Handling the PPE Shortage: Update on Mask Design and Fabrication

Full Webinar: https://www.youtube.com/watch?v=sKqlqghyaUvs&feature=youtu.be

Dr. Darryl Hwang (Reusable Filtered Mask)
- Full Webinar: 1:20 – 22:20
- Asst. Prof. Research, Dept. Radiology @ Keck School of Medicine of USC and Dept BME @ Viterbi School of Engineering
- Goal is to provide protection better than a bandana
- Tentative name of “pseudo N95 masks” have been changed to “reusable filtered masks” -- a more accurate description
- Timeline
  - 3/22/2020: Joe Savoie (from east coast), Director of Imaging Services, texts 3D printed masks
  - 3/23/2020: Prototype printed overnight
  - 3/24/2020: Met with Infection Prevention
  - 3/25/2020: Fit test with Respiratory Support, asked on Facebook for people with 3D printers
  - 3/26/2020: Connect groups in LA, CRASH Space (https://blog.crashspace.org/), Sunweaver Creative, iovine and Young Academy, USC School of Architecture, USC School of Engineering
- Reusable filtered mask
  - Can be sanitized in a hospital setting (reusable)
  - Provide filtration comparable to N95 or better (filtered)
  - Fit on a healthcare worker and be worn all day (mask)
- Disinfection
  - Step 1: 1.4% hydrogen peroxide, let it air-dry
  - Step 2: UV sanitation —> UV box or pulsed xenon robot
- Filter material
  - Not creating our own material, but assessing different material for efficacy and installation
  - Looking for quantitative analysis from laboratories
  - Required criteria
    - MERV 16 (lowest to hit the N95 requirement) or better
    - Must not have fiberglass —> can be an irritant, silicosis
    - Easy to adapt
  - We are currently using Honeywell filter (model: HRF-R1)
    - Different than the one shown in prior webinar
    - This one appears to be N95 or better (older one was not)
- ~300 printers are printing for Keck daily
- Design was selected because no support material is needed
- One roll of material: ~12-13 masks
• Finishing the mask
  o Frost King Premium Rubber Self-Stick Weather Seal and hot glue gun —> form a gasket between the mask and the user
  o Currently no 3D printed masks are being used because FDA says not to use these until actual PPE are used up
  o 2200 masks received so far (medium and large sizes)

Shawn Chapman (Production in Times of Crisis)
• Full Webinar: 22:23 – 33:24
• Sunweaver Creative
• Problems
  o Shipment of PPE is unreliable
  o Shortage of normal materials
  o Lack of good data for new paths forward
  o Dire need to protect people
• Solutions
  o Set easy goals to achieve
  o Unify the vision forward
  o Begin rapid testing cycle
  o Avoid crowds (to find supplies)
• Design for mask based on Lafactoria from Spain
  o Generates little waste
  o Sterilized with hospital protocol
  o Minimal filter material
  o Material doesn’t wick
  o Has a nose cone that allows one to put the mask down (unlike regular N95 masks)
  o Anyone can fabricate this mask (open source)
  o Working with the open source community
• In one month, we created over 8 prototypes of which 4 were put into production after testing
  o Currently on version 3
  o Making each version backwards compatible
  o Working with partners to ramp up their facilities for production
  o Molded silicone gasket so hot glue does not have to be utilized
• Need for masks is extreme
• Using version 5 face shield from USC
• Nasal swabs currently in development
• Also working on cloths masks (Halyard 600 masks)

Daniel Stemen
• Full Webinar: 33:30 – 42:40
• No PowerPoint presentation was given, so no document link
• Keck School of Medicine of USC, Manager of Respiratory and Interventional Pulmonary Services
• Current devices in need of potential substitutes
  o Normal surgical mask: isolate yourself from others but doesn’t filter the air, only keeps droplets contained
  o N95 mask: filters air, breathe through it, statically charged to capture virus
  o PAPR/CAPR masks: positive pressure to apply filtration, highest degree of protection
• Healthcare staff have to get a fit test
  o Put the mask on (only two sizes available)
  o Spray liquid and see whether there is leakage
• Limitation of current N95 masks is that the whole mask is a filter
  o Cannot interact with it since in contact with aerosols or droplets
  o Aerosol does not fall and contaminate surfaces – trapped in a filter
  o Aerosol will contaminate the filter whereas gas permeates through after filtration
• 3M main manufacturing for N95, projected shortfall through August
  o About 40% shortage

Q & A Session
• Full Webinar: 42:40 – 58:05
• Please note that some questions were mentioned in the chatroom in the Zoom conference, so it won’t necessarily reflect the webinar YouTube segment
• Janice: How many reusable filtered masks are in clinical use at USC currently? If they are being used in clinical settings, are they being used as true replacements for N95s?
  o Currently no 3D printed masks are being used because FDA says not to use these until actual PPE are used up
• Bingbing Li: If CSUN plans to join the efforts of printing reusable filtered masks, who to reach out?
  o Reach out to S. K. Gupta (guptask@usc.edu)
• Janice: What is USC doing about PAPR shields if at all?
  o Darryl: We have a pattern to laser cut replacement shields for the CAPRs. To create the shroud portion, we figured that you could use blue painter’s tape and sheet plastic with elastic
• Amir H: Is the Haylard sterilization wrap as effective as the Honeywell filter you’re using in your design?
  o Darryl: Halyard material not designed to make masks, design to keep sterile trays sterile. Needs to be tested for filtration function
• Robert Kearney: For the FFF printed masks, do we have any preliminary findings on how well these interfaces filter out aerosols? Perhaps the filter works, but is compromised by the FFF shell?
  o Darryl: Shell is good at not leaking and passes the taste/leak test
• Anonymous: Are you cleaning your 3D printed masks with hydrogen peroxide wipes? Or are you using UV?
  o Darryl: Sterilization plan is to wipe with hydrogen peroxide and then expose to UV light
• Anonymous: How often does the filter in your 3D printed design need to be replaced?
  o Daniel: Allow extended use of N95 up to 8 hours, staying inside regulatory recommendations
Anonymous: Are you planning on disposing the elastic after single use?
  o Daniel: Guidelines for reusing N95 masks – not recommended at all. Reuse is only because of shortage of masks
Anonymous: Is UV effective given it’s not just a flat surface? How do you avoid a shadowing effect?
  o Darryl: UV systems have shadow effect. Robotic system moves light around. Could also rotate object within box
Anonymous: Can Halyard 600 bias tape be used in lieu of elastic?
  o Shawn: Halyard material could be used in place of elastic bands
  o Darryl: Elective surgeries are reduced and so Halyard material more available. But does not recommend Halyard material for strapping because other materials are available. Does not recommend non-elastic material for a hard mask