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Editorial

Worldwide 3D Printers against the New Coronavirus

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Abstract: The pandemic caused by the new coronavirus has placed national health systems of different countries in difficulty, and has demonstrated the need for many types of personal protective equipment (PPE). Thanks to the advent of new three-dimensional printing technologies, it was possible to share print files (using stereolithography (stl)) quickly and easily, improve them cooperatively, and allow anyone who possessed the materials, a suitable 3D printer and these files, to print. The possibility of being able to print three-dimensional supports, or complete personal protective equipment has been of incredible help in the management of COVID-19 (Coronavirus Disease 2019). The times and the relatively low costs have allowed a wide diffusion of these devices, especially for the structures that needed them, mainly healthcare facilities. 3D printing, now includes different fields of application, and represents, thanks to the evolution of methods and printers, an important step towards the "digital world".

Keywords: coronavirus; COVID-19; 3D-printing; DPI; protection; public health

Three-dimensional printers and millers are now widely used in the world; both in the medical field and in other areas such as electronics, engineering, construction, and military fields [1]. Technological development has made it possible to print (or mill) different materials, with multiple characteristics, and with good resolutions and reliability compared to analogue techniques [2–4]. 3D (3 dimensional) printing (or additive manufacturing) allows the creation, starting from a digital model, of three-dimensional physical objects, by depositing, layer by layer, of overlying materials. 3D printing dates back to the 80s. Beginnings could be considered with stereolithography (rapid prototyping and STL (STereo Lithography) format), followed by sintering (selective laser sintering), to arrive at fused deposition modeling or 3D printing with molten material [5,6]; it was thanks to the three dimensional printing that it became possible to print in color, while with the Electron beam melting, or even electron beam fusion, it was possible to obtain metal objects with a high density [7,8].

At the end of 2019, scientists isolated a new coronavirus in these subjects, designated SARS-CoV-2 (Severe Acute Respiratory Syndrome—Coronavirus-2), found to be similar to at least 70% of its gene sequence to that of SARS-CoV. Patients experience flu-like symptoms such as fever, dry cough, tiredness, difficulty breathing [9–15]. Certainly, the most common methods of diffusion of the virus involve the spread of infected droplets at a distance, through coughing, sneezing, or simply speaking. In more severe cases, often found in subjects already burdened by previous pathologies, pneumonia develops, acute renal failure, up to even death. 3D printing has found wide application in the medical field also in the Covid-19 (Coronavirus Disease—2019) emergency period. In fact, given the difficulty in finding official health supplies, thanks to this technology, many people have mobilized in a completely autonomous way to find concrete solutions. The whole world of "markers" and digital companies has exploited 3D printers in order to make up for these shortcomings by creating spare parts, fittings and

compatible tubes for medical instruments in record time, useful for dealing with emergencies [16–19]. Recently, doctors, running out of valves for respiratory intensive care equipment and unable to purchase them from companies, needed to find a solution to save the lives of hospitalized patients.

This impactful event shone the spotlight on the activity within the community made up of makers and producers, which for some time had started to make a contribution to the health emergency, starting to organize itself to produce materials missing or that it would have been better to manufacture on site to avoid delivery delays. In fact, to print in 3D it is not enough to connect a machine to the internet. However, you also need:

- The printing material, which can be powder or filament of plastic, metal, ceramic or other;
- The so-called post-production, or someone who takes care of pulling the piece out of the machine, eliminating the supports, the unnecessary parts, cleaning it from extra dust and, if necessary, finishing it.

In a short time, makers and big producers came to organize themselves to have everything quickly. CAD (Computer Aided Design) files of all types have sprung up at the makers' sites, from valves to face masks. On Facebook® the communities and groups in which people recommend the best materials, the most effective design and so on have multiplied too. University researchers are contributing to efforts in various centers of excellence. Finally, companies that supply pieces to complement those printed, such as fabrics or screens for protective masks, have accelerated their production and donated materials to the Italian regions (as Decathlon® did with its snorkeling masks). In short, the market has been populated with alternatives and solutions, giving life to an extraordinary offer, albeit very varied in terms of quality [20–26].

Especially when it comes to medical devices and personal protective equipment, European consumer protection legislation is very strict and requires a long process of certification before being placed on the market. For example, some protective equipment may require approval by the Food and Drug Administration (FDA). Therefore, it must be ensured that companies that deal with additive manufacturing have a pass to continue their activity even during the lockdown period. At the international level, the flow of data (and therefore the design of 3D printed objects) should continue to be free of localization policies, barriers and duties. 3D printing has undoubted advantages when it comes to small productions, custom objects or complex designs. The additive manufacturing cancels the adaptation and configuration times of the machines (such as those for the creation of new molds), and allows the creation of complex and customized pieces without splitting up costs and production times [27]. It therefore remains to be understood how, once the emergency has passed, people may be able to take advantage of the specific benefits of this technology and whether its use in crisis situations will push for a more widespread adoption.

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