“Our imagination is struck only by what is great; but the lover of natural philosophy should reflect equally on little things.”

― Alexander von Humboldt

**LAGI Mannheim Murmurations - Energy Pollinators**

**Die Zukunft ist Elektrisch!**

Each Fall and Spring thousands make a pilgrimage to the marshlands of the Wadden Sea to watch the spectacle of flocking starlings. The aerobatic fluid forms are the manifestations of collective but not quite synchronized individual actions. These are the inspiration for our proposal:

**LAGI Mannheim Murmurations BUGA 23**

We celebrate the startling advances in nano and robotic technology to suggest an alternate scale of green energy production that is not tied to the archaic infrastructure of the 19th and 20th centuries. We mine nano modular assemblies to create forms that are static and manufacturable (tile patterns) and dynamic and wondrous (murmurations).

We confront a dystopian future (an inevitable reality of mass extinction) that our proposal suggests: a future where living systems are replaced by manufactured surrogates but offer an alternative outcome.

Mannheim Murmurations proposes flying nano-robots as temporary guardians and docents for fragile biological communities. Our initial research of the project site revealed that local pollinators' habitats were on the verge of collapsing and many pollinating species were threatened with extinction (butterflies and moths (*Lepidoptera*), bees (Anthophila), bats (Chiroptera), etc.) “Greener than ever” is the branding of the Bundesgartenschau, BUGA 23, but without the natural pollinators the future of all garden shows is in peril.

The robotic murmurations will do the work of the decimated insect pollinators, nurturing insects and indigeous plant communities until the natural ecosystems can be replenished and restored. From there, these robotic species can migrate (under their own photovoltaic power) to support other threatened biological systems throughout the globe or be deconstructed and recycled at a processing facility within the U-Halle.

During the Bundesgartenschau Mannheim the nanobots will be programmed or tasked with activities normally carried out by the indidigeous insect population such as pollination and warding off invasive species. Other combinations of bots will serve as docents, ensuring that the garden visitors have the best possible experience. Yet other bots will assist naturalists, biologists, and gardens with their activities. It should not be forgotten that a primary function of the bots is energy collection, storage and distribution. Always ready to help, you may see bots recharge a mobile phone or two, an electric scooter or car. Their capacity is scalable and as production increases, the bots will become a migrating photovoltaic array, ready to create and distribute power wherever and whenever needed.

**Kein Wunder Nötig!**

The U-Halle serves as the production site for the nanobots. The robots are initially produced by composite-carbon 3D printers as sophisticated multi-layered sheets incorporating high density battery storage, nanocircuitry for controls, microfiber sensors, and ultra-thin organic photovoltaic cells produced using a novel tetraphenyldibenzoperiflanthene (DBP) vapor deposition process.

The sheets are composed of tiled triangular modules, which are then laser cut to produce a variety of nanobot units. The patterning allows the robots to micro-crease to become rigid, and actuate for flight over a medial folding axis. Once mobile these various units can self assemble into larger structures, each designed to fulfill a specific role:

Nanobot series **Helios**
Active between dawn and dusk

**Mono helios**

The basic unit flies, pollinates and seeks to combine with other units to perform specific tasks. Mono helios, and it’s nighttime cousin Mono selene, using advanced heuristics and machine learning is able to communicate with biological species. Each mono unit is anticipated to generate approximately one watt per year (1300 watts/square meter of sun\*1600 hours of sun per year in Mannheim\*0.0000045 square meters per Mono helios\*10 percent efficiency).

**Di helios**

The smallest combined unit, like its progenitor mono helios it seeks to combine with other units to perform specific tasks.

**Tri helios**

The Weeder: Invasive species control.

**Tetra helios**

The Pollinator:assists native insect species to pollinate local flora.

**Penta helios**

The Germenator: tasked with planting seeds throughout the grounds.

**Hexa helios**

The Repairman: finds bots and can repair or charge them.

**Hepta helios**

The Weatherman: senses changes in barometric pressure and reports live-time weather reports at a microclimatic scale.

**Octa helios**

The Docent: Human interface, wayfinding, plant and insect identification, universal translator.

**Ennea helios**

Awaiting Assignment

**Deca helios**

The Killer B: Tracks, collects and delivers parasites to the U-Halle for research.

**Hendeca helios**

The Watchman: identifies and notifies park maintenance staff to invasive species.

**Dodeca helios**

The Gardener: monitors the health of the gardens, tracks rainfall, soil acidity and other agricultural/environmental data.

**Triskaideka helios**

The Charger, capable of recharging small equipment, when combined with other units has greater charging capacity

Nanobot series **Selene**

Active between dusk and dawn

**Mono selene**

The basic unit: performs basic pruning task and seeks to combine with other units to perform specific tasks.

**Di selene**

The Smallest combined unit responsible for providing additional electricity for larger combination of units. Like its progenitor Mono selene it seeks to combine with other units to perform specific tasks.

**Tri selene**

The Pollinator: Assists native insect species to pollinate.

**Tetra selene**

The Reaper: Transports disabled and damaged bots back to the U-Halle to be recycled.

**Penta selene**

The Woofer: Embedded with micro-speakers to provide broadcast sound for wayfinding, announcements and concerts.

**Hexa selene**
The Illuminator: Can provide on demand lighting throughout the park, clustering as needed to provide varying intensities of light.

**Hepta selene**

The Nightwatchman: provides security alerts and controls trespassers of all sizes

**Octa selene**

The Swimmer: Can land on water and be briefly submerged, giving it the ability to pollinate water specific plants.

**Ennea selene**

The Medic: locates lost bots and guides them back to the U-Halle

**Deca selene**

The Beacon: Initiator and leader of nighttime murmurations, organizing nanobot movements throughout the site.

**Hendeca selene**

The Irrigator: Circulates throughout the site providing power to irrigation pumps as needed.

**Dodeca selene**

The Watch-me: basic building block of display screens, providing park goers with facts about the park and special programming. Large combinations of Penta selene are suitable for displaying movies, sporting events etc.

**Triskaideka selene**

The Battery: dormant during sunlight hours in dense agglomerations storing energy. Circulates throughout the night providing energy where needed (for lighting, irrigation systems, wayfinding, etc.)

*U-Halle scientists have successfully combined the Helios and Selene series bots to create a new class of nanobots capable of greater range of migration and power generation.*

**Mannheim Murmurations Environmental Impact Statement**

The environmental impact of the production of the nanobots can be measured in the production of electricity and in the carbon sequestered in the materials used. The greatest impact will be to build a power generation system that is mobile, flexible that does not rely on antiquated power grids, while reminding us all of the wonder and beauty of natural phenomenon that it will help to restore, rebuild and make resilient. It is a vision of an all electric future, a world without fossil fuels, where energy production is a source of civic pride.