# The Royal Academy of Engineering: COVID-19 African Rapid Entrepreneurs (CARE) Project

The Royal Academy of Engineering is working to stimulate innovative business actions to respond to the COVID–19 crisis in Africa.

Our goal is to mobilise our African-based alumni SMEs and leverage the Academy's Fellowship and networks to help provide capacity and resources to respond to the situation in a constructive way.

## Background

Covid-19 has already caused widespread repercussions in many OECD countries including the UK, by its speed, virulence and exponential growth. Even robust and well-resourced healthcare systems have been overwhelmed by the quickly developing situation, and the next 1-2 months pose significant challenges.

In many regions of Africa, the density of urban populations and the lack of adequate hygiene and healthcare could present even more extreme and dangerous challenges.

There is a motivated and talented young population, and governments appear willing to take necessary measures, however the outlook is surely very concerning.

The Academy has a wide and varied stakeholder network which can support our alumni, and who could also benefit from the expertise in our alumni network. We will aim to support these connections and collaborations throughout this project.

**We are launching *three* parallel and complementary strands of activity:**

1) Kick-start short term face mask and visor 3D printing, manufacture and assembly in Africa
2) To support the manufacture of face masks at greater scale
3) To support alumni SMEs to temporarily pivot their businesses to help address Covid-19 concerns

## Project Aims

- The primary project aim is to support African Engineering entrepreneurs to make and supply PPE which is effectively used in hospitals and clinics in sub-Saharan Africa.
- A secondary but important aim is to leverage the know-how gained to encourage and support as many other parties as possible to increase supply of fit-for-purpose PPE globally

**Specific project goals include:**

**Support for entrepreneurs**

- Encouraging over 50 entrepreneurs to build skills, including for 25+ by 3D printing face masks and c 50 making visors and selling them to local health facilities.
- Ensuring that all PPE meets adequate standards and quality for protecting clinical staff from Covid-19 as far as is reasonably practicable, recognising this is a global crisis with severe supply chain disruptions such that relevant equipment certification is unlikely.
- Increasing the supply of such PPE in the countries concerned, by encouraging scale-up of the operations, building strong local networks and ecosystems, and facilitating replication by others.

- Supporting the users of the equipment with appropriate protocols and training materials to maximise the chances of safe PPE usage and disposal.
- Measuring impacts on the capacity of the entrepreneurs and, where practical in the circumstances, getting evidence of outcomes in usage, reduction of infection and saving of the lives of medical and other staff.

**Leveraging the knowhow**

- Making available open source all the intellectual property (designs, specifications, testing experience; protocols for manufacture and usage) and the learnings from entrepreneurs and communities of users (medical, care home etc.).
- Promoting this to maximise the replication and scale up in order to increase PPE supply globally - and especially in countries where there are significant shortages of certified equipment.

Project Overview and Progress

**Theme 1 – Kick-start short term face mask and visor 3D printing, manufacture and assembly in Africa**

**Summary –** Rapidly provide 26 alumni entrepreneurs with resources and technical knowledge to manufacture effective, fit-for-purpose clinical facemasks, and facilitate up to 50 alumni to assemble simple visors. Support the alumni to sell these products to appropriate recipient authorities at local, regional and national levels including city governments, hospitals and clinics.

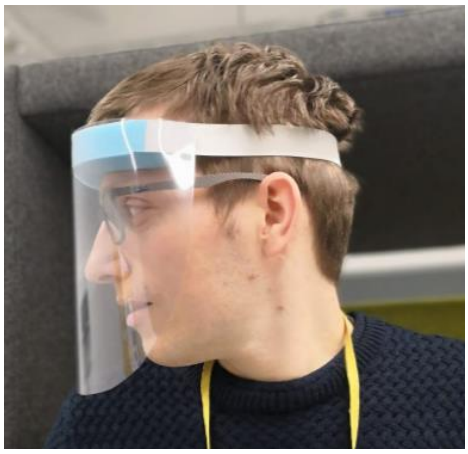
**Progress:**

**Team**

- Assembled an expert team of 30 biomedical engineers, 3D printing experts, and top health specialists. The international collaboration includes representatives from various institutions including biomedical and mechanical engineering experts from Leeds University, University College London and Cape Town University , and clinical experts such as Professor David Jayne from Leeds University and Professor Robin Wood MMed FCP DSc, the Institute of Infectious Disease and Molecular Medicine, Cape Town.

**The Corran Visor**

- Selected an agreed visor design: the Corran visor. The chosen design, developed by 4c Engineering and Aseptium in Inverness, is manufacturable using easily available materials in approximately 4 minutes, and ihas been adopted in Highlands hospitals.

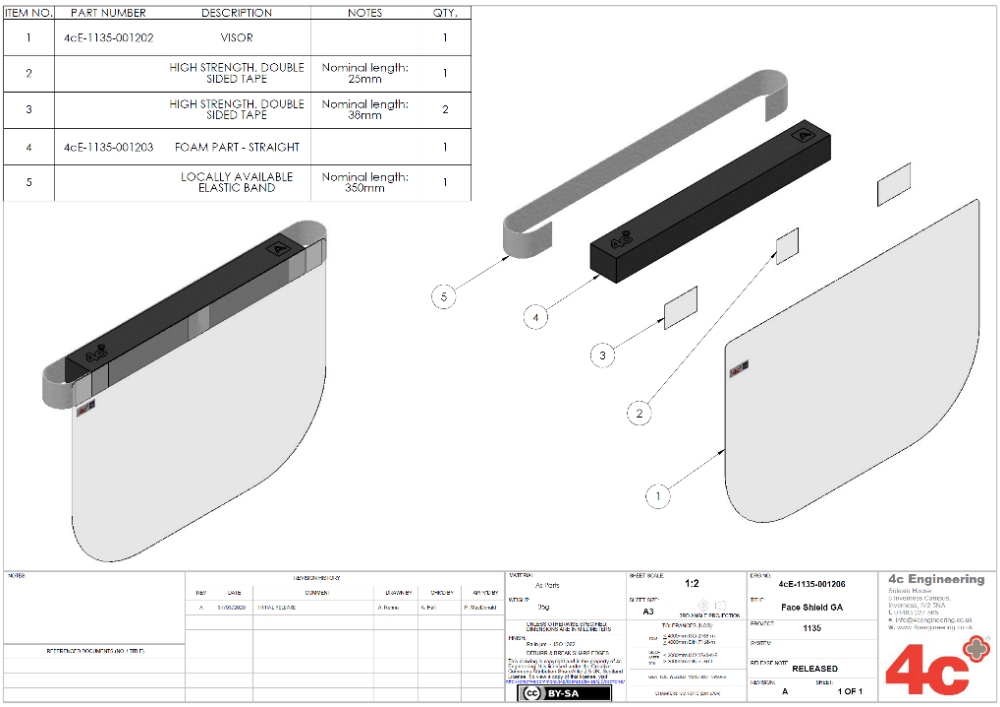


The Corran design is simple, and unlike alternatives does not require 3D printing – it is made of four commonly available components. The design is being made freely available and can be found on this link with full manufacture guidance. A further evolution of the design by UCT in Cape Town is currently undergoing review for approval by SAHPRA in S Africa.

4 fundamental items of the Corran design:

1. Foam - expanded polyurethane foam (e.g. upholstery/packaging foam) or similar - 25mmx30mmx240mm
2. A4 PVC Clear Binding Cover - recommended 250 microns
3. 20mm wide woven elastic
4. Strong double-sided tape

| ITEM NO. | PART NUMBER | DESCRIPTION | NOTES | QTY. |
|---|---|---|---|---|
| 1 | 4cE-1135-001202 | VISOR | | 1 |
| 2 | | HIGH STRENGTH, DOUBLE SIDED TAPE | Nominal length: 25mm | 1 |
| 3 | | HIGH STRENGTH, DOUBLE SIDED TAPE | Nominal length: 38mm | 2 |
| 4 | 4cE-1135-001203 | FOAM PART - STRAIGHT | | 1 |
| 5 | | LOCALLY AVAILABLE ELASTIC BAND | Nominal length: 350mm | 1 |



**The CARE3D Mask**

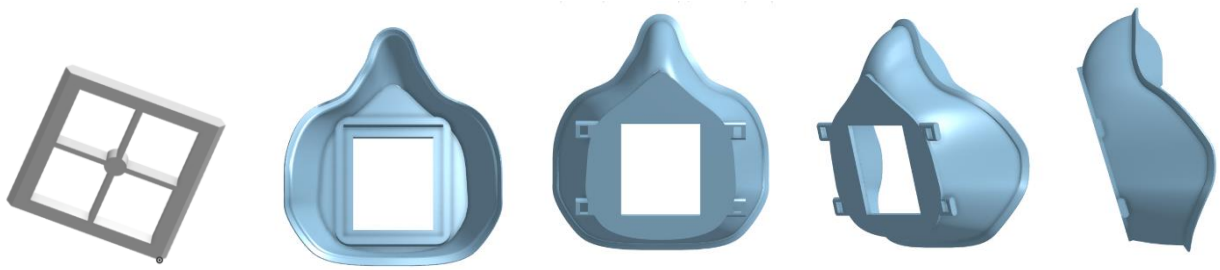
- The team have agreed on a reusable face mask design, the CARE3D Mask - still to pass user and full technical testing - with filter performance aiming to meet the tests for EN 14683 Type IIR surgical masks , and the mask and filter combination aiming to meet tests equivalent to EN149 FFP2. That said, because this is a 3D printed mask where the manufacturing process is inherently less controlled than mass manufacturing, this will not be an FFP2 certified mask.
- The mask is made of 3D printed plastic with a removable filter cartridge which contains the disposable filter material, which should be replaced at least daily. The mask and cartridge are then re-sterilised and new filter material inserted to be ready for re-use.

The advantages are:

- Much lower use of filter material than disposable FFP2/N95 masks
- Normal surgical grade polypropylene sheets can potentially be cut up to supply the filters.

The key issues to be verified to ensure mask functionality are:

- Effective filtration of droplets, aerosols and airborne virus
- Breathing comfort during sustained exertion
- Comfort of fit and effectiveness of seal to face
- Can be sterilised repeatedly without degradation of properties
- Speed of manufacture



Design, led by Peter Bloom, and testing, led by Anne Neville, has made good progress in filter material selection optimisation trials and the team are working to reduce print time to below 90 minutes.

Further testing is taking place in The University of Leeds and UTC Training Solutions Cape Town.

**The Florida Mask**

- The team has been developing prototypes of the facemask originally designed by The University of Florida Health's Department of Anaesthesiology.
- The masks can potentially be produced in large quantities using materials already found in hospitals and medical facilities.
- A team in the UK are exploring these options further and prototypes made from HEPA material are being tested.


**Entrepreneurs**

- Selected 26 African entrepreneurs, based in 11 countries[1], who will receive three 3D printers, filament, and filter material.
- We have also selected another 30 entrepreneurs, based in 6 countries, who we will provide with the Corran visor materials, and potentially the Florida mask materials, and assembly instructions.
- In the week commencing 20th April we will collate the first printers and other materials in facilities provided by Network Rail in the UK. Delivery of the printers and filament should allow small-scale manufacture to start early May in the 11 African countries selected.

[1] Burkino Faso, Cameroon, Ghana, Kenya, Malawi, Nigeria, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.

**Theme 2 - To support the manufacture of face masks at greater scale**

**Summary -** A competition: to scale up the manufacture of suitable specification face masks or visors. Six companies will be selected for financial support of £5,000 each during May.

- This will focus on the approximately 50 RAEng alumni selected for Theme 1 and will also be opened to other suitable SMEs in the Academy's networks who will be encouraged to apply.

**Progress**: this theme was launched on the 7th of April and is being further defined by a team of experts.

The method of manufacturing at a larger scale will likely focus on compression moulding and/or injection moulding with entrepreneurs generally being able to leverage existing, locally available facilities.

The team is currently working on finalising the reference 3D printed design, after which it can be evolved for better methods of manufacture at scale , which it can share with the wider SME community to solicit interest.

**Theme 3 - To support alumni SMEs to temporarily pivot their businesses to help address Covid-19 concerns**

**Summary -** A competition to positively pivot SMEs to help in any other relevant area which can contribute to the COVID-19 challenge. We will award £5,000 in financial support each to six companies by the end of April.

- This will focus on our approximately 100 SME alumni, who have not been selected for Theme 1.
- Possible ideas could include manufacture of other PPE; more reliable back-up power supply to critical health facilities; additional water supplies for remote health facilities; on-line training for health professionals; training for the public and key workers in basic health and hygiene practices; scaling up e-learning platforms for children isolated at home; manufacture and distribution of hygiene products including effective soaps, disinfectants and alcohol gels etc.

**Progress**: this theme was be launched on 10th April and is being further defined by a team of experts.

The application process has now been sent to the approximate 100 SME alumni and they have 18 days to apply.

Once the scheme is closes on 28th April, the application will be reviewed, interviews will be held, and 6 successful awardees will be selected on 1st May.

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