Proposed: UMass Lowell Computer Science Department Pandemic Suppression R&D Initiative *$1.1M over 90 days*

How Can We Be Safe *and* Open-for-Business as we Transition Back to Work?

As of May 2020, we are facing two threats. One is the COVID-19 (C19) health crisis that involves varying degrees of illness and potential death. And the other is an economic crisis that involves hardship for individuals and businesses. Both threats are real, and both are related. A society can lock down longer and harder; and reduce economic output, increase unemployment, and increase risk of recession. Or lock down less, gain more short-term economic output, and risk viral re-emergence.

Lock-down does not necessarily need to be on or off. It can be done in varying degrees as we transition back to work.

We propose to address six different problems related to the balance between C19 lockdown and a gradual return to a normalizing (and eventually normalized) economy, without causing a resurgence of the virus spread.

The Principal Investigator is Professor Haim Levkowitz, Chairman of the Computer Science Department at The University of Massachusetts at Lowell. Levkowitz can marshal engineering resources at one of the largest state-lead research institutions in Massachusetts and is in a position to develop the missing "glue" required to fight a pandemic, as we explain in this proposal.

We estimate that for a cost of $1.1M over 90 days of development we should be able to introduce technologies and training materials that will help the economy function *during* a pandemic, as well as easing its way out of it. We propose to create tools for Pandemic Workers (PW). PW includes medical professionals, police officers, National Guard, military, essential corporate employees (e.g., supermarket and pharmacy workers), and personnel hired for specific C19 work.

It is our intent to create tools to suppress our current pandemic, as well as future pandemics.

Project #1) Develop Point-of-Care COVID Test with 15ft Offset

Currently, the most common way to test an individual is to acquire a sample of mucus from the nose via a swab ("Q-tip"), send to a lab, and look for the appropriate organism. The sample is typically acquired by a medical professional who comes in close contact with the client, and therefore must wear protective clothing. We propose to develop a method for performing this test without close personal contact and without potentially scarce PPE, thus enabling many more people to perform the test (e.g. Police, National Guard, and lay volunteers).

Here is an example. A PW without Personal Protective Equipment (PPE) but with mask and gloves places a self-test kit on the ground; PW withdraws 15ft; client approaches kit; client acquires sample with swab and places in tube; client places on ground a form with name/address/phone/email/DOB and an ID; client withdraws 15ft; PW approaches kit; PW takes photo with smartphone App capturing ID, written information, and bar code/serial number on sample tube; PW collects sample and form into a plastic bag; and PW leaves for client a 1x3 inch label with test kit serial number (~16 random characters). This label contains the internet address of a webpage that shows test results and a downloadable PDF file. Indoor air might contain the virus; therefore (weather permitting), sample collection is done outdoors, with PW preferably upwind. Medical tests currently exist to do this, yet supporting software is lacking.

We propose to develop:

1. Android and iPhone App, a back-end database, and a website user interface to support Point-of-Care (POC) testing with 15ft offset between client and tester; and
2. Training videos and materials.

We further propose to train potential personnel, including, e.g., police, National Guard, fire fighters, and supermarket workers. Trainees will deploy and will be observed to update the procedures, software, and training materials as needed.

Rationale and Strategy: During the current (and any future) pandemic, the health care community with PPE might become overloaded. Therefore, offloading tasks to non-PPE resources is an easy way to increase testing. Also, it is likely that testing infrastructure will not scaled up at the moment a future pandemic strikes; subsequently, communities might rely on existing infrastructure, such as police, while a better equipped capability is assembled.

Researchers: 3 CS PhD 100% time, 2 CS Prof 30% time, 1 Video GS 50% time, 1 Writer GS 50% time, 2 Med Prof 30%. We also expect to tap the expertise of the Mechanical Engineering and Biomedical Engineering faculty and their students on a consulting basis as needed.

Total Cost: $220K [$figures to be revised]

Project #2) Get COVID Test within 10 minutes via 911

This project builds on Project #1 and develops technology to assist in deploying a POC tester to a client site. When a client reports not feeling well to a 911 operator, a tester will be deployed to the client site, and a sample will be collected outdoors while maintaining 15ft separation, following Project #1's protocol. The tester potentially could be police, National Guard, fire firefighter, paid PW worker, or a volunteer.

We propose to develop support software that includes smartphone Apps, database backend, and website user interface. A 911 operator will collect and enter important information into a webpage; field personnel will interact via a smartphone App (e.g., a map that will show the client's location).

While on the street, field personnel can ask pedestrians, "where's the COVID?", and log reports into the App. A street presence, with software support, can help ferret-out hot spots before they become clusters.

The system will be designed to support both police and non-police personnel (e.g., National Guard in a car). We will create training materials and videos.

We aim to implement at one small police department that deploys both police and National Guard POC personnel. We will update the software and materials as needed based on field experiences.

Rationale and Strategy: Identify infection clusters sooner via an automated testing system that relies on *existing* 911 police call centers. In many areas of the country, 911 personnel are underutilized and could potentially be deployed to suppress an outbreak quickly. Alternatively, one might look at a dedicated non-police call center; however, it is unlikely to be set up when you need it most since it takes time to hire, train and assemble teams of good people and supporting infrastructure.

Researchers: 2 CS PhD 100% time, 2 CS Prof 30% time, 1 Video GS 50% time, 1 Writer GS 50% time, 2 Med Prof 30% time. As in Project #1, ME and BME expertise will be used on a consulting basis as necessary. Further, we are exploring the possibility of deploying ROTC cadets for testing purposes.

Total Cost: $195K

Project #3) Improve Point-of-Entry Control

Point-of-Entry (POE) locations include entrances to public transportation points (bus-, train-, subway stations, and airports), super-markets and shopping centers, and large buildings.

POE Control involves a variety of tasks, including checking forehead temperatures with a handheld temperature scanner, distributing masks, distributing gloves, dispensing a hand sanitizer (e.g., Purell), administering COVID tests, and counseling people who are not feeling well. POE personnel potentially include corporate employees, police, military, and security personnel.

We propose to develop software and training videos/materials that assist a POE Worker (POEW). This includes sourcing (or, if not available, developing) vests with pockets to hold and rapidly access items that are necessary to carry out POE control (e.g., handheld forehead thermometer, masks for sale, plastic gloves for distribution, and test kits). Multiple training videos will cover the various tasks performed by the POEW, including collecting a sample with 15ft offset and counseling people who are potentially infected.

We propose to develop a smartphone App that records information about pedestrians with elevated temperatures or not feeling well. POEW will collect basic information such as name, address and phone number for follow-up by others.

We will create training materials and videos, and implement pilots at several locations, such as a food store. We will update the software and materials as needed based on field experiences.

Researchers: 1 CS PhD 100% time, 1 CS Prof 30% time, 1 Video GS 50% time, 1 Writer GS 50% time, 2 Med Prof 30% time. The development of physical artifact (e.g., vests) will require expertise that is not within our CS focus, but more like ME and / or BME, which we will contract as consultants on a need-basis.

Total Cost: $180K

Project #4) Improve Elevated Body Temperature (EBT) Detection Systems

Currently, thermal cameras detect forehead temperatures and alert an operator if a person is exhibiting an elevated temperature level. A number of companies offer these products (e.g., FLIR), and they face several challenges:

- Most products require an operator to guide pedestrians and manually process each measurement.
- Most thermal cameras have an absolute accuracy of ±2°C. Camera sensors tend to shift due to temperature drifts, which means they need to be calibrated periodically by placing a known healthy subject in view and pressing a button.
- Thermal cameras often have low resolution (e.g., 240x480 pixels), which requires the camera to be placed close to the subject's face.

We propose to create technology that improves upon existing systems:

- Develop software that supports an unattended system. For example, a supermarket worker who regularly bags groceries will occasionally tend to an elevated reading. Or a lobby security guard will carry out their traditional chores while occasionally processing an elevated subject. This might require communication between the camera and the PW's smartphone App, a notification that will alert the PW, and a regular photo taken to help identify the elevated subject. More businesses and locations would utilize thermal systems if they required less support.
- Develop software that locates face and forehead, assuming belt barriers guide pedestrians into a narrow lane and a camera is positioned close to the lane. Working with close-ups will enable researchers and businesses to not devote time struggling with low resolution.
- Develop software that continuously calibrates the camera by looking for faces that are elevated relative to others, including applying machine learning techniques that will help the system learn to identify positives vs negatives.

We will create training materials and videos and deploy at several locations, such as a subway station. We will update the software and materials as needed based on field experiences.

Strategy: We will provide all the technology for free; we thus hope to encourage thermal camera companies to improve more quickly.

Researchers: 1 EE PhD 100% time, 1 EE Prof 100% time, 1 BME PhD 100% time, 1 BME Prof 20% time, 2 CS PhD 100% time, 2 CS Prof 30% time, 1 Med Prof 15% time.

Total Cost: $197K

Project #5) Develop Field Medicine Support Technology

As of May 2020, most hospitals are not overloaded; however, it is possible that future waves or other countries will experience hospital overloading. When this occurs, the sickest tend to be admitted, while those less ill are told to stay home and work with a primary care physician (PCP) via telemedicine. A potential missing element might present itself when the PCP wants to obtain blood (or other samples) for lab testing. Yet if the client is at home, how does one collect a blood sample, safely and at reasonable cost?

We propose to develop a mobile blood collection system that involves a vehicle that travels to a client site for blood draw.

We will develop smart phone Apps, backend database, and a website user interface that facilitates high volume production. Client or support personnel will enter a request on the website, and the system will respond with an appointment time that reduces travel time for mobile vehicle (Traveling Salesmen math problem). A smartphone App in the vehicle will guide to the client site. Client will be given a 1x3" label with a test serial number which enables them to access the result via a web browser.

We assume that, weather permitting, blood draw will occur outdoors with client and medical personnel sitting side-by-side, e.g., on a step to avoid as much as possible indoors interaction since virus might be circulating inside.

We will create multiple barriers in prototype form, made by hand, that will be placed between client and PW. These will be tested in the field to get a better sense of efficacy and ease-of-use. An example might be a 3x4 ft Plexiglas wall between client and PW with a hole for arm, and a plastic trash bag with small hole that covers client arm, to access skin. Arm might rest on pillow desk, on PW's lap, with trash bag barrier between arm and pillow. Perhaps researchers can figure out how to safely draw blood, while only changing gloves and plastic bag at each draw, instead of entire set of PPE?

We will create training materials and videos; and deploy at least one mobile team. We will update the software and materials as needed based on field experiences.

Researchers: 2 ME PhD 100% time, 1 ME Prof 20% time, 1 BME PhD 100% time, 1 BME Prof 20% time, 2 CS PhD 100% time, 1 CS Prof 30% time, 1 Video GS 50% time, 1 Writer GS 50% time, 2 Med Prof 30% time.

Total Cost: $205K

Project #6) Develop Air Testing Support Software

COVID-19 circulates indoors and can infect inhabitants. While there are many existing techniques for testing air that could potentially be used at various locations and facilities, each has their own challenges, which is beyond the scope of this document.

We propose to develop a backend database, smart phone App and website UI that will assist in logging and displaying air data. For example, a smart phone App will capture GPS coordinates and a photograph of the data collection point, will record a test serial number, and a website will display results on a geographical map.

We propose to create a prototype system and make all software available free and open, so that others can build on this work.

Researchers: 3 CS PhD 100% time, 1 CS Prof 30% time, 1 Med Prof 20% time.

Total Cost: $100K

Free and Open to Maximize Utilization

If the United States is clean and a foreign country is not, and an infected person travels, it becomes our problem. It is therefore in everyone's best interest to maximize the utilization of technologies that will be developed by these initiatives.

It is often difficult for a small unknown company to build a business and scale quickly; therefore, free and open distribution is the only way to achieve fast results worldwide. Therefore, we will follow the “open source” distribution model and will make all developed materials available to the public domain, free of charge -- anyone can copy and modify at no cost. If a company wants to copy and build a business around any of these technologies, they, as well as anyone else, is welcome to do so.