

How a Maker can Address the Medical Waste Generation Issue during the Pandemic

- Closing the loop
 - Design to Reuse
 - Decontaminate to Reuse
 - Recycle what cannot be Reused
- Self-sterilizing materials



Medical waste at the west campus of Wuhan Union Hospital, Source: [South China Morning Post](#)

- Lessons learnt from the food packaging industry

“It’s a rapidly changing environment right now and forecasting volumes is challenging,” Stericycle Vice President of Corporate Communications Jennifer Koenig wrote in an email to *The Verge*. *“We are closely monitoring the situation with all relevant agencies to determine next steps.”* Source: [The Verge](#)

Design to Reuse

PURPOSE: avoid making disposable PPE in the first place

- Design with durability in mind and with autoclave compatible materials, e.g. Polypropylene or launderable materials, e.g. cotton
- If every household in the US were to source disposable face masks to be used on a daily basis, there could be in excess of [300k tons of ppe waste generated](#)



[Open Standard Respirator](#)



[Reusable Snorkel Mask](#)



[Cloth Mask](#)



[Autoclave Shield](#)

Decontaminate to reuse

PURPOSE: decontaminate existing PPE

- Repurpose existing autoclaves or wet ovens for decontamination
- [Hydrogen Peroxide Decontamination Chamber](#)
 - Schwartz 2020
 - Design and validation of [ionizing] vaporizers
- [UV-C Decontamination Chamber](#)
- [Ozone Generator](#)
 - Hudson 2009
 - SARS-COV-2 is an enveloped protein, susceptible to ozone, limited research on ozone efficacy

Related:

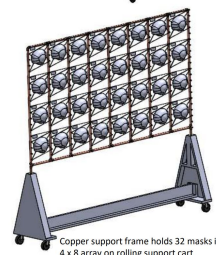
- PPE racks for these disinfection methods



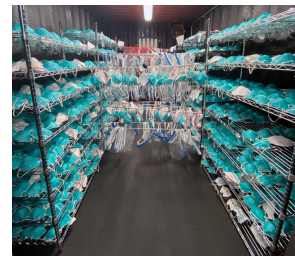
[Steramist H2O2 Ionizer](#)



[UNebraska UV Lamp](#)



Copper support frame holds 32 masks in 4 x 8 array on rolling support cart



[PPE Racks](#)

Recycle what cannot be reused

PURPOSE: repurpose constituent materials

- Manufacture Polypropylene filament from recycled plastic (gowns, bottles, ...)
 - Recycled Polypropylene Filament for 3D Printer (Herianto 2020)
 - Suitability of recycled PP for 3D printed filament (Lunolainen 2017)
 - Value of PP filament ~\$70/kg
- Manufacture Polyethylene terephthalate (PET) filament from recycled plastic
 - Feasibility study: production of recycled 3D print filament (Monteith 2016)
 - [Precious Plastic, machines for DIY recycling](#)
 - Value of PET filament ~\$25/kg (less of an incentive)
- Use PET as an additive in construction
 - Mitigates concerns with medical waste reuse

Related:

- [DIY Spectrometer for materials identification](#) (Identify clear materials PVC, PC vs PET)
- [Mechanical Trash Compactor](#) (Minimize footprint of recycling materials, and enable multi-stream recycling)



[Filabot Extruder](#)



[Precious Plastic, shredder](#)

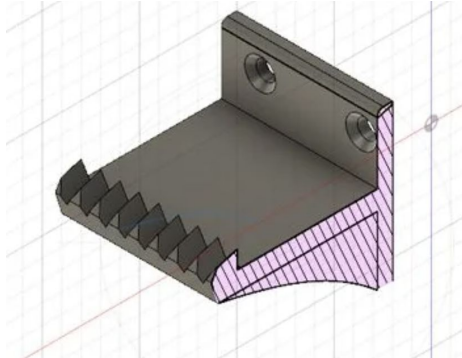
Products from Self-Sterilizing Materials

PURPOSE: Mitigates wipe/sanitizer waste

- Replicating high use items with virucidal materials
- **Use colloidal silver or other nanoparticles to make disinfecting paper (Sim 2018)**
 - E.g. Nanoseptic (bottom right corner)



[Copper Nano Particle PLA](#)



[Foot Door Opener](#)



[Materialise 3DP Handle](#)



[Nanoseptic](#), paper installation

LESSONS FROM FOOD SERVICE INDUSTRY: leaning towards reusable containers

- Reusable takeout containers (RTCs) in a variety of business models:
 - Cost of collection, washing and distribution is covered by delivery app fee (DeliverZero), monthly subscription (Go Box, [Wisebox](#), [Coffee Cup Collective](#)), or deposit / token system (UC Merced, [Middlebury](#), Harvard, Michigan, etc.).
 - **Campus-based systems appear to be most robust currently, citing savings. Convenience for dropping off used containers (multiple locations or pickup) is key to expansion for service model.**
- Partnership with manufacturers (e.g Nestlè) to produce reusable packaging for online shopping, home delivery and container pickup ([Loop](#))
- Bottle bills in 10 US states and across Canada produce high rates of recovering beverage containers, with comparatively cheap deposit rates. How much is reused vs. recycled?
- [Environmental Impacts of Takeaway Food Containers](#) (Gallego-Smidt et al., 2018) used life cycle assessment (LCA) on styrofoam (EPS), aluminum and polypropylene (PP) containers. Reusable containers must be used 8-208 times to become more environmentally friendly, depending on the metric, given **current** rates of recycling.

Backup

Comments from Session:

@NikLal @JuliaHansen must address the psychology of reuse. HCWs at our facility (and others) are very adverse to the idea of wearing a mask that has been disinfected and had been used by someone else... whereas they have no problem donning scrubs, face shields or gowns that have been disinfected and/or laundered

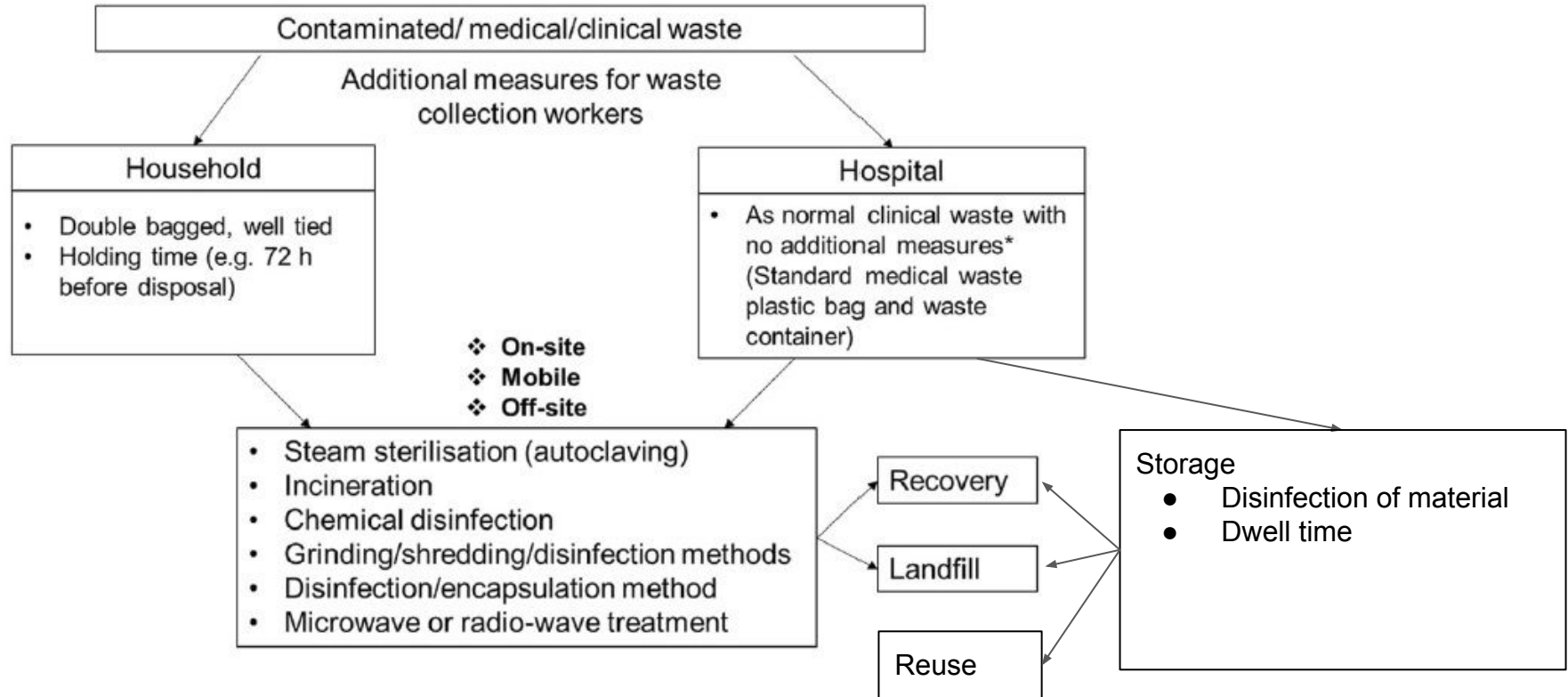
From William E Baker to Everyone: (11:02 AM)

So each item planned to be disinfected/reused should involve some component of user endorsement through either pre-project field testing and/or concurrent implementation of a 'marketing' campaign.

From William E Baker to Everyone: (11:03 AM)

I'm confident that reuse can be successful with aggressive engagement of front line workers

Medical Waste Process Flow



Tech that helps the plastic **recycling** industry

- [DIY Spectrometer for materials identification](#)
 - Identify clear materials PVC, PC vs PET
- [Mechanical Trash Compactor](#)
 - Minimize footprint of recycling materials, and enable multi-stream recycling

References

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