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# Planning for the Future – Towards a Virtual Twin of the Ocean

Spatial Planning Support Systems help policy-makers and planners of spatial infrastructures in all stages of a planning process with geo-spatial analysis and simulation. Advanced systems such as the TYGRON Geo-design platform also use game-technology and game design to support the interaction and learning of politicians, planners, stakeholders, and citizens. [1] They are the **Flight Simulators** of spatial planning. A **SimCity for Real**. And increasingly rebranded as **Digital Twin** (DT).

A Digital Twin refers to a **digital replica** of a **reference object** that already exists in reality or can be foreseen to exist in the future. The digital replica is based on a set of (accurate) data derived from the reference object, and a means to dynamically update or adjust the data if and when the reference object itself changes. Changing the digital replica parameters should accurately predict and evaluate the reference object's behavior in the real world [2]. Claims about **data accuracy**, **high fidelity**, and **external validity** make a Digital Twin significantly distinct from models and simulations in a generic sense.

Digital Twins now widen their scope from artifacts such as a medical instrument to **complex systems,** like cities and oceans. **The EU project Destination Earth** [3] even calls to develop a Digital Twin of the entire Earth.

This aggregation jump takes the underlying philosophical questions and the technical challenges of Digital Twins to an entirely new level. It requires serious (re)thinking how we can, want, and should (not) use Digital Twins.

It would be a mistake to consider this as merely a challenge for data-scientists and systems engineers. I firmly believe we should look at game-technology and game-design for some of the answers, alongside ethics and political science.

## A Virtual Twin for Maritime Spatial Planning

Human activities at sea, such as offshore wind farming, shipping, and fishing, quickly get into each other's way. And they have a long term impact on the marine environment. In 2014, the EU Parliament and the Member States agreed on the Maritime Spatial Planning (MSP) Directive (2014/89/EU). This Directive lays down obligations for the EU Member States to establish a maritime planning process, resulting in a maritime spatial plan by March 2021.

Support systems for planning human activities and ecology at sea are more recent and less developed than terrestrial planning [4]. There is ample room for innovation in this area. In its Green Deal, the European Commission recently called for proposals to develop a Digital Twin of the Ocean. [5]

By whom and for what purpose can such a Digital Twin of the Ocean be used? How are societal and ethical considerations taken into account in the design and engineering? Can policy-makers interact and learn from those systems, even if the answers are not straightforward or unequivocal? (How) do we act upon what the Digital Twin tells us?

With this in mind, we have recently investigated the development of a Virtual Twin for the North-Sea.

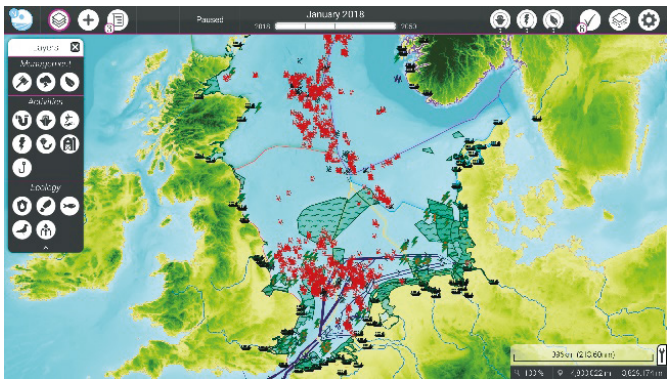

**Figure 1 Digital Twin for the North Sea (in interactive game-platform)**

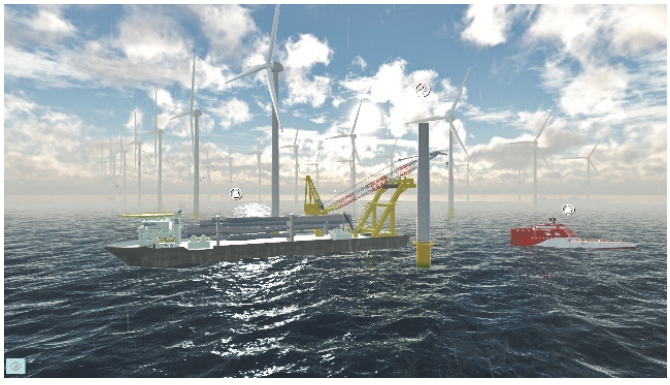

**Figure 2 Virtual Twin of the North Sea (in Virtual Reality)**

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Maritime Planning in 202?. Dutch and German planners have designed a wind farm in their part of the Doggerbank area in their planning support system. The planners expect broader impacts than on energy alone: ecosystem pressures – noise, surface disturbance, artificial substrate – as well as interference with shipping routes and commercial fishing. They receive a message in the geo-system: Ready to XP! Sara puts on a Virtual Reality-headset and picks up the VR controller. She finds herself high above the planned wind farm area, as if in a helicopter. It looks very realistic. She sees many wind turbines spaced apart evenly and hears them rotating. Bustling shipping routes; maintenance ships go in and out, and fishing vessels. Now she goes underwater. Quite some noise from the turbines and ships. How far the sound carries. Cetaceans seem to be moving away from the noise. Clams grow on the pylons, schools of fish that do not seem bothered by the underwater noise. Coming up, she clicks on an icon above a turbine. This displays information about the turbine, type, capacity, maintenance. She notices more options to view the turbine from the inside, select the engine only... Hmm, let's change to a futuristic new turbine that combines wave and solar energy. She clicks on a button in the shape of an ear. An expert starts to explain this radical innovation, how it works, and when available. She asks one of her team colleagues to adjust parameters in the simulation platform. There you go. She sees that one of her team members has now joined in VR. They discuss what they see and come up with adjustments. Too close to the shipping routes. They should recheck the heat maps and indicators. Anyway, the VR world display is nearly ready for the consultation process. The next step, arrange a virtual tour with the planners from other countries. And to show the general public how impressive and vital the North Sea is

Two demonstrators for realizing the above scenario have recently been realized: a VR-application for the Doggerbank (a shallow area in the heart of the North Sea) and an Augmented Reality application for the Amalia Park wind farm, just of the Dutch Coast.

The demonstrators are based on the same data-set, and simulators for the North Sea in a game-based planning support system named the MSP-Challenge simulation platform [6]. In the MSP Challenge simulation platform, planners and stakeholders see the entire sea region and review many different data layers to assess the current status. They develop plans for future uses of sea space over several decades. The consequences of the decisions for energy, shipping, and the marine environment are simulated and visualized in indicators and heat maps. The VR platform demonstrator uses state of the art game AI and a library of 3D objects, such as wind turbines or marine life, to rapidly generate 3D worlds and world scenes, such as described above. Not yet as sophisticated as in the script above, but also not so far from it.

## References

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