the ambulance. The trainees using glasses would have seen walls while the rest could see through it. One-way privacy film would have been the most efficient solution but proved too costly. The Venetian blinds would be heavier and require a more sturdy frame, weighing down the entire structure. Due to costs and dimensions, mesh tarpaulin was finally preferred, providing visibility but also structure.



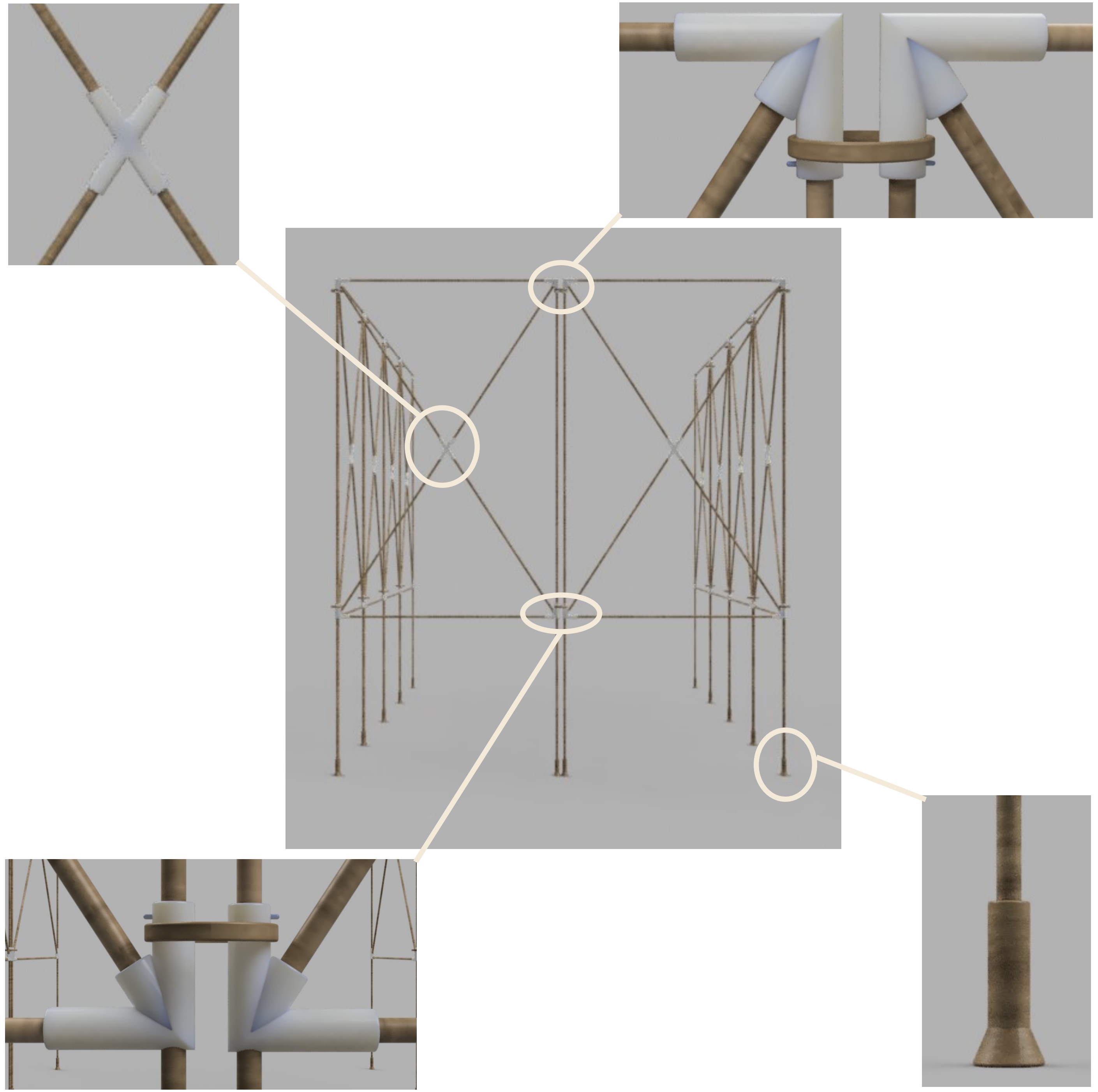


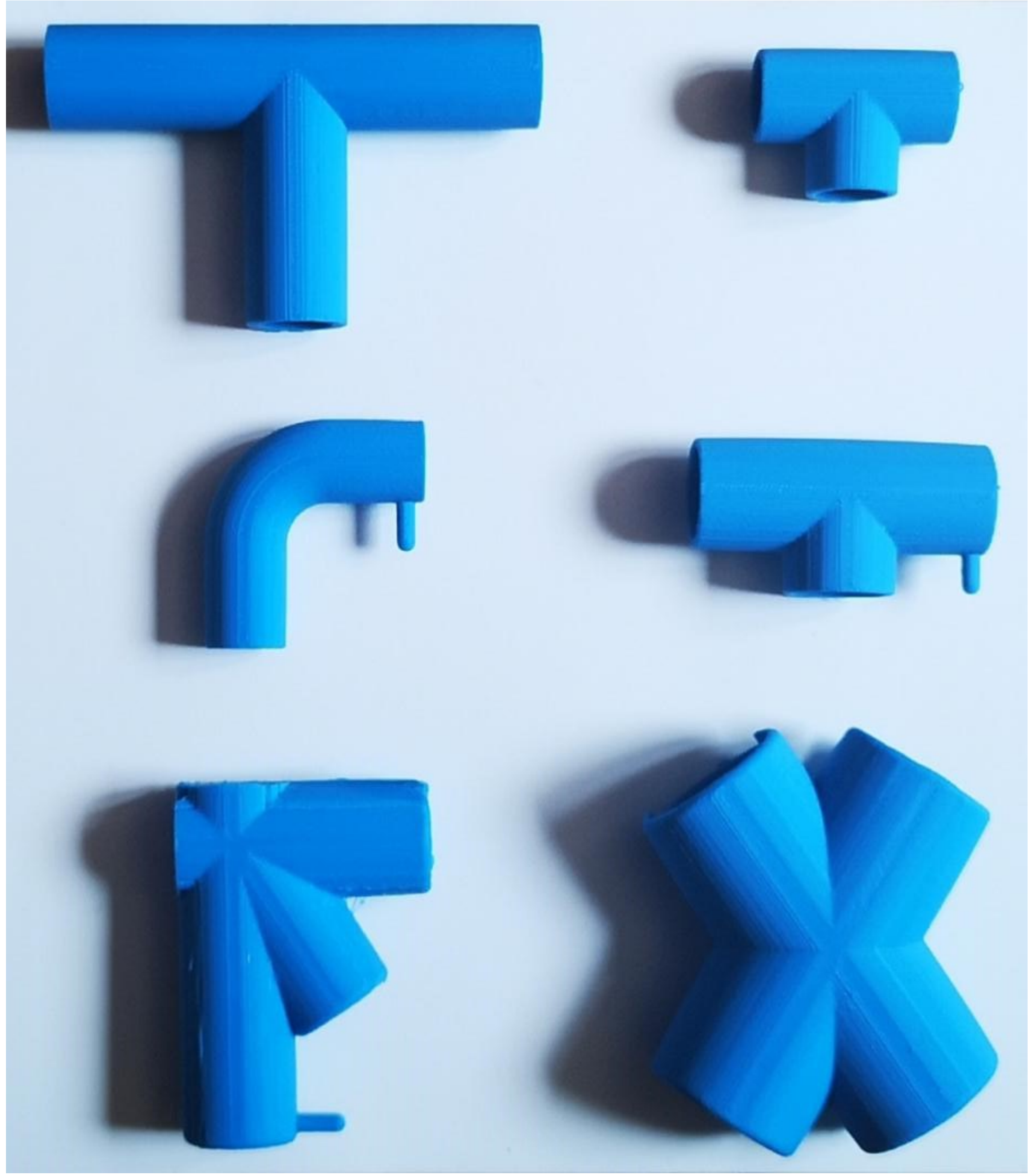
The top 2 prototypes for the connectors, were designed for the small bamboo panels (p.19). They were created to let the middle supporting beam go through and join the rest of the frame. The length and width of the joints were drastically reduced to tailor to the width of the bamboo. This allows faster 3D printings and less material to be used.

They were then redesigned so a circular hinge could fit around them. This would provide enough surface area for handling and glueing but also smoother corners to avoid discomfort.

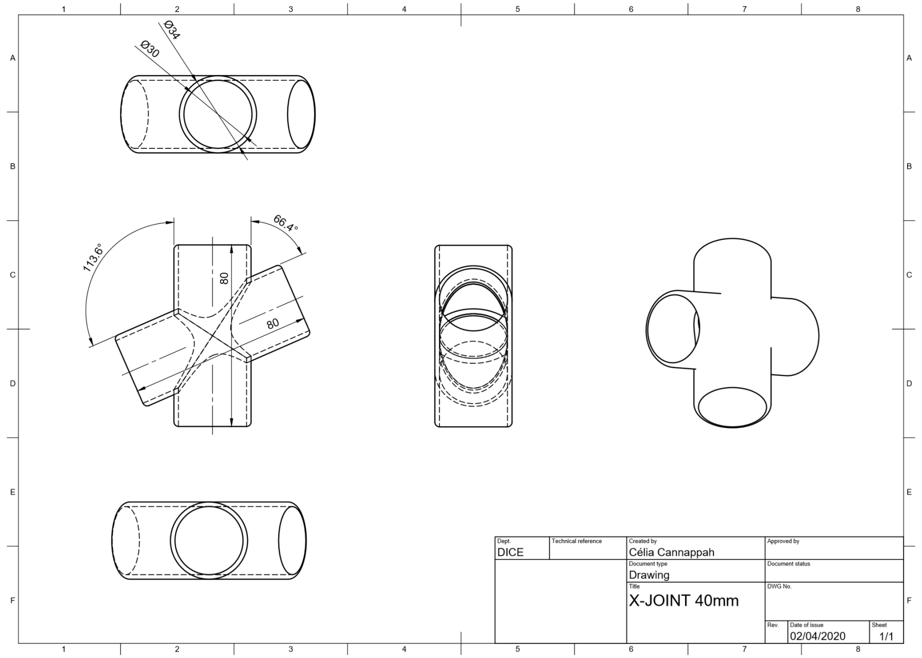


A rendering of the entire structure was created to provide plans and exact measurements for all the components. The latter can be seen on the right. There are T-joints both at the top and bottom of the frame, hinges linking 2 T-joints and an X-joint to provide grip and strength to the structure. The foot stand provides a base for the uneven ground and for the weights to rest on.



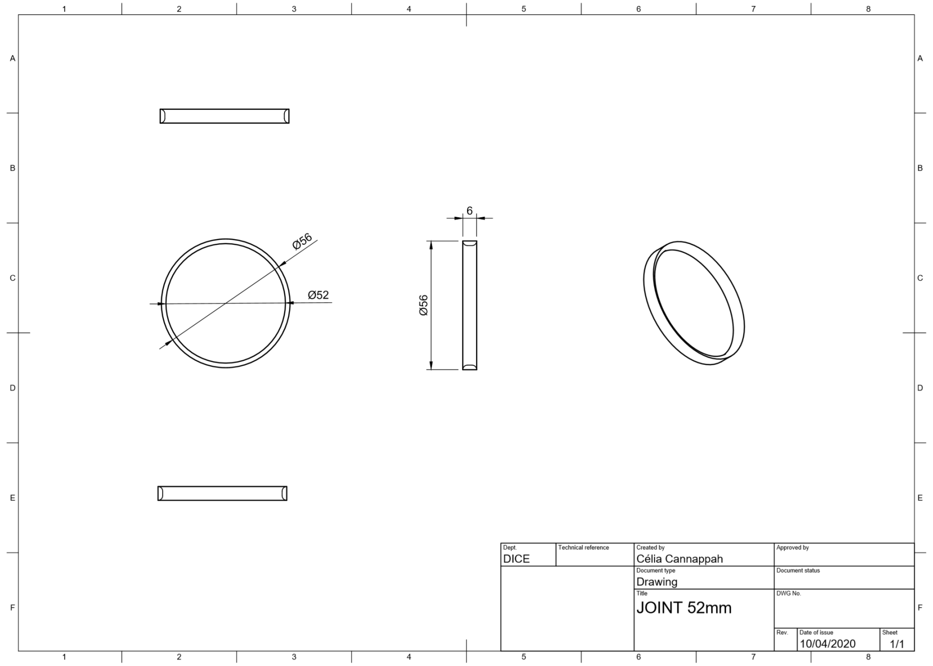


The final joints that were created can be seen at the bottom of the picture. Their angle has been adjusted to allow a triangular frame to avoid torsion of the beams during handling. The joint on the bottom left can be used at the top of the corners of the structure or the lower ones as seen in the rendering (p.32). The joint on the right is meant for the inner cross which allows a good grip for the user to move the frames. After those joints were created and tested to fit the bamboo, engineering drawings were made to be used by the general public.

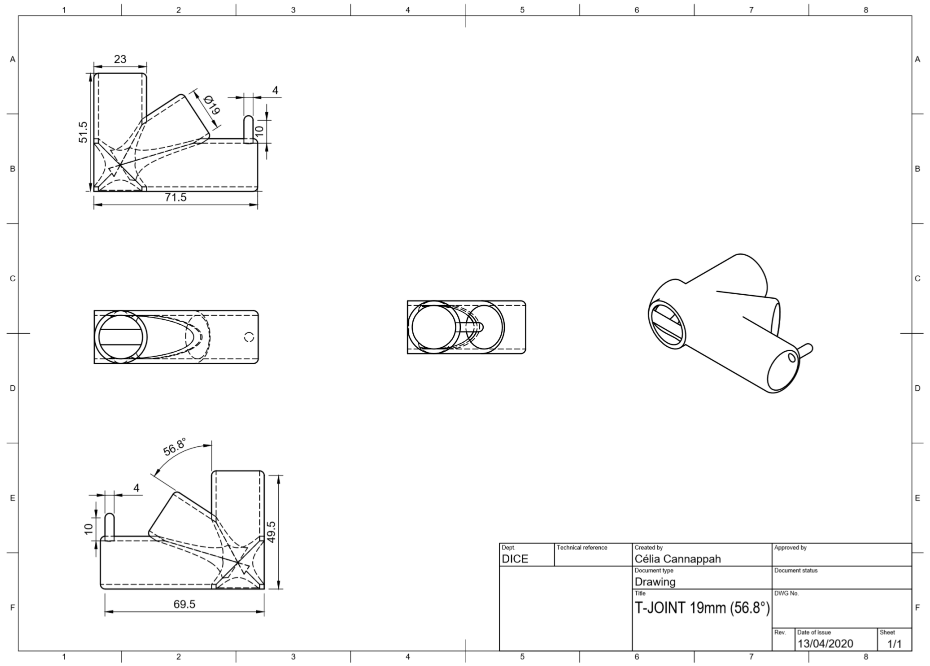


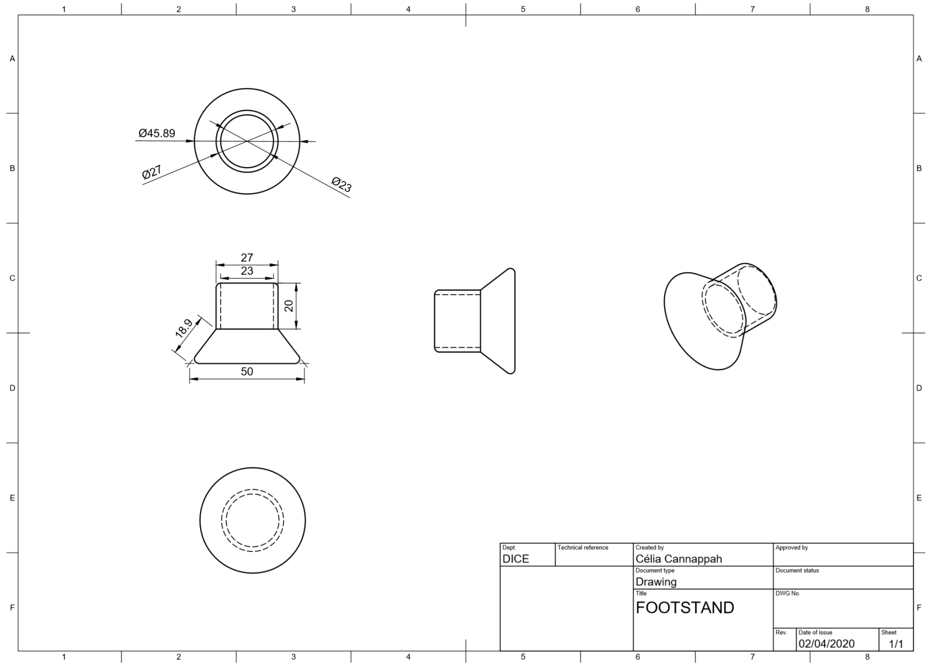
On this page are plans for the middle cross. They allow the two rods to criss-cross within the frame to avoid weakening the structure.

The hinge helps the user to move the frame freely within range but also fold inwards or outwards. It rests on the corner joints.

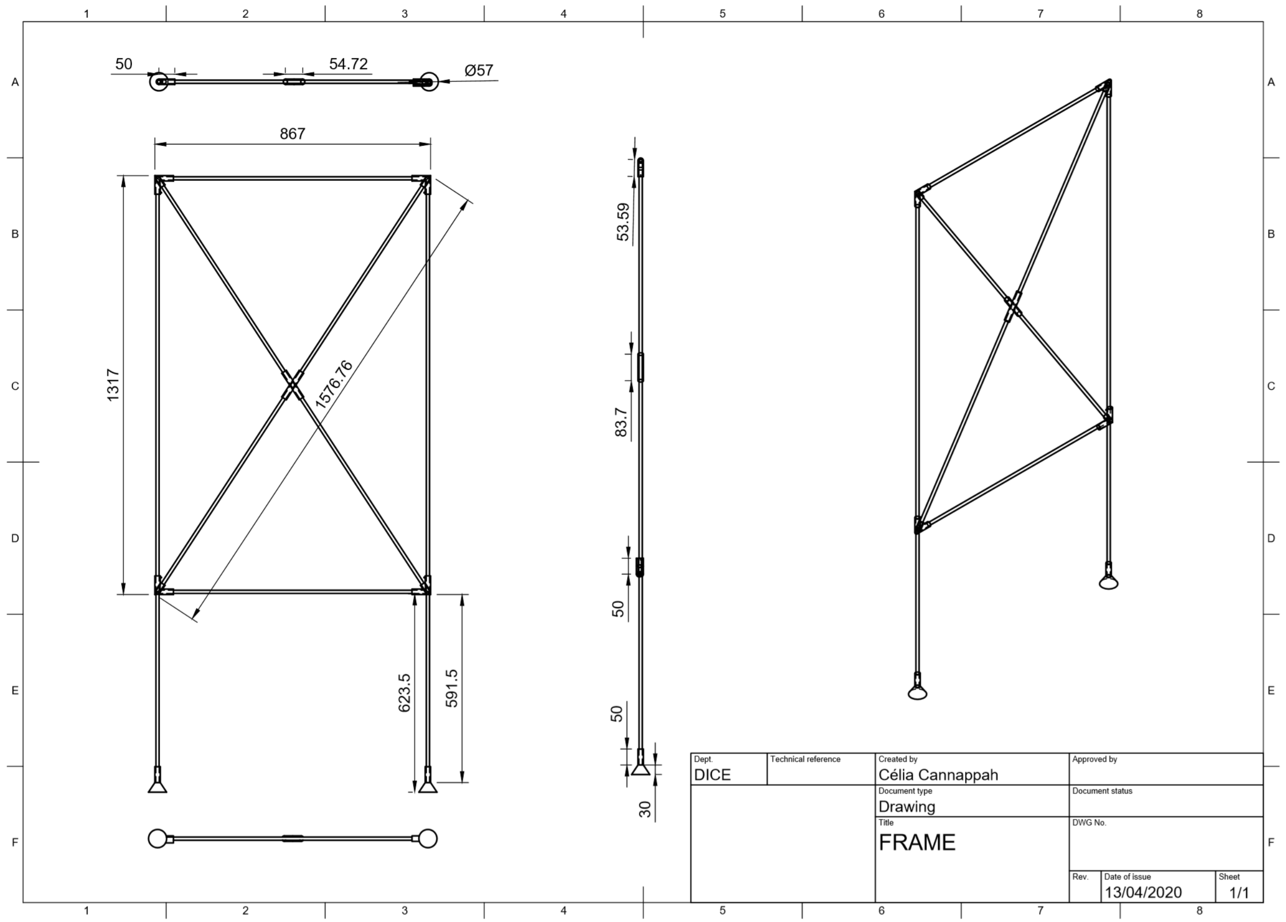


On the right, the corner connector provides contact for the corner rods but also for the cross. In addition, they bring an area for the joint to rest upon and move.





The foot stand provides an ideal surface area for the bamboo to rest in and helps the structure to stand. The weights can also be fastened around it.



The engineering drawings are also available on the website that was created for this project. This allows download for anyone who would need it, as well as a user-manual through a video to show all its features.

GUIDE

How to build it

MATERIAL

Necessary elements:

- 20x Bamboo (2m)
- 30x Bamboo (1.80m)
- 40x T-Joint
- 18x Hinge
- 10x X-Joint
- 20x Footstand
- Gorilla Glue
- 5x Tarpaulin Mesh Sheet (1.5x1.8m)
- 20x Tarpaulin Bungee balls
- 4x Weights and Bottles (1L)
- 11x Weights and Bottles (1L)

Optional elements:

- 2x Fluorescent Bands (3.40m)
- 1x Fluorescent Band (1.70m)
- 4x Hook-and-Loop Fasteners
- 1x Bag with Handles

PREPARING

Cut the bamboo according to the plans.

- 20x Bamboo (1.90m)
- 20x Bamboo (1.55m)
- 20x Bamboo (0.85m)

Print the joints and footstand.

Reuse water bottles by using rain water or fill them up.

Weights bags can be made by creating two pockets that can withhold two bottles of water, with two straps that can go around it and hook-and-loop fasteners to hold it.

Hook-and-loop fasteners can be added for the fluorescent bands.

Fluorescent bands are optional and can be made with yellow and green rectangles (0.60x0.30m).

ASSEMBLING

Place the bamboo in all the joints and hinges first, then glue it and let the glue set.

Attach the Tarpaulin sheet to two consecutive frames from the first one using bungee balls.

Put the filled bottles in the weights bags.

Attach the bag to all the feet of the frames or just at the four corners of the entire structure.

Attach the fluorescent bands on the bags to mimic the ambulance by using the hook-and-loop fasteners.

PUTTING AWAY

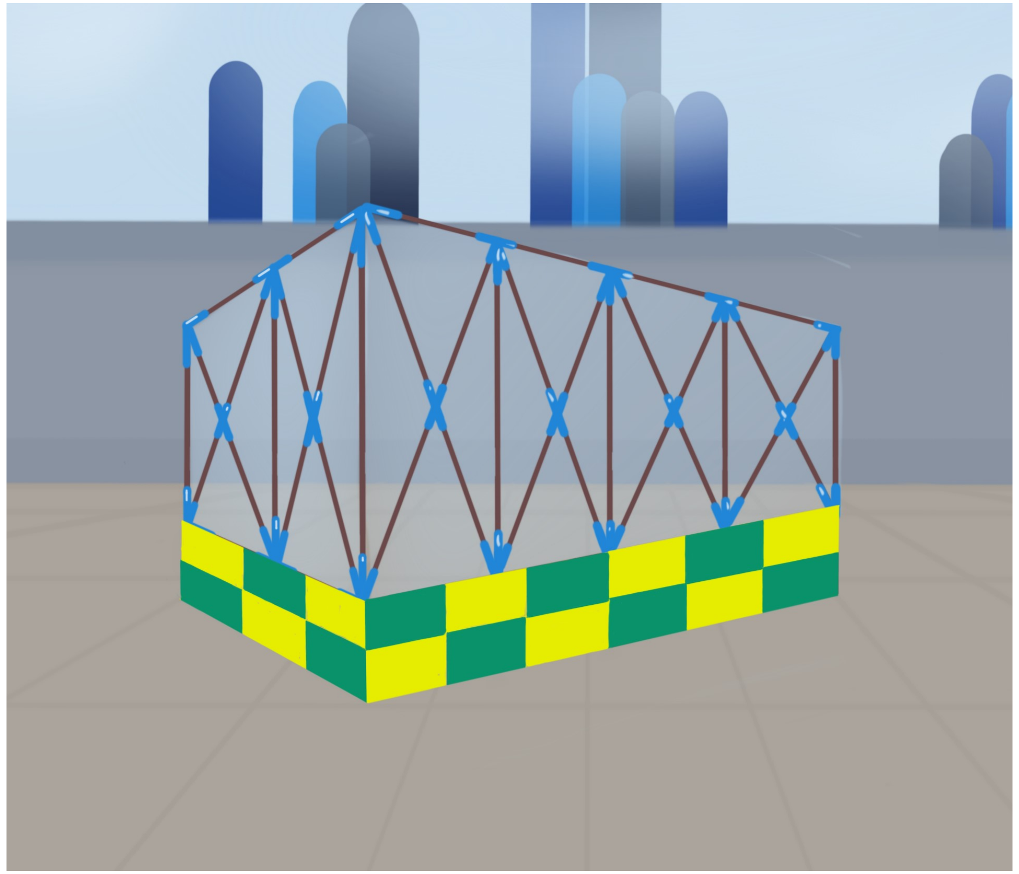
One person folds the structure by rotating the panels, the other holds the frame. Place the hook-and-loop fasteners along the sides of the folded structure for easy transportation and containment. Place it inside the bag.

A guide on how to build the structure is available on the website. After testing and feedback with the LAA, a properly written manual with drawings would have been created to make sure anyone can build it.

EXPERIENCE

This entire project was created to help trainees visualise a scenario: dimensions, colours and props. The mesh can look transparent from the outside of the structure so the mentors can observe the trainees and guide them. The trainees will be able to operate as if they were inside an ambulance as the mesh will give the white-wall feel.

A lot of attention was brought upon easy set up for the users. The joints provide safe and easy grasp for the user due to the slightly ribbed finish. When setting up, recycled water bottles can be repurposed as weights around the leg of the structure. Yellow and green fluorescent strips can be added on top of the weights to resemble an ambulance. They can also be removed to place oxygen bottles or a desk to mimic shelf space.



VIDEO + TRACK

A website was created to provide plans to build the structure for anyone needing to. It also has a soundtrack created for the LAA to recreate the environment in which they operate. The tracks are more than 30 minutes long, which is the training time for each moulage. They include sirens, city sounds, ECG and driving sounds. A video explaining the set-up and wrap-up of the frame, as well as highlighting the different elements of the construction, can also be found.

SCAN ME

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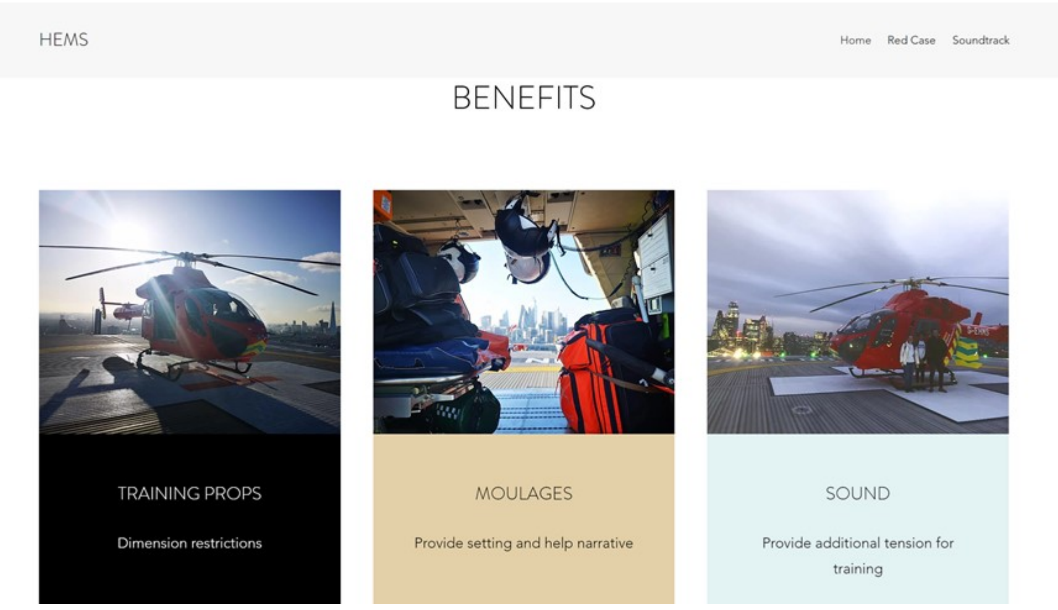
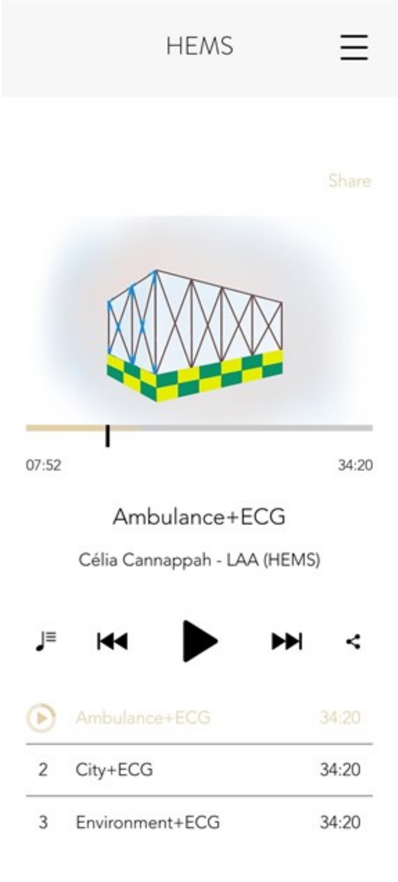
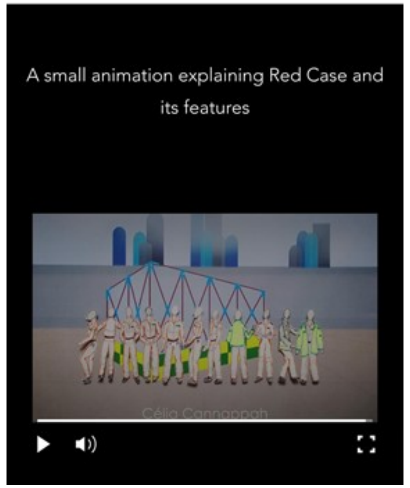
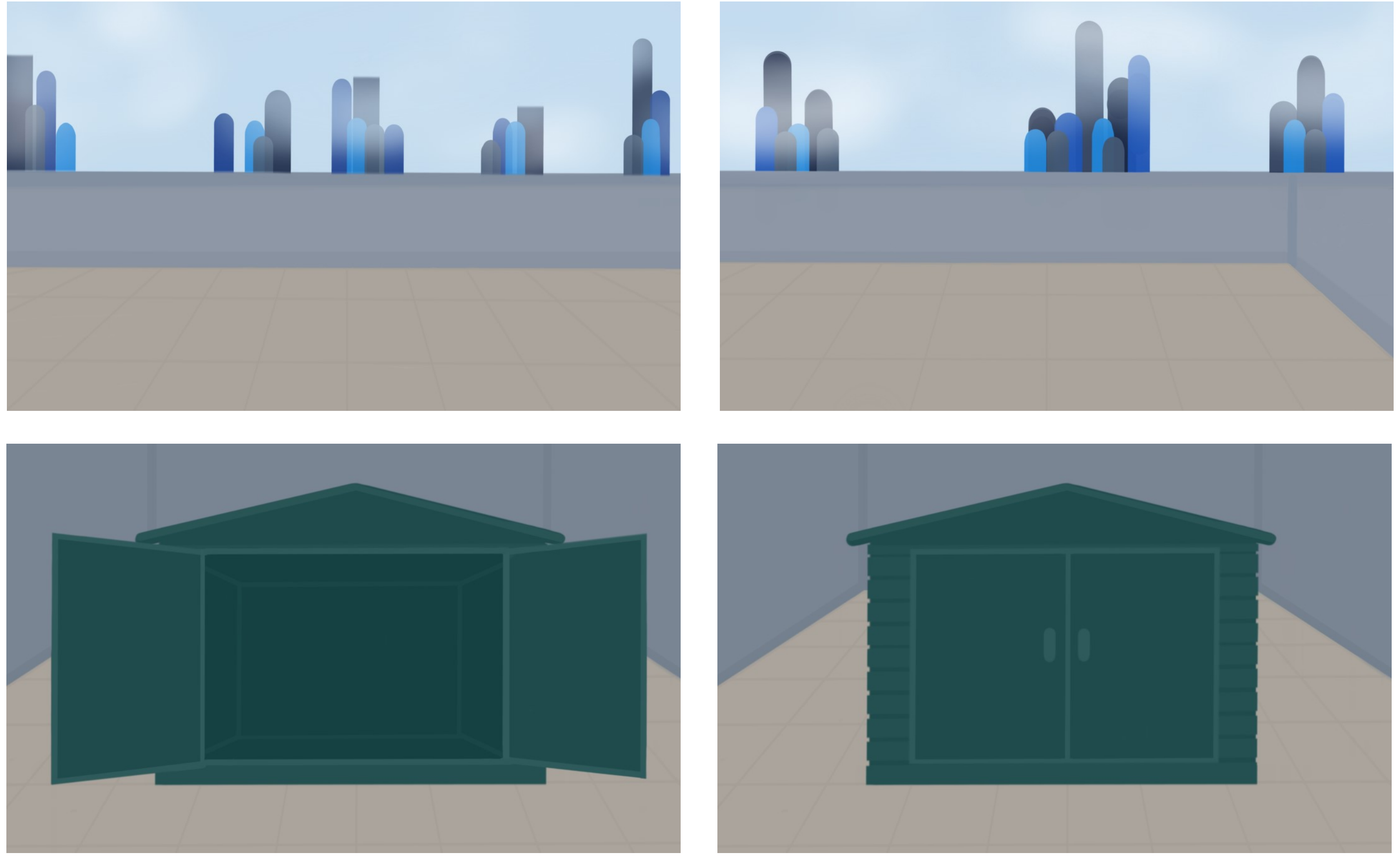


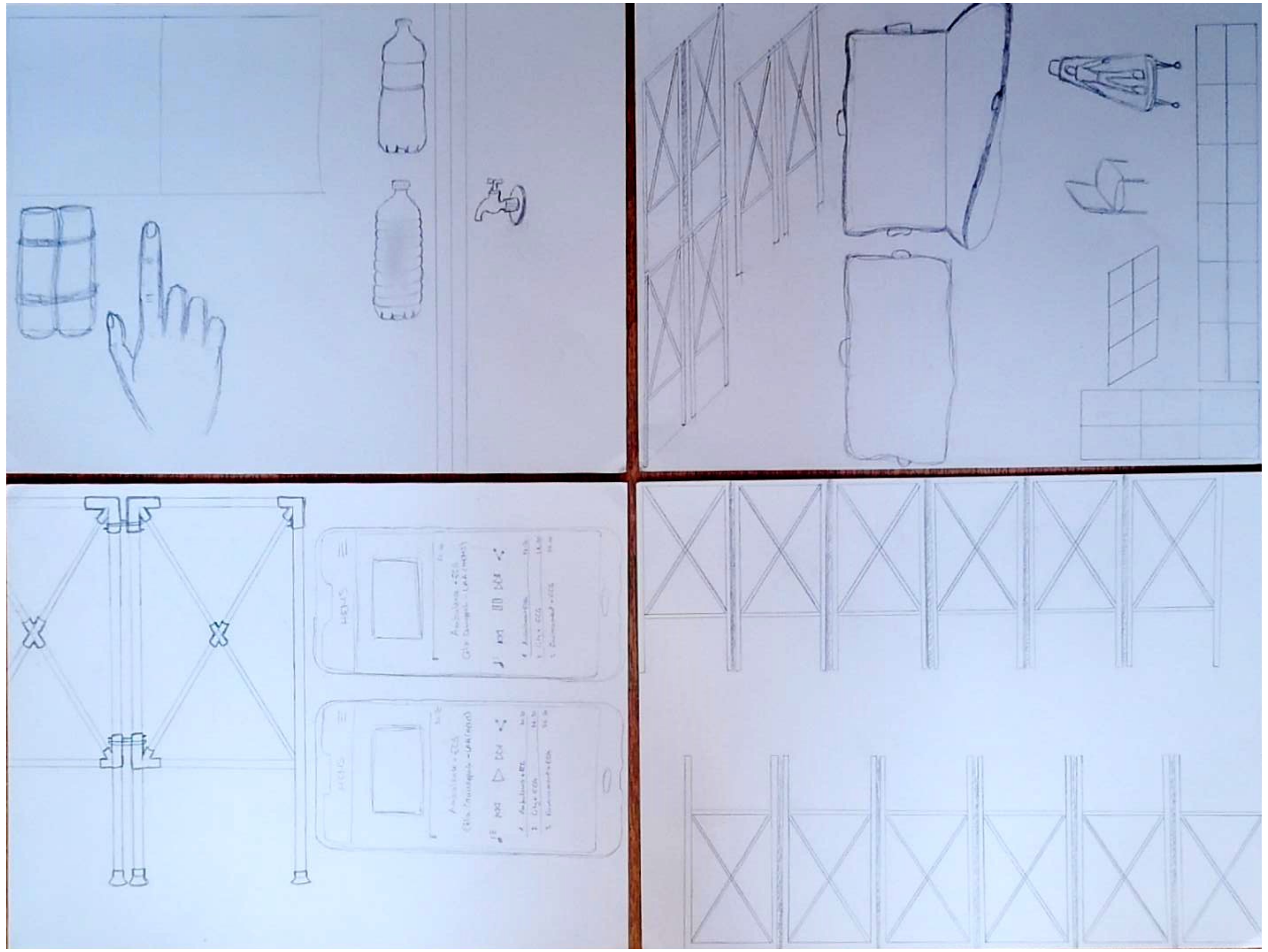




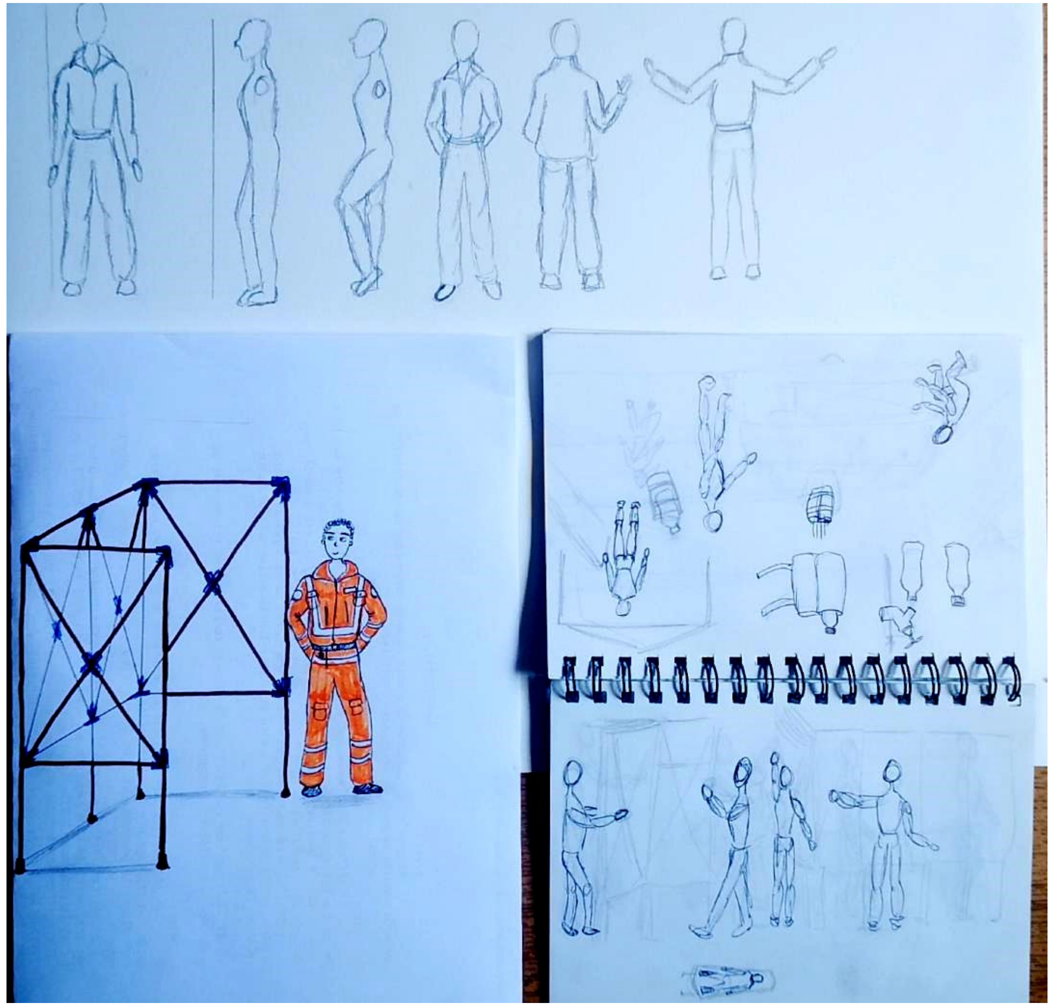
The website explores the features of the project, plans of the structure, elements and a guide on building it. A link is available to the LAA website if the person wants to know more about them. The 3 tracks can be found on the home page but also on the track page. The video is an animated guide on the product's use.



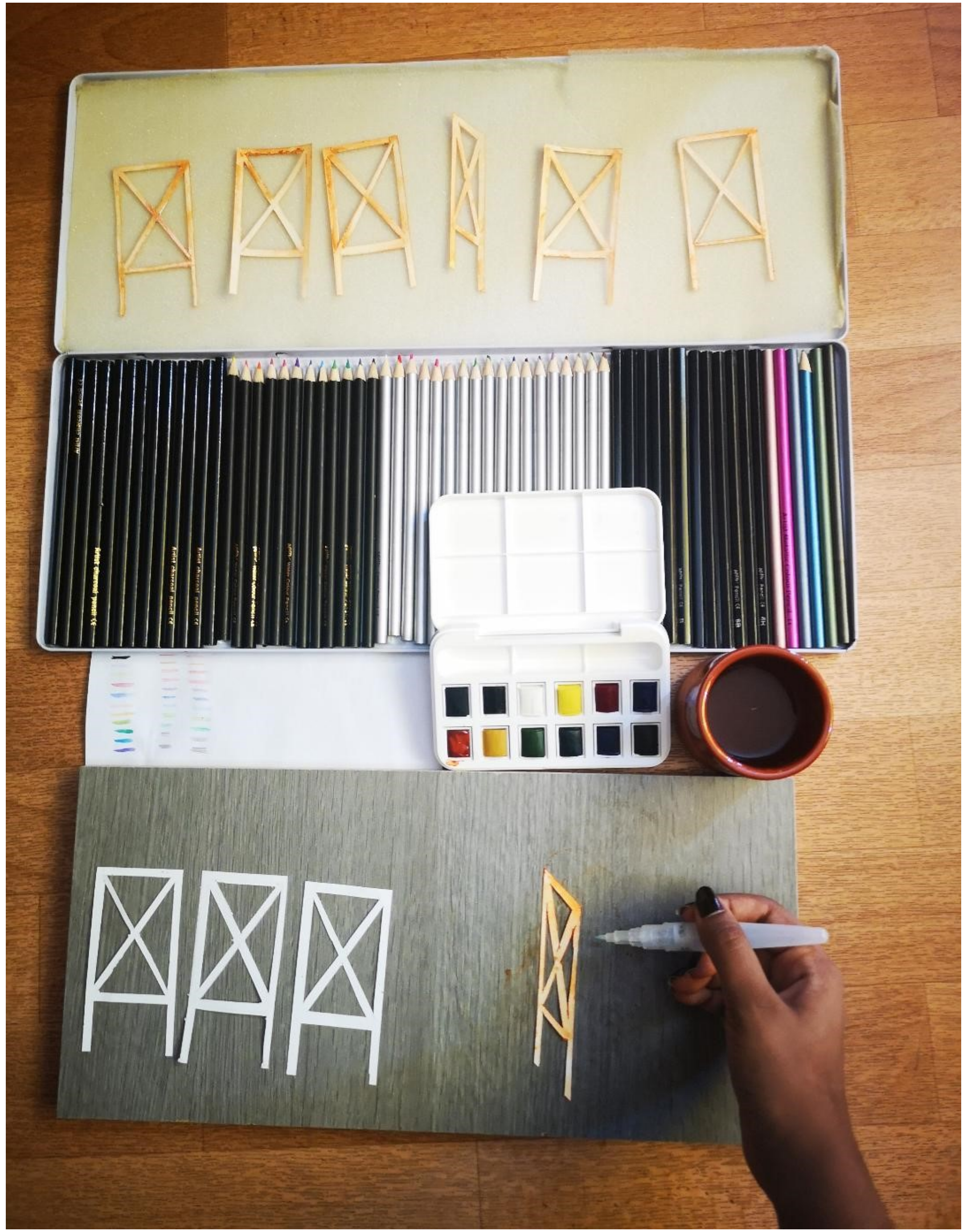
A plan of the 59 different shots of the video was created. Backgrounds were made to add dimension and context to the product. Behaviours and positions of the characters were studied to help break down their movements.

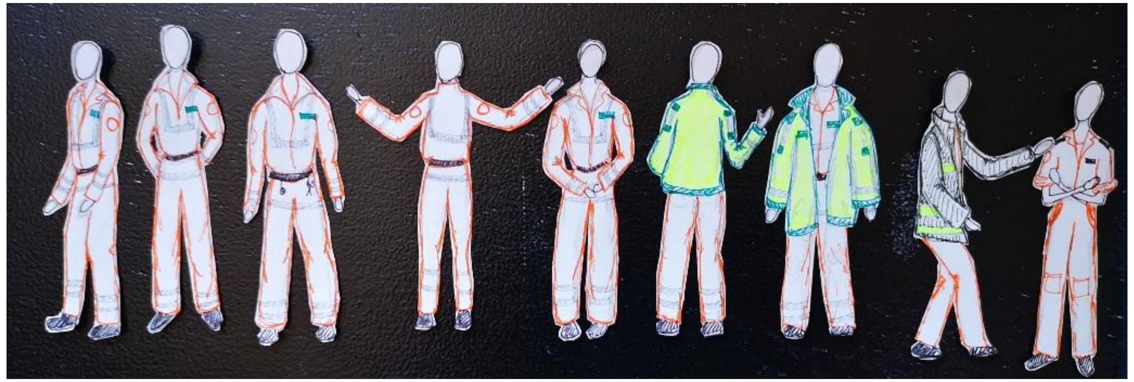


The numerous elements were then drawn to scale to see the ratio between a human of 1.70m and the structure of 3.40x1.70x1.90m. The impression of depth, texture but also movements was essential to depict the features of the product and understanding of the video (transparency, mobility, audio).



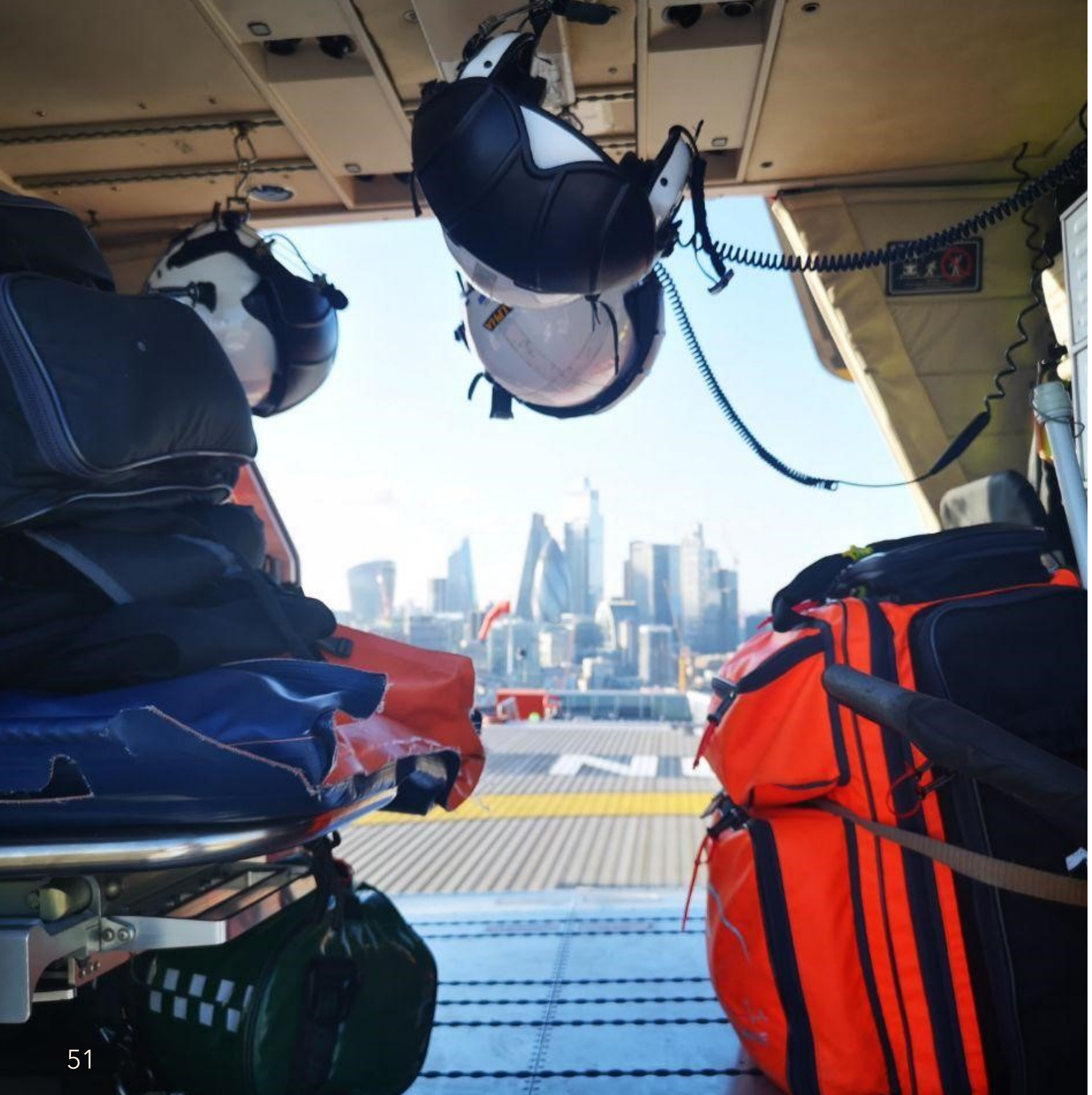
By planning the shots as well as the characters' movements, it was easier to try and draw them in different positions, giving the impression of movement. Their uniform and props were reproduced to be recognisable.





CONCLUSION

By making this ambulance simulator easier to reproduce and cheap, a wider number of users could be able to make it and train their future crews on cases they have worked on. By making the scenario more visual and using audio, this creates the tension that the mentors usually have to build up themselves. This would relieve their minds from those two tasks to focus on their trainees and the scenario.



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