Accelerating Biomimetic Design Evolution Using Advanced Analytics and Rapid Prototyping: An Api-Centric Hive for Domestic Apis mellifera

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Honeybee populations in the U.S. are declining at an unsustainable rate. For Apis mellifera, aka the domestic honeybee used on farms, the primary culprit is the varroa mite. This is not the case for wild honeybees. Research has shown that wild honeybees are resistant to infestation due to their habits of nesting in small cavities and swarming frequently; inversely, colonies with large hives and high population density are more susceptible to varroa. The most obvious factor distinguishing the domestic honeybee from the wild honey bee is the hive – which would be identical if not for human intervention in the form of the Langstroth hive. The Langstroth hive is a bee-keeping structure akin to a file cabinet – bees live unnaturally in rows of moveable frames, where they produce much more brood and honey than they would in the wild. Not only do these production values make the bees more susceptible to varroa, but the design of the hive itself violates superorgansim theory, which dictates that the bee organism is not each individual bee but the hive of bees itself, thus heavily disrupting the bodily functions of the hive. It was hypothesized that creating a new type of commercial hive would counter the population loss due to mites. The project began by translating an existing, biologically intuitive hive model – the Sun Hive – into a 3D-printable computer model. Design adjustments were made to maximize efficiency and integrate GPU-based monitoring for specialized analytics. Now that there is a template for rapid-prototyping via 3D printing and an integrated Internet of Things, natural designs are more accessible to engineers. The hive is set to be tested in the field during the month of April at an ecology center out in California.

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