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Siemens enables underwater farming revolution with digital twin solutions

- **Siemens' Xcelerator digital twin of Nemo's Garden sustainable sub aqua biosphere enables team to iterate design and test at massively accelerated rate.**
- **Easy to access digital transformation empowers small, specialized team to take advantage of enterprise class product innovation toolsets.**
- **MindSphere® enabled machine learning algorithm deployed to Industrial Edge computing devices allows remote monitoring, process automation and feeds back into design.**

Siemens Digital Industries Software today announced that Nemo's Garden, a startup focused on sustainable underwater cultivation of crops, has deployed Siemens' Xcelerator portfolio of software and services to shorten its innovation cycles and move more rapidly towards industrialization and scale.

Nemo's Garden was founded in 2021 by Sergio Gamberini, President of Italian scuba diving equipment manufacturer, Ocean Reef Group, and his son, Luca Gamberini. Their team of engineers, divers and scientists have been working to prove the viability of cultivating herbs, fruit and vegetables underwater. Nemo's Garden's key innovation, a sub-aqua biosphere, is a unique type of underwater greenhouse, able to harness the positive environmental factors of the ocean – temperature stability, evaporative water generation, CO_2 absorption, the abundance of oxygen and inherent protection from pests – to create an environment ideal for crop cultivation.

The team has not only successfully harvested a variety of crops from its prototype biospheres, but also discovered that plants grown in this environment are nutritionally richer than those grown traditionally. The next big hurdle in achieving

their goal was to turn this prototype into a solution that could be deployed globally; however, they didn't want to wait another 10 years to make that happen.

Harsh winters, short summers and initial seafloor-use permit limitations capped Nemo's Garden to one growth cycle a year, which has meant only one innovation cycle per annum. Design changes, lengthy physical testing and heavy manual monitoring processes during the growth cycle led the Nemo's Garden team to seek out ways to speed up their innovation and scale the operation. The team reached out to TekSea's Matteo Cavalleroni for insight on how to leverage cutting edge technologies to achieve their goals. After the initial consultation, Siemens was invited to join the project, leveraging the Xcelerator portfolio of software and it's services to help Nemo's Garden get to the next stage of development and get ready for industrialization/commoditization.

"When I first saw Siemens' digital twin technology, I was mesmerized. Nemo's Garden is a one-of-a-kind system and we need to adapt to each environment where it is to be installed. If you can model that environment virtually before you start, you can foresee the challenges and address them in the best way," said Luca Gamberini, Co-Founder, Nemo's Garden. "We have seen benefits in understanding the flow of water around the shapes of our biospheres. We have a greater understanding of the points of stress on the structure around the biospheres. We also understand how the different interactions of the solar radiation, the temperature and all the physical factors, act on the plants. All thanks to the ability of the digital twin to replicate our system."

A comprehensive digital twin of the Nemo's Garden biosphere has been built that encompasses not only its design evolution using Siemens' NX™ software, but also enables simulation of the growing conditions within it, the impact of the equipment on the body of water, as well as the full environment in which they are installed – all accomplished using Siemens' Simcenter™ STAR-CCM+™ software. The Nemo's Garden team are no longer limited by weather conditions, seasonality and short growing seasons or limitations on diving and monitoring. Adaptations to the biospheres can be tested in the virtual world, enabling the team to refine the design at a massively accelerated rate.

Monitoring at the edge

In addition to engineering the physical biosphere, Nemo's Garden also needed to optimize and scale the processes for growing, tracking, and harvesting the plants. To create a sustainable business that did not rely on sending trained divers to collect data, a fully digital, automated approach was created that drew on Siemens' extensive experience in leveraging software to automate traditional farming practices.

Existing video of the growing cycles along with reference data from traditional farming operations of the same target crops, at various growth stages and health conditions was analyzed using Siemens' MindSphere service. From this, Siemens was able to train a machine learning algorithm to monitor plant growth as well as the environmental conditions within the domes.

When this algorithm is deployed onto Siemens' Industrial Edge computing devices in each biosphere, the plants can be monitored via a cloud-based dashboard throughout the season, from anywhere, in real time. Next season, these Industrial Edge devices will be connected to actuators – to automatically adjust air circulation, humidity, irrigation and nutritional dosing throughout the whole season. This will be the foundation of a global agricultural service, optimized for subsea operations and tuned for each of the world's oceans.

Through true adoption of digital transformation, Nemo's Garden has taken something that began as a light-hearted challenge over dinner with friends and are turning this unique concept into a commercially viable subsea farming platform that can sustainably be deployed globally. While the newly designed biospheres will not be deployed until the next growing season, thanks to the comprehensive digital twin of the growing environment the team continues to push forward with plans to further optimize their designs and automate their processes for global deployment.

"Digitalization isn't only for big companies, it is for all companies. In fact, great gains can often be realized in smaller or start-up companies. The work we do with startups can amplify the impact they have on the world, aiding in and speeding up innovation," said Eryn Devola, Vice President of Sustainability, Siemens Digital Industries Software. "It is easy to get excited when you we find a passionate team

with human-centered technology that is working to feed people while having a positive impact on the environment."

Siemens Digital Industries Software is driving transformation to enable a digital enterprise where engineering, manufacturing and electronics design meet tomorrow. The Xcelerator portfolio helps companies of all sizes create and leverage digital twins that provide organizations with new insights, opportunities and levels of automation to drive innovation. For more information on Siemens Digital Industries Software products and services, visit siemens.com/software or follow us on LinkedIn, Twitter, Facebook and Instagram. Siemens Digital Industries Software – Where today meets tomorrow.

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Siemens Digital Industries (DI) is an innovation leader in automation and digitalization. Closely collaborating with partners and customers, DI drives the digital transformation in the process and discrete industries. With its Digital Enterprise portfolio, DI provides companies of all sizes with an end-to-end set of products, solutions and services to integrate and digitalize the entire value chain. Optimized for the specific needs of each industry, DI's unique portfolio supports customers to achieve greater productivity and flexibility. DI is constantly adding innovations to its portfolio to integrate cutting-edge future technologies. Siemens Digital Industries has its global headquarters in Nuremberg, Germany, and has around 76,000 employees internationally.

Siemens AG (Berlin and Munich) is a technology company focused on industry, infrastructure, transport, and healthcare. From more resource-efficient factories, resilient supply chains, and smarter buildings and grids, to cleaner and more comfortable transportation as well as advanced healthcare, the company creates technology with purpose adding real value for customers. By combining the real and the digital worlds, Siemens empowers its customers to transform their industries and markets, helping them to transform the everyday for billions of people. Siemens also owns a majority stake in the publicly listed company Siemens Healthineers, a globally leading medical technology provider shaping the future of healthcare. In addition, Siemens holds a minority stake in Siemens Energy, a global leader in the transmission and generation of electrical power.

In fiscal 2021, which ended on September 30, 2021, the Siemens Group generated revenue of €62.3 billion and net income of €6.7 billion. As of September 30, 2021, the company had around 303,000 employees worldwide. Further information is available on the Internet at www.siemens.com.

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