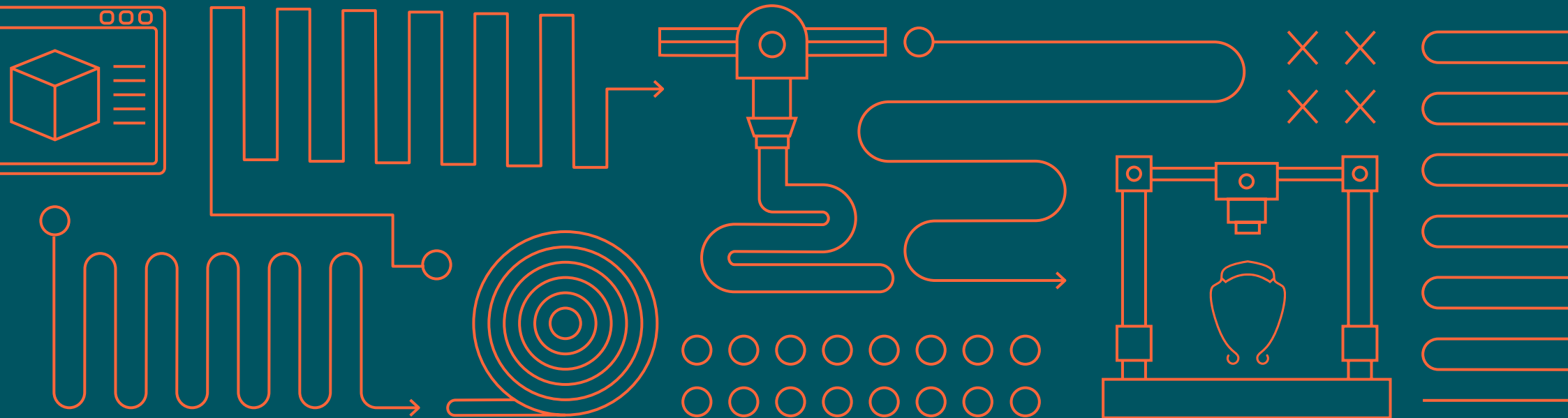


Open Source PPE Project

A report by Benchspace.



benchspace



A National Crisis

Witnessing the challenges facing other countries during the emerging COVID-19 pandemic allowed Ireland to plan in advance its response to the crisis.

Shortages of personal protective equipment (PPE) were highlighted as a critical issue for frontline healthcare staff - placing these workers at high risk of infection and reducing the ability of healthcare services to save lives. Governments and public health officials were faced with the considerable challenge of obtaining sufficient quantities of PPE on competitive international markets.

Face shields are an essential component of PPE for healthcare providers treating patients with confirmed or suspected COVID-19 infection. In Ireland, this includes the large number of frontline healthcare workers in COVID-19 testing centres, community assessment hubs and nursing homes.

In anticipation of the needs of these healthcare workers, a number of manufacturing companies in Ireland had started developing face shields. However, it would be weeks before these were available to the Health Service Executive (HSE) for purchase. Because of this, a gap was expected between the immediate needs of Irish healthcare workers and the availability of a reliable supply of PPE, including face shields.



The Open Source PPE Project

In the fourth week of March 2020, as the number of COVID-19 cases in Ireland passed 1,000, several organisations in Cork were working to meet the needs of Irish healthcare workers for face shields.

One such group of engineering and regulatory professionals from local healthcare industries had started prototyping designs and working with healthcare organisations to test them. At the same time, the staff and members of Benchspace - Cork's shared manufacturing hub - brought together a national network of 3D printers and established a crowdfunding platform to finance face shield production.

The Open Source PPE project began as a collaboration between these two groups. We combined our expertise to bridge the gap between the immediate needs of Irish healthcare workers for face shields and the anticipated arrival of a commercial supply. To achieve this we were joined by a coalition of nonprofits, industry partners, the Irish Defence Forces and over three hundred 3D-printing, collection, and assembly hub volunteers.

Together these Open Source PPE volunteers built a nationwide manufacturing network, established three central assembly hubs, and in just seven weeks, produced over 50,000 face shields for frontline healthcare workers in COVID-19 test centres, community assessment hubs and nursing homes.



Face Shields

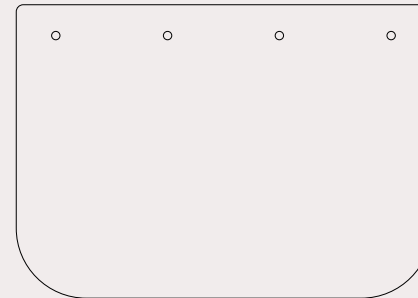
The engineering, and regulatory experts of the Open Source PPE team worked closely with the Quality and Safety Department at the HSE's Cork/Kerry Community Healthcare, to identify a face shield model for production.

The engineering, and regulatory experts of the Open Source PPE team worked closely with the Quality and Safety Department at the HSE's Cork/Kerry Community Healthcare, to identify a face shield model for production. This involved infection control assessment, clinical approval and in-the-field testing of several models. From this process the Verkstan face shield design was initially selected.

Throughout the project we received regular feedback on the performance of these face shields. This led us to switch to an alternative design on Day 12 of production. This newer N3DPS face shield had a larger gap between the user's face and visor, providing more room for wearing face masks or glasses and reducing fogging. The visor attachment to the frame was also more secure.



Visor
Template

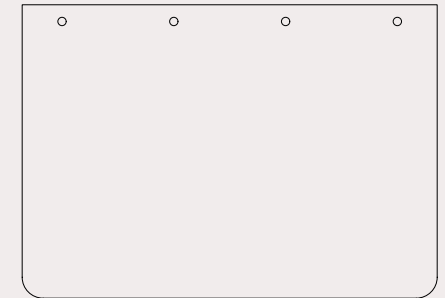


Verkstan Face Shield

- Open source design developed by Swedish company (3DVerkstan)
- <https://3dverkstan.se/3dvfaceshield-och-den-otroliga-kraften-inom-3d-branschen/>
- 2 components: 3D printed frame & A4 Size Clear Visor



Visor
Template



a Face shield

- Open source design developed by UK's National 3D Printing Society
- <https://national3dprintingsociety.co.uk/medical-am-covid-19/>
- 2 components: 3D printed frame & A4 Size Clear Visor

3D Printers Unite

A Micro-Factory Network.

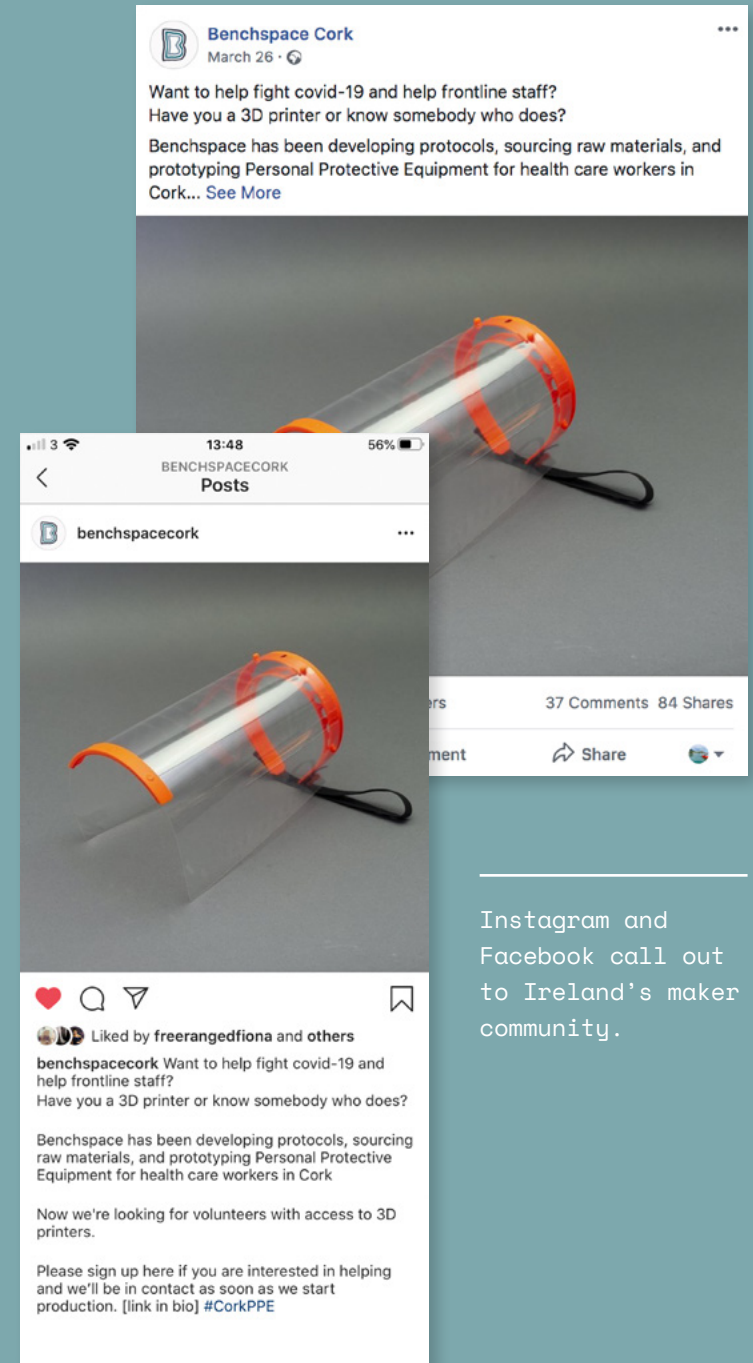
As stay-at-home restrictions were introduced across Ireland, we opened a national campaign to recruit volunteers with access to 3D printers.

This began with a simple social media call, reaching out to Ireland's maker community. It soon grew to include local and national newspapers, alongside radio and television coverage. In the first few days of the campaign, 80 volunteers signed up to participate in our micro-factory network. This increased daily, to a network of over 300 volunteers nationwide.

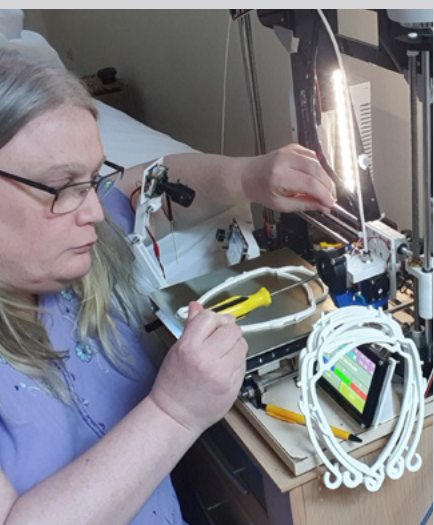
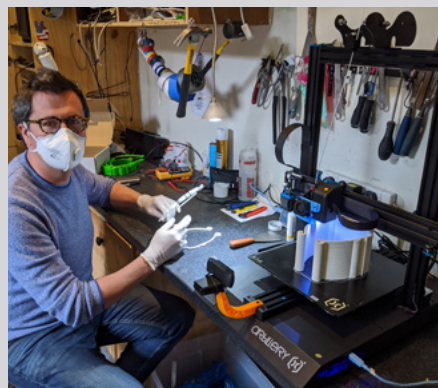
The majority of these volunteers were individuals with home-based 3D printers. They included hobbyists, professionals, students, and families. Our youngest

volunteer was just 10 years of age. Many came from Ireland's engineering community; after Engineers Ireland promoted the Open Source PPE project to its members. As the network expanded, it was joined by volunteer organisations with access to large numbers of 3D printers. These included schools, libraries, institutes of technology, universities, industry and the Irish Defence Forces. Where these organisations could not participate directly, they generously loaned their 3D printers to volunteers in the network instead.

Many volunteers went beyond 3D printing to provide online technical support, develop our website, coordinate the national collection service and establish assembly hubs. The Open Source PPE project could not have happened without their contributions.

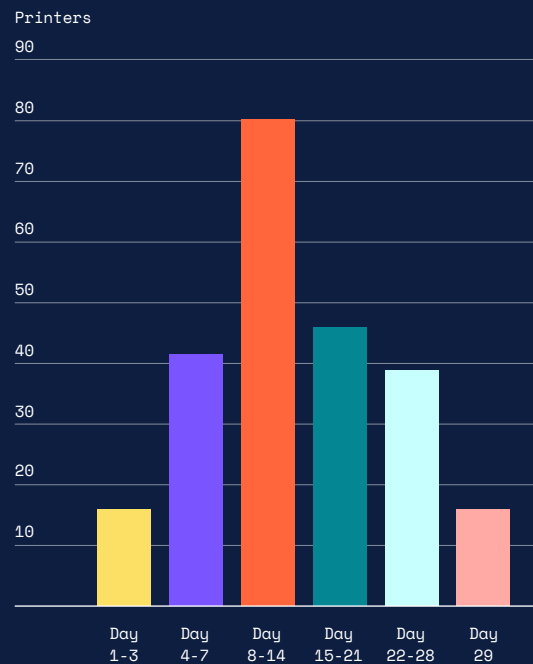


Instagram and Facebook call out to Ireland's maker community.

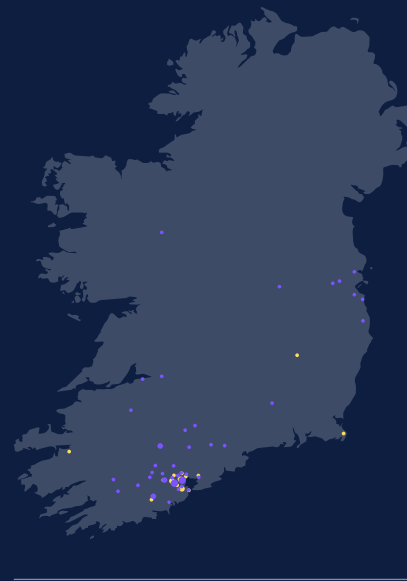


Printer Recruitment Map

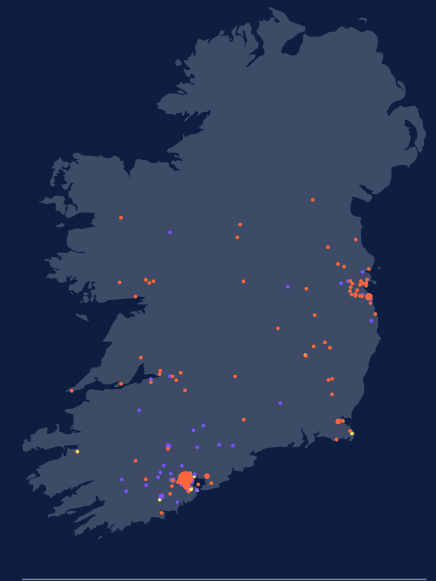
Volunteers with 3D printers from across the country signed up to help. Many were searching for opportunities to contribute PPE to the national COVID-19 response but were unsure of what to make, or how to get it into the hands of healthcare workers who needed it. The Open Source PPE project tied all of these pieces together and made it easy for anyone with a 3D printer to get involved and contribute. We supported each volunteers with an online technical support community and a production tracker where they could easily follow and compare their contribution to the project.



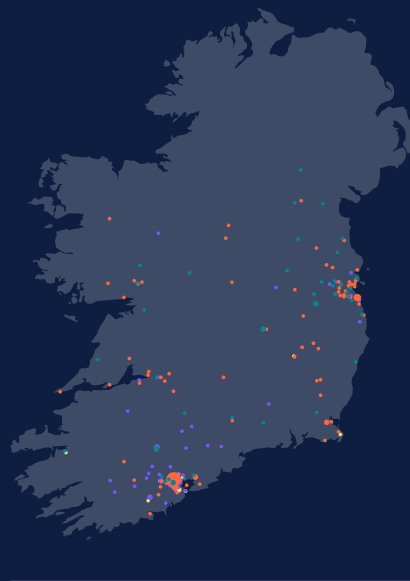
Day 1-3



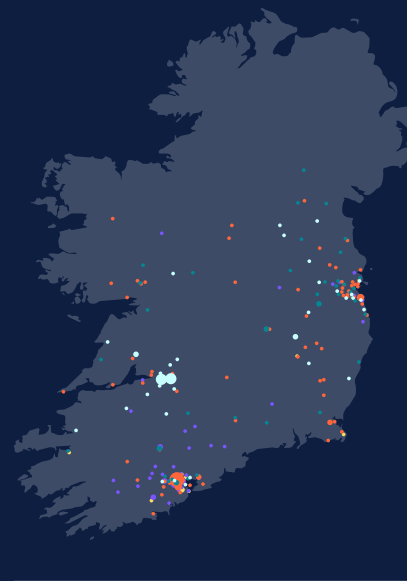
Day 4-7



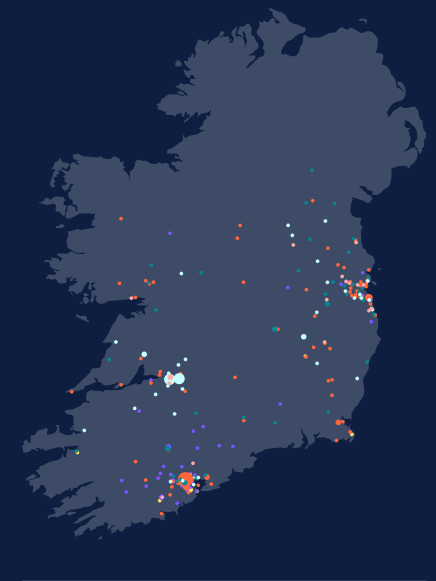
Day 8-14



Day 15-21

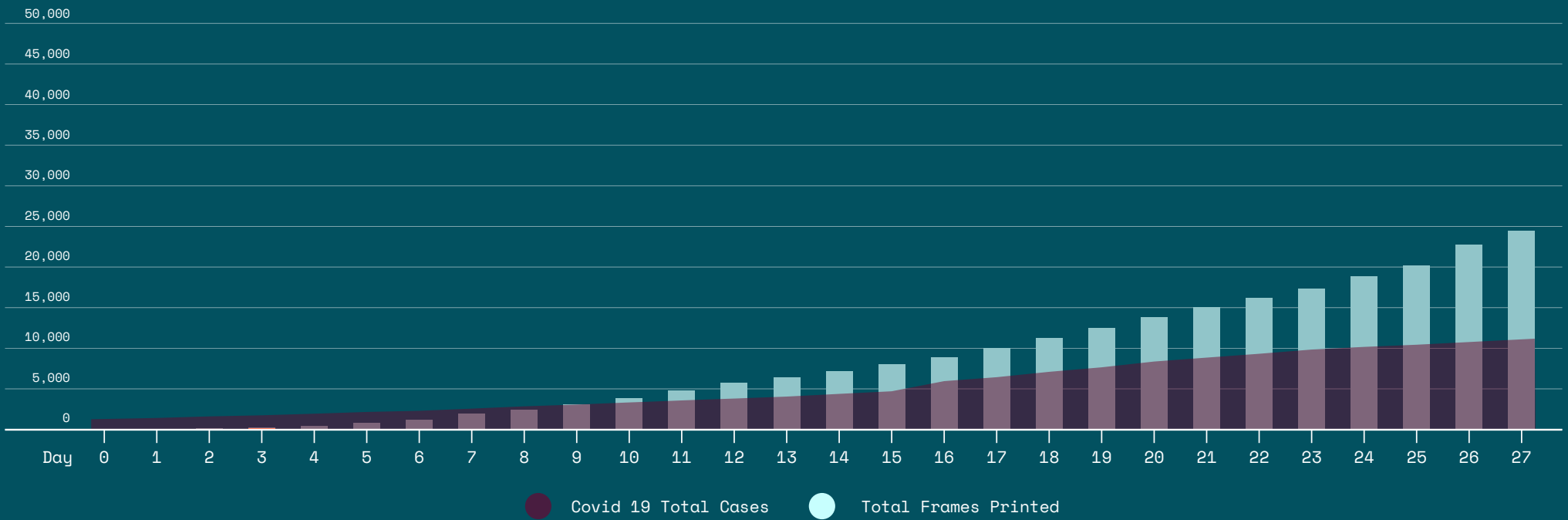
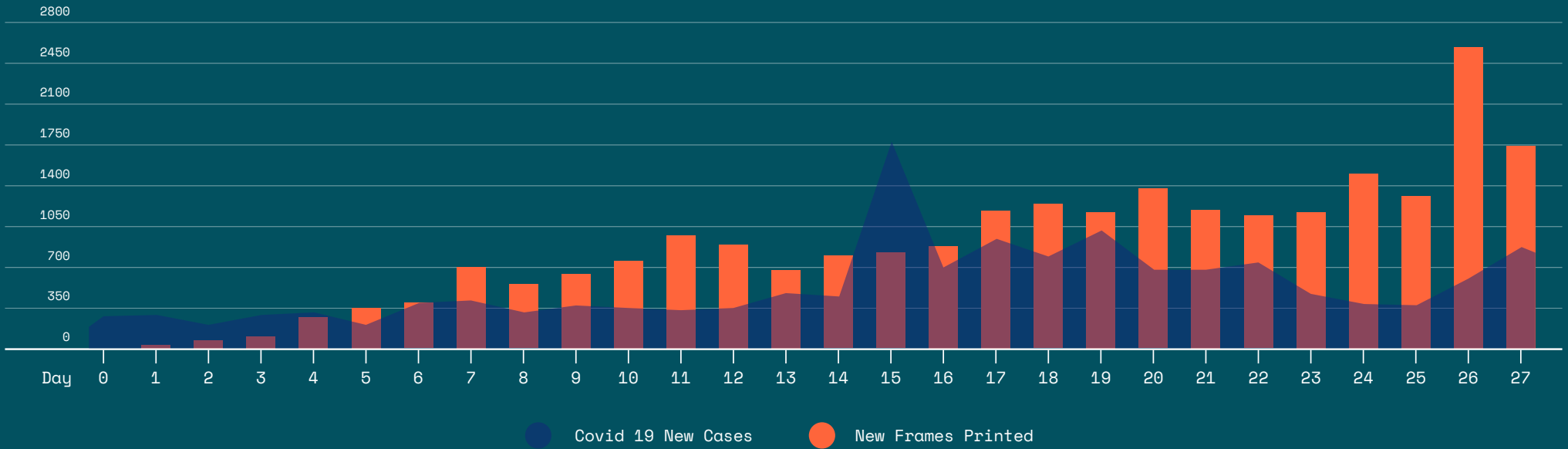


Day 22-28

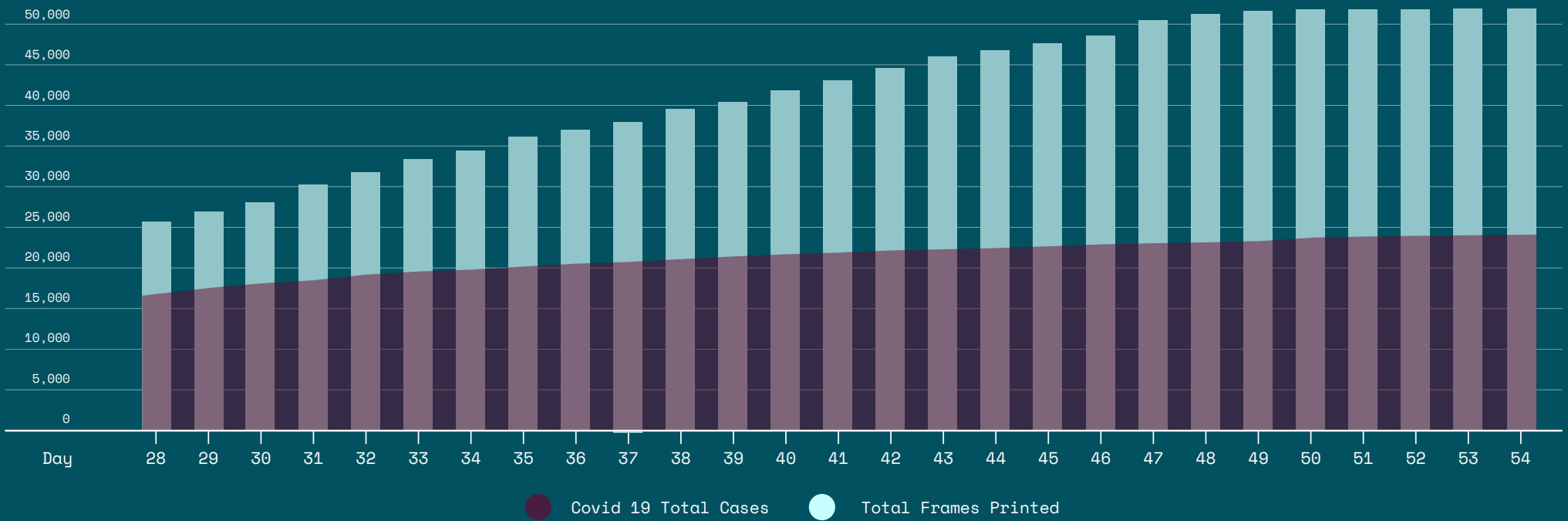
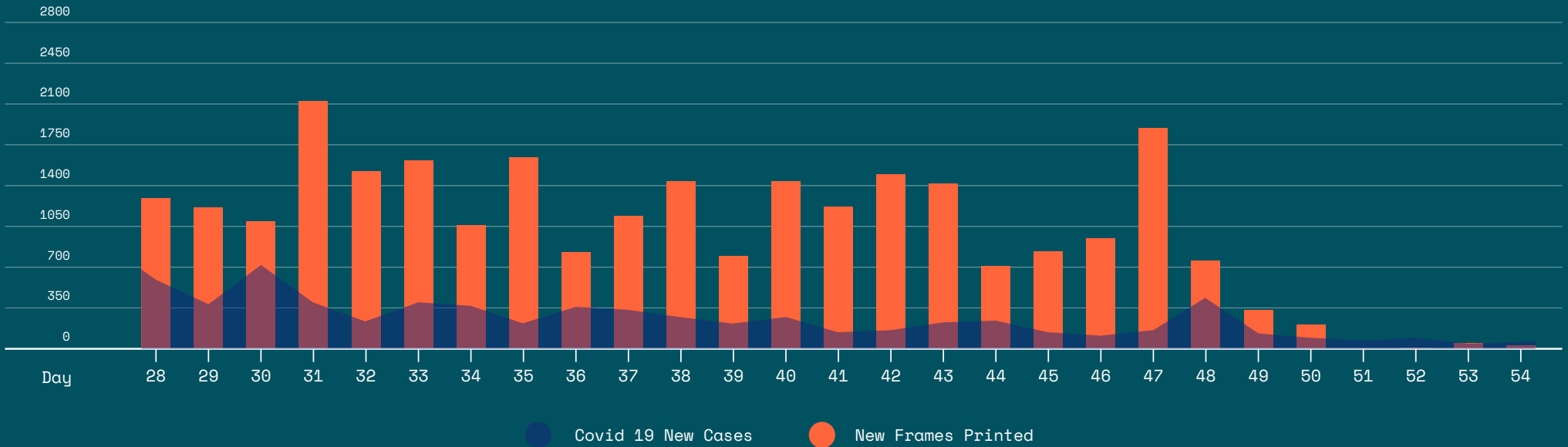


Day 29

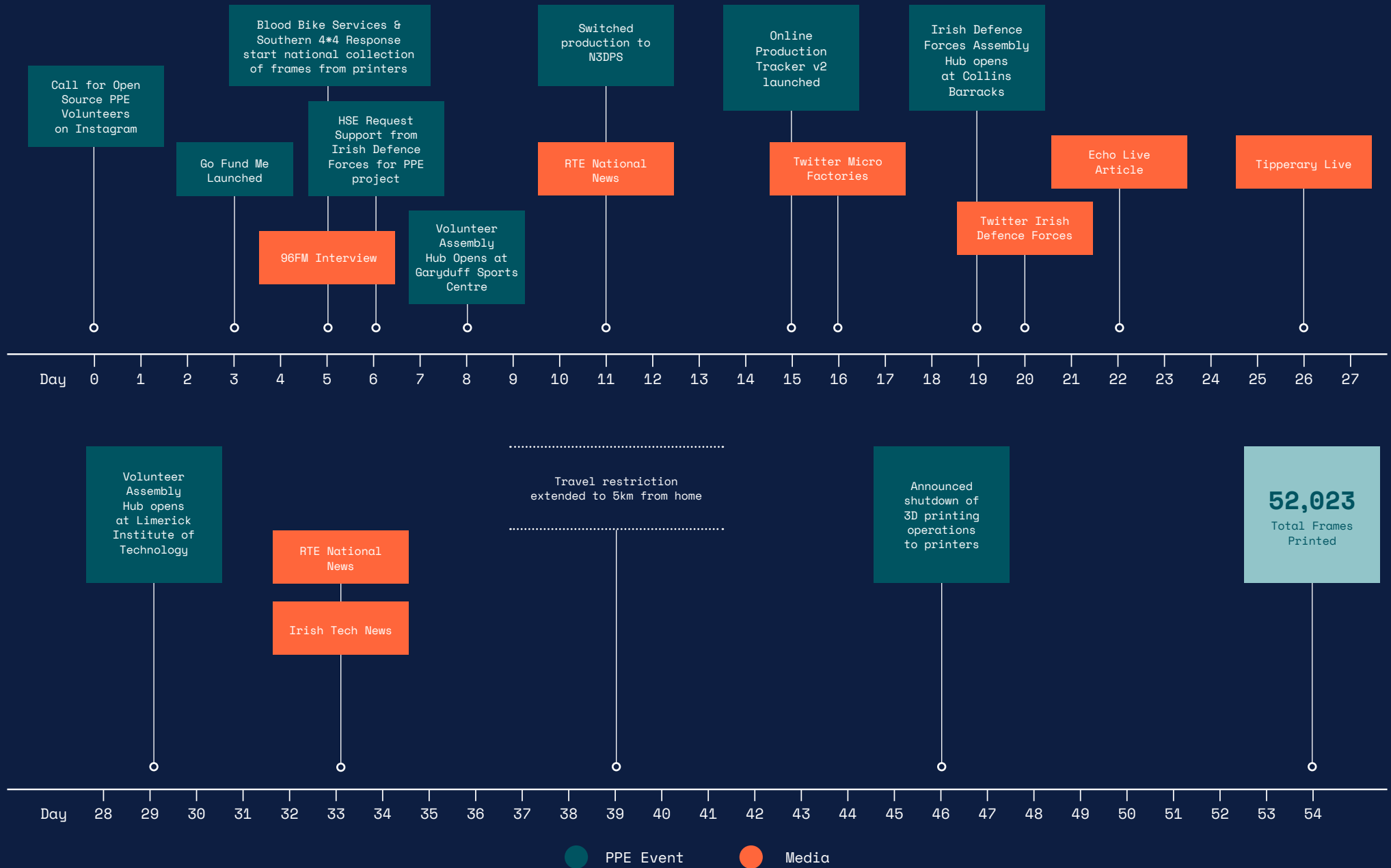
Timeline Day 0-27



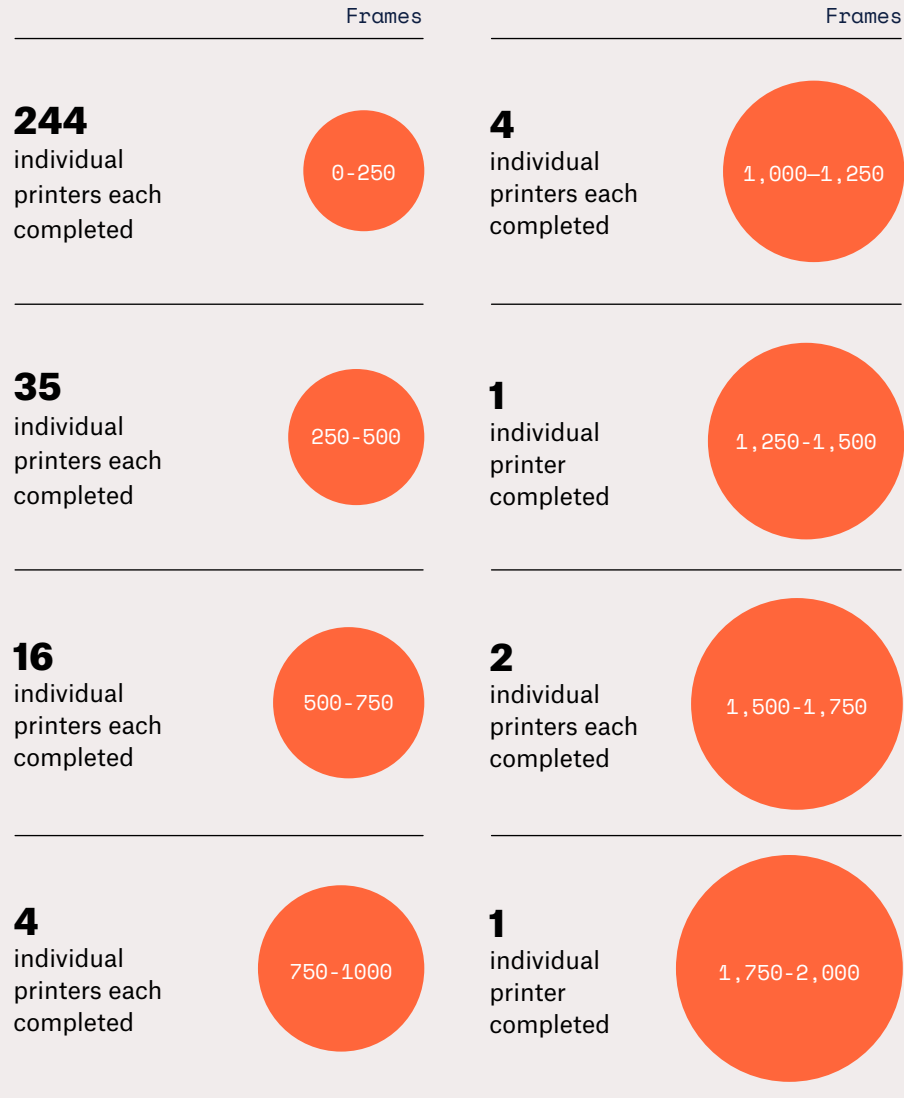
Timeline Day 27-54



PPE Events and Media Day 0-54



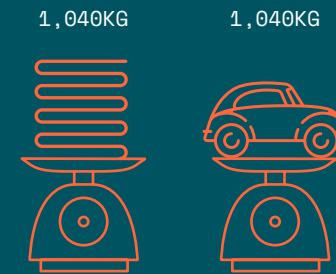
Printer Statistics



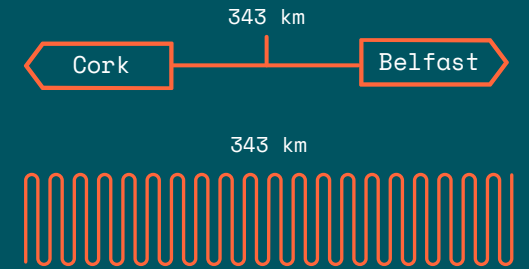
Resource Statistics



3D Printer Filament



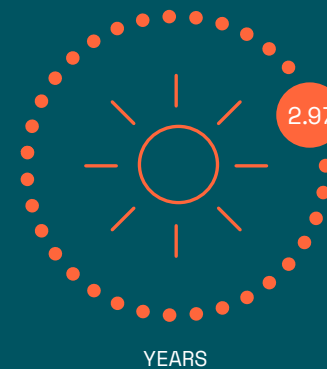
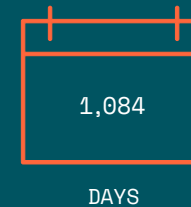
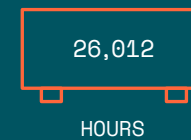
Estimated total weight of filament used (kg)



Estimated length of filament @330m (km)

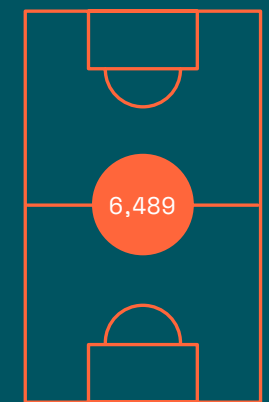
Print Time

Estimated total of print time



Visor Material

Estimated area of visor material used (sqm)



Nationwide Collection Team

Two voluntary groups, Blood Bike South and Southern 4x4 Response took on the challenging task of organising a collection and delivery service for the hundreds of stay-at-home members in our 3D printing network.

Within just a few days they had implemented a nationwide logistics service, coordinating with the National Blood Bike Network, Bike Marshalls and Bravo Charlie Tango motorcycle volunteers where necessary. Between them, these teams collected face shield frames from volunteer printers in every corner of the country and delivered these to central assembly hubs. Many of these collection teams were on the road seven days a week, often at their own expense. To help us manage this national collection service, one of our volunteers built a website to track the quantity and location of printed face shields, schedule these for pickup and organise the resupply of 3D printer filament.

Blood Bike South

Blood Bike South is an out-of-hours urgent medical transport service, part of a national network of Blood Bike Groups (Blood Bike East, Blood Bike MidWest, Cú Chulainn Blood Bikes and Blood Bikes South East). Coordinated by a Blood Bike South volunteer, this national network contributed to the Open Source PPE project while simultaneously maintaining the out of hours services they provide to public hospitals on a daily basis.

Southern 4x4 Response

Southern 4x4 Response comprises a group of trained and vetted 4x4 owners who offer severe weather and off road transport to support emergency services and communities in Cork and Kerry. Their drivers visited printers two to three times a week and like so many volunteers around the country who helped neighbours, relatives, friends and strangers found the experience very rewarding.





Irish Defence Force

On 3rd April the HSE requested the Defence Forces to assist with the Open Source PPE project. In response, they established two 3D printing farms in Collins Barracks Cork and the Curragh Camp. These used the Defence Forces' existing 3d printers as well as additional printers and material acquired specifically for the project. In total the Defence Forces 3D printed over 3,000 frames for face shields. This work was carried out by members of the Ordnance Corps and the Communication and Information Services Corps. In addition to 3D printing the Defence Forces also built up a logistics and assembly hub in Collins Barracks Cork.

Assembly Hubs

- Collins Barracks, Co. Cork.
- Garryduff Sports Centre, Co. Cork.
- Aula Max, LIT, Co. Limerick.

Before delivery to healthcare workers, all 3D printed frames had to be checked for quality, paired with two clear visors, and packaged. This work was completed at three central assembly hubs. The visors required for this were cut and processed by Watermans and Carrig print in Cork, who generously volunteered their services.

The first assembly hub was established by a team of volunteers from DePuy Synthes Cork and the Garryduff sports centre. This pop-up factory was operated 3-4 times per week by groups of twelve volunteers. This was followed by a second site opened by the Irish Defense Force in Collins Barracks Cork and operated by young soldiers whose training had been suspended in response to the COVID-19 pandemic. A third assembly hub was opened at the Limerick Institute of Technology's

Aula Max and independently run by volunteers from LIT. These assembly hubs worked together to complete the final steps of face shield manufacture, packaging and distribution to the HSE.

Towards the final weeks of the project, members of the Open Source PPE team worked with local industry to produce injection moulded frames for face shields. Over 10,000 of these were also packaged and distributed by our assembly hubs.



DePuy Synthes Cork

The Corporate Social Responsibility team from DePuy Synthes (a medical devices company in Cork) offered their logistics expertise to the Open Source PPE project to develop the assembly line procedures that were needed to clean, check and package face shields before delivery to the HSE. They also brought together over 100 volunteers from across their company and the Garryduff Sports Centre to run our first assembly hub.

Fundraising and Financial Transparency

For each Euro donated to the Open Source PPE project we were able to produce one face shield. These were donated to healthcare workers free of charge.

We fundraised a total of €50,870 to finance the purchase of materials needed for manufacture. Members of the public donated €34,563 to our crowdfunding campaign and the remaining €16,308 was donated by local healthcare industries and businesses. Many businesses also donated their time, services and materials for free.

Of the total funds raised, 96.2% (€48,956) was spent on purchasing raw materials for manufacturing. This consisted of 3D printer filament (31.9%), visor material (59.5%) and packaging supplies (4.8%). The total of all other expenditure was €1,833 (3.6%). This consisted of crowdfunding fees (2.4%), website hosting (0.3%), shipping and admin costs (0.9%). The balance of funds remaining at the end of the Open Source PPE project was €81 (0.2%).

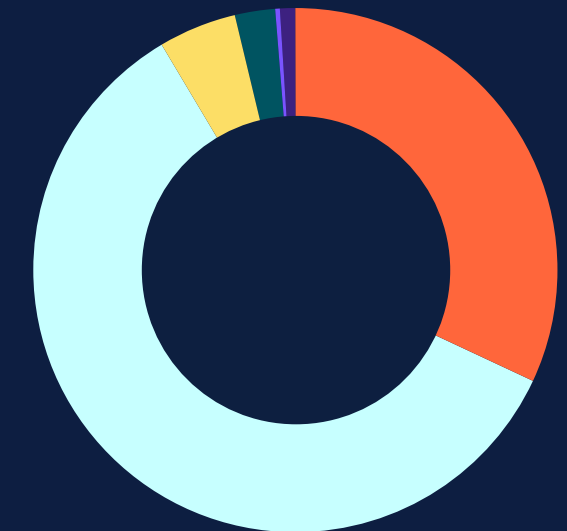
Income

- Corporate Donation (Aspen Grove)
- Corporate Donation (Anonymous)
- Corporate Donation (Anonymous)
- Public Donations (GoFundMe)



Expenditure

- 3D Printer Filament €16,239
- Visor Material €30,288
- Packaging €2,429
- GoFundMe €1,234
- Website, Shipping & Admin €140
- Shipping & Admin €459



National Efforts Capacity Per Day

Future Plastics:
10,000 frames

ACME Blinds:
10,000 frames

CALT Dynamics:
10,000 frames

Key Plastics:
5,000 frames



Benchspace:
1,200 frames

University
of Limerick:
5,000 frames



Merv Colton:
1,000 frames



Cartolytics:
500 frames



Cork Institute
of Technology:
500 frames



Kinsale
Community School:
200 frames



Fablab Nerve Centre:
150 frames



Sligo Institute
of Technology

Blocblinds:
400,000 frames

Shnuggle:
25,000 frames

Achievements and Thanks

”

I am so proud to be part of a volunteer effort that sprung up in such a short space of time. The organisation involved was colossal and the leaders made it look easy! Huge thanks to the bike marshals for their efforts, chats and positivity.

—
Tom English
Co. Clare

”

A testament to the spirit of togetherness in crisis.

—
Mark Carr
Co. Kilkenny

”

I have heart and lung conditions, and all this mess is to protect people like me. This project provided me with unique opportunity to contribute, to provide some help to people who are trying to help. Much appreciated!

—
Josip Almasi
Co. Cork

”

It was inspirational and super well organised. My 14 year old daughter was really happy to play a part in helping out. We bought a second printer to increase production, and will donate this to her school whenever they go back to school.

—
Les & Ellie Mahon
Co. Cork

”

I am very glad to have been able to have played a very small part in a monumental effort. If in the future there are other schemes I would love to be involved.

—
Paul Howarth
Co. Kerry

”

I was the second youngest printer part of this. And honestly this was probably the most fun I have had in ages, just the sheer amount of knowledge

—
Harry O'Connor
Co. Cork

”

This project showed the power of community spirit and what can be achieved.

—
Aoife Devlin
Co. Cork

”

Our staff were proud to have been of some help to the project.

—
Tipperary County Council Library Service
Co. Tipperary

”

I'm very proud to have been part of such a well run, well intentioned group. A very good memory to have in one of the worst of times.

—
Mary Lynch
Co. Clare

Project Contributors

+ 200 Anonymous Printers

Printers

Aaron Barry	Darek and Paulina Halka	Facebook Cork	John O'Connell	Miriam Nugent	Sean Forsyth
AlanJ	Darran Kerwick	Fachtna Roe (TCFE)	John Walshe	Miroslaw Jutkiewicz	Sean Smyth
Andrei Calistru	Darran Shortt	Farivar Kaghazchi (Fa)	Jonny Rowan	Niall O'Connor	Grange Community College
Andrei Reaboi	Darrell O'Brien	Fergus Somers	Joris	Niall Whitty	Sebastian Knapp
Andrew Cashman	David Furlong	Fingleton White	Josip Almasi	Nicolas Wijnstekers	Sgt John Meere
Aniket Latpate	Dean Gallagher	Finn Yore	Karl Grabe	Nikk George	Shane O'Donnell
Aoife Devlin	Coláiste Dún an Rí	Frank Courtney	Ken O'Connell	Noel O Flaherty	Simon Kenyon
Aoife for CCAE, UCC+CIT	Derek Farrell	Gaetan Meister	Les & Ellie Mahon	Paddy Fagan	Stefan Bondorf
Ben Lenihan	Fire1Foundry	Garry O'Mahony	Leslie Simons	Paddy Foley	Stephen Martin
Bob Finley	Dermot Saville	Gavin Pay	Lorcan Murphy	Patrick Gaynor	Stephen Moroney
Bryan Alexander	Don Kenneally	Harry O'Connor	Mark Carr	Patrick Rooney	Tal Eretz Kdocha
C. Mulder	Donnacha Kelleher	James Temple	Mark Gaffney	Paul Howarth	Thomas J. Fleming
Castleblayney Youthreach	Ed Doyle	Jay Bradley	Mark McLoughlin	Paul Quinn	Timothy Buckley
Chris Allen	Eddie Connolly	Jeffrey McCormick and Eva McGreggor	Martin O'Driscoll	Pawel-Donabate	Tipperary County Council Library Service
Chris Fenlon	Eimantas Kozeniauskas	Jens Köpke	Mary Lynch	Piotr Wieczorek	Tom English
Ciaran Patterson	Elise Kenneally	Joe Fahey	Matthew O'Neill	Raf Peeters	Tomasz Nicinski
Colin Russell-Conway	Emmanuel Stone	John Alfred	Michael D. Murphy (MeSSO CIT)	Rafal Szczepanik	Tomra
Colm Gibbons	Eoghan Lenihan	Adare, Co Limerick	Michael Gargan	Richie Cunningham	University College Cork
Conor Burke	Eoghan Mulholland	John from Gypsy	Michiel DeLepper	Robert Roche	
Conor O'Neill	Evan Dargan Hayes	John O' Shea	Mike O'Sullivan	Scott Phelan	

Project Contributors

People

Fergus Somers	Hyacinthe Jacquet
David Scannell	Community Outreach Team
Ian Barron	Diane Fehilly
Michiel DeLepper	Victor Twohig (T&T)
Martin Horgan	David Kyle
Sean Walsh	Pat Crowley
Alan O'Halloran	Martin Lehane
Deirdre Hourihane	Paul O'Brien
Sean O'Sullivan	Luke Harman
Thomas J. Fleming	Michael McLaughlin
Seán Elliott	Kevin Geary
Enda Moynihan	Ciaran O'Loughlin
Nicky Bent	Marc O'Riain
Martin O'Driscoll	Gavin Russell
Conor O'Neill	Owen Kelly
Bernard Yore	Deirdre Breen
Wan Waterman	Cathal Brown
Jay Bradley	Colm O'Neill
Joe Fahey	
Eoghan Calnan	

Organisations

Irish Defence Forces	Garyduff Sports Centre	CIT Interior Architecture
Blood Bikes Ireland	Watermans Printing	UCC & UCC Library
Blood Bikes South	Carrig Print	JB Roche
Blood Bike East	Engineers Ireland	Bike Marshalls
Blood Bike MidWest	Aspen Grove Solutions	LIT
Cú Chulainn Blood Bikes	3D Fuel	Bravo Charlie Tango
Blood Bikes South East	Cork City Libraries	DePuy Synthes
Southern 4*4 Response	CSN College	



**Óglaigh
na hÉireann**
IRISH DEFENCE FORCES



Thanks

By mid May 2020, the HSE Cork/Kerry advised us that commercial suppliers had begun to meet their demand for face shields, and as such we could wind down our voluntary effort.

The Open Source PPE project had fulfilled its purpose, to supply face shields to frontline healthcare workers until the arrival of sufficient commercial supplies. What had initially been conceived of as a small project, which we hoped could produce 10,000 face shields, had grown into a national operation with over 300 contributors making 50,000 face shields over a 2 month period during the COVID-19 pandemic.

The Open Source PPE team would like to thank all those who contributed to this project. Many had family or friends who were frontline healthcare workers; many were cocooning to protect themselves, and others contributed to this effort despite uncertainty about their own employment and financial security.

The response to the Open Source PPE project was extraordinary; every request for support was met with overwhelming generosity and motivation. That Ireland has such a pool of selfless, skilled and experienced individuals who will respond to a crisis such as the 2020 COVID-19 pandemic is cause for pride and confidence. This was a demonstration of community, institutional and industry collaboration at its best.





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