Observing an Observation Hive

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Who we are: Welcome to Pacific Science Center in Seattle, Washington! Created in 1962 during the World's Fair, Pacific Science Center began as the United States Science Pavilion. After the World's Fair ended, it became the standalone institution it is today. Around our 50th anniversary in 2012, we also achieved status as an historic landmark. Our structures, designed by the notable architect Minoru Yamasaki, were to be preserved in their original form. That designation, in addition to recognizing our building's place in the community, also put limits on alterations we could make to the space. We are also located in the heart of the city, where land is limited and restrictions abound. It is within that context that Pacific Science Center's Life Sciences team is working when we operate our observation bee hive.

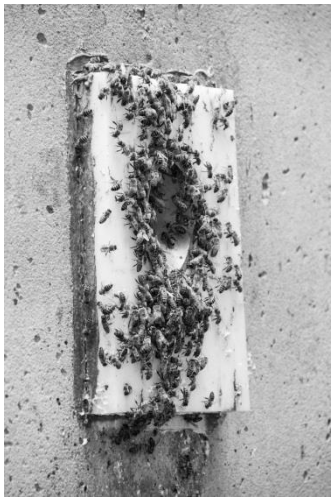
On left: our iconic arches. On right: the observation hive with exit to the outdoors on the lower left.

We have little space behind the scenes and few changes we can make to our external building, so our bee keeping has to operate with little flexibility. We have a single hive that is four frames tall by two frames wide and is viewable through acrylic glass on both sides. In addition to the care we give the hive in-house, we also have a contract with a local beekeeper, Corky Luster, of the Ballard Bee Company. We enlist his services when larger projects are needed, for instance if we need to replace our queen, put frames of honey into the hive to feed the bees, or completely replace our hive. Fabrication and modification of the hive was done by the Exhibits team at Pacific Science Center. Our bee keeper, Exhibits team and Animal Care department staff work together to provide for the needs of our bees.

Goals of the exhibit: People see bees so often that many probably do not stop to question where the bee was before her journey, or after she pollinated that flower. The bee flies away and they go about their business. Another common reaction to seeing bees outside is fear; between allergies to bees and their resemblance to more aggressive insects, like wasps, it is difficult for many people to feel safe getting a closer look. And since the public does not get many

opportunities to see a working hive in real life, many people never learn how to identify a honey bee. Despite this disconnect, there is a clear want for more knowledge about bees, and answers to the many questions surrounding their declining numbers. There have been numerous recent documentaries on bees, many studies on Colony Collapse Disorder, and a growing interest in backyard beekeeping, yet it is still difficult for the average person to connect in person with the pollinators in their neighborhood. The observation bee hive offers this chance, without any fear of being stung. Here a guest can form a knowledge base and an emotional connection between the abstract bees of the news and the ones they encounter in person.

The early history of our hive: In 1996, the decision was made to add a new exhibition hall and IMAX theater on to Pacific Science Center's west wall. The exhibit space became our Tropical Butterfly House and the adjacent gallery which is home to our Insect Village. An observation hive was designed by Entomologist Evan Sugden, an experienced beekeeper with a strong passion for sharing his knowledge. His design involved a cabinet, with a movable 'cassette' structure in the middle that could completely contains the bees and could be slid into the cabinet. In theory a beekeeper could close all the exits of the cassette, pull it out of the cabinet, wheel it outdoors and perform any beekeeping necessary without trouble.



On left: keepers sliding cassette into hive frame. On right: bees outside the hive entrance.

When the exhibit opened, there was a dedicated entomologist, who happened to also be a beekeeper and who manipulated the hive when needed, bringing 2 or 3 helpers for lifting. When we moved to a contract beekeeper, coordinating a good time to work on the hive was a huge obstacle to effective management of it. All work had to be done in the early morning, and either required the beekeeper to bring assistants or staff available at 6 or 7 to begin work. The entrance of the hive runs along a driveway often used for loading in equipment for events, so hive work could not be done before events with catering staff, who were adversely impacted by bee activity.

One of the early lessons about installing new bees was that the biggest, strongest hives were not always a good fit for the space. Our beekeeper would select frames with full complements of brood and honey. Once the brood emerged, the queen would fill all the empty spots with new

eggs and suddenly the hive would be full of bees and brood, with nowhere for new eggs to go. When this happened, we might have a swarm on our hands. The most memorable time was probably the swarm that took place during a Pride Parade that ended in a party on our campus. The bees were congregated in a tree above the celebrants, and our beekeeper had a very hard time clearing a space where he felt he could catch the hive without leading to panicked people if the bees began flying.

Reframing the hive: In 2009 our Life Sciences department began a blog to share our stories with the public. The beehive was a popular topic for both staff and readers. Having this blog changed our relationship with the hive. We started looking at it as a bigger picture story and thinking about the narrative it was telling over time, instead of just the information it gave guests at a specific moment in time. The blog was overseen by one of our volunteers, Terry Pagos, who was also formerly a photographer by trade. Her photographs that went along with the blog gave us more opportunities to see the progress of the bees than we had in the past. The notes that we had recorded on the hive in past years became fleshed out histories that we could refer to in later years for better comparison. In the early days of the blog, we operated with the assumption that we would be replacing our hive after it died out in the winter. With the added information from past years, we started thinking about the possibility that we could get our bees to survive through more than one year and began making changes to make that a possibility.

Redesigning the hive: The beehive was safe and functional when it was assembled, but over time we grew to dread any day when we had to work on it. The inner 'cassette' part was incredibly heavy. The eight frames of sticky honeycomb and four sheets of double-paned glass, along with woodwork and the huge metal clamps that held it all together added up to over 70 pounds. These were also pounds of potential disaster if dropped while moving, with the fear of broken glass, honey and bees everywhere. It was a perfect nightmare to even think about.

There were smaller problems too. Over time the bees applied a coating of sticky, dark propolis to every surface. Trying to remove it damaged the wood and scratched and hazed up the acrylic glass. The glass panes got small dings along the edges, and were always either having to be replaced, or cutting our hands when we carried the framework. All the small plastic parts were starting to break from repeated cleanings and usage, and were held together by more and more glue, sometimes assisted by toothpicks and other ingenious contrivances. And perhaps most critically, there was no easy way to feed them. The outer plastic portion of the cabinetry had one small hole cut out for adding a very small feeder, about the size of a large test tube. This was never enough when the hive was hungry, and even with continuous refilling, we had no way to get the bees through a long period of minimal resources, like the rainy winter typical of Seattle.

In 2013, we spoke with our exhibit designer, Craig Matsuda, about making some changes to the hive. Along with other changes, Craig convinced us to use acrylic sheets instead of glass for the inner cover of the hive. We had several concerns about this: the plastic can bow and sag over time. It scratches much more easily than glass, and we were concerned that the potential for developing a static charge would irritate the bees. None of these concerns have been a big issue, and it is cheap enough that we can replace it if it scratches. Changing to the clear acrylic

lightened the overall weight, and it could be held in place with screws instead of the metal clamps we used before. It also insulates the bees, trapping in more of the heat they generate. We also added a much larger feeding system for sugar water or honey and four small openings into the hive that allow a computer vacuum in to clean out bees.

Bee feeder installed on the side of the hive

Overall, beekeeping and bee maintenance are much easier, and in some cases only became possible, with these improvements. It has taken time for us to get the maximum use out of the changes, like knowing when to start and stop feeding. But having the parts in place makes all of those decisions easier.

Recent hive history: Since the rebuild, many of our hive headaches have gone away, but working with an observation hive is still nothing like working with a movable frame beehive. We still operate within the Science Center building, and while we can make small adjustments, like adding sugar water and pollen, fairly easily, bigger changes still require completely dismantling the hive when we are closed to the public.

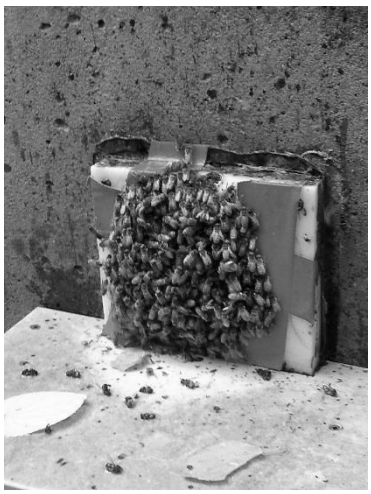
All the bees hanging out on the side of the hive nearest the window and ignoring the rest

The bees do not use the space of the observation hive the way we expected them to, but more like the way they use space in a Langstroth hive, vertically. They have stored honey both on the upper and lower frames of the hive, and choose certain areas to brood, but all of their activity is

focused on the four frames closest to the window and their entrance to the hive. They will travel to the far side of the hive, but do not build there. In the past, when we've added frames of honey to that side of the hive, they have foraged it over to their chosen side as if they were robbing a neighboring colony. When bees die, the hive typically removes the dead bees to outside the hive, but occasionally "outside" seems to also refer to the foreign side of the hive.

In the past few years, we have had some challenges with the bees and have yet to successfully complete a full year of survival, but there is not one common denominator in all our hive problems. One year, an observant guest looking in the hive realized they were looking at wasps instead of bees. Our hive has a rather large exit to the outside and in order to allow the bees to more easily guard their home, we taped over the majority of the opening in hopes of restricting the wasp's access. Unfortunately, we did not properly communicate our intentions to the bees, and they responded by vacating the hive and bearding on the entrance, making themselves an even easier target for the wasps. Eventually, they figured out the new entrance and combined with the bait pheromones we put out to attract the wasps, the hive survived that ordeal mostly intact. In addition to fighting off wasps, wax moths are also becoming residents of the hive, and due to the complications involved in dismantling the hive in order to remove them, we are forced to put up with their presence.





From left: a wasp seen alongside bees in the hive, the closed off cover of the entrance, the beard that the bees formed over the entrance

While the new plastic walls of the hive are better at insulating than the glass of the past, weather is always a concern when trying to get a beehive to survive a winter. We have considered partially closing the entranceway to conserve heat when fewer bees are traveling through it. We have debated about whether to heat the hive or not and settled on not heating the hive, banking on the fact that Seattle tends to have fairly mild winters. We also are always concerned about their honey lasting throughout the long winters and worry that heat would confuse them into not properly conserving resources. When it gets cold, we see increases of bee frass inside, but have not yet found a solution to change that behavior.

Despite the modifications to our feeder, providing supplemental resources for the bees throughout the year is still a challenge. Our feeder now allows us to offer the bees whatever concentration of sugar syrup they need in quantities large enough to sustain them. But this system was not well designed for adding pollen. Adding pollen to the hive without bees escaping

feels like a slight of hand trick. During very active times when honey is rapidly depleted, we need to open up the hive by sliding the inner cassette out and removing the covers, then swapping empty frames for ones filled with honey and closing it all up before the bees notice.

Monitoring the hive: Although we have been making observations about our hive ever since it was built in 1996, in 2015 we implemented a weekly monitoring system so that we can have a more concrete understanding of the hive's health, and a baseline history for the future. Our goal is to have a better understanding of when the bees need us to intervene, and what we need to provide for them, so that we will have the best chance of them succeeding. Our monitoring system takes roughly a half an hour, and is best accomplished with two staff members. Together, the staff members look at each frame of the hive and record the presence of uncapped honey, capped honey, pollen, drone cells, uncapped brood, brood, and the approximate percentage of bees, and then go on to the next frame. This is an opportunity for seeing population growth and quantity of food stores, which indicates a successful healthy hive, or low numbers and lack of new brood, which indicate poor health or some dramatic change in the beehive. In addition to tracking the population and food stores, bee monitoring is also an opportunity for watching the general activity level of the hive; we count for how many bees are leaving and entering the hive, which gives us an idea of their comfort level in leaving on a given day. If bees are coming and going regularly, then we expect for the level of cleanliness to be high in the hive; they carry out their dead, they go outside to self cleanse, and they remove intruders such as wax moths and wasps. Since the same few staff members perform the bee monitoring weekly, they are likely to notice a shift visually, and can double check with the records we keep. If there is a decline in the numbers, an increase in pests, or a lack of cleanliness, the monitoring guarantees that we will notice it within a week, which ensures more time to observe the cause behind the decline while we work together to form a plan. Because we have this in depth knowledge, the daily visual inspection of the hive is well informed. We are quicker to notice trends, even between full monitoring sessions, such as the rapid depletion of stores that used to always happen faster than we expected.

Recently, one of our queen bees was replaced by a new queen, and we knew within a week, possibly the very day, that this happened. It started during bee monitoring one day. We noticed that we could not find our queen, who was marked. Within two days we saw a new, unmarked queen with retinue. We watched the new queen nervously; she was very small, and did not seem to be laying eggs. For over two weeks we saw a lack of new brood and a decline in the population. Although we soon observed the new queen going through the motions of oviposition, we were unsure if she was successful. We were already talking about potentially needing to introduce a new queen, or install a new hive, when we finally saw our new queen laying eggs and the growing brood. In past years, we might not have noticed the transition between queens so rapidly, so we might not have had as much time to worry, but we also might not have had as much time to plan. We do quick check on our hive every morning, but since our bee monitoring process calls for finding the queen, waiting to see if she lays eggs, and making sure she has her royal court with her, we were certain to pick up on the transition. Our scheduled weekly monitoring keeps us aware of the goings on in the hive on a different scale than our previous observations did, and we will be more prepared to handle future situations when they arise.

A staff member points out the queen bee to a young guest

Interpreting with visitors: One of the most rewarding aspects of our work with the observation bee hive is communicating directly with the public. We typically do our bee monitoring during open hours, and invite guests to help us while we answer questions. It is wonderful to have a reason to be stationed at the bee hive for a half an hour or more so we can provide interpretation for guests. In general, people tend to ask the same set of questions: "Where is the queen?" "How did she get that mark on her?" "Are you counting all of them?" "How many do you have?" "Do they go outside?" Those types of questions can sometimes lead into bigger conversations, but for many people, once they get their questions answered, they move on to the next exhibit. One of our goals with the hive is to help people understand the life cycle of bees and their role as pollinators, so when we have guests who stay for longer than a question or two, our interpretation tends to be focused on providing introductory information on bees. Many people enjoy learning about their life history, and we have a lot of success in teaching them about pollination, the waggle dance, diet, and reproduction. We often will have an entire family choose to stay for the duration of a bee monitoring session. The kids and adults alike will ask questions until they leave with a more complete understanding of the honey bee's life history and the ability to identify them in their own backyard.

Beyond bee basics, other dynamic conversations take place at the hive. We have many beekeepers who ask us for details on the logistics of our observation hive. They generally end up asking about our numbers and success in overwintering, which gives us a glimpse into their situation, and its similarity to our own. In addition to beekeepers, since population decline has been in the news a lot lately, many guests want to discuss the latest documentary or news that came out on bees. Because Colony Collapse Disorder is a very complicated subject, and the public has heard many different media blurbs about it, it can be challenging to provide guests with the closure they are seeking on that matter. We avoid giving them quick answers that would oversimplify the complex topic; instead, we encourage questions, curiosity, and critical thinking. Despite the fact that we cannot always give the answers that many guests crave, there is an overwhelming sense of support for the bees. Every guest who spends time at the bee hive, particularly those who stay for longer than a question or two, want us to know that they are on

the bee's side; they want to hear that the bees numbers are doing better, and they want to know how they can help.

Looking forward: All of this improvement in design and monitoring has given us a new relationship with the bee hive. Currently, we have a successful hive that has made it through the toughest part of winter. However, this has not been a particularly cold winter. We could be seeing the thriving bees because of the changes we have made in their care, but the particulars of this year's flower population and weather could also be the primary factors in their survival. Unfortunately, we have no way of knowing for sure. Within the past few weeks we have noticed a new queen in the hive, so we may be looking at a swarm in the near future, or a hive that does not swarm but runs through its resources before winter has even begun. We have a plan in place with our exhibits team to get a pollen feeder installed on one of the sides of the hive, but we cannot go forward with this plan as long as there are still bees in the hive. Our thriving population is actually getting in the way of the progress in design for the time being.

An observation hive brings with it both wonderful and frustrating characteristics. On the one hand, you have the ability to see the bees making changes and growing in real time and see the relationships between them. They are a remarkable teaching tool. On the other hand, sometimes you have to watch them fail, knowing that there is no way to help them solve their problem. Our monitoring efforts are giving us a closer understanding of the bees' needs throughout the year, so we can make small adjustments in their care more quickly. While we do not know what the future will bring, we know that our past knowledge and experience will make us more prepared to handle whatever the bees throw our way and help them have the best possible chance to survive. We are looking forward to the challenges ahead.

ACKNOWLEDGMENTS

We are a small part of the crew that has taken care of this hive over the years. Thanks to all the Animal Caretakers, entomologists and beekeepers that have worked on the hive. We would like to thank Terry Pagos for providing many of the pictures in the paper and presentation. Thanks to Amber Bond and the Sunday team for many observations at the bee hive and the very thorough bee population counts. Jenn Purnell and our horticulture volunteers have created a beautiful garden to help feed our bees throughout the year. Craig Matsuda's designs have changed our hive so much for the better.