Applications of nonconventional technologies in the current global pandemic

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Abstract. Starting from the first part of the previous year, the mankind faced a very unusual challenge. Starting with the spread of an animal-based virus found in the exotic food markets in Wuhan Province, China, the SARS-COV-2 virus quickly began to spread on a global basis on the entire planet. With such a high contagiousness it was only a matter of time till the virus made its presence in the countries all over the world, infecting many people and, unfortunately, rising the death toll every day. Based on this situation, a global pandemic was instituted by the World Health Organization resulting many restrictions and rising many problems for the medical systems all around the world. In this paper we would like to present some of the applications of modern technologies that helped, in way or another, in the fight against the pandemic, being sometimes a helping hand in the global fight against this virus.

1. Introduction

The Severe Acute Respiratory Syndrome Coronavirus 2 known shortly as SARS-COV-2, it's a virus that caused the COVID-19 global pandemic. It's a respiratory illness that is believed to have a zoonotic origin, having a close genetic similarity to bat coronaviruses. Being a very contagious virus, studies showed that it has a infection rate of 2.39 up to 3.44, if no members of the community are immune or if there not taken any preventive measures like social distancing, wearing masks, vaccination or other methods. [1], [2].

It is known that the virus is spreading mainly via respiratory droplets produced from coughs, sneezes or by speaking. The COVID-19 spread can be reduced inside a community by some measures and simple precautions like physical distancing, wearing a mask, keeping rooms well ventilated, avoiding crowds, cleaning your hands, and coughing into a bent elbow or tissue.

From a global standpoint, the protective equipment were a big concern from many point of views. The high demand of protective equipment started to create a global blockage in the supply chain for every country. [3], [4].

Personal Protective Equipment, also known as PPE, were mandatory for anybody who could have a direct contact with an infected person. Medical personnel were the first ones in the fight against the pandemic are were the first ones to have huge logistics issues with the mentioned PPE.

PPE include gloves, gowns, overalls, face-shields, googles and protective masks. For some of them as presented in [4], new and modern technological processes came in hand to help in the process of manufacturing, resulting thus an advance in the contact beetwen infected people and healthcare practitioners.

Figure 1. Personal Protective Equipment worn by medical personnel.

2. Methods and cases

Globally, the medical equipment industry went under a huge pressure based on the high demand of them, straining the supply and distribution of them. As a first response on a worldwide scale, engineering branches came in helpful with the manufacturing of protective equipment and many more.

Other nonconventional technologies like Rapid Prototyping or 3D printing came in handy being able to manufacture much needed components for the medical field. It's not unusual for medicine to be in a harmony with engineering, but in this case it was more important and visible than any other time.

3D printers are known for their reliability, efficiency, precision and also cost effectiveness. Medical equipment such as face-shield, protections, head supports were reproduced in a computer aided design software and manufactured in a very short amount of time. In the following figure is presented the equipment used for additive manufacturing in our laboratories. [5],

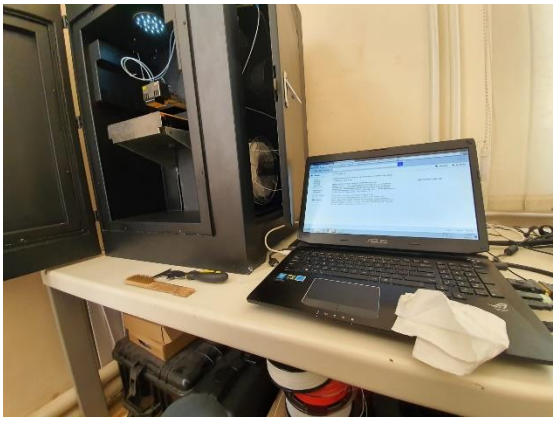

Figure 2. 3D printing system at University of Oradea – Industrial Engineering Department

Speaking about manufacturing, many manufacturing companies tried to bring their contribution on this fight against the logistic and production stranding. One of the most notable event, even from the start of the pandemic, was related to the production of face-shield on an industrial scale. Caracol-AM company from Northern Italy together with KUKA robots. They developed an automated additive manufacturing process that can process up to 1000 face-shield every day. Also, the drawings, STL files

for 3D printers and any other details are open-source, so everybody from anywhere in the world can download and use the models to reproduce their product, solidarity being a keyword in this worldwide collaboration.

Speaking about the idea above, locally, many companies tried to contribute in the same way to support the medical system. Face-shields, accessories, flow regulator and even artificial respirators were reproduce on 3D printers. In Figure 3 is presented a medical practitioner wearing a face shield against respiratory droplets. [5], [6].

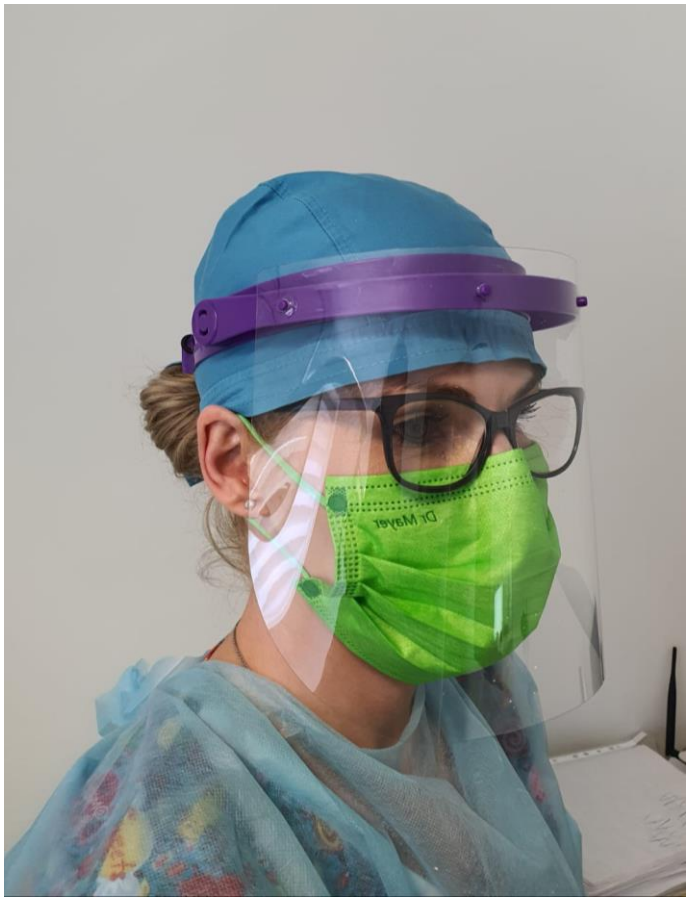

Figure 3. Face-shield used by medical practitioners made with the help of 3D printer – the plastic head support was made with the help of additive manufacturing than the transparent foil was mounted on the front clips.

Due to the hazardous effects of the infection with the SARS-COV-2 virus, patients with consistent medical history were in need of mechanical respirators. Components for this machines were mainly reproduced on 3D printers not only because the cost was more than affordable for those situations, but also for being manufactured in a shorter time.

Open-source projects made by students and teachers have been uploaded on different portals and took part in the efforts to sustain life for patients in critical stages, that were mostly in intensive care units as seen on references [7] and [8].

As for today we are aware of the many issues the COVID-19 pandemic raised on a global scale, increasing the demand for medical equipment and devices, creating thus a new market of products, helping in a way or another solving the supply chain disruptions. One of the reasons of using nonconventional technologies, in this case 3D printing or any procedures of additive manufacturing, represent the advantage of quick manufacturing of complex parts. This require a long period of manufacturing planning and processing. With the help of this new technologies, minimal time is required

to deliver small batches of components resulting a quick response in time of crisis. When the pandemic started to gain proportions on a global scale, people started helping as soon they had STL format files. Also another point of view consist of non-complex planning or infrastructure for this additive manufacturing that provides a more efficient crisis response.

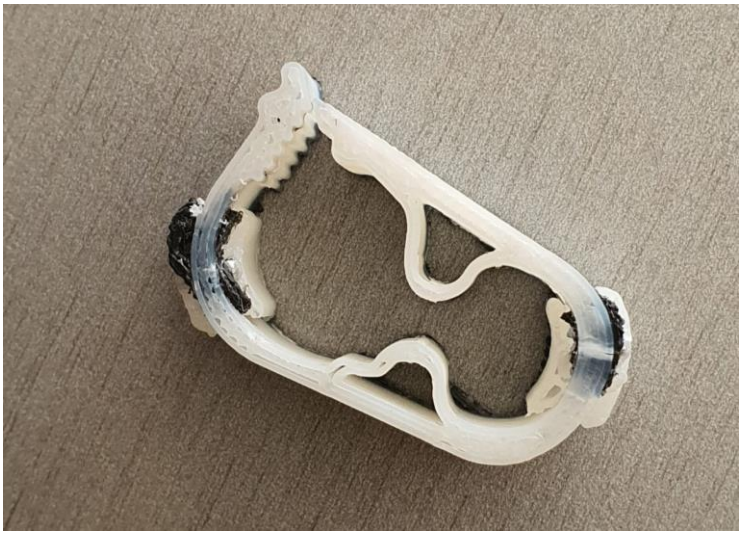

Figure 4. Flow regulator used for artificial respirators and also for intra-venous infusion kits – this one was made on a 3D printer in our laboratories at University of Oradea

3. Conclusion

As for today we are aware of the many issues the COVID-19 pandemic raised on a global scale, increasing the demand for medical equipment and devices, creating thus a new market of products, helping in a way or another solving the supply chain disruptions. One of the reasons of using nonconventional technologies, in this case 3D printing or any procedures of additive manufacturing, represent the advantage of quick manufacturing of complex parts. This require a long period of manufacturing planning and processing. With the help of this new technologies, minimal time is required to deliver small batches of components resulting a quick response in time of crisis. When the pandemic started to gain proportions on a global scale, people started helping as soon they had STL format files. Also another point of view consist of non-complex planning or infrastructure for this additive manufacturing that provides a more efficient crisis response.

Another advantage of this nonconventional procedures is related to its presence at a global scale, 3D printers being very popular machines worldwide. 3D printers do not require high-end knowledge to produce parts. Many printable files can be found on the internet, many open-source or open-design repositories being created in the last year [7], [8].

Additionally, many companies worked and engineered efficient and reliable design solutions for the additive manufacturing workforce worldwide. Also, many scientific papers are a real help, being used in many ways to gather information regarding disciplines that are interconnected in medicine, engineering, researching, etc.

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