Summary of projects for COVID-19 calls

Computational support for real-time quantification models of new unreported COVID-19 cases in Spain and other countries

Argimiro Alejandro Arratia Quesada, Terrassa School of Industrial, Aerospace and Audiovisual Engineering (ESEIAAT) – Department of Computer Science (CS)

The project aims to develop software and provide high-performance computing support for a set of mathematical models that allow for real-time quantification of new unreported COVID-19 cases in Spain, by autonomous community or other zones of interest. These tools can also be used in other countries. In fact, we have already begun a collaboration with the government of Uruguay. The models will be constructed based on similar models developed by UAB and CRM researchers, and the estimates they provide will be used to study the dynamics of the disease based on the application of compartmental epidemiological models (SIR, SEIR, SIRS, etc., which we will also develop). These models will allow for more precise estimation of associated mortality and morbidity. Similarly, the estimates obtained will be used to perform an exhaustive analysis of cost-effectiveness in various realistic scenarios for action, both from the point of view of public management and at the social level. This analysis will provide information to guide decision-making in relation to the national public health system and within each autonomous community, enabling authorities to deal with the current pandemic and any similar situations that arise in the future. The results of the project will be published on a website that has already been created: https://underreported.cs.upc.edu. Collaboration with Mathematics against Coronavirus.

Collaborative work platform against COVID-19 for designers, engineers and health professionals

Josep Maria Monguet Fierro, Barcelona School of Industrial Engineering (ETSEIB) – Department of Engineering Presentation (EGE)

The http://design2fightcovid19.org platform aims to connect engineers and designers with demand from health professionals in an emergency situation. Designers, engineers and health professionals work together online within the framework of an open solidarity initiative aimed at meeting demand from primary-care, social and health professionals and hospitals. The platform provides a digital method and tools for collaborative, multidisciplinary design in a context of express innovation in the health field. It should be open to anyone who wants to use the infrastructure to work more productively and efficiently. The goal is simple: to connect people and operationalise projects that require knowledge, contacts and time sharing. So far, a dozen express projects have been launched through the platform. The design of the system, which harnesses collective intelligence, can be a powerful way to forge links between technology and health.

Medical equipment manufactured using 3D printing for use in the treatment of COVID-19 patients

José Antonio Travieso Rodríguez, Barcelona East School of Engineering (EEBE) – Department of Mechanical Engineering (EM)

The project involves manufacturing medical equipment to be used in Catalan hospitals for the treatment of COVID-19 patients with respiratory problems and to protect staff who are in contact with patients. In the context of the pandemic declared by the WHO, contributions from all sectors of society are vital to deal with the situation that the population is facing. The care capacity of Catalan hospitals is starting to be overwhelmed as a result of the need to provide care for a large number of patients with severe symptoms. The community of 3D printing makers (@coronavirusmakers) has carried out a number of unique projects that involve using additive manufacturing techniques to make items such as protective visors and components that make it possible to adapt commercial diving masks for use as protective equipment for medical staff. Given that all of the content of these projects has been made public, this EEBE team decided to join the effort to manufacture these components.

3D technologies to fight COVID-19

Miguel Ares Rodríguez – Centre for Sensors, Instruments and Systems Development (CD6)

In this project, we will investigate the design and development of 3D parts that are useful in the fight against COVID-19. Due to the rapid spread of the disease, stocks of spare parts for ventilators and protective masks are rapidly becoming insufficient. The development of 3D printed parts has emerged as a key tool for meeting the urgent needs of hospitals, institutions and health professionals caring for COVID-19 patients. Therefore, the use of these technologies is also helping to prevent the spread of infection and save lives. We will focus on investigating and developing the 3D printed parts that are most useful to the community at any given time as the situation evolves. Accordingly, we will focus on investigating practical designs for 3D printed parts and designing parts with a longer useful life, parts that are compatible with equipment currently being used in hospitals, parts that are more adaptable or customised to each specific use (in line with personalised medicine), and designs that are in synergy with other local, national or international initiatives. The project will allow us to work with CD6's 3D Optical Metrology Group and the 3D Surgical Planning Lab (3DPTLab) of Parc Taulí Foundation, both of which have extensive experience in 3D technologies.

Development of a low-cost pulmonary ventilator prototype with Raspberry Pi

Leonardo Acho Zuppa, Terrassa School of Industrial, Aerospace and Audiovisual Engineering (ESEIAAT)

As a result of the coronavirus pandemic, many research centres and universities are innovating in the development of new low-cost automatic ventilators that are easily reproducible. Ventilators costing between €2,600 and €18,000 are currently available on the market. However, in certain situations and in poor regions experiencing epidemics of

diseases that affect the human respiratory system, designing a very low-cost ventilator that can be produced quickly is a major challenge. With advances in electronic technology, the development of any mechanical system – from drones and robots to micro-control systems for robots used in medical treatments – is now relatively straightforward. The Terrassa Campus has extensive experience in designing electronic-mechanical and control systems. In this technological innovation project, carried out jointly with the Federal University of Technology – Paraná (Brazil), we will work on developing and clinically validating a low-cost automatic ventilator (€350).

Portable architectures: COVID-19 face shields

Maria Elena Fernández Salas, ETSAB – Department of Architectural Design (PA) – LAB-MAQ

The LAB-MAQ model laboratory of the ETSAB is using its three 3D printers to make face shields in collaboration with Coronavirus Makers and the Group of Architectural Experts, Forensic Architects and Mediators of the Association of Architects of Catalonia. The project submitted, entitled PORTABLE ARCHITECTURES, aims to boost production by increasing the equipment available and carrying out on-site production 24 hours a day.

Design and development of personal protective equipment using digital manufacturing tools and 3D printing, for testing and free dissemination

Felip Fenollosa Artés, CIM Centre

As a result of the COVID-19 pandemic, there are currently shortages of many medical supplies, including mechanical ventilation systems, PPE for health professionals and the general public, and other equipment. These shortages mainly affect the health system but also pose a significant public health problem when it comes to controlling the pandemic and protecting the population during the lockdown exit phase. In the challenging situation created by the pandemic, engineers, hospitals and companies have joined forces to meet needs that have emerged, but this is not a situation in which anything goes. Any equipment developed must meet standards of safety and effectiveness, and solutions must always be clinically and functionally validated. The Research Institute and Innovation Department of Sant Joan de Déu Hospital, together with the CIM UPC Centre, have launched a number of innovation projects that bring together clinical knowledge, technical knowledge, and manufacturing and logistics capabilities to develop solutions to emerging challenges. So far, the focus has been on developing PPE for health professionals (currently being used in several hospitals), prototyping for non-invasive ventilation equipment for breathing support, and other support tools. The aim of this project is to continue and develop this research activity, which focuses on solutions for tackling the current pandemic. Our objective is to start by providing support locally and to be able to scale up solutions for countries that need them through links with European and international networks of developers.

The eways #acércales ("bring them closer") initiative

Francesc Xavier Estaran Latorre – INNOVA Programme

The eways #acércales ("bring them closer") initiative is a web platform that collects electronic devices to give to COVID-19 patients isolated in hospital so that they can communicate with their families. Social isolation makes hospital stays even more difficult for patients and hinders their recovery. In the worst cases, people in this situation die without being able to say goodbye to their loved ones. This situation is especially critical for groups that are more technologically excluded, such as the elderly and poorer people who do not own smartphones or tablets. Via the eways website (www.eways.io), anyone can donate a smartphone, tablet, computer, etc. by filling in a simple form. Through a network of courier companies and volunteers, we pick up the devices at people's homes and take them to hospitals where they are needed. We also provide training and support to health staff so that they can use the devices. We are currently working in Barcelona (with TelecomuniCAT) and in smaller towns such as Tortosa, Olot and Vic (where we have created a parallel network). Through this project, we are able to reach remote areas where the population is older and the need for these devices is therefore greater.

CerveMakers_COVID19 skin project

Montserrat Solsona Rullo, Research Area, Baix Llobregat Campus

The project aims to harness four elements in the fight against COVID-19: (i) the UPC's knowledge and expertise in the area of image recognition; (ii) institutional support in the form of human and material resources provided by the Cervelló Town Council; (iii) support from private companies in the form of material resources provided on special terms; and (iv) the social, human and participatory experience of citizens of Cervelló, led by the CerveMakers community. We propose to have a web platform for uploading data ready for use in one week. The platform will be designed to be used on a mass scale, free of charge, and in an anonymised manner by participants in a research study aimed at identifying possible COVID-19 cases based on photographs of the subjects' skin submitted via the platform. In this case, the study will focus on children in the educational community of the municipality of Cervelló.

Reducing the psychosocial impact of COVID-19: detecting and dealing with post-traumatic stress disorder

Juan Manuel Soriano Llobera, Barcelona School of Building Construction (EPSEB) – Department of Management (OE)

In the current pandemic, a significant proportion of patients have required treatment in ICUs or critical care units. ICU survivors may suffer long-term psychosocial consequences that markedly affect their health and quality of life. Post-traumatic stress disorder (PTSD), a psychological morbidity with significant psychosocial and functional repercussions, is very frequently identified in this group. In the case of COVID-19, apart

from the ICU stay itself, the disease has specific characteristics that greatly increase the risk of PTSD. Specifically, it presents with respiratory distress syndrome and is associated with a marked stigma. Detection of PTSD in ICU survivors is an unmet need, and in the current context (a large number of sufferers and an overwhelmed health system), this situation could significantly worsen. The use of technology-based solutions such as smartphone apps could help overcome obstacles and facilitate management of PTSD patients. Our goal is therefore to develop and implement an app that facilitates early detection of PTSD symptoms in survivors of ICU treatment for COVID-19 and specific intervention to prevent the psychosocial consequences and disability associated with this pathology. This project is being carried out in collaboration with Taulí Park.

resUPCManresa

Pere Palà Schonwalder, Manresa School of Engineering (EPSEM) – Department of Mining, Industrial and ICT Engineering (EMIT)

Development of a low-cost ventilator design (target cost €750) that is replicable around the world to meet intensive care needs in areas with minimal medical infrastructure. This is a viable proposal, as the results achieved to date show: the prototype has demonstrated superior performance to other reported alternatives, costs less and provides greater replicability. Since 20 March, a multidisciplinary team made up of administrative staff, teaching and research staff (members of accredited consolidated research groups with experience in the health field) and students has been working on the project with the support of Althaia, a benchmark hospital in Central Catalonia. The development of the prototype has now advanced to the point where it can be considered functional. The prototype is based on an open-design approach: open hardware, open mechanical specifications, low-cost, readily available components, and free and open-source software.

COVID-19 protective masks: analysis of the viability of local manufacturing and possible approaches to reuse and/or recycling to minimise waste generation

Mònica Ardanuy Raso – Terrassa Institute of Textile Research and Industrial Cooperation (INTEXTER)

Due to the situation caused by COVID-19, there has been a large increase in demand for textiles to protect health workers and patients as well as the general public. Face masks are the main protective barrier for the mouth and nose. This has led to major supply problems and others related to poor understanding of this protective equipment and its correct use, which is vitally important to curb the spread of the virus. This project is aimed at improving provision, use and recycling of locally made face masks through two lines of work. The first focuses on transferring knowledge to society by building a network to share information on prevention and how to protect the population against COVID-19 through population information. The other focuses on the local manufacture and distribution of high-quality protective masks and proposals on how they can be reused in line with the principles of sustainability and the circular economy.

SDL-PAND

Pau Fonseca Casas, Barcelona School of Informatics (FIB) – Department of Statistics and Operations Research (EIO) – inLab

This project focuses on developing a functional prototype for evaluating alternative approaches to containing the COVID-19 pandemic suggested by modelling hypotheses based on graphic conceptualisation of models. The system must be expandable so that it can draw on two key sources: data on the evolution of the pandemic (data about the past) and data from sensors (mobile phones or other devices) that provide a picture of the current situation and can be used to define models for predicting the spread of the pandemic based on behaviours of members of the public. It must also be possible to expand the model (based on co-simulation, for example) to include traffic management models, evacuation models, etc. The aim is to generate a web application to analyse alternatives and define a working methodology that establishes a common framework for the various specialists who must collaborate on the definition of complex models, understand the hypotheses that underpin the models, and, based on these hypotheses, understand the resulting causality effects. The validation of the proposal and the resulting tool will be carried out by the Catalan Institute of Oncology and a team at Hospital Clínic de Barcelona.

No child without access to schooling from home

Leandro Navarro Moldes, Barcelona School of Informatics (FIB) – Department of Computer Architecture (DAC).

In the context of the ongoing COVID-19 crisis in Catalonia, thousands of families with school-age children lack computer equipment and internet connectivity. During the lockdown, which is expected to last until the end of the school year and possibly longer, children with limited access to digital technology will not be able to engage in remote schooling. The Government of Catalonia is defining an emergency programme to supply mobile phones, tablets and data connectivity to 50,000 families. While this programme will be of some help, due to a lack of resources it will not be sufficient to solve the structural problem of families affected by the digital divide. A group of entities involved in the collaborative, social and circular economy, with years of experience in collaborative initiatives, would like to support the action being carried out by the Government of Catalonia. This support will take two forms: 1) supplementing the supply of equipment with desktop computers and wireless connectivity, and 2) comprehensive follow-up, which includes working with and monitoring families and children with respect to issues beyond IT. The project focuses on just 30 vulnerable families, identified by grassroots organisations, who will be provided with equipment, connectivity and training aimed at helping overcome the structural and neighbourhood-level problems they face so that they can stay connected after the lockdown ends.

Identification of emerging social needs due to the COVID-19 pandemic and its effect on social services in Catalonia (INSESSCOVID19)

Karina Gibert Oliveras – Sustainability Institute

In just weeks, the COVID-19 pandemic has led to an unprecedented situation that has forced governments the world over to declare total lockdowns of their populations. What patterns of social vulnerability will emerge from the COVID-19 crisis and require attention? How should the organisation of social services in Catalonia be changed to gain coverage, strengthen the system, increase efficiency, and boost the capacity of social services so that attention to real vulnerability in the population can be ensured? We do not yet have answers to these questions, but there is an urgent need to find them and take corresponding measures as soon as possible. This project provides a methodology for harnessing the combined strength of data and knowledge in an initial prospective study aimed at generating insights to anticipate and plan a possible resizing and reorganisation of the system of 104 basic social services areas (municipal and district-level) in order to deal as effectively as possible with the vulnerabilities that will exist in Catalan society in the wake of the COVID-19 pandemic.

Development of a support tool based on clinical data to identify COVID-19 patients referred to ICUs who are able to breathe on their own (DESBANCAR-COVID19)

Luis Eduardo Mujica Delgado EEBE – Department of Mathematics (MAT)

The strain on health services due to the pandemic has clearly shown that resources available for adequate patient care in these cases are not unlimited. The decision to use mechanical ventilators for COVID-19 patients referred to intensive care units (ICUs) is currently based on a combination of clinical parameters, such as blood oxygen content for a given fraction of inspired oxygen (FiO_2). However, there are a number of measures and indices that can be considered for each patient to help determine if they are able to breathe on their own and therefore do not require intubation and mechanical ventilation (risky procedures that can have serious adverse effects). This is where the knowledge and experience of participating UPC members comes into play. Participants will work together on the development of a tool based on data processing and analysis (clinical and analytical parameters) that will help experts determine the optimal allocation of the resources available to ICUs anywhere around the world. Optimising use of resources is particularly important in developing countries, where they are more limited. The project is being carried out with the Anaesthesiology and Resuscitation Service (surgical ICU) of Hospital Clínic and the company UBIKARE.

TelecomuniCAT

Núria Salán Ballesteros, Terrassa School of Industrial, Aerospace and Audiovisual Engineering (ESEIAAT) – Department of Materials Science and Metallurgy (CMEM)

The UPC, in close collaboration with the Catalan Society of Technology, FibraCAT and other entities, is supporting a citizen and solidarity project known as TelecomuniCAT that aims to help COVID-19 patients admitted to Catalan hospitals by ensuring that they do not feel lonely when they cannot have visitors due to isolation and lockdown measures in effect. Patients are provided with mobile devices, free of charge and on a temporary basis, so that they can keep in touch with and receive support from friends and family. The devices, which come from social donation campaigns and/or companies, are suitable for making video calls and do not need to be configured. In a simple, intuitive way, patients can contact whoever they like just by touching a screen and without keeping medical staff from their work. This virtual contact between sick people and their relatives is aimed at improving the mood of patients and putting them in a more positive frame of mind to fight the disease. Everything will be okay!!

Monitoring the evolution of the Covid-19 pandemic in countries and regions in the Global South

Núria Pedrós Bernil, Barcelona School of Agricultural Engineering (ESAB) – Department of Physics (FIS)

The aim of the proposal submitted is to monitor the evolution of the COVID-19 pandemic in various countries and regions in the Global South by analysing available data and making predictions on this basis. Given the lack of reliable data in some countries, a multi-pronged approach to monitoring the pandemic is proposed. When reliable data is available, we will seek research groups with analytical capabilities and transfer the methodology used to them. If suitable research groups cannot be found, we will seek NGOs or university groups that are in contact with health authorities and can serve as a communication channel with respect to local predictions on the pandemic. These predictions are intended to help authorities plan health and policy actions that involve limiting population mobility. Finally, if no official data is available, we will analyse the content of formal and informal media in the country in question to estimate the evolution of the pandemic. The project also includes a final campaign to raise awareness in the UPC community and Catalan society on the need for universal health care and the importance of strengthening existing international bodies.

Design, automation and manufacture of an actuator for manual ventilators

Maria Elena Blanco Romero, Industrial Equipment Design Centre (CDEI) – Department of Mechanical Engineering (EM)

In collaboration with the Josep Trueta Hospital in Girona, the CDEI-UPC is designing and automating an actuator for manual ventilators used in Catalan hospitals. The aim is to be able to use manual ventilators without the need for health staff to operate them. Both ventilators and health staff are currently in short supply in the Catalan health system. The proposal submitted to this call is to adapt this design to the technological, manufacturing and economic context of Ecuador in order to meet current and future needs in the country's hospitals. Automatic ventilators are in short supply in Ecuador's

public health system, whereas manual ventilators are more widely available. The mechanism that this project focuses on makes it possible to take advantage of the manual ventilators available without the need for staff to operate them. A mechanism for controlling the movement of the ventilator will also be implemented. The design will be simple and economical, and the actuators could be manufactured in Ecuador, which would provide opportunities for local workshops. The initiative could also be extended to other countries.

COVID-19 data exchange between specialised outbreak software suites

Alberto Abelló Gamazo, Barcelona School of Informatics (FIB) – Department of Service and Information System Engineering (ESSI)

Go.Data is an outbreak investigation tool for collecting field data during public health emergencies. Since the 2010s, DHIS2 has been implemented by many countries as their national health information system, notably in Africa, South-East Asia and the Western Pacific Region. Consequently, the World Health Organisation (WHO) has identified the need to support countries in cross-matching anonymised outbreak data from Go.Data to DHIS2 if they have implemented both systems to collect outbreak and routine health data, respectively. This will empower countries to gain deeper insights into the current picture (e.g. identify the population at risk of being infected and potential pressure on the health system during epidemics). But cross-matching Go.Data and DHIS2 data is far from trivial and requires advanced IT skills that are not available in developing countries. Our proposal is four-fold: (i) ensure the private use of Go.Data on a server without compromising patients' personal data; (ii) empower countries to import data from Go.Data into DHIS2 (so they can monitor the emergency with the tool they are used to); (iii) suggest advanced analysis of COVID-19 outbreak data generated from Go.Data and/or DHIS2; and (iv) enable advanced data integration with other relevant data to provide contextualised visualisations, analysis and forecasts based on the WHO Information System to Control and Eliminate NTDs (WISCENTD).