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A THOUSAND FACE SHIELDS FOR MEDICAL PERSONNEL IN THE LOCAL COMMUNITY: AN EXPERIENCE REPORT

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ABSTRACT

Over the past half year, the disease caused by the new strain of coronavirus has spread to all countries and territories of the world. In the fight against this global epidemic, the first of its magnitude since the Spanish flu in 1918, health systems around the world were under enormous burden, and medical personnel, who are on the front line of defense, needed continued assistance in protective equipment, to minimize their risk of infection in daily contact with patients. This paper presents an experience report in community engagement to make and distribute a thousand face shields for medical personnel, originally planned to support local needs but reacted to numerous requests and grew to answer the immanent needs of health and social care professionals all over Croatia. The face shield design was based on open source blueprints and adopted to fit the requirements for fast and high quality production of these equipment necessary to fight COVID-19 pandemic. This work provides an insight to campaign planning and execution, as well as analysis of delivered results and media coverage. Discussion provides guidance for similar actions to be taken in the future by local community activators to contribute to social good.

KEYWORDS: face shields, humanitarian action, COVID-19, CNC cutting machine, fundraising

1. INTRODUCTION

On the New Year's Eve 2019, the Chinese office of the World Health Organization[1] received information about cases of pneumonia of unknown etiology, which appeared in the city of Wuhan with population of 11 million, in the province of Hubei. The new coronavirus SARS-CoV-2 was isolated as early as 7 January 2020, which sequenced genome then reached scientific communities around the world. By January 20, the first cases appeared in Thailand, Japan and South Korea, proven to have been imported from Wuhan, where six patients died of this unknown infectious disease, later called COVID-19. On January 25, the first cases shown up in Australia, the USA and France and by the end of the month there were also cases in Germany, Canada, the United Arab Emirates, Finland and Italy. By the end of February, Italy became Europe's largest focal point with 888 confirmed cases, while Iran had 388 and South Korea as many as 3.150, all of which confirmed the local transmission of disease among the population.

The first case in Croatia was confirmed on February 25 as imported from Italy. On March 5, the Croatian health minister made a decision declaring the danger of an outbreak of infectious coronavirus disease, which enabled the mobilization of all resources in the health care system and, if necessary, the movement of infectologists and other health care professionals and equipment in order to better manage the health care system. The World Health Organization declared the pandemic on March 11. The daily number of new COVID-positive persons in Croatia reached its first peak on April 1 (96), and the following day the total number of infected exceeded one thousand. Countries around the world have closed borders and declared movement restrictions, recommended keeping physical distance and other epidemiological measures aimed at preserving the health of the population. In the late spring and beginning of summer, as the number of active and new cases lowered, countries have eased the measures and have begun to open for travels and business. Nevertheless, the global statistics for COVID-19 kept rising. By mid-August, the global number of people with COVID-19 had exceeded 21.2 million, with over 760 thousand deaths and over 14 million recovered cases, while in Croatia the number of total cases increased to 6,258 with 5,134 recovered cases and 163 reported deceased. Croatia has reached its second peak on August 14 (208), with 106 patients currently in hospitals and 10 of them being put on a respirator.

In the fight against this global epidemic, the first of its magnitude since the Spanish flu in 1918, health systems around the world were (and still are) under enormous burden, and medical personnel, who are on the front line of defense, needed continued assistance in protective equipment, to minimize their risk of infection in daily contact with patients. This paper presents an experience report in community engagement to make and distribute a thousand face shields for medical personnel, originally planned to support local needs but reacted to numerous requests and grew to answer the immanent needs of health and social care professionals all over Croatia.

The paper is structured as follows: section 2 describes a motivation and setup for a humanitarian action of making and distributing face shields in the local community, while section 3 provides an overview of face shield design and production; section 4 delivers details on the campaign execution, while section 5 presents the action results and discusses the particularities of the approach taken and wider impact made; section 6 concludes the paper.

[1] https://www.who.int/emergencies/diseases/novel-coronavirus-2019 (access date: August 14, 2020)

2. MOTIVATION AND SETUP

From the beginning of COVID-19 epidemic, many initiatives for the creation of protective and other equipment using 3D printers took place around the world, especially for making protective face shields (also known as: visors). 3D printing manufacturers are committed to supporting a united front to address shortages and rising demand triggered by COVID-19 to better help efforts that protect the lives of those impacted by this global pandemic [WEF, 2020]. Even more, there is a growing trend of open source software and hardware solutions to help medical staff, public administrations, businesses and citizens in their daily activities [Joinup, 2020].

This paper describes an experience report of a humanitarian action implementing the need for and usage of face shields as a tool to help exit lockdown and prevent further spikes in infections of COVID-19. Face shields are plastic face visors that provide full face protection, which can play an important role in tackling the virus, as they provide a high level of protection for the wearer [Wain and Sleat, 2020]. Face shields cover the mouth, nose and eyes, as shown in Fig. 1, so a high percentage of viral particles are prevented from reaching the wearer, making them very useful tools for those facing very regular contact, at close proximity, with others, e.g. in medical settings.

Figure 1. Personnel of the Institute of Emergency Medicine in Koprivnica-Križevci County

There has been research done in this area before 2020 and COVID-19 epidemic. The study [Lindsley et al., 2014] that used coughing-patient simulator and a breathing-worker simulator found that: (1) 9% of the initial burst of aerosol from a cough can be inhaled by a worker 46 cm from the patient, (2) During testing of an influenza-laden cough aerosol with a volume median diameter (VMD) of 8.5 μm, wearing a face shield reduced the inhalational exposure of the worker by 96% in the period immediately after a cough; (3) The face shield also reduced the surface contamination of a respirator by 97%; (4) Increasing the distance between the patient and worker to 183 cm reduced the exposure to influenza that occurred immediately after a cough

by 92%. It also showed that "health care workers can inhale infectious airborne particles while treating a coughing patient. Face shields can substantially reduce the short-term exposure of health care workers to large infectious aerosol particles, but smaller particles can remain airborne longer and flow around the face shield more easily to be inhaled. Thus, face shields provide a useful adjunct to respiratory protection for workers caring for patients with respiratory infections. However, they cannot be used as a substitute for respiratory protection when it is needed."

Another, newer study [Perencevich et al., 2020] stated that: (1) Face shields offer a number of advantages. While medical masks have limited durability and little potential for reprocessing, face shields can be reused indefinitely and are easily cleaned with soap and water, or common household disinfectants; (2) They are comfortable to wear, protect the portals of viral entry, and reduce the potential for autoinoculation by preventing the wearer from touching their face; (3) People wearing medical masks often have to remove them to communicate with others around them; this is not necessary with face shields. The use of a face shield is also a reminder to maintain social distancing, but allows visibility of facial expressions and lip movements for speech perception; (4) Most important, face shields appear to significantly reduce the amount of inhalation exposure to influenza virus, another droplet-spread respiratory virus.

Recognizing face shields as practical intervention that can be quickly and affordably produced and distributed, the local volunteer initiative in the City of Križevci, Croatia (population: 22,000), has been established by three young enthusiasts – Karlo Siladi, Jelena Širjan and Lucija Herceg. Having different professional backgrounds and trainings in electrical engineering and information technology, mechanical engineering and dental medicine, they have served as highly motivated multidisciplinary team aiming to engage local community in protecting medical personnel while they provide healthcare services during COVID-19 epidemic. They have started a humanitarian action on March 22, 2020, and reached out to the P.O.I.N.T. Association, a local non-governmental organization (NGO) experienced in innovative use of new technologies and modern paradigms, as well as engaging in citizen journalism, promoting education, e-learning and new technologies, especially driven by information and communication technology (ICT), to provide a benefit to the Križevci community and wider throughout the region and the country.

P.O.I.N.T. Association was founded in 2004 and since then it gathers students, youth, and activists around projects and platforms which deliver independent culture, non-institutional education and humanitarian services. The association has been one of the most active organizations in Križevci, Croatia and its surrounding by completing in the last 15 years more than a hundred projects (around 8-10 per year) and initiatives, in 2015 also awarded by the City of Križevci for its impact in the local community. Its 64 members have diverse skills, interests and backgrounds, of which more than 50% are university educated (8 of them hold a PhD degree).

3. FACE SHIELD DESIGN AND PRODUCTION

The initiative first started by 3D printing and assembling around 10 face shields per day, as shown in Fig. 2, according to the Prusa Face Shield [Prusa, 2020], an open source model developed and delivered by a 3D printing company based in Prague, Czech Republic. This prototype face shield quickly got two verifications with the Czech Ministry of Health and has been adopted globally. This model and algorithm was then enhanced by the electrical engineer

Robert Ljubek[2] from Varaždin Electrical Engineering School, who was also a mentor at the Centre of Excellence for New technologies (CENT), which fastened its adoption all around Croatia.

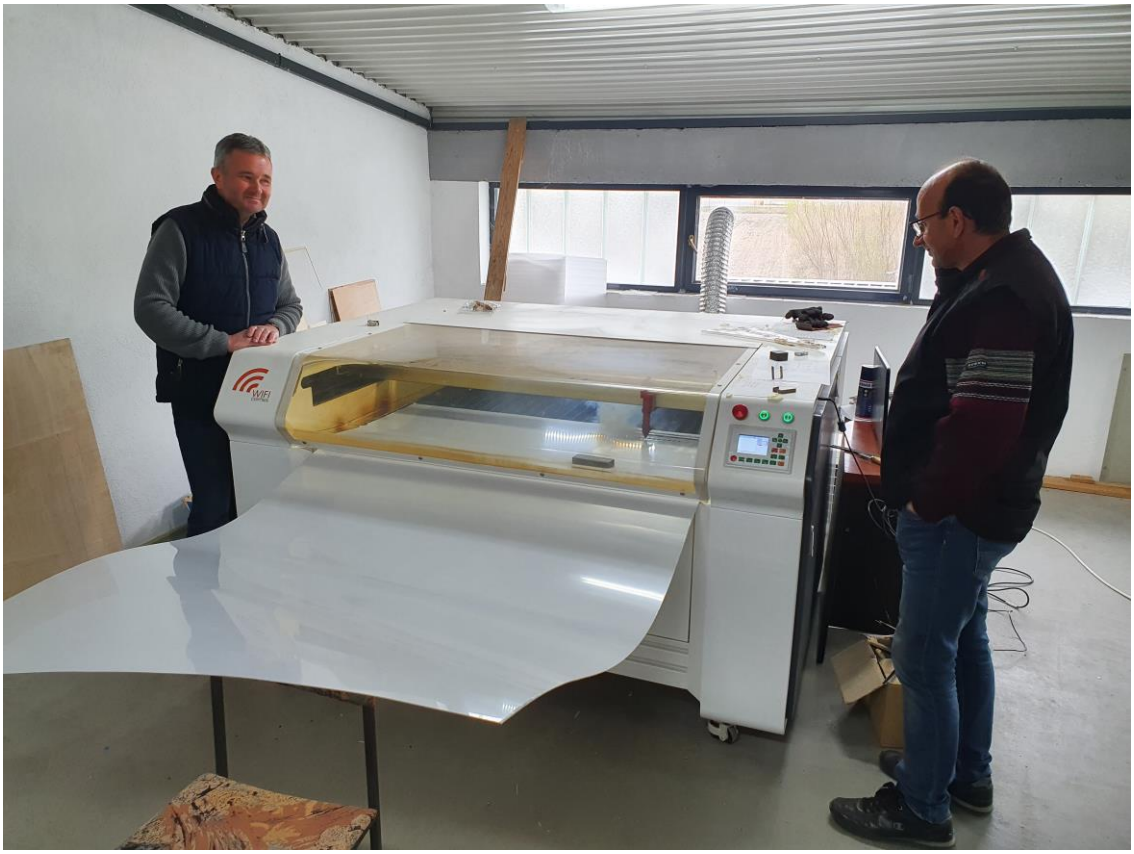
Figure 2. 3D printing of face shield parts in homemade production settings (Prusa Face Shield).

With the growing need and a number of requests from the users and health institutions in Croatia, the initiative quickly learned of another technical approach enabled by the new, openly available design of protective visors – Proto Shield [Proto, 2020], which enabled significant acceleration of production with CNC machine, without using 3D printer. The Proto Shield is an open-source, low-cost, quickly produced face shield, designed to be functionally equivalent to the Prusa face shield and compatible with 3D printed Prusa parts. In order to find available CNC machine in a local community, the initiative searched among local SMEs and agreed to work with Deltametal Ltd.

Their experts have worked tirelessly and pro-bono, and have redesigned the Proto Shield model so they could use even more solid material more effectively. The face shields were made of high quality 1.5-millimeter PETG (a Glycol Modified version of Polyethylene Terephthalate) plates, commonly used to manufacture water bottles, ensuring their endurance and ability to be reused after disinfection, but also having a slightly softer surface which makes it prone to wear. The material also benefits from great thermal characteristics, allowing the plastic to cool efficiently with almost negligible warpage[3]. It is important to emphasize that all face shields were made under controlled conditions and disinfected, and then packed and prepared for delivery. A total of one thousand visionaries were made on the CNC machine of the company, as shown in Fig. 3.

[2] https://www.civz.hr/izrada-vizira-algoritam-za-3d-printer/ (access date: August 14, 2020)
[3] https://www.simplify3d.com/support/materials-guide/petg/ (access date: August 14, 2020)

Figure 3. Deltametal Ltd. staff while producing face shields on the CNC machine (Proto Shield).



4. CAMPAIGN EXECUTION

Originally planned to last for ten days and to primarily fulfil local needs for face shields for medical personnel, the action reacted to numerous requests and grew to answer the immanent needs of health and social care professionals all over Croatia. It ended on April 22, 2020, lasting one month in total.

The action has invited citizens and business entities to donate funds, through local media on three occasions. The main information platform for the campaign has been news portal Križevci.info[4], managed by P.O.I.N.T. Association for more than 15 years now, and visited daily by about 1,000 unique visitors. The portal has publish articles about all activities for the entire duration of the action. Also, there is accompanying Facebook page having more than 5,000 followers, which served as a basis of advertising the action. Facebook campaigns have been executed to ensure the maximum visibility of the action to the targeted user groups, as shown in Fig. 4.

[4] https://www.krizevci.info/ (access date: August 14, 2020)

Figure 4. Facebook insight for the boosted Križevci.info article about the action on March 31, 2020

In addition to Križevci.info, other media have also reported on the action, as shown in details in Table 1: HRT – Croatian National Television, Poslovni dnevnik, Radio Križevci, Prigorski.hr, Klincek.com, Drava.info, and Glas Slavonije. The Institute of Emergency Medicine in Koprivnica-Križevci County has published a thank-you video on their website[5], showing their gratitude for the delivered face shields. In order to make it easier for users to assemble the face shield, we have prepared a short 3-minute video-tutorial with the instructions and posted it on YouTube[6].

Table 1. Detailed media coverage of the local face shields making and distribution action

Publish date	Media type	Reference
March 26th	Online portal (regional)	*POMOZITE I VI! Mladi iz Križevaca i okolice priključili se akciji izrade zaštitnih vizira!* https://prigorski.hr/pomozite-i-vi-mladi-iz-krizevaca-i-okolice-prikljucili-se-akciji-izrade-zastitnih-vizira/
March 28th	Online portal (local)	*Pomozite i vi, podržite inicijativu izrade zaštitnih vizira za medicinsko osoblje u lokalnoj zajednici!* https://www.krizevci.info/2020/03/28/pomozite-i-vi-podrzite-inicijativu-izrade-zastitnih-vizira-za-medicinsko-osoblje-u-lokalnoj-zajednici/
March 29th	Online portal (local)	*Naši bivši učenici Jelena Širjan i Karlo Siladi, uključili se u akciju izrade vizira za liječnike* http://www.klincek.com/?p=17345
March 31th	Online portal (local)	*U Križevcima se izrađuje više od 400 zaštitnih vizira za medicinsko osoblje – podržite ovu akciju i vi!* https://www.krizevci.info/2020/03/31/u-krizevcima-se-izraduje-vise-od-400-zastitnih-vizira-za-medicinsko-osoblje-podrzite-ovu-akciju-i-vi/
March 31th	Online portal (local radio station)	*I Križevčani izrađuju vizire za zdravstvene radnike*

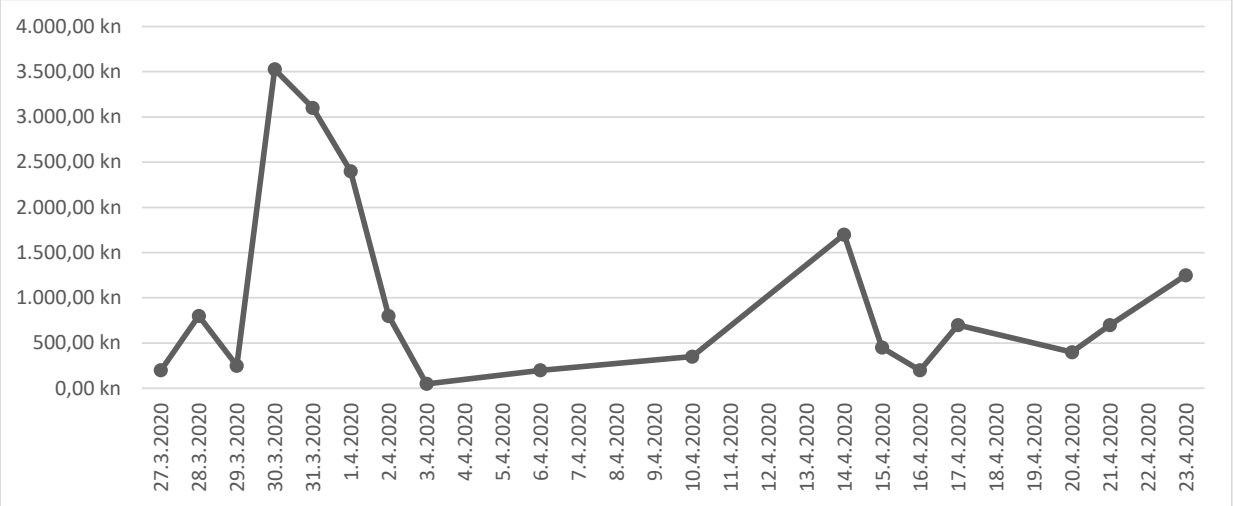
[5] https://www.hitna-kckz.hr/zahvala-za-donaciju-zastitnih-vizira/ (access date: August 14, 2020)
[6] https://www.youtube.com/watch?v=J9Rk9MmGIGo (access date: August 14, 2020)

Publish date	Media type	Reference
		https://radiokrizevci.hr/2020/03/i-krizevcani-izraduju-vizire-za-zdravstvene-radnike/
April 2nd	Online portal (national)	*U Križevcima se izrađuje više od 400 zaštitnih vizira za medicinsko osoblje – podržite ovu akciju i vi!* https://www.poslovni.hr/domace/u-krizevcima-se-izraduje-vise-od-400-zastitnih-vizira-za-medicinsko-osoblje-podrzite-ovu-akciju-i-vi-4223746
April 3rd	Television (national)	*Križevačka akcija izrade zaštitnih vizira za medicinsko osoblje* https://www.youtube.com/watch?v=57HIOrrxPcU
April 3rd	Online portal (local radio station)	*Karlo Siladi donirao vizire u GDCK Križevci* https://radiokrizevci.hr/2020/04/karlo-siladi-donirao-vizire-u-gdck-krizevci/
April 14th	Online portal (local)	*Dodatnih dvjesto zaštitnih vizira iz Križevaca ide za Vinkovce i Vukovar* https://www.krizevci.info/2020/04/14/dodatnih-dvjesto-zastitnih-vizira-iz-krizevaca-ide-za-vinkovce-i-vukovar/
April 14th	Online portal (regional)	*[FOTO] HEROJI MEĐU NAMA Mladi iz Križevaca isporučili 400 zaštitnih vizira, još 300 izrađuju* https://prigorski.hr/foto-heroji-medu-nama-mladi-iz-krizevaca-isporucili-400-zastitnih-vizira-jos-300-izraduju/
April 15th	Online portal (local radio station)	*Viziri iz Križevaca putuju za Vinkovce i Vukovar* https://radiokrizevci.hr/2020/04/viziri-iz-krizevaca-putuju-za-vinkovce-i-vukovar/
April 15th	Online portal (regional)	*Mladi trojac uključio se u akciju izrade zaštitnih vizira, više od 400 komada poslano je ordinacijama diljem županije* https://drava.info/2020/04/mladi-trojac-ukljucio-se-u-akciju-izrade-zastitnih-vizira-vise-od-400-komada-poslano-je-ordinacijama-diljem-zupanije/
April 16th	Online portal (regional)	*Donirali zaštitne vizire što su ih izradili na svojim 3D printerima* https://www.glas-slavonije.hr/430261/4/Donirali-zastitne-vizire-sto-su-ih-izradili-na-svojim-3D-printerima
April 16th	Online portal (regional radio station)	*Zaštitni viziri za zdravstvene djelatnike* https://radio.hrt.hr/radio-osijek/clanak/zastitni-viziri-za-zdravstvene-djelatnike/227941/
April 23rd	Online portal (local)	*Tisuću križevačkih vizira diljem Hrvatske, P.O.I.N.T. donirao gradski Crveni križ* https://www.krizevci.info/2020/04/23/tisucu-krizevackih-vizira-diljem-hrvatske-p-o-i-n-t-donirao-gradski-crveni-kriz/

5. RESULTS AND DISCUSSION

During the action, a total of HRK 17,075.00 has been collected due to the selfishness of 47 donors, including companies, crafts, associations and citizens, as the fundraising trends show in Fig. 5. Donations have been collected on the P.O.I.N.T. Association business account and used to cover the costs of materials and distribution of face shields all around Croatia.

Figure 5. Fundraising trends for face shields production and distribution; total sum HRK 17,075.00



The list of donated health institutions and offices include, among others: "Sisters of Mercy" University Hospital Center in Zagreb, "Dr. Fran Mihaljević" Clinic for infectious diseases, General hospital in Zadar, General County hospital in Našice, Healthcare Center in Sesvete, Healthcare Center of Koprivnica-Križevci County, the offices of general practitioners and family medicine, dental medicine, pediatrics and gynecology in the areas of Križevci Kalnik, Sveti Petar Orehovec and some delivered to Dugo Selo, Tuheljske Toplice, Sveti Ivan Zelina, Zaprešić, Bedekovčina and Sesvetski Kraljevac. In Koprivnica we have also donated to departments of anesthesiology, psychiatry and radiology, as well as the General hospital in Bjelovar, "Dubrava" Clinical Hospital and the Zagreb Trauma Clinic. Emergency services in Križevci, Koprivnica and Đurđevac have received 25 face shields each, medical transportation crews were equipped, and pharmacies, medical-biochemical laboratory, patronage nurses and specialist offices of radiology and ophthalmology were also equipped in Križevci, as well as the local Centre for Social Welfare and the local Red Cross Society.

At the very end of the action the P.O.I.N.T. Association additionally donated a package of three-layer surgical masks, protective gloves and disinfectants worth a HRK 1,000.00 to the local Red Cross Society, whose volunteers tirelessly worked on medication, food and necessity supplies delivery to senior citizens and persons in need.

6. CONCLUSION

The necessity of physical distancing and personal isolation during the novel coronavirus epidemic must not grow into permanent social alienation. In these resource-limited circumstances, it is even more necessary to foster social solidarity and mutual cooperation in local communities, with the aim of creating resilience and building sustainable local ecosystems. In order to create such environment and empower its habitants, we have applied the humane and steady use of digital technologies to engage the community in making and distributing a thousand face shields for medical personnel, originally planned to support local needs but reacted to numerous requests and grew to answer the immanent needs of health and social care professionals all over Croatia.

We strived to learn from this global health crisis and employ the following approaches: prevention rather than treatment (by providing additional protection to the medical personnel), reliance on science and technology instead of myths (by using approved and adopting open sourced solutions), exercising crucial changes to personal habits (being in lockdown but choosing to assist those in need), and continuous focus on vulnerable groups of citizens (by equipping medical personnel we also protect senior citizens who use healthcare services at most). We hope this action has been a constructive and productive step towards this direction.

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