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# Medical DIY Equipment KIT For Nepal

Update Date 3/22/2020

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### Disclaimer

This document is prepared as a Do It Yourself Compilation Guide for Nepali engineers, biomedical enthusiasts and entrepreneurs for last minute resorts to tackle the COVID-19 or such disastrous incidents. This is in no way shape or form a replacement for hospitals or medical professionals. This is only a means of use in emergency situations for individuals under dire stress for the individuals of their own accord.

The author/s do not hold authority, responsibility or liability of any actions generated by the reader as a result of this document. This document is meant only as an open source compilation of critical medical equipment needed for people in Nepal since trading routes are closed and widespread pandemic could create a shortage for medical equipment.

### Warning

The author/s do not claim to be experts or authority over any medical field. The sole responsibility of the harm to any individual as a result of any equipment created using this document rests in the creator of such equipment. The author/s shall not be held responsible for the risk of untested equipment or the failures of the inventor of such equipment.

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Sincerely  
Gunjan Ghimire

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## DIY Ventilator

### Introduction

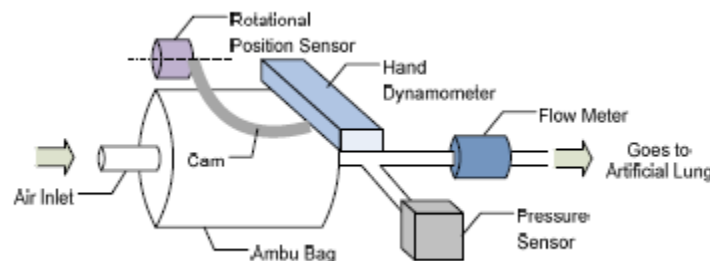
The need for Ventilators for Respiratory Isolation for Corona Virus Patients is dire. Nepal cannot manufacture or provide ventilators in large scale; thus this document can be used to create locally sourced tools and materials to create Ventilators in this time of dire need.

### Possible Do it Yourself Options Available

- The Pandemic Ventilator- [Link](#)  
This is a useful technique to get yourself acquainted with. If you are actually going to deploy it to a patient, the recommendation is not to do it. It is a prototype with not enough research (with all due respect to the inventor). Also, the parts cannot be sourced in Nepal.
- The Portable Mechanical Ventilator- [Link](#)  
This is the choice of ventilator DIY option to go for. First of all, it was created using grants from the DOD at MIT and second they have used tools and equipment that can be bought off the shelf or 3D printed. This document will explain in brief what this research paper holds.

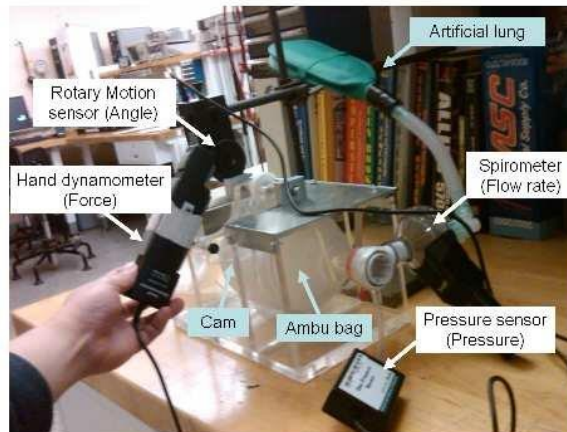
### The Portable Mechanical Ventilator

This ventilator is designed to be portable and runs on battery. It uses simple principles and equipment. The following diagram from the research paper is a representation of the mechanism with which the device operates.



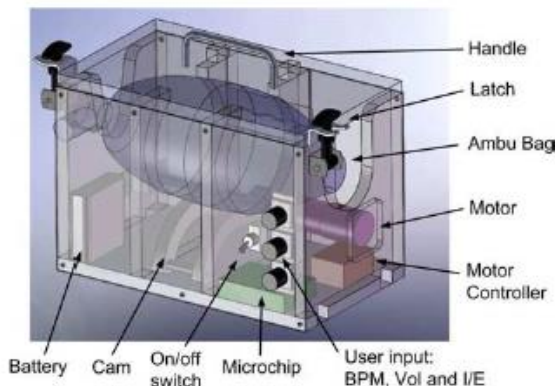
The curved cam is designed to react to change in air volume in the Ambu Bag (the giant balloon thing). The cam's angular displacement (change in angle) is measured by rotational position sensor. The Hand Dynamometer (force sensor) measures the force exerted on the cam.

The pressure sensor will measure the internal air pressure and the flow meter will regulate the flow of the air outlet. The point where it says artificial lung is the air outlet. This experimental figure was created as the first prototype in the following picture. For sizing and other directions, please refer to the link.



The Spirometer is the flow meter. This can be designed in 3D. The hand dynamometer was used to detect change in force, a substitution of weight sensor may be used (please calibrate all your sensors before checking). The rotary motion sensor is very easy to find, if you can't find one search for "Charkha Machine" and disassemble it.

Ambu Bag is easily sourced. The only substitution that was found for the Spirometer in terms of locally sourced parts is an ASCO valve. It is analog, thus a converter from analog to digital might be useful for you if plan to use it as a part. The following pictures represent the two prototypes in 3D and in final product form.



### Parts List in Kathmandu

- Rotational Position Sensor- <https://himalayansolution.com/product/rotary-encoder-small>
- Hand Dynamometer/ Weight Sensor- <https://himalayansolution.com/product/human-body-weight-sensor>
- Flow Meter/Spirometer-<http://www.ibizkart.in/KATHMANDU/products/asco-valve/140>
- Pressure Sensor-<http://www.ibizkart.in/KATHMANDU/products/asco-valve/140>
- Microcontroller-<https://himalayansolution.com/category/wireless-and-iot>

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- User Control Switches- <https://himalayansolution.com/product/dpdt-switch>
- Battery-<https://himalayansolution.com/product/9v-battery>
- Ambu-Bag-<http://annapurnapharmacy.com/drug/1473-ambu-bag-silicone-adult>
- Motors-<https://himalayansolution.com/category/motors>

### DIY Solution for Individual Parts

DIY Nano Spirometer

<https://maker.pro/arduino/tutorial/diy-arduino-nano-spirometer>

Spirometer Turbine 3d link (Would highly recommend this over ASCO Valve)

<https://grabcad.com/library/turbine-flow-meter-1>

DIY Arduino Rotary Encoder

<https://www.electroschematics.com/rotary-encoder-arduino/>

DIY Hand Dynamometer

<https://www.instructables.com/id/DIY-Microcontroller-Hand-Dynamometer/>

### Updates

Date 3/20/2020:

Contacted Author of the paper, requested him for CAD Files. Makes Life Easier for us. I will be adding more designs to this if 3d models are not available tomorrow. This will be the hardest equipment to design, this I will take time and effort to add to it. If you have something to contribute, email me at [difr.application@gmail.com](mailto:difr.application@gmail.com)

Date 3/21/2020

CAD Files found Link <https://github.com/RuairiSpain/openVentilator>

Date 3/22/2020

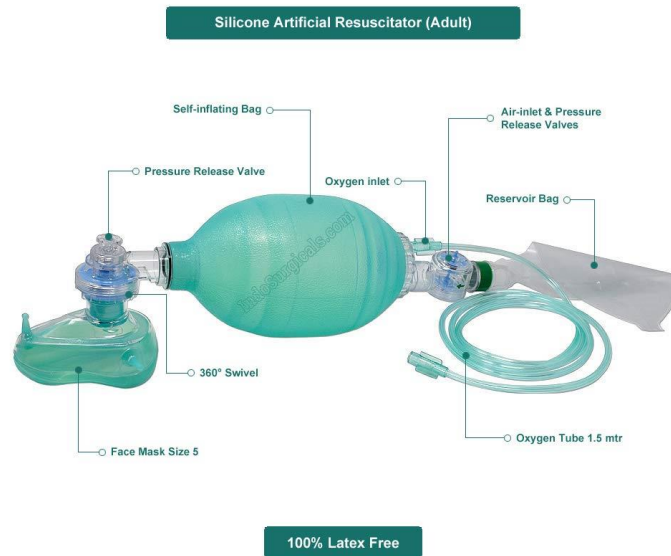
Himalayan Solutions Pvt Ltd, Madhukaa Drone Services Pvt Ltd, CNC Aakriti Pvt Ltd have lend their resources and team to continue the project in Nepal.

Differential Pressure Control DIY

<https://www.instructables.com/id/Low-Cost-Spirometer/>

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## How does an AMBU Bag work?



## Current Design for the Linear Actuator



Update 3/23/2020

Within our design Parameters, Controls are visualized by these components

- A. Breathing Cycle Rate: Speed of the linear plate controlled by the microcontroller
- B. Breathing Volume: Extent to which the bag is pushed is a function of distance
- C. Inhale/Exhale Ratio: Furthest Distance the motor travels away from the bag (Pressure Calibration Requires further testing)

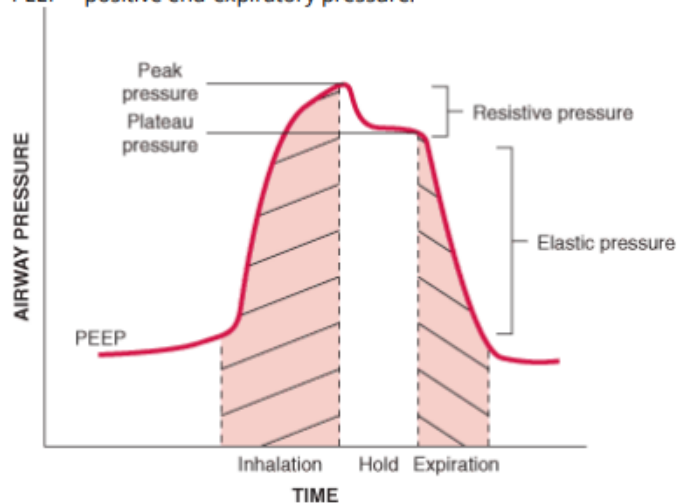
Parts Used:

(Supplied by Himalayan Solutions, Assembled and prototyped by Gunjan Ghimire, Madhukaa Drone Services and CNC Aakrtiti)

- NIMA 17 Motor and Motor Controller (TB6600)
- 10 mm Rod, Bearings and Clamps
- Arduino MEGA 2560
- BM 180 Pressure Sensor

### Components of airway pressure during mechanical ventilation, illustrated by an inspiratory-hold maneuver

PEEP = positive end-expiratory pressure.



- PEEP
- Peak Pressure- Display
- Resistive Pressure- Display
- Elastic Pressure
- I/E Setting- 1:3 or 1:4 (Normal)

$$\text{Peak airway pressure} = \text{resistive pressure} + \text{elastic pressure} + \text{PEEP}$$



## DIY Hand Sanitizer

### Introduction

Prevention and safety is better than cure. Thus, Hand Sanitizer or spirits that can clean your hands are essential and there is a market shortage. Do this to save yourself.

**Warning:** Please use caution while using Chemicals and always be safe. This was compiled from the internet; thus, the author bears no liability or responsibility for the actions of the reader. Keep away from Children while reading and performing any activities listed below.

### Quick Gel Recipe from Wired- [Link](#)

- 3 parts Isopropyl Alcohol – Source it from [https://www.nepalyp.com/company/63524/Shree\\_Rani\\_Sati\\_Trading\\_Concern](https://www.nepalyp.com/company/63524/Shree_Rani_Sati_Trading_Concern)
- 1 part aloe vera Gel – Source it from <https://www.daraz.com.np/products/khadi-natural-transparent-herbal-aloevera-gel-200g-i100113252.html>
- Some natural oil for flavor or lemon juice according to this [article](#)

## DIY Isolation Suit

### Introduction

There is a lack of care to the caregivers. They are in the frontline and they need the best medical prevention kit out there but that might not be available at the time. Here is the next best alternative.

There are two alternatives that I found in the internet, that can be made low cost.

- [Space Dev Club](#)
- [PAPR LOW COST](#)



[This mask](#) shown in light blue strap is attached in the mouth, the goggles for protection of eyes and the head gear for protection to face. The air compressor and the battery can be housed in the bag and the pipe can be used to channel the air through the air filter. The guy who designed this is wearing it in the picture above. (Thank this dude, he made the sacrifice in fashion for this invention).

As he mentions, a hood with face apparatus that can help visibility and a breathing hole in the back is perfect for solutions. He goes in deep with the construction of the air compressor, I found a better solution (Juggad method, test it out, you might need a lot more since humans need more than fishes in an aquarium).

The aquarium air filter does the same thing this guy mentions (I might be wrong, so do it at your own peril). The aquarium air filter at the cheapest model costs 650 Rs. Use that to supply air using a similar tube as shown above. Although, you always have the option of following his steps. Your final product should simulate this image.



### DIY Individual Parts

CPAP Mask

<https://www.stlfinder.com/model/cpap-mask-fBQ1pBhk/7479650/>

Hood

<https://workersafety.3m.com/cbrn-papr-prepared-breathe-easy/>

### Parts List

- Air Tube- <https://www.daraz.com.np/products/air-pipe-tube-for-air-pump-for-aquarium-2-meter-length-i101356857-s1022126199.html?spm=a2a0e.searchlist.list.11.4bdc11ebowK8gp&search=1>
- Air Compressor- <https://www.daraz.com.np/products/minjiang-internal-filter-ns-f260-for-aquarium-i101178465-s1021908496.html?spm=a2a0e.searchlistcategory.list.11.268b2307oYQGuj&search=1>
- Hood/Body Suit Material (They provide fabric for fumigation tents and other materials Including the transparent plastic. 3d print the air valve in a body suit stitched with a table stitch and you have a body suit with an opening for compressed air.)- <https://www.bansalcanvasudyog.com/kathmandu/index.html>

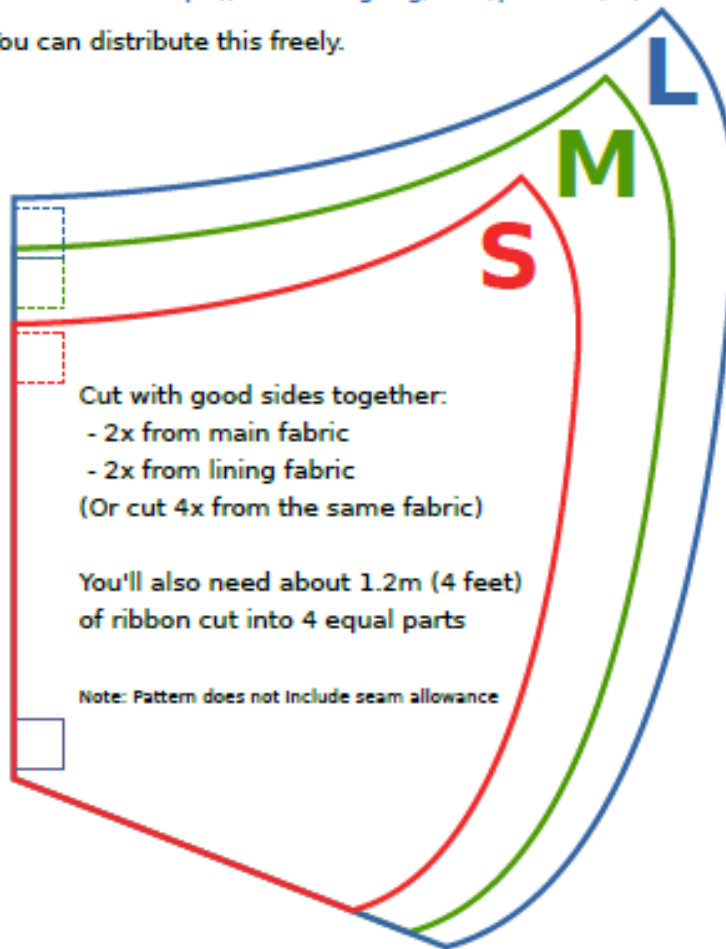
## DIY Face Mask

This is based on [freeseewing.org](https://freeseewing.org)'s Fu Face Maks pattern.

You can generate your own at: <https://freeseewing.org/designs/fu/>

Instructions: <https://freeseewing.org/docs/patterns/fu/instructions/>

You can distribute this freely.



The (white) inside of this box should be 10cm wide  
The (black) outside of this box should be 4" wide

## DIY Hospital Beds



This is a [3d File](#) free to download from Sketchup (you won't need sketchup, you can view it online). My solution for this is use the dimensions on the 3d file to create a real bed using basic tools such as welders, cutters, nuts and bolts. The rolling wheels are easy to source online. Do not try to 3d print a hospital bed, rather optimize your process flow using tools you have. It does not have to be that fancy.

### Parts suggestion

- Use Old clothes, quilts and other non-essential clothes to make the mattress. Try to make it comfortable (Hospital beds are uncomfortable) . And yes, wash the clothes and material with some sterilizing material before you make it a hospital bed mattress. Same goes for the pillow. (Mattresses aren't cheap apparently!)
- Try to make a bed with rollers at the leg. It will be easy for the doctors (if this is used at the hospital).