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Design in emergency scenario: project of a hand sanitizer dispenser in public transport using Design Sprint method

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ABSTRACT

In the emergency scenario generated by COVID-19 pandemic, the development of fast solutions to reduce the contagious curve can mean saving lives. Democratic access to prevention methods is essential, especially in places with high exposure to contamination and whose activities have not been interrupted, such as public transportation. This work presents the development of a hand sanitizer dispenser for public transportation and other possible locations in the urban environment, designed during an online marathon. The focus is on the development of the Design Sprint method and its adaptations to fit the remote work and other constraints due social distance. The final product was designed to be produced by 3D printing and open design, to fast distribution and replication. It fits in the bus's handrails, with some positioning possibilities and the use of PET bottles as alcohol containers. As a result, the paper highlights the particularities of agile methods for the design process at a distance and demonstrates that the process used allows for quickly responding to solutions for emerging needs.

Keywords: 3D printing, COVID-19, Design Sprint, hand sanitizer, product design, open design.

INTRODUCTION

The year 2020 brought to the world the reality of the first major pandemic of the 21st century. While medicine strives to find a cure, society undergoes a very rapid and urgent adaptation process in daily activities, prioritizing social distance as an efficient tool to combat the spread of COVID-19. The pandemic accelerated changes, in a matter of weeks, that would normally take out over years or decades. In addition to that, technologies that until then were underutilized are now part of the routine - such as online meetings and videoconferences.

Therefore, Design emerges for the creation and adaptation of products/services to this new reality. According to the definition of the World Design Organization (WDO, 2015), “Design is a strategic problem-solving process that drives innovation, generates business success and leads to a better quality of life through products, innovative systems, services, and experiences ”. It is important to highlight the character of the problem-solving presented by the field of Design, introducing it as a factor that promotes a better quality of life or a fast adaptation facing this new scenario.

The focus of design projects is the human being, its complexity, and its diversity. The user is the center of the process, as a crucial factor for design decisions. There are nearly 17 million people infected by COVID-19 in the world and more than 2.400.000 in Brazil (data from July 28th, 2020, according to Johns Hopkins University, 2020). Fortunately, there are a great number of initiatives and proposals to face the pandemic.

In this context, the IFSul (*Instituto Federal de Educação, Ciência e Tecnologia Sul-rio-grandense* - Federal Institute of Education, Science and Technology Sul-rio-grandense) proposed in May, 2020 an online marathon, five days long, to motivate the academic community to develop viable and innovative solutions, with social impact, related to the production of ideas, actions, products or services facing the pandemic problematic.

Based on the event's proposal, a team of students from the LEP (*Laboratório de Experimentos em Prototipagem* - Laboratory of Prototyping Experiments) was formed, along with their supervisors, to develop a product that helps control the spread of the coronavirus. Thus, the objective of this article is to present the project of the alcohol dispenser for public transport, developed during this hackathon, and also highlight some relevant contributions on the design process carried out at a distance in this emergency scenario.

1. DESIGNING IN AN EMERGENCY SCENARIO

The incidents of the pandemic created an emergency scenario that demands project development to be fast and remotely executed. In this way, the methodology for the design process must adapt its stages, as well as the use of resources and tools to make them agile, prioritizing team interactions.

However, the main constraint imposed by this scenario was social distancing. During the hackathon, the design team met exclusively remotely. The access to the laboratories was restricted due to school instructions and the limited public transportation available due to COVID-19. In the initial stage of the pandemic, there was no possibility of face-to-face interviews with stakeholders, like drivers, passengers, companies.

These requirements initially help the team to find a suitable method. References for agile methods were sought focused on the development of a product that would solve the problem proposed in the time available. At first, it was considered the use of Human Centered Design (HCD) methodology, that begins by examining needs, desires and behaviours of people whose lives are connected to the problem situation. But the ground of HCD is close contact with users, immersion in the context and field research, which are activities that go against the proposal for social distance.

Researching for agile methods, a team member found out and proposed the Design Sprint method (DS), created by Jake Knapp at Google in 2010, which intended to guide a small workgroup through the design process in five days, same available time as the online marathon. Furthermore, in the method's website (The Sprint Book) there is a learning guide, with tools, checklists, facilitator's handbook and videos, to clarify the process to all team members in a practical way, by online and simple access.

In this context, DS seemed to be a promising alternative, as it creates a design process where a team joins efforts to answer critical questions of the product/services through design, prototyping, and testing ideas (Knapp et al, 2016). Despite the activities were elaborated to

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presencial work, the team considered to adapt the method by its focus on challenges and opportunities, agility drive and its recent creation.

The method is structured in five stages (Figure 1): first, it is made a map of the problem; second, each one sketches solutions; in the third day, it is decided which sketches are strongest; on the fourth, it is built a realistic prototype; and the last, it is tested that prototype with target customers (The Sprint Book, 2020).

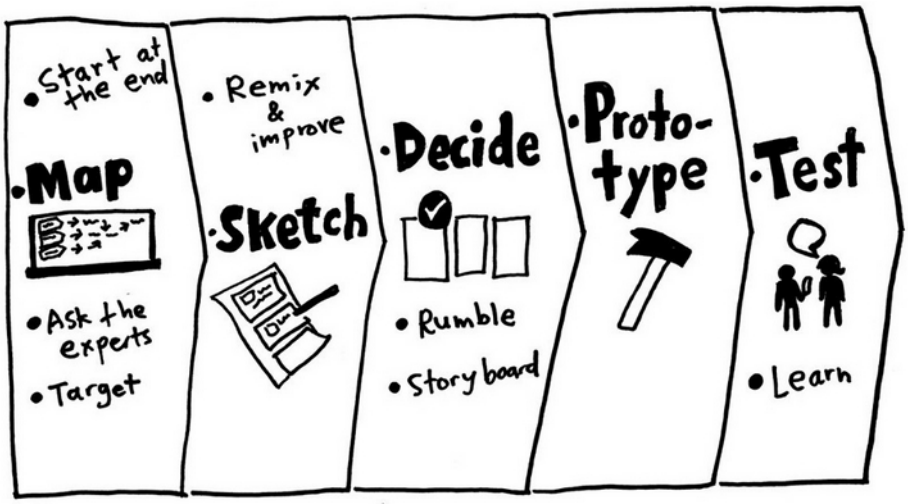

Figure 1. Design Sprint Method. (Rietch, Sprint Stories, 2018).

DS takes advantage of the creative capacity of the team in an organized way, aiming to solve the main problem in a short time. Also, prioritizes the direct and daily contact of all project members in the same physical space, without distractions and holds the main objective aligned by the team.

Therefore, this method requires simultaneous visibility of the design materials, media, annotations, photos, research data. This enhances the process of identifying patterns and synthesizing ideas among the group sharing the same space and resources.

The initial challenge was to build this integrated project space, with the entire team involved working remotely, plus the short deadline. Thereby, some decisions were quickly made to define the project space:

- All meetings were held remotely (Google Meet and Whatsapp video), with an open channel for instant and direct communication, for viewing concepts and for discussing ideas (video conference);
- Sketches, visual and research references were shared by pictures through a project management tool (Trello), to organize the creative flow in a shared-use repository;
- Prototyping should go only to virtual models, awaiting sanitary conditions to allow 3D printing of the first mockups and prototypes to test.
- All members had a stable and fast broadband connection.

Once the project space is defined, the requirement for starting the design process is to adapt the existing tools to the project constraints (time, social distancing, remote work).

2.PRODUCT DEVELOPMENT

In the next sections, the steps and activities developed based in DS method will be presented.

2.1. Map

In the first stage, the focus was on building a foundation, sharing knowledge, understanding the problem, and choosing a target for the week's efforts. Structured conversations were held to create a schedule for the project. This allows the team to start seeking as much information as quickly as possible, avoiding unfocused conversations (Knapp et al, 2016).

On the first day, we focused on defining the design problem. Thus, information about the coronavirus pandemic was collected, generating a comprehensive mental map of the scenarios that were directly or indirectly affected. Among these, the essential services with higher transmission risks were highlighted.

One of them was public transportation, a critical area for any other sector of society that continues to operate as essential services. Public transportation systems must be considered a high-risk environment for the spread of COVID-19 due to a large number of people in a confined space with limited ventilation. In addition to that, there is no access control to identify potentially sick people and users should touch and hold to various surfaces (card machines, handrails, ratchet, door handles, in addition to the supports to go up/down and hold on during the journey) (UITP, 2020).

According to the National Association of Urban Transport Companies (2020), the June 2020 numbers on public transport shows that among the 5,570 Brazilian municipalities, 2,901 are served by organized public transport services by buses, totalling a fleet of 98,975 buses. Considering the data from the city of Pelotas, in the state of Rio Grande do Sul, the focus of the project's development, the current fleet is 210 buses and 12 microbuses, which make about 3,500 trips per day, with approximately 103,000 users daily (Pelotas City Hall, 2020).

Facing this problem, public transport was defined as the project's field. An online survey of sanitizer products for public transport was carried out. We also gathered information on the norms covering public transport during the pandemic in Pelotas City, its macro-region, and elsewhere in the world. These resulted in a brainwriting about possible problems and solutions within public transport.

Another activity suggested in the DS is "ask the experts", an interview with an external guest skilled on the topic in question to share what he knows. An online interview was conducted via messaging app with a public bus ticket collector. One of the team members questioned details about daily life at public transportation, their current and previous efforts. The main information collected was that users do not feel safe when using public transportation, and collectors and drivers feel unprotected in their work environment.

Given the information obtained in these early stages of the project, a user journey map of the activity analysis was developed to obtain an overview of the process of using public transport by bus, which also generated a risk contact map (Figure 2). From this journey map, it is possible to see the main points of contamination and to trace the route of contacts and manual touches from waiting at the stop to getting off the bus.

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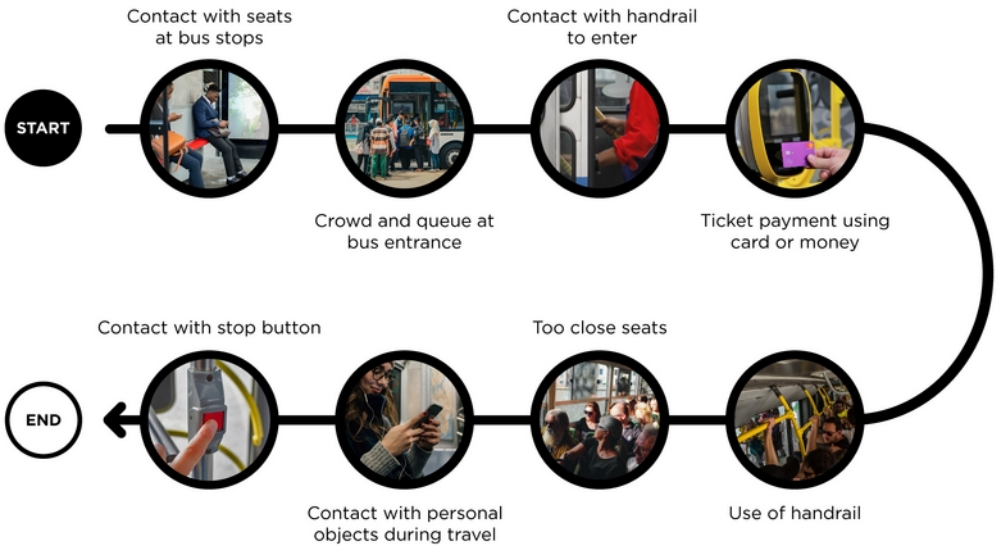

Figure 2: User journey map with risky contact points using public transport.

Through the user journey map, it can be seen that there is a high incidence of touch on handrails and buttons, which are made by all passengers. It is known that one of the main forms of infection of COVID-19 occurs in contact with contaminated objects or surfaces, followed by contact with the mouth, nose, or eyes. However, it is possible to minimize the transmission and spread using adequate and frequent hand hygiene. The WHO (World Health Organization) recommends the use of 70% ethyl alcohol for the hands asepsis, and also the cleaning of surfaces and objects when it is not possible to use soap and water.

An ongoing initiative at IFSul is the production of 70% glycerin alcohol, from the distillation of alcoholic beverages captured by the Federal Revenue, which are filled in 2-liter bottle packages (supplied by a local soda factory). Thus, combining the issue of public transport with the opportunity to obtain 70% alcohol at low cost, the focus of the project problem was reached: the development of a hand sanitizer dispenser that aims to facilitate and democratize the access and distribution of alcohol 70% in gel or glycerin within transport public, in order to minimize the risk of transmission of the COVID-19.

2.2. Sketch

The next step, on day 2, is the idealization of solutions and the generation of ideas. At this stage, the challenge was no possibility of using creation tools and strategies together. The social distance forced each team member to draw alone and share their ideas through photos and videos. In the first moment, there was no team's interference: each one drew individually, exploring possible solutions for a predetermined time. All the sketches pictures were made by smartphones, and update them to Trello management platform, allowing the discussion and sharing. Sometimes the understanding of a particular idea was not complete, which led to the need for video calls or notes and descriptions for detailing.

Some principles of the Sketch step of the DS methodology were adopted, such as: "ugly drawings are accepted", "words and descriptions are important", "it is ok to mix and improve ideas" - generate alternatives on top of existing ideas, "anyone you can draw" and "concrete is better than abstract"- creating sketches to transform an abstract idea into a solution that can be understood by others (Knapp et al, 2016). Using these tips was important to reduce the pressure and self-criticism normally found in the concept generation stage. Additionally,

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the freehand drawing technique was maintained to express ideas, attempting to speed up the process.

It started from the definition of a product for hands hygiene to be installed inside public transport buses, and proposals were generated freely, considering different ways of activation (automatic, with the foot, elbow), different places of installation (on the handrails, at the collector's station or the bus entrance) and forms of the container. The ideas once sketched could be explored by the group, in terms of their limitations and possibilities (Figure 3).

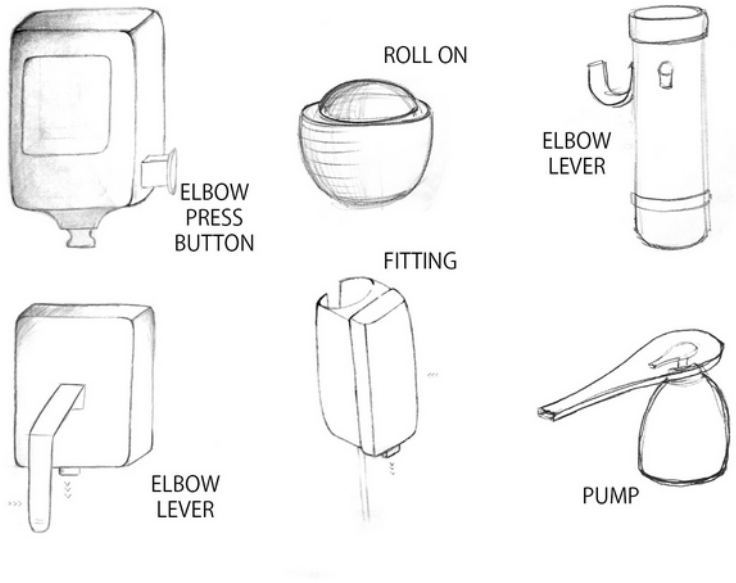

Figure 3. Pictures (made with smartphones) of some ideas from the initial sketches.

The proposals varied in several aspects and allowed the members to follow different paths. During remote meetings to discuss the sketches, one of the insights precisely pointed to taking advantage of the 2 liter PET bottles of alcohol as a container, which dispensed with the need for new packaging, directing ideas towards creating a viable support.

This definition directed the decision that the dispenser should be capable of digital manufacture through 3D printing, which would increase its replicability, feasibility, reach and speed of production. 3D printed products are not depending on industrial injection molds and streamline the testing and adjustment process. As the team has knowledge about prototyping and digital manufacturing, this requirement was considered mandatory and guided the sketch process.

Another determining point was about the distribution of the project: it was defined for the Open Design (OD), democratizing access, which concerns the ease of execution and understanding of the proposal. According to Cabeza et al (2014), open design is a way to promote innovation and social transformation resulting in a transparent, open production model, based on free, collaborative and cooperative work, deprioritizing the closed and monopolizing industrial production mode. Is a free and online way to distribute the product's manufacturing file, so that everyone interested can access and print it, replicating the solution and proposing changes. In this context “the role of the designer is radically transformed in the processes of creating and making the product, which enters a complex dimension - the dividing line between the designer, the manufacturer and the user is blurred” (Cabeza et al, 2014, p. 58).

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An OD project needs to offer the required information, in any readable format, so that it can be used, replicated, modified and redistributed by anyone. What seems important is the possibility for anyone, professional or amateur, to reproduce, optimize and customize such projects using the lesser possible number of proprietary tools and without any hidden data behind documentation (Freire et al, 2018).

Additionally, a tool proposed by DS called "Crazy 8s" was used. This tool divides a sheet of paper into eight squares, and draws a variation of the best sketch on each one, for a total of 8 minutes. After the bottle was defined as a container, there was a new session for generating ideas, now focused on meeting a series of requirements developed after these activities and classified as mandatory or desirable:

Mandatory requirements:

- Use 2L bottles as the main packaging, and other PET bottles (other brands and volumes) can be used;
- Digital manufacturing through 3D printing;
- Easy replacement of alcohol packaging (refueling);
- Adjustable height for installation on buses handrails or public metal posts;
- One-hand operation, as the passenger usually embarks carrying bags or belongings;
- Be a replicable solution in open design distribution.

Desirable requirements:

- Adaptable to different social contexts;
- Take up little internal space on the bus;
- Possibility of use inside buses or at stops;
- Intuitive and inviting use.

With the new concepts generated (Figure 4), some online meetings were held that facilitated the reconciliation and the development of ideas, which integrated two or more solutions.

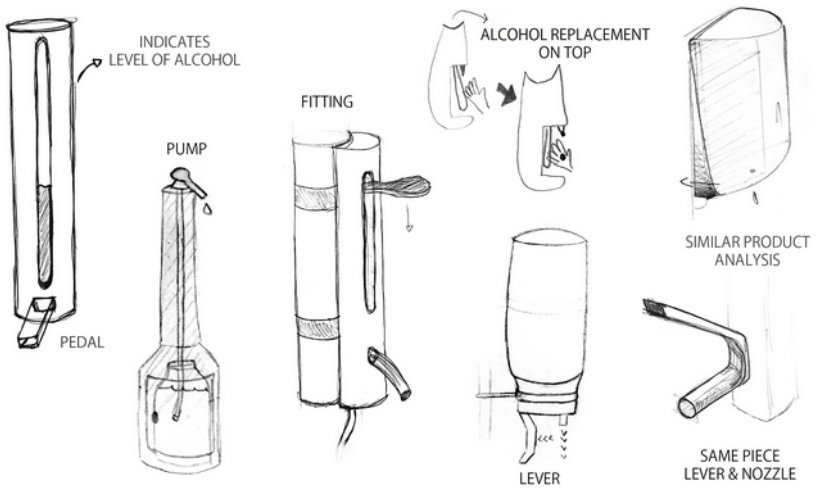

Figure 4. Pictures (made with smartphones) of some concepts from the second sketching session.

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The ideas generated in the second session showed a greater degree of detail and concern with the viability of the solution. The project requirements also served as a basis for the evaluation and decision process of the most appropriate alternative, carried out in the next step.

2.3. Decide

This stage happened during the third day when the "Decision" process was conducted. Then, the team converged the thoughts and questions raised previously into a single idea. As part of the decision on the best interface for the release of alcohol, one of the members of the group carried out an analysis of the dispenser systems of several packages and taps that he has at home, photographing the products in use, describing the hand position and the ease of activation during use (Figure 5). This task facilitated the understanding of the system and provided a sense of the size scale of the parts.

Figure 5. Analysis of the use of different dispenser systems.

In the decision-making process, instead of group debates and decisions, the DS methodology suggests to identify the best solutions: to visualize all the ideas together in the same physical space (in this circumstance, using Trello); systematic individual voting on preferred solutions; quick criticism of the solutions that were highlighted in the previous activity; and deciding vote. The winning concepts went to the prototype stage, to be evaluated in more volumetric and 3D detail.

Important decisions guided the concepts towards a smaller number of parts and ease of production, as it was understood that 3D printing and OD would contribute to achieving the goal of distribution and speed of replication.

It was defined that the dispenser should have two parts: the lower support, with the bottleneck fitting, the actuation valve, the alcohol outlet nozzle and the fixation on the handrail; and the lower support, a piece to give more firmness between the bottle and the handrail, preventing it from moving with the movements of the bus. Thus, the selected ideas were modeled three-dimensionally. They are depicted in Figure 6.

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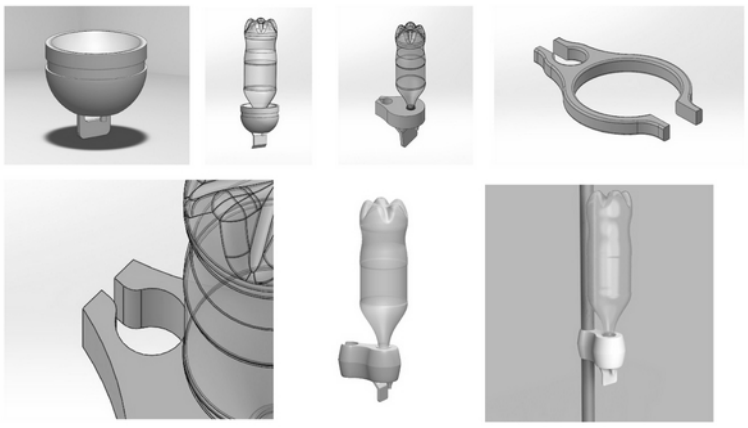

Figure 6. Virtual 3D models of solutions.

From the modeling, flaws were detected in some concepts, such as excessive sizing (which could take up a lot of space in the installation inside the bus), fragile points on the parts and fittings compatible with only one packaging model.

2.4. Prototype

On the fourth day, the developed solution ideas were prototyped. Due to the difficulty of accessing the prototype laboratory during the hackathon, they were modeled and tested digitally, using virtual 3D modeling software. According to DS, the goal of prototyping is to simulate a finished product for your customers, following a "fake it till you make it" philosophy. A realistic-looking prototype will get the best possible data from the test step (Knapp et al, 2016).

After several sketches and the virtual modeling of the concepts, we reach the final idea. The dispenser acts as a support for the bottle, providing a system that releases a specific amount of alcohol per time. It has a hanger that grabs the bottle and the handrail, offering stability. The material of the 3D printer filament is a thermoplastic polymer for fused deposition modeling, usually PLA (polylactic acid) or ABS (acrylonitrile butadiene styrene). Both materials do not react chemically with alcohol and have a good mechanical resistance, enough to support the weight of the bottle and the compression force of the actuation valve. Besides, the polymeric materials have the necessary flexibility to open to fit the bottle and the handrail, returning to the position after that. The final proposal is shown in Figure 7.

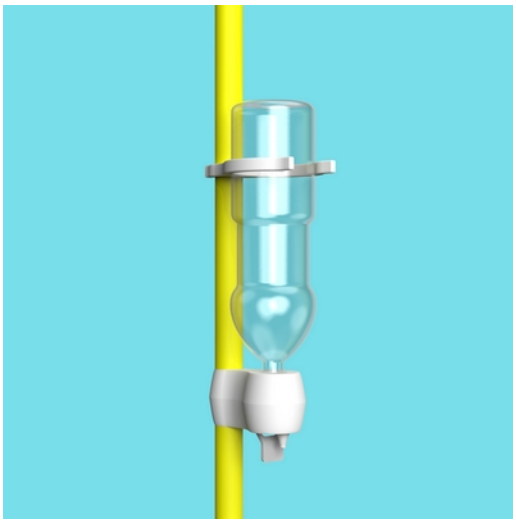

Figure 7. Digital prototype of the hand sanitizer dispenser solution.

The design has the appropriate fittings in the handrail, providing the support to the bottle, and the concern with the peculiarities of 3D printing, such as the maximum size of the print area, the need for a straight face at the base to facilitate the adhesion to the impression's start and the correct dimensioning of the parts, avoiding the excessive time of impression and material waste.

It also focused on the use of the pet bottles as main containers, but taking into account that other packaging can be adapted (based on the principles of OD). Besides, this solution can be fixed at any heights, made it accessible for wheelchair users (Figure 8).

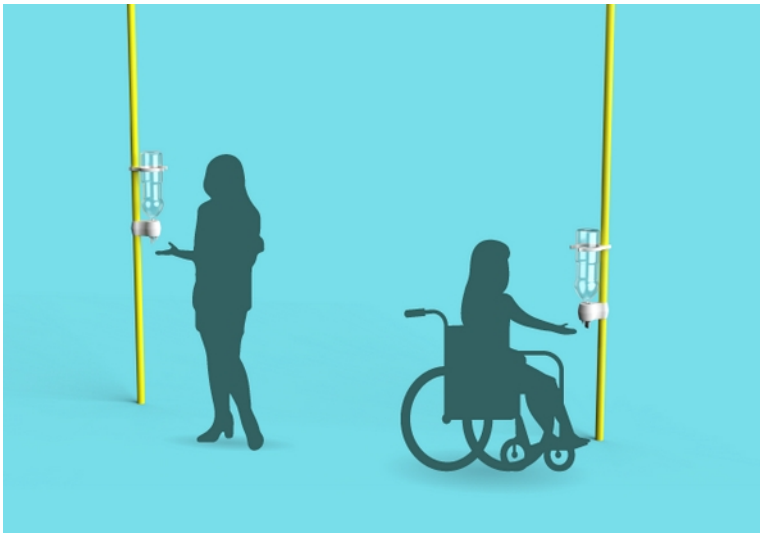

Figure 8. Digital prototype showing height possibilities for installation on the handrails.

The developed product has fittings for the bus handrails and upper support providing greater stability. The fitting also allows for installations at bus stops and it has a trigger handle to be activated by a single hand. Among the advantages of digital modeling, the project is interested in the generation of the digital distribution file for OD, exported by the same 3D modeling software, with the requirements for 3D printing. The gaps in this process are the domestic access to the software and the ability of this tool, which can severely impact the production.

2.5. Test

The fifth and final stage of the Design Sprint is Test, when the prototype is presented to customers individually. As it was not possible to execute physical prototypes, the renders were made to simulate the dispenser developed in its real scenario and scale of use, providing the impression of something real, necessary for the evaluation and testing (Figure 9).

Figure 9. Renders set in real use situations, inside public buses.

During the Hackathon, the project's deliverable documents were evaluated by a panel composed of six members from the health, information technology, and business areas, considered the project's first consumers and testers. This committee validated the proposal, emphasizing the viable and accessible solution to a real problem that is directly linked to the spread of the virus, contributing to increase the safety of those who need to circulate during the pandemic and depend on public transportation.

The project is currently in progress, now focusing on testing the internal mechanisms in 3D printing. Tests are expected to be carried out with users after the physical prototypes are manufactured. The first batch of 15 units will be installed in Pelotas city buses and put into real use, for obtaining feedback and making final adjustments to print and distribute the hand sanitizer dispenser product and files.

3. RESULTS AND DISCUSSIONS

Among the various projects received by the hackathon organization, the hand sanitizer dispenser won first place. The project awarded scholarships for the students to implement the proposed action. This result is a positive feedback that drives the development of other design solutions, also themed around the pandemic.

As a project for a latent need, it is supposed agility in project deliveries and also in production. The use of the DS methodology proved to be effective in the distribution and fulfillment of activities over the planned days.

Due to the emergency nature of the project, some of the project stages, usually performed with more depth, were shortened. In the step "map", mood boards, semantic and conceptual panels were not carried out, using this time to understand the problem, research about important subjects related and ask an expert. This results in the understanding of the basic

use of urban public transport, supporting the elaboration of the risk contact map and definition of the product that would meet the demand.

In the "sketch" phase, divergent and convergent thinking allowed two sessions to generate ideas, even with reduced time. At this stage, the mandatory distance and remote work brought difficulties but also interesting results. Each member of the team sketched their alternatives individually, exposing their ideas without the influence of others, which generated an appropriate number of different solutions. After the exchange and discussion, in the second session of ideation, the drawings already presented a mixture between two or more concepts and all members felt comfortable to sketch and present.

One of the mandatory requirements was digital manufacturing by 3D printing for a few reasons: it speeds up the project in the testing and correction stage, and decentralizes production - several people can access the file and make the product, in different locations, meeting the OD proposal. We concluded that the use of OD contributed to produce a solution more viable (easy to reproduce) and economic (rational use of the material).

Logically, an industrial mass production, by polymer injection for example, is more convenient against 3D printing, in terms of production quantity, speed and cost in the final product, but the digital file allows to do product testing and adapting at any available 3D printer, at low costs and short time.

With this digital distribution, OD benefits the production of the hand sanitizer dispenser at any place in the world, a scalable product with editing capacity providing better conditions to adopt this model. The counterpart is that it depends upon technology resources and modelling software knowledge.

In the "decide" stage, the effectiveness of structured decision-making methods to the project time is highlighted. The systematic voting tools and joint contemplation of the alternatives used served to organize and externalize logical reasoning, which contributes to the agility of the activity, in addition to minimizing the chance in the choices made. The research and analysis of mechanisms, adapted to be carried out in the home environment of the members of the team, also proved to be interesting because it solved questions of product sizing and contributed with ideas to activate the dispenser. It was possible to understand and adapt mechanisms to the project, in addition to stimulating the search for similar ones in other digital sources.

In the "prototype" and "test" stages, it was possible to define the product design through digital modeling. The model allows the generation of renders that can be uploaded for viewing by the team in the project space, as well as simulating their volume and instantly checking for possible flaws and correcting in real-time. However, some requirements need the physical prototype for evaluation and test.

Therefore, the shortening of stages and activities delimited by time has speeded up the development processes, without significantly compromising the mapping of the problem, the generation of concepts, the definition of the design, and the digital prototyping. It should be noted that the composition of the project team, whether in number or plurality of areas, is a complex variable to estimate in terms of gains or losses of time in the execution of activities.

The development of remote work required adaptations of tools and the creation of a non-physical design space. Despite the Design Sprint based on the principle of a work team centralized in the same physical location and focused on a specific problem, the team was

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able to adapt this methodology for a remote project. It is important to note that, as well as a design method, each team configures this space according to the conditions of those involved.

Analyzing the stages of the design process from the barriers offered by social distance, these were mostly resolved through a design space with virtual tools, such as sending pictures of sketches, videos, or remote access to software modeling, which were fundamental. There were favorable conditions for the use of such tools by the members of the project team, who had minimal resources to access and manage these technologies.

Using online tools result in a huge amount of information, probably bigger than in a presencial project. All the DS steps were organized, with each team member's content, so the feedback and iteration process could occur at any time, not depending on everyone being online. This ensured freedom for each team member to organize their work schedules, creating an online collaboration cycle and provides enough information for the team, with easy access. On the other hand, a lack of structure in the project documentation can cause development failures, and this is a positive aspect for the use of a structure method.

4. CONCLUSION

This work presents the design as a problem solver in emergency scenarios. Designers have always been at the forefront of approaching the needs of the world, responding to an existing situation, and defining a solution that benefits society (Covid-19 Design Challenge, 2020).

It is expected that the presentation of the project contributed to highlighting particularities of product development in social isolation, mainly from the agile method and carrying out activities at a distance. In the same way that this solution is proposed for the specific demand of public transport, the results of each stage of the project can serve as a baseline for other developments about hygiene and the virus in this context, to bring more safety to users involved.

Some design steps were shortened, however, they presented satisfactory results. Therefore, it is understood that there is a trade-off relation within the emergency scenario, which must be considered when developing agile methodologies. In this case, a balance between design agility and amount of data, it is up to the project team to set the rule.

The article presents that it is possible to do a project without any face-to-face meeting. However, it is clear that there were not so many spontaneous changes and interactions during the activities, especially in the final stages of defining the design, when compared to face-to-face development. The manual modeling of ideas, a usual activity in product design, was also hindered by the lack of access to materials and prototype lab. As a research gap suggestion, it is possible to further analyze the differences between project activities carried out in person and carried out at a distance.

It also highlights the importance of setting a moderator to manage the project space. In this case, the supervisor teacher acted as a project manager, moderating the time of activities and dividing tasks between the team. It suggested new data research when lack of information was noted and exchange of activities when the team was not stimulated. It is possible that a lack of leadership could have a negative impact on the design process.

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Should be noted that, after the end of the development phases, the DS methodology was adapted by its authors to the remote mode – The Remote Design Sprint Guide (Knapp et al, 2020) – and became available on their official website, since June 2020. However, the design of the dispenser was carried out before this publication, in May 2020, through spontaneous adaptations of DS. Therefore, future investigations can also compare the resources and tools, used and suggested, to verify patterns.

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