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BRIGHT

Erasmus+ strategic partnership for Higher Education

BOOSTING THE SCIENTIFIC EXCELLENCE AND INNOVATION CAPACITY OF 3D PRINTING METHODS IN PANDEMIC PERIOD

O4 - BRIGHT testing e-learning webinar

Project Title	**Boosting the scientific excellence and innovation capacity of 3D printing methods in pandemic period 2020-1-RO01-KA226-HE-095517**
Output	**O4 - BRIGHT e-learning webinars on the use of 3D printing technologies in development, testing and producing of medical parts in pandemic period – BRIGHT testing e-learning webinar descripion**
Date of Delivery	**30th of November 2022**
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Content

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1 Introduction

BRIGHT testing webinar presents standards, quality control and testing methods that are used in medical products testing. It consists of a theoretical lecture of various standards and testing methods and multiple case studies for specific examples. In this webinar three case studies have been considered. The case studies relate to mechanical testing, 3D scanning/measurement and simulated surgery. The first case study evaluates a 3D printed hand orthosis which is highly relevant in personalised orthopaedics today. A tongue with tumour example was chosen for the simulated surgery case study. In the final case study, a face shield is evaluated, this example was recently highly important during the COVID-19 pandemic. The objective of this webinar is to present the students with:

- the medical stands that are used today,
- the classification of testing methodologies which are used and
- specific examples of medical testing, with explanation of the procedure which is used.

Equipment like 3D scanners, universal testing machines, 3D printed surgery models was used in this webinar. For each method specific instructions are given on how this procedure should be carried out.

The webinar is available on the BRIGHT project website by accessing the following link:

https://bright-project.eu/?p=342

Webinar can be accessed directly also from YouTube, by accessing the following link:

https://www.youtube.com/watch?v=zzux7x11sjE

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2 Webinar 4 description

2.1. Structure of the webinar

The webinar structure consists of two main elements: the theoretical lectures and case studies. Each of these elements is divided into multiple subject related parts. The theoretical lectures consist of standards and quality control in medical engineering and testing methods for medical devices. The case studies consist of three examples which showcase the application of mechanical testing, 3D scanning and simulated surgery methodologies. The entire webinar is narrated, this is used to explain each of the steps in the methodologies and give additional insight into the objectives of each case study. The narration is followed by subtitles and slides for the important steps in order to raise the accessibility of the webinar to those who are hearing impaired and those who have difficulties understanding English. The case studies follow relevant examples of 3D printed devices. This webinar aims to teach the students the theoretical knowledge behind standards and testing in medical engineering and show them how specific test are carried out.

2.2. Steps of the webinar in detail and methods used for teaching

The demonstrations in this webinar are based on three specific cases: hand orthosis, tongue with tumour and protective equipment (Figure 1).

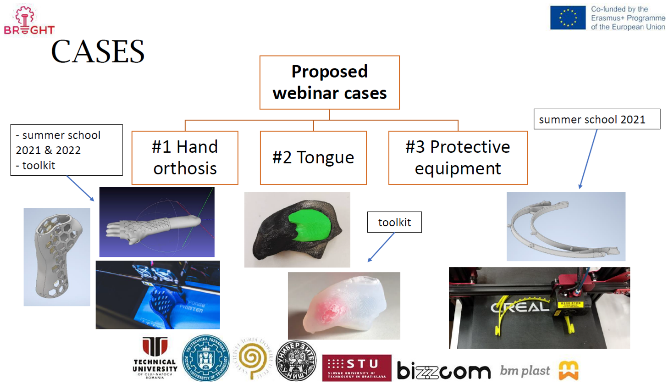

Figure 1- Testing webinar case studies

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The first case study considers testing of a personalised 3D printed hand orthosis. This orthosis is used for stabilization of wrist or elbow injuries making the healing process more comfortable. Previous webinars showed how the orthosis was made, and this webinar showed how it was tested. This case study begins with a short description of the device followed by a fit test to the patient (Figure 2). In this step functionality and the comfort of the orthosis are checked on a specific patient.

Figure 2- Hand orthosis testing fit with patient

Next a mechanical (3-point bending) test of the orthosis is carried out. First it is shown how the orthosis is mounted on the universal testing machine (Figure 3) using custom fixtures due to its personalised shape.

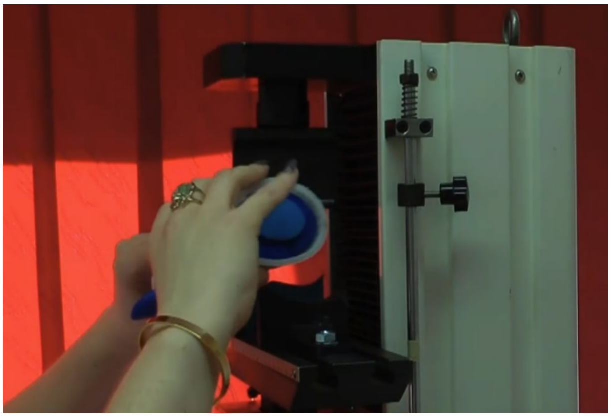

Figure 3- Hand orthosis mounting to testing machine

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Then the 3-point bending test is presented (Figure 4) showing the relationship between the applied load and resulting displacement.

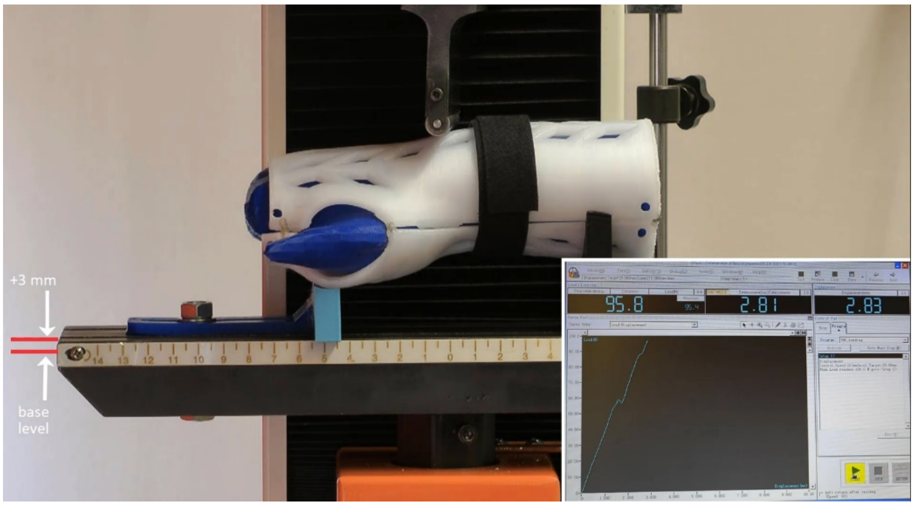

Figure 4- 3-point bending test of the orthosis

Next the 3D printed orthosis is prepared for the 3D scanning procedure (Figure 5), it is painted with a white spray in order to prevent issues which can arise due to shine surfaces of the plastic material.

Figure 5- Pre-processing the orthosis for 3D scanning

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Now the 3D scanner settings are chosen, and the scanner and orthosis are positioned, this is followed by the scanning procedure (Figure 6).

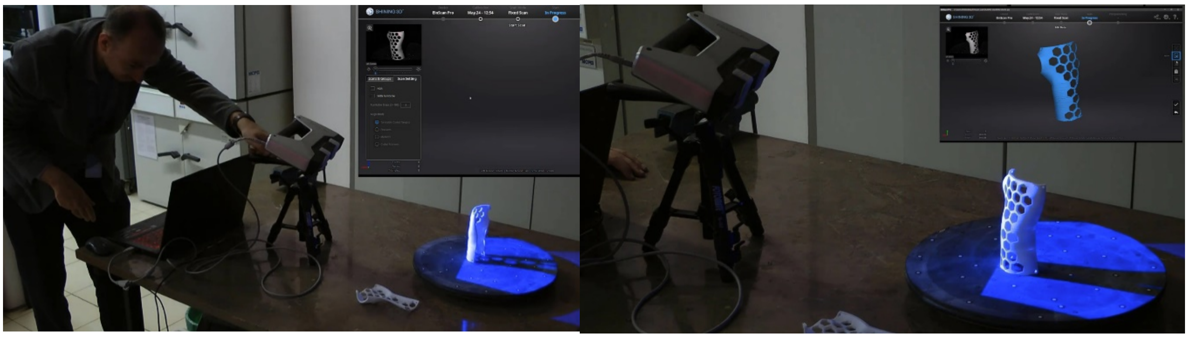

Figure 6- Preparing the software and 3D scanner

Next the volumetric model of the orthosis is created, which is then compared to the original CAD model of the orthosis to determine the geometry deviations created during 3D printing (Figure 7).

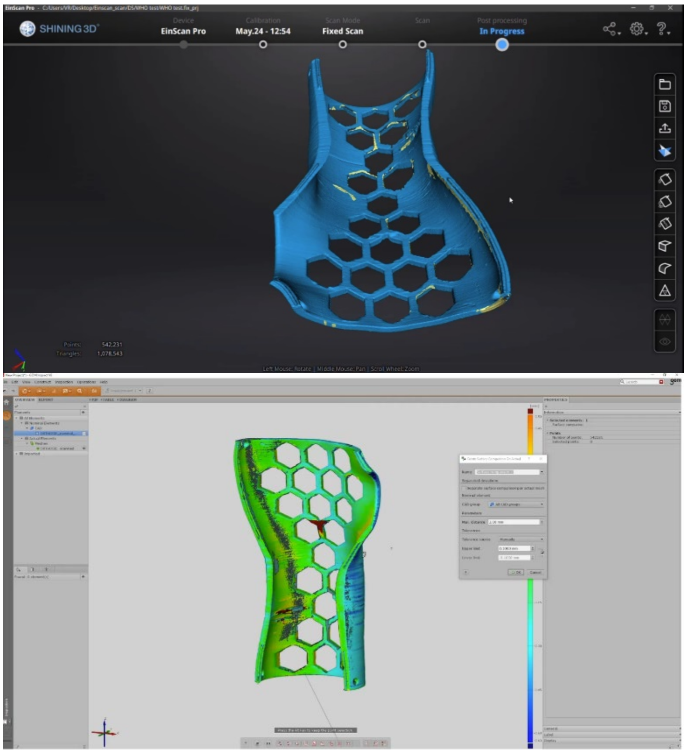

Figure 7- Creating volumetric model of the scan and comparing with CAD model

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The second case study considers a simulated surgery for a tongue with tumour. The 3D printed model helps in pre-operative planning, that is to simulate the surgery and help the surgeons prepare for it. This case study begins with a short description of the procedure followed by planning the incision on the model (Figure 8).

Figure 8- Pre-operative planning and familiarization with the model

Next the surgery procedure is simulated, and the tumour is removed from the tongue (Figure 9).

Figure 9- Simulating the surgery

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The third and final case study considers testing of a face shield. This protective equipment was designed in the first days of the COVID-19 pandemic to help medical personnel mitigate the spreading of virus. In this case study the strength of the face shield is evaluated, then it is 3D scanned to compare its dimension with those of the 3D CAD model, and finally a fit test is carried out. This case study begins with a short description of the device followed by mechanical testing. First the test method is prepared in the testing software and then the face shield is mounted on the universal testing machine (Figure 10).

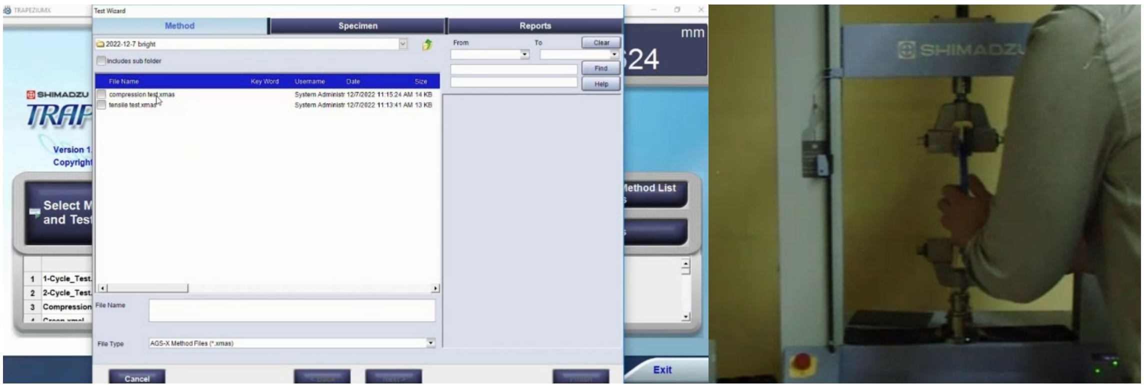

Figure 10- Face shield preparation for mechanical testing

Next the compression test is carried out (Figure 11). The same procedure is repeated for tensile testing.

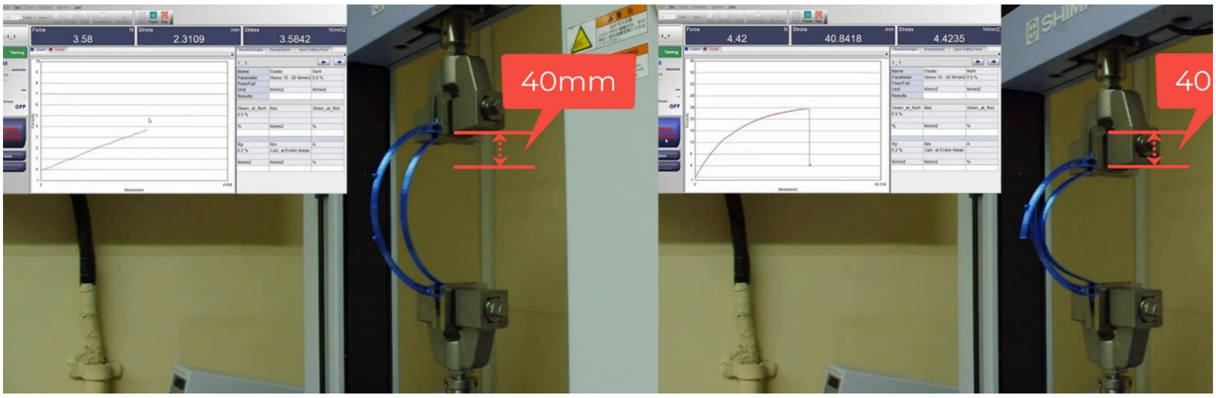

Figure 11- Face shield compression test

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Next the 3D printed face shield is prepared for the 3D scanning procedure (Figure 12), it is covered with a white powder in order to prevent issues with 3D scanning.

Figure 12- Pre-processing the face shield for 3D scanning

Now the 3D scanner is calibrated, then the settings are chosen, and the scanner and orthosis are positioned, this is followed by the scanning procedure (Figure 13).

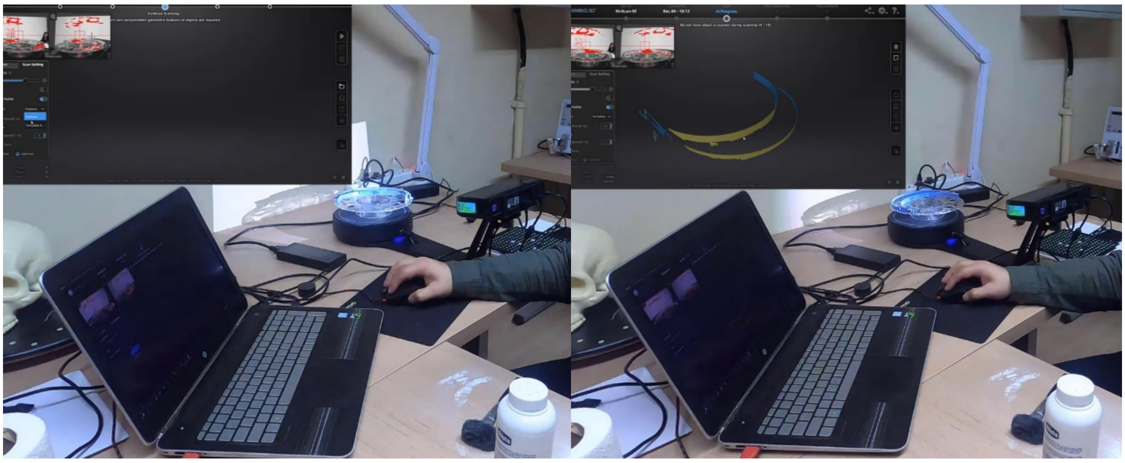

Figure 13- Preparing the software and 3D scanner

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Multiple scans are made, combined and edited, after which the mesh model of the face shield is created, then the dimensions of this model are checked whit those of the CAD model (Figure 14).

Figure 14- Comparing the scan model dimensions to those of CAD model

This case study ends with a fit test of the face shield to multiple subjects (Figure 15) to confirm its ability to adapt. In this step functionality and the comfort of the face shield are also checked.

Figure 15- Face shield fit testing

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2.3. Importance of the webinar and of the presented results

The results of the presented webinar consist of an informative review of standards and testing methods in medical engineering followed by instructive tutorials on how to carry out specific tests, which technologies to use and explanations why all of this is important.

In the first case study (Figure 16) the fit of the 3D printed orthosis was tested, to check its design and comfort. This result is important to confirm the benefits of a personalised (3D printed) medical device. Then, 3D scanning was used to obtain the shape of a 3D printed orthosis, which helped to check its dimensions in respect to those of the CAD model. This result confirms that the chosen 3D printing technology is sufficient to meet the geometrical requirements of the medical device. Finally, the orthosis was mechanically tested, to determine whether it would withstand the loads that arise during its use, which confirms the functionality of the orthosis to provide immobilization and guard against refracture. This is a complete result in terms of medical device testing and has informative and instructive use for members of the medical sector.

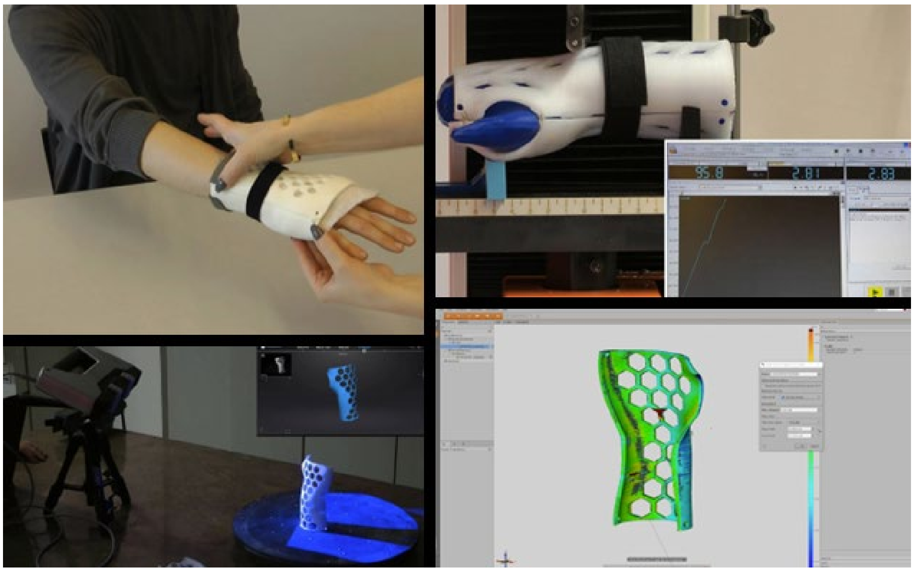

Figure 16- Hand orthosis testing

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In the second case (Figure 17) a 3D printed model of a tongue with tumour was used to perform simulated surgery, determine the best surgical procedure. This method results in an effective training of medical personnel for surgeries.

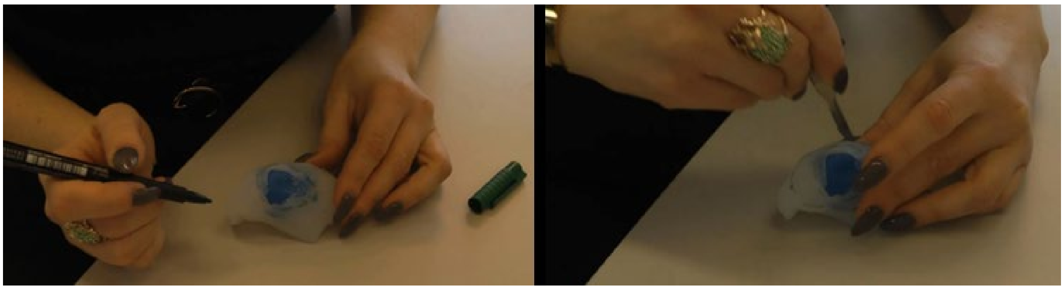

Figure 17- Simulated surgery

In the third case (Figure 18), a 3D printed part of face shield was mechanical tested to determine its strength in real application. Then it was 3D scanned, to check the dimensions of the printed product in relation to the 3D model. Finally, the fit of the shield to human faces was tested. All demonstrated technologies have a very important role in biomedical engineering. The results of the last case can be applied during a pandemic like that of COVID-19 to reduce the risk of infection.

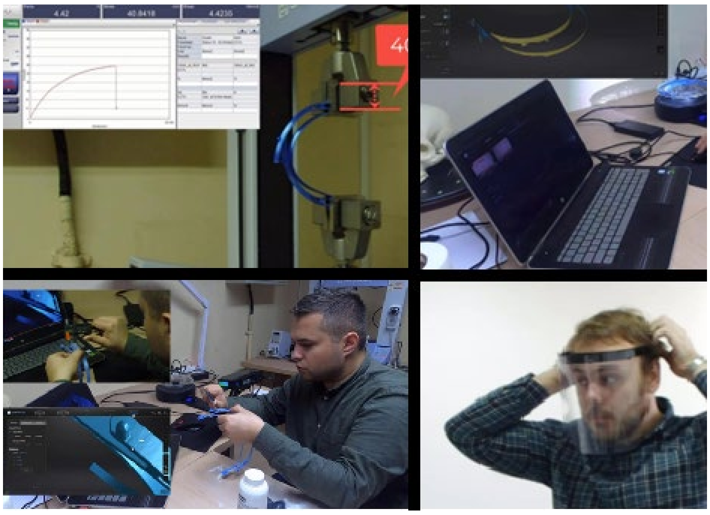

Figure 18- Face shield testing

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2 Conclusions

The testing webinar can support students and medical engineers in developing their knowledge in the fields of:

- medical device mechanical testing,
- standards in medical engineering,
- quality control,
- 3D scanning and
- simulated surgery.

Also, the shown methodologies are an essential part of medical device development. Finally, the face shield case study is directly applicable to pandemics such as COVID-19 and shows the procedure for evaluating the quality of protective equipment, which can also be applied to other cases. This webinar explains the use of multiple modern engineering technologies and it can be used to educate new generations of medical practitioners and engineers.

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