



TECS Editorial: Rethinking and Re-evaluating in the Time of Crisis

In the book *Guns, Germs, and Steel: The Fates of Human Societies*, Professor Jared Diamond told us that germs played a significant role in shaping human societies in different parts of the world. Appearances of new germs, outbreaks of viral diseases, and intermittent pandemic episodes have punctuated human history periodically in the past. The current COVID-19 crisis is a unique experience for all of us. It has thrown tremendous challenges to our way of life as we knew it before this crisis. It seems that the nature is sending us a strong message—to re-evaluate our priorities, our way of life, our science and technology investments, and overall, our contribution to the structure and direction of the societies we live in.

Some of these issues are not specific to the readership of this journal, but embedded computing researchers are also part of the society, and if anything, this crisis is pointing to the dependence of the survival of individuals on the larger society and how it functions. We must rethink and reshape the societies as the crisis recedes and a tendency to go back to the usual norms tries to overpower us. Even though some of us are living detached lives with our professional concerns around computing and science in general, the crisis must shake us to the awakening that society needs reshaping in a radical new way—otherwise, there is no hope for the survival of us as a species, no matter how much technological progress we make. We must endeavour to influence science and technology priorities, research investments, public health infrastructure, and most importantly the economic models of tomorrow—as the status quo over the past decades is failing us in every way during the crisis.

Having said that much, I want to make some observations regarding the scope of embedded computing technology during the current pandemic. One of the most challenging parts of managing the crisis has been in the medical field. Due to the cumulative effects of continual reduced public expenditure on national health infrastructure and welfare of citizens, we find ourselves in a severe shortage of lifesaving equipment. Ventilators for patients with severe respiratory incapacitation, the test kits to diagnose patients, and the personal protective equipment that would assist health workers with active monitoring of hazard are either in extreme short supply or need to be manufactured on demand when our hospitals run out of them, endangering lives. The medical professionals are the frontline combatants in a war against the germ, but they are handicapped by the lack of ICU beds, ventilators, test kits, and their own protective gear. Under duress, we find that many universities around the world, including my own, have come up with design for ventilators overnight and started producing them in a cottage industry mode. Even though these are not of the expensive calibrated variety built by medical equipment manufacturers, it is amazing that engineers around the world rose to the occasion and fashioned mobile phones and other processor boards at their disposal to program the sensing and actuation of mechanical components to build lifesaving equipment. This is a fine example of embedded computing at the hour of need, built

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even by non-experts. Although the bigger question is yet to be answered as to why most governments have reduced the public health infrastructure budget leading to this tremendous shortage, it is quite reassuring to see how engineers are able to help out at the hour of crisis. It may be not embedded computing research, or it may be even achievable with basic knowledge of programming, but it is still a great humanitarian occasion for those associated with embedded computing.

Another example of embedded computing being used to fight this pandemic is mobile computing apps. They are being designed and downloaded by the millions in the form of tracking apps. This is quite alarming. It is unclear that tracking through mobile phones is the only way to track patients and trace their contacts. It is, however, very clear that a pandemic crisis is being used by many governments to infringe on the privacy of citizens. This should be considered very seriously. One cannot suspend basic rights—and in many countries, the “right to privacy” is a fundamental right of citizens using the excuse of a crisis.

No government should be allowed to appropriate the privacy of its citizens.

For example, in India, the government has launched a tracking app whose terms of usage, and non-transparent data usage policy, is alarming, which in turn could sow mistrust and diminished use of the app, defeating its purpose anyway. Embedded and mobile computing experts working in security and privacy must investigate these apps.

One interesting mobile app idea,¹ which to a large extent is privacy preserving, is based on exchange of random numbers between mobiles in each other’s vicinity. The idea is that once a patient has been diagnosed, she can send the random numbers her phone sent in the recent past to a central repository. Others can check the repository periodically to see if there is a match with the numbers her phone received recently. A match and the volume of the match would indicate proximity and its duration to a recently diagnosed patient. Such a match would indicate that she has to consult a doctor to get tested. This does not give up privacy of the patient, and certainly no personally identifying information ever leaves the phone. The technique was proposed back in 2014, and certain pitfalls have been discussed, and further privacy protection techniques have been proposed. Further research is required not only for privacy-preserving mobile app design but also for diagnosis of a newly designed app for their privacy and security issues. Unfortunately, as far as I know, none of the governments have paid attention to privacy and security while launching these apps, making it dangerous for users even in the future when the pandemic is over.

Many other aspects of healthcare, contact tracing, sanitization, and privacy issues are coming up where computing—especially embedded computing—has a lot to contribute, not necessarily in a fundamental way but in pragmatic matters. So what I am advocating here is that as researchers, we should not be detached from the societal needs of our trade, and we must engage more vigorously with the current and future needs of society—be it in lab-on-chip for antibody testing, NEMS/MEMS-based blood testing, or design of lifesaving equipment such as ventilators, among others. Our engagement with the societal problem is a call of duty that we must not ignore, even though our goal is also to do fundamental research and develop novel theories, methodologies, and tools for futuristic technologies. We need to balance both.

Finally, this is my final editorial as the Editor-in-Chief of ACM TECS. It has been an honour and privilege to serve the embedded computing community for slightly more than 6 years, and now the time has come to pass the baton to the very capable hands of Professor Tulika Mitra, who takes over the Editor-in-Chief’s responsibility. I must thank all of the associate editors I have worked with in my first and second terms for volunteering their precious time and energy in getting manuscripts evaluated and pushing them from submission to final decision. I thank the reviewers for their time and effort in helping us getting manuscripts vetted. I must thank Professor Tulika Mitra

¹<https://github.com/DP-3T/documents>.

and Professor Hiren D. Patel especially for their senior associate editor role in my second term, relieving me of some of the hard work. Professor Hiren D. Patel also volunteered as the Information Director of the journal for 6 years and meticulously kept the ACM TECS website up-to-date. Extra thanks are due for him.

I also thank Ms. Laura Lander from ACM for her guidance and numerous help throughout. Without her help, it would be impossible to manage. In addition, Ms. Arriane Bustillo has been an excellent and responsive journal assistant. I acknowledge her assistance with gratitude. Finally, Ms. Kelly Crooks has helped publish the content for every single issue in such a timely fashion so that we could keep to the journal's schedule. I must thank her for her dedicated service to ACM TECS.

With that, I wish my best to the new Editor-in-Chief and the new editorial board for continued improvement of the journal in quality and quantity. May the best authors publish in this journal, and may all of our authors contribute to societal betterment with their expertise.

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Editor-in-Chief