Interview Questions Nemo's Garden

Project Overview:

- What is Nemo's Garden?

Nemo's Garden is an underwater greenhouse system for production of superfoods/enriched/unique plants – a sustainable agriculture alternative to traditional land-based cultivation of plants – an underwater research lab studying effects of extreme environments on plant growth and physiology – a beautiful touristic attraction.

- Where did you get the idea for Nemo's Garden?

the idea came to Sergio Gamberini during a dinner with friends as a result of a "bet" a challenge from a dear friend who asked him to create a bridge between Sergio's work (uw equipment development) and his passion (gardening).

- When you started the organization, what were you trying to achieve?

OceanReefGroup: create the future of scuba diving equipment / invent unique products. Nemo's Garden : proof of concept. Taking the garage-experiment to a real industrial / commercial product/service.

- What have you achieved so far?

So far we have succeeded in proving that growing a plant uw is possible, it can be replicated, that it can be done sustainably or with a massive reduction of the related footprint created, that it can be an exportable system, that it can fit in the existing place and ecosystem selected, that It carries indirect benefits for the local ecosystem, that it produces enhanced plants. That it speaks to the people that are lucky enough to visit. We have successfully grown several different types of plants definitely more than 50.

- Who has contributed to getting Nemo's Garden to where it is now?

Main funding comes through our organization, but also a lot of technical sponsors and companies providing support with specific technology and gear. Paramount contribution has come from our employees, our families, their passion, their support, their ability to think outside the box and solve issues that are unique and difficult to understand for anyone else.

- Explain how the biosphere works? What impact does it have on the environment?

Biospheres replicate, on a micro scale, the normal water cycle. They are confined volumes of air, submerged below sea level, anchored to the sea floor. These underwater bubbles feature a surface of water exchanging gasses between the sea and the internal volume of air and providing a natural evaporation of this surface of water in the confined volume above. The humidity contained in the volume of air will condense along the internal surface due to the difference of temperature of the air and the outside body of water. The condensation is purified fresh water that can be collected and used for plant irrigation. The sea around the biosphere acts as a huge, natural, basin of thermal energy (either absorbing the excess, or slowly giving it to the biosphere – acting as a natural balancing of the internal volume of air.

Acting as a refuge for small organisms, the biospheres naturally attract a food chain that quite quickly develops on and around them, repopulating the vicinity much like an artificial reef wood.

- What are the environmental benefits of using a subsea biosphere rather than a regular greenhouse?

Biospheres maximize the natural sea warming/cooling effect, reducing the need to do it by consuming energy. Biospheres naturally feature a desalinization process, reducing the need to consume energy to provide plants with fresh water. Biospheres can be installed in bodies of water an "unused space", a huge volume that can be sustainably exploited – whereas greenhouses need free land surface with a set of accessory needs that might not be available (such as fresh water, heating/cooling). Biospheres do not

need any sort of pesticide and are not prone to any contamination from the outside. Biospheres have a natural cut of harmful frequencies of light. Biospheres feature a semi-closed system that can exploit the sea to provide (by diffusion) quantities of Oxygen as well as CO2 → also some CO2 sequestration from the water itself.

- What did the first biosphere look like, how was it constructed, what did you grow?

The first biospheres looked like a balloon. They were a balloon! A lifting bag made of transparent plastic that could be easily shipped around the world occupying minimal volume. The internal structure in the beginning was absent. We used "pouches" to fit small containers with soil. We had to manually water, attend the plant, the space was limited, there were no sensors, no fans etc. We used to grow mainly basil, but we did experiment some different types of plants.

- And what do they look like today? How has the design changed? Size? Plants grown?

Today they look more like floating "contact lenses"! they are beautiful transparent domes, anchored to the floor – much like a Star Wars seen from the underwater civilization on a fictional planet. The structure is rigid, making it standard, durable, replicable in any environment. The medium size has increased to 2m diameter. The internal system has been developed from a nutrient-film hydroponic system to a DWC (deep water culture system).

- What is Nemo's Garden's mission/vision? How has the mission/vision of Nemo's Garden evolved over time?

Our mission is to pursue all 4 objectives that we see achievable for Nemo's: Nemo's Garden is an underwater greenhouse system for production of superfoods/enriched/unique plants – a sustainable agriculture alternative to traditional land-based cultivation of plants – an underwater research lab studying effects of extreme environments on plant growth and physiology – a beautiful touristic attraction.

- Where are your biospheres deployed?

Our pilot plant is in Noli, NW Italy, not distant from Genova (our HQs). We do have 1 Nemo's Garden in Beringen – Belgium (TODI), we have deployed for a limited time a Nemo's Garden biosphere both in the Florida Keys and in Mauritius.

- What are the fundamental benefits of taking a subsea approach?

Accessing a unique environment with incredible effects on the growth of plants. Utilizing, sustainably, an enormous amount of available space in an earth covered for 70% in water and incredibly damaged by traditional agriculture's footprint.

- What kind of places would benefit from operating a subsea biosphere? *(answer, anywhere with Unrestricted land and fresh water, or highly variable conditions – Maldives, Caribbean, Singapore, Saudi Arabia, Mexico, Southern California, etc)*
- Which kind of industries would benefit from higher nutrient density? *(answer: Specialist / super-foods, aromatics, plant-derived medicines, cosmetics...)*

The Challenge:

- What challenges have you faced in the development of the biospheres?

Mainly: being underwater. Water does not cope well with electricity, and it does present a unique set of physical rules that come with it (buoyancy, absence of easily accessible air/oxygen, storm power). Complete absence of a "guidebook".

- What challenges are the unique challenges that a subsea environment presents?

Specialized and specifically trained workmanship as well as gear. Durability of electronics. Like working in space.

- How much is materials science a contributing factor to your development processes?

The ability to have nanotechnology treatments on biospheres (that do not release harmful chemical agents in the water) is incredibly interesting. reducing the work of cleaning the biospheres (guaranteeing natural light filtration) is very important. Strong, transparent materials such as methacrylate that can be molded "easily" to big sizes and shapes is the base of creating our biospheres. There are more advanced options connected to materials sciences as well as futuristic options to advance the system – possibly things we don't even know about yet.

- What does a typical innovation cycle look like? How long does it take?

We have no idea. This is uncharted territory. We know how slowly we moved for the first years and how fast we moved lately on the learning curve – but we also know how limited we are on cutting edge technology that is connected typically to the digital&software world and usually not accessible in our line of work. I would say our innovation cycle takes years, also heavily crippled by the possibility of implementing, studying and testing most of what we do during the warmer months due to lack of infrastructure during winter.

- In working toward a sustainable solution, how do you evaluate your impact on the environment?

Our dream is that this technology will be used along shorelines across the globe, capturing and sequestering CO2 from the oceans, growing food for coastal areas, reducing and limiting the need to increase land-arable land (diminishing the pressure on scarce resources such as land, water). Reducing the need for isolated, water-locked countries and communities to ship massive quantities of produce across the globe. Creating a new industry sector, new jobs, empowering coastal and lake communities to become underwater farmers. Boosting the connection of our technology with sustainable seaweed and seashell farming, improving the impact of fish farming.

- How has your work at Ocean Reef influenced your development and engineering work for Nemo's Garden?

Without the ability to communicate, operate comfortably underwater, Nemo's Garden innovation cycle would have been duplicated in duration. Our knowledge of underwater physics, interaction with electronics, communication systems and ability to marinize technology at a reasonable price has taken us to where we are today.

- What lessons could be applied from the development of scuba gear to your Nemo's Garden project.?

Build stuff to be tough, saline resistant, pressure resistant, comfortable, and easy. Make gear that is adaptable to different working scenarios. Rules that apply to our scuba gear, also apply to Nemo's Garden.

- Will you sell this as a product/technology, or would you offer it as a service?

We will do both.

- What challenges will exist in trying to produce agriculture in bulk?

Maximization of produce output. Stabilization of produce output. Fresh water provision calculation/stabilization. Reduction of specialized human operations/ cost reduction.

- How will you assure the safety of the people that you use to support and service the equipment?

  By using our full-face masks and communication systems as well as simulating through Siemens technology maximum stress bearing of the structures and LCAs.

- What are you looking for when working with technology partners?

  Freedom & vision. A technology partner that can invest in research, in innovation with an organizational structure that values forward thinking, that promotes out of the box thinking

and has the means to significantly support us in reducing the innovation cycle through real life condition complex simulation is the best possible partner.