

FUTURISTIC BEEHIVES FOR A SMART METROPOLIS

Deliverable D7.3

Progress report on community forming procedures

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Introduction	3
Purpose and scope of the document	3
Overview of the document	3
Acronyms and Abbreviations	3
1. Community forming	4
1.1 Online survey & article in Austrian beekeepers journal	4
1.2 Maker Workshop with kids	5
1.3 Exhibition at the Vienna Design Week 2019	8
1.4 Project introduction at the Global Biosummit 3.0	10
1.5 Installation at the “Styria Show: What will be”	11
1.6 Collaboration with artists to visualise honeybee research	14
1.7 Mobile app for beekeepers (BeeApp)	15
2. Empowering people	15
2.1 Participation in the “Scientific night 2021”	16
2.2 Higher education	16
2.3 Mini Online Series on beekeeping “Lyuba and the Bees”	17
2.4 HO Apiary visits by citizens	17
2.5 World Bee Day celebration - 20th May	18
2.6 Presentation of HIVEOPOLIS to the bee breeder community	18
3. Enriching the teaching and learning community	19
3.1 Activities in schools	19
3.2 HO Apiary visits by beekeepers	19
Local beekeeping holiday	19
Populating the 2021 HO units	21
Private presentations for beekeepers	23
4. Summer schools	23
References	24

Introduction

Purpose and scope of the document

Here, we report on the work we achieved from the very beginning of the project until now. We report how we involved the different target communities into HIVEOPOLIS and how we publicised the future beehive. The aim of this report is to give an overview of the current status of the following areas of bio-hybrid socialisation in this project: community forming management, empowering people, enriching the teaching and learning community, and summer schools.

In this deliverable we report on the community forming processes to:

- Improve interaction amongst various stakeholders involved in ecological, societal, and agricultural issues
- Strengthen the teaching community in ecological, biological, and technological disciplines
- Strengthen the ties between beekeepers ranging from one-hive hobby beekeepers up to professional or even industrial beekeepers

Overview of the document

We tackled the challenges caused by the current Covid-19 situation, which highly affected the interaction with the public, and were able to achieve most of our community forming goals. Here we report on our community forming activities, such as an online survey, articles, displays and a workshop in maker festivals, arts and design events, and conference talks, respectively. In order to empower people to use smart bee hives of the future we conducted a series of courses as described below. One of our primary concerns is to familiarise pupils, the future of our society, with modern technology, such as our beehive of the future. Due to Covid-19 courses could only be offered online. Regrettably, we could not offer summer schools due to the Covid-19 restrictions that were in place all over Europe.

Acronyms and Abbreviations

Acronyms and Abbreviations

Definition

UX/UI

User Experience / User Interface

HO

HIVEOPOLIS

TL

Task Leader

1. Community forming

Task 7.3, Community forming management, aims for managing and coordinating all central community-forming activities. In the following we will report all performed community forming activities from the beginning of the project up to now.

1.1 Online survey & article in Austrian beekeepers journal

The partner UNIGRAZ developed and published an online survey that targets the beekeeping community. The aim of the HIVEOPOLIS online survey is to involve the beekeeper community and their expertise in determining what kind of technology beekeepers urgently need to improve their apiaries. To specifically address certain groups of beekeepers we ask for data such as county, sex, age, experience in beekeeping, and number of managed bee hives. In the survey we ask the participants to state the current challenges in beekeeping, which data they want to receive from a hive, and how they wish to receive the data. We also ask the participants which features a smart bee hive should provide, which material they currently use for their hives and for their frames (wood or polystyrene) and how much they would spend for such a hive. Our online survey includes a data privacy statement.

We also submitted an article on HIVEOPOLIS advertising the online survey to the Austrian beekeepers journal. This article includes a link and the QR code to the [online survey](#).



This link is also provided on our [web page](#).

Below we provide a simplified version of the queries of the survey (translated to English):

- *In which area of beekeeping would you like to have a technical improvement?*
- *What are the three major problems or challenges, respectively, in your own apiary?*
- *What are the three major problems or challenges, respectively, in beekeeping generally?*
- *What are the five most important data you would like to receive from a bee hive (ordered)? Possible would be: Honey, temperature, humidity, number of Varroa mites, density of bees, area of brood comb, water content of honey.*
- *How relevant are the following factors for our bee hives? (design, environmental friendliness, weight, mobility, simple suability, robustness, costs, other)*

- *What material are your hives made of? (except mating hives) (wood, polystyrene, both, other)*
- *What material are your frames made of? (except spacers) (wood, polystyrene, both, other)*
- *How much would you spend for a smart bee hive which permanently informs you via your smartphone about the Varroa infection, changes in weight, humidity, inside temperature, and outside temperature?*
- *How would you like to receive the data of your bee hive? (App on smartphone, device at beehive)*
- *Are you currently using technological devices that are connected to your mobile, such as hive balances or monitoring cameras?*
- *What would you like to have as a relevant improvement for beekeeping?*
- *You are a hobby beekeeper (1-10 colonies), small semi-professional beekeeper (11-100 colonies), big semi-professional beekeeper (100-300 colonies), professional beekeeper (more than 300 colonies).*
- *You keep bees for 0-3 years, 4-10 years, more than 10 years.*
- *You are 0-10, 11-20, 21-30 etc. years old.*
- *Your sex is male, female, other.*
- *You live in the Austrian county Vienna, Lower Austria, Upper Austria etc.*

The survey is still running, the results will be published as soon as a sufficient amount of data is available.

1.2 Maker Workshop with kids

The design and biomaterial investigations have been exhibited for two days as one of the ten exhibition pieces within the “Distributed Design Exhibition” as part of the “Foreningen Maker (6-8 June 2019), RESPOND Festival - Planet, Earth and Technology”, organised by the Danish Society of Engineers in Copenhagen, Denmark. The third day we held a maker workshop during the “Kids Respond Festival”. During the workshop more than 60 children were introduced to the design and material ideas of HIVEOPOLIS. They individually chose the design parameters of their samples, interacted with the prearranged parametric 3D models (Rhinoceros3D™, Grasshopper3D™), and had a chance to 3D print them themselves. This led to a creative flow of ideas between the kids. The method and the material was the same that we use to produce the mycelium grown HIVEOPOLIS hives. The kids then took their material samples back home to show them to family and friends.



Impressions from HIVEOPOLIS at the Distributed Design Exhibition and Kids Respond Day.



Impressions from HIVEOPOLIS at the Distributed Design Exhibition and Kids Respond Day.

1.3 Exhibition at the Vienna Design Week 2019

At the Vienna Maker Faire in April 2019, “Distributed Design Market EU” and “Maker Faire Vienna” awarded us a spot at the Vienna Design Week 2019 as a programme partner. From 27. 09. to 6. 10. 2019, we had a permanent display and daily presentations at the festival centre. Within these 10 days, we reached out to a large community of varied ages, interests and backgrounds including makers.



Daily school visits at the Vienna Design Week 2019, Festival Centre. The visitors observed various prototype materials and building stages of our mycelium hives. These included digital media showing our parametric design processes, a fully 3D printed cellulose based hive structure, the ongoing fungal growth within and around one of the printed modules and several inactive (dried and heated) mycelium composites that we used in order to develop a full scale hive.



Exhibition and presentations at the Vienna Design Week, 2019.



Public lecture by Thomas Schmickl on 6.10.2019 at the Vienna Design Week, Festival Centre, Lecture Hall.

1.4 Project introduction at the Global Biosummit 3.0

In October 2019, we participated at the 3rd Global Biosummit which took place in MIT Media Lab, MA, USA. This was a large gathering of biohackers from all over the world including people from fields such as biomedicine and bioengineering, as well as hobbyist hackers, bio artists and educators. The biohybrid design ideas, novelty potentials and most importantly the challenges of making large scale, functional mycelium structures were discussed.



HIVEOPOLIS Project Introduction at the Global Biosummit 3.0, MIT Media Lab, main conference hall.



Poster Discussion and table talk at the Global Biosummit 3.0, MIT Media Lab.

1.5 Installation at the “Styria Show: What will be”

In April 2021, we installed a combined HIVEOPOLIS exhibition as part of a curated, 6-months event called “Steiermarkschau”. Our set up is placed at the Kunsthau Graz which is a contemporary art museum and an architectural landmark. The theme of the Kunsthau section of the event is built upon the question “Can we plan the future?” and many research & development projects about environmental urbanism supported the theme.



Installation at the Kunsthau, Graz. Left: The Living Arch: A Study Model for a Novel Wellbeing Architecture for Honeybees. Right: HIVEOPOLIS: Beehives of the Future.

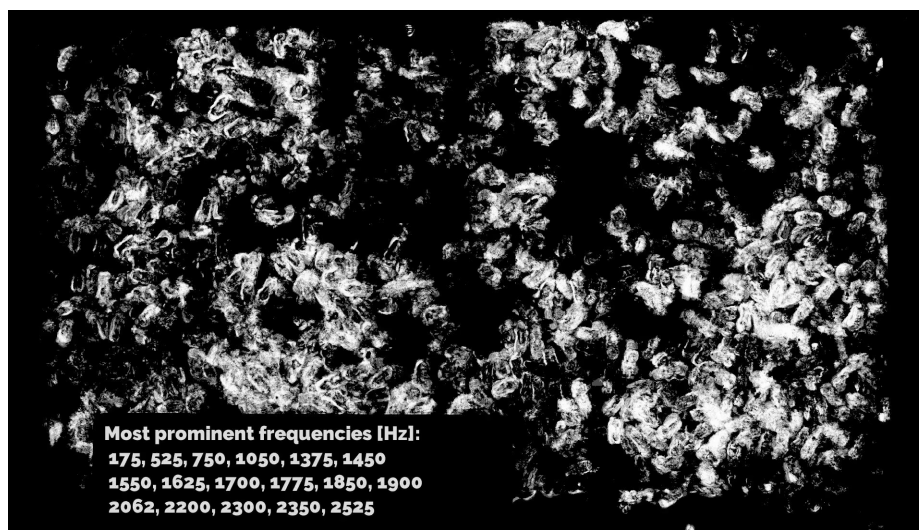
Our setup includes two screens and a mixed media installation piece:

- 1) **“HIVEOPOLIS. Beehives of the Future”**: One of the two screens is dedicated to a movie created with several data visualisations from our earlier hive experiments (brood comb and temperature, dance and vibration). The other screen plays the HIVEOPOLIS project introduction and overview movie, describing the topics covered in the first year of the project:

[English](#)

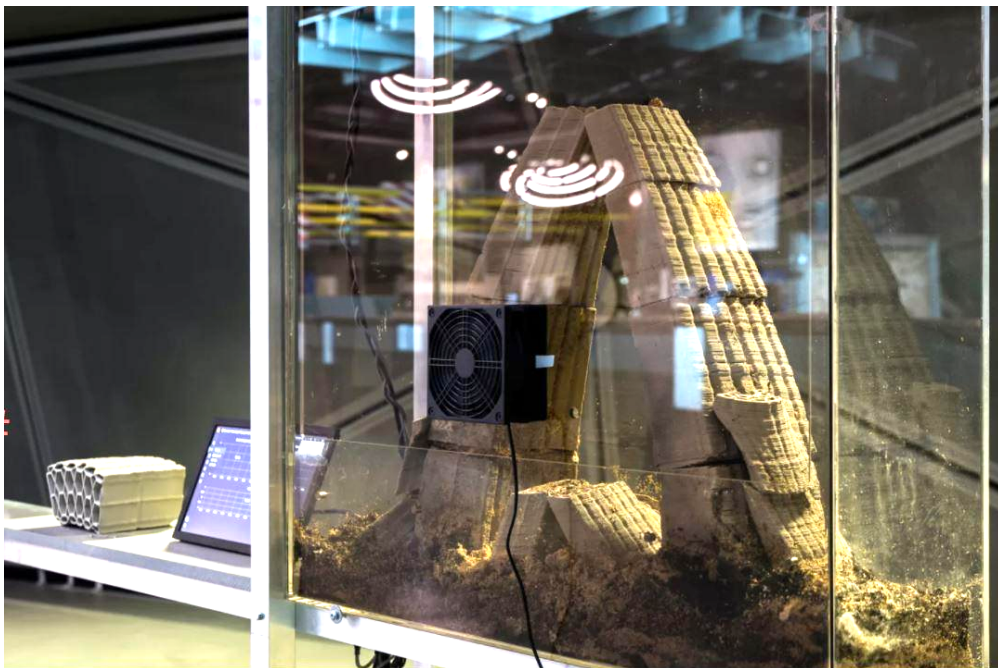
[German](#)

For more detailed information, please visit the [exhibition catalogue](#).



A screen shot from the HIVEOPOLIS experiments data visualisation movie.

- 2) **“The Living Arch: A Study Model for a Novel Wellbeing Architecture for Honeybees”**: In a custom built plexiglass box (detail design and construction by Studio Itzo, Wien), we installed a 3d printed clay structure with fungal mycelium filling. We designed an arch form which can be built using the same material and assembly logic of one of the HIVEOPOLIS hives (composite elements made of an organic stay-in scaffold and mycelium of common mushroom are stacked to grow further). We also placed temperature, humidity and carbon dioxide sensors to monitor and display the changing climate on a small screen next to the grow box. As the box is equipped with HEPA filter openings for air exchange and a PC fan for manual ventilation triggering, we planned to expose a usually in-lab developed biotechnological setup and material production. For more detailed information, please see the [exhibition catalogue](#).



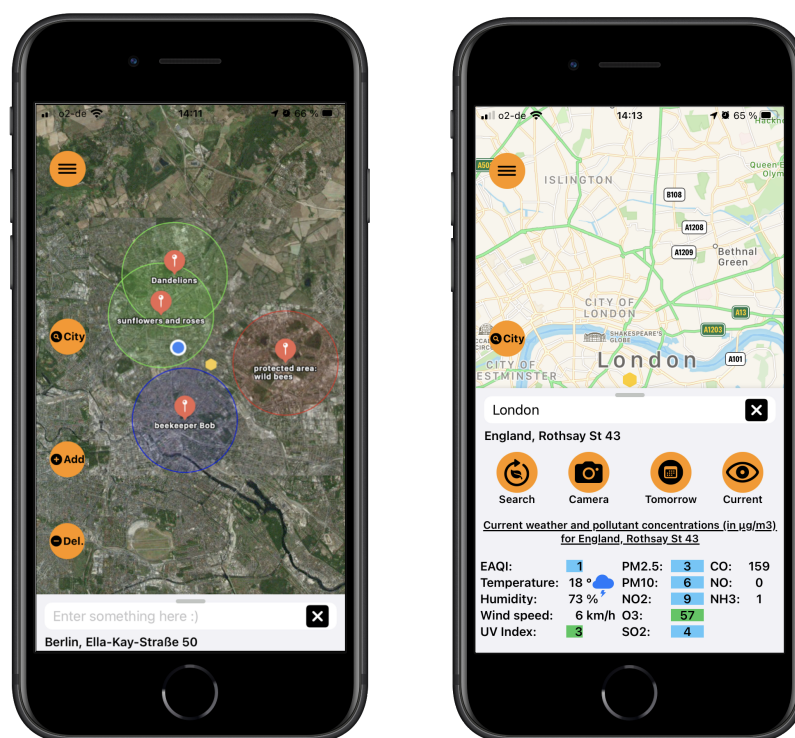
The Living Arch: Setup (top) and final installation during the exhibition (bottom).

1.6 Collaboration with artists to visualise honeybee research

A group of artists and graphic designers, led by Aladin Borodin working under a grant from the Eyebeam foundation of New York, developed a website, *Apian.ch*. The project aimed to help a general audience understand honeybees, through various technologies. The site visualises research from several scientific groups, including three of our own (UNIGRAZ, EPFL, FUB). Besides providing visuals and accessible text for several of the elements, we also worked with the artists and designers to find a way to present honeybee hive data in a style that matched their vision of bringing a honeybee experience to humans. We participated in the online presentation of the project (Feb 2021) and have some mutual linking on social media platforms.

1.7 Mobile app for beekeepers (BeeApp)

We investigate the functionality of a mobile app for beekeepers (BeeApp) that has been developed by Puzynin et al. (2021) from the partner UBER. The app informs beekeepers about the current situation in the vicinity of their hives, including weather and air quality data.



The figure shows a view of the application. Left: Overview with some annotations with examples where interesting plants, other beekeepers and wild bees are. The buttons on the left view are from top to bottom: Hamburger menu with more functions; set focus to a specific city; add and delete annotations. Right: Slide up menu with current weather and pollution data. Buttons here are from left to right a “Search” button for displaying information of a specific plant; “Camera” for taking pictures; “Tomorrow” for future weather and air quality; “Current” for weather and air quality at the moment for the targeted area.

Further community forming possibilities are integrated in the app by allowing users to chat with each other. Non-beekeepers can be integrated in the process of beekeeping with beekeepers by exchanging messages. Future work is to integrate gamification in the app to motivate and hook users to the app. Beekeepers could set tasks, such as labeling certain areas, and reward them with some honey, for example. This data collection from the users can be further processed in a database. BeeApp has been developed for iOS using Swift. A first prototype is available and a preliminary user evaluation has been created as an online survey (Puzynin et al. 2021). After the preliminary user evaluation, features were added and the user interface was revised. Beekeepers were invited to use the app themselves and this was used by the partner BST as an early alpha test.

The app can serve as a basis for the HIVEOPOLIS app that will be developed in Task 7.10. It can be extended so that beekeepers are able to control and monitor their intelligent hives from HIVEOPOLIS via the app.

1.7.1 Tests by BST of the BeeApp developed by UBER

Part 1 - Alpha testing: We distributed the test app among our company's broader team, including UI/UX (User Interface and User Experience) experts and marketing professionals. The process provided some meaningful feedback regarding the usability of the BeeApp. No experts were officially hired to take part in the survey.

Part 2 - Beta testing with actual beekeepers: Two separate groups of beekeepers took part in an info session organised by our team in an open-space environment due to the COVID restrictions in July. They were shown the explanatory video which the app developer of UBER prepared for the test. Our team members translated the video live and showed the app to the beekeepers simultaneously in groups of 3-4 people. Afterwards they all spent between 3-10 minutes with a phone provided by us. Due to some technological limitations like not owning an iPhone (the app is being developed in the iOS platform first) and a complex process of having to download the "Test Flight" app and later download the actual app using a link, we provided our own iPhone devices to conduct the survey. Overall 23 beekeepers took part in those tests on two separate occasions. The data was collected on paper forms, which were later digitized and provided to UBER for later iterations.

2. Empowering people

With activities in Task 4.7 we aim to empower interested individuals to perform successful beekeeping and connect them to other stakeholders to form an interest group that shares info, knowledge and data. Therefore, we develop courses and teaching material and inform non-experts about the inclusion of technological devices into living honeybee colonies.

2.1 Participation in the “Scientific night 2021”

The team from the partner LLU participated in the virtual event called Scientific night 2021, where a presentation about precision beekeeping, cyber bees and futuristic hives was given to the general public, empowering interested individuals to think about the future of bees and beekeeping.



Poster of the Scientific night 2021 (in Latvian)

The team from LLU also has a close cooperation with the national Latvian beekeepers association, and is using their communication channels by which actual information and findings are disseminated to the beekeepers.

2.2 Higher education

Information about precision beekeeping and application of information and communication technologies in beekeeping, together with the findings and developments within the HIVEOPOLIS project are introduced to the study course “Beekeeping and pollination biology” for master students of faculty of Agriculture of Latvia University of Life Sciences and Technologies starting from the study year 2020/2021.

Topics of the course include:

- Introduction to precision beekeeping
- Bee colony monitoring methods and approaches
- Analysis of the bee colony temperature measurements
- Weight monitoring of bee colonies
- Future bee hives
- Augmented bee colonies
- IT services for the beekeepers

2.3 Mini Online Series on beekeeping “[Lyuba and the Bees](#)”

With this project, managed by BST, we have tried to interact with a wider audience amid the pandemic. The series follows the current challenge that the bees are facing globally through the eyes of a girl who, when learning about bees, becomes so captivated by their story that she herself decides to become a beekeeper. The first two episodes have some interesting facts about bees and the ecosystem and the 3rd and 4th episodes are mostly circling around the HIVEOPOLIS grand vision of modern beekeeping. The first three episodes are out and the fourth (almost all about HIVEOPOLIS) is due in the middle of October '21.



Shooting of “Lyuba and the Bees” at the HO apiary at our partner BST

2.4 HO Apiary visits by citizens

More than 55 people have visited our HIVEOPOLIS units at BST and heard the story about the vision and mission of the consortium. Among them were families, organised groups of kids and bee enthusiasts. The lecture is about 45-60 minutes long depending on the interest of the audience and it covers the basic idea of the project, the separate systems that are being developed, progress and expectations along with opening up the HO units when inspection is due.

2.5 World Bee Day celebration - 20th May

The team from BST organised the largest celebration of the “World Bee Day” in Bulgaria. We held it in a very popular area in one of the biggest central parks in the Bulgarian capital Sofia - South park. Among various workshops for children and adults, we showcased the HIVEOPOLIS project at one booth and even presented one of each prototype designs - “star shape” and “mitochondria” to the audience. There was a 30 minute lecture on our goal, progress and process followed by Q&A. Among the diverse audience were a lot of naturalists, beekeepers and zero-waste movement enthusiasts. The event was visited by roughly 3,000 people and was held according to all suggested Covid-19 measures and restrictions.



Visitors inspecting HO prototype designs and discussing with members of BST

2.6 Presentation of HIVEOPOLIS to the beekeeper community

On the 21st of September 2019 we presented an overview of our project to a large group of international beekeepers at the annual beekeepers conference of the Austrian Carnica Association in Brixen (Italy). First, we presented the international HO team and our areas of expertise. We then presented the aims of HIVEOPOLIS and how we are trying to achieve them. We proposed the future honey bee colony and presented an outlook of how we could change modern beekeeping once the project is completed. As expected, the audience was highly impressed by the highly unusual and diverse aims of our project.

3. Enriching the teaching and learning community

3.1 Activities in schools

The pandemic situation has posed significant challenges concerning outreach activities within schools. Although the school programs local to EPFL have not suffered as heavy disruptions as in some other countries, bringing additional extra-curricular social contacts to schools during this period would not have been responsible. Accordingly, we have decided to concentrate the effort for actions within this teaching-related task to the latter portion of its runtime. Within the upcoming academic year we have slightly lower uncertainty regarding school programs and conducting activities safely; and thus we aim to advance in course design, including syllabus matching and verification with teachers experienced in the targeted age groups. If the situation permits direct outreach this should ramp up in the coming period.

The EPFL team, with support from the FUB team, also made some investigations into an embedded implementation of real-time waggle dance detection, and whether this could be incorporated into hives. This exploration has some synergies with the technical work in waggle dance detection systems work ongoing within WP4. If it were possible to use low-cost, field deployable equipment to facilitate waggle dance detection and decoding, it could open the possibility of running certain educational activities revolving around bee foraging sites. This investigation made it clearer where some key challenges lie with a field deployment of a complicated technical system, and although it did not yield a feasible solution, it has helped evaluate the effort of using such a system in an educational context.

3.2 HO Apiary visits by beekeepers

This summer the HO units at our partner BST were demonstrated in front of beekeepers who took interest in understanding more about the HIVEOPOLIS project.

Local beekeeping holiday

On Jul 8, 2021 - local beekeeping holiday, we invited a club of local beekeepers and had a series of long discussions related to the project. The event started in front of the office of a local beekeeping club following all COVID precautions, and we even had the mayor of the small town visit and congratulate us on our innovative approach. The event later continued at our apiary where the beekeeper had the chance of participating in regular HO unit inspection. The event was later featured in one of the two most prominent Bulgarian beekeeping printed newspapers - Pcheli.eu (translation from Bulgarian: Bees.eu) as its editor, who is a very well-known beekeeper, also participated.



Beekeepers exploring and testing one of our new prototypes



Interested beekeepers at the event

Populating the 2021 HO units

This year BST invited a few beekeepers to observe the population process of the HO units. Unfortunately due to some unexpected rain showers and few postponements, most of the beekeepers left but 3 of them waited until 3 am when we had concluded the population and became serious fans of the project.



Visitors inspecting the new cubic design.



Developers and beekeepers ready to work at the hives



Developers and beekeepers working together

Private presentations for beekeepers

Private presentations of the HO vision and progress were held for beekeepers who expressed interest in our project. A few beekeepers visited the BST office and/or apiary to learn more about our approach and grand vision. They were very keen on understanding more about the technological part as well as provided real feedback about potential applications and usability. The most interesting topics for them were related to the gate module and the dancefloor module. Some even got to hang around for gate module tests.



HO units in rural (left) and urban (right) settings.

4. Summer schools

Due to the restrictions on travel and gatherings in the ongoing Covid-19 pandemic we were unable to organise summer schools yet. We therefore focused on tasks that do not require direct contact to people (e.g. online survey) or events that could be held within the Covid-19 restrictions within the respective country (e.g., outside activities, museum installations). We will allocate more time and resources for this task when we are able to do so.

References

Puzynin, E., Mellmann, H. and Hafner, V. V. (2021). A Novel Mobile App for the Next Generation of Beekeepers. 29th International Workshop on Concurrency, Specification and Programming (CS&P'21). Berlin, Germany. CEUR Workshop Proceedings, ISSN 1613-0073. Vol. 2951, pp. 113-116. <http://ceur-ws.org/Vol-2951/>