©Port of Rotterdam

The Port as Habitat

A bio-inspired view on robotics and ports

Ing. M.H. van Dijk, MSc.

Full text of lecture presented at the TUS Expo Conference, April 21st, 2017, The Hague [NL]

In the early days, port operation was pretty straightforward. The cargo was carried manually over gangways to the quay, with the main challenge being: Watch out and carry on!

Over the years, ports have evolved into the centres of technological highlights, with efficiency as their contemporary challenge. Fortunately technological progress brought us the new materials and computer power needed and sensors that can now see, hear, feel, smell, taste. This resulted in automated and autonomous systems like control systems, navigation, collision avoidance and motor management, realising reduction of transport costs and maximization of throughput. And with these technologies at our disposal, our daily activities are also taken over by wireless, remote controlled, auto piloted and smart systems. Increasing automation and autonomous products ease up our lives. Or does it?

Extract-and-dump

It was mainly competition that pushed this technological progress, resulting in the so-called extract-and-dump model. We produce using high heat, high pressures, corrosive chemicals, resulting in disposable products we do not really need, in amounts we cannot handle, generating everlasting waste and with most of the environmental damage done before the products reach the consumer.

On the contrary, in nature everything is manufactured at life friendly conditions, using only materials locally available and producing no waste, resulting in materials we are still jealous of, like:

- Spider silk: a waterproof fibre five times stronger than steel
- Abalones nacre: twice as tough as ceramic and when stressed it behaves like a metal
- Mussel adhesive, which works under water and sticks to everything or
- Rhino horn, which contains no living cells, but is able to repair itself.

Nature's Solutions

Fortunately we sometimes do look at nature's solutions. Like the Festo Corporation, which developed a flexible gripper arm based on the power and subtlety of an elephants' trunk. Or the way Interface solved the problem of matching carpet tiles, by looking at leaf covers and the shape of the kingfisher's beak, which provided the solution for the sound bang the Japanse Shinkansen high-speed train produced when entering a tunnel.

These are only a few examples of the vast amount solutions we copied from nature. Besides copying, nature's principles can also function as an inspiration for businesses. Like the multidisciplinary and binding power of mycelium, that sleeps underground until it is the right moment to grow mushrooms, either to kill (parasite), clean (saprophyte) or exchange (symbiosis) nature's products. Meanwhile the mycelium functions as a glass fibre network for communication between trees in case of attacks or other misfortune (Benyus, 1997) (Hasselt & Romanesco, 2014) (Poelman, 2015). A tree with a mycelium network grows 50 times as fast as trees without.

Or the way ants in a colony cooperate. An individual ant is a rather dumb animal, but as a colony they are highly effective. A colony exists of approx. 10.000 ants, each having a different role and task: maintenance, waste management, exploring for food and collectors. Not aware of management systems or status, they fulfil the task assigned and switch roles when necessary. This ability to adapt enables a colony to withstand even the toughest conditions.

Profit and Growth

Learning from nature's principles and strategies in solving human problems is a discipline called biomimicry, also referred to as: innovation inspired by nature or bio-inspired innovation. With over 3.8 million years of experience, nature provides us the principles and solutions for not only our technical challenges, also for our issues with sustainability, resilience and inclusion.

This is basically due to the fact that nature and humanity work with different business models and survival strategies. We strive for profit maximization and believe in the awkward notion there is such a thing as endless growth.
The 'business model' within nature is aimed at a right balance for survival with a cost-benefit ratio expressed in energy. Ever seen a lion catch more than one gnu because they are 'at his disposal'?

A similar thing is happening with survival strategy. Although in nature and humanity's (eco-) systems to survive means growth, in nature it is aimed at preservation of the species, where humanity considers growth as an end in itself.

Control

Preservation means coping with changing conditions. The ability to adapt is one of nature's greatest strengths and proved to be the ultimate survival strategy: survival of the fittest. By being adaptive, ecosystems are able to control the demands of a changing environment. But the way organisms interact with their environment is still far ahead on computers. The brain is able to gather all the information it considers essential for assessing situations. It can instantly see connections, recognize patterns and establish relationships, providing insight and overview of complex situations, considering options and decide accordingly. Yet we approach control as something to be achieved by sensors, computers and robotics. We even refer to them as 'smart' and ascribing them intelligence.

The 4th industrial revolution is opening the ways for Machine Learning and Deep Learning. Although promising, machine learning is still based on processing algorithms and data to learn how to preform a certain task in a certain environment. And compared to a human brain where billions and billions of neurons can make random connections with other neurons, Deep Learning is still bound to discrete layers, connections and directions[1]. And robots make decisions depending on their tasks, circumstances and goals. Robots are then still to be considered as linear processing systems, able to perform a repertoire of tasks in stable and predictable conditions, based on code provided by their programmers. Nonetheless, professionals are more and more replace by robots. But to completely rely on technology in replacing human tasks, ignores the fact that it also replaces tasks not immediately thought necessary. So where in nature control is the power to adapt, we approach control as something to be left to technology.

Bio-inspired Innovation

Although smart and intelligent systems prove to be very useful in our society, technological progress left us confronted with rigidity and exhaustion. For the port it means challenges like energy transition, reduction of CO2 emissions, clean ships and bio-based and bio-friendly industries. This asks for innovation and the power to adapt to these changing conditions. And as we have seen, nature offers a rich collection of strategies and solutions ready to apply. Bio-inspired innovation is key in tackling these challenges and realise a port really fit for the future.

So, if we approach all ships, workers, terminals, robots etc. as organisms and the port as their habitat, we could ask ourselves; what would nature do?

[1] https://blogs.nvidia.com/blog/2016/07/29/whats-difference-artificial-intelligence-machine-learning-deep-learning-ai/

References

Benyus, J. M. (1997). Biomimicry. Innovation Inspired by nature. New York: HarperCollins Publishers.

Hasselt, E. J., & Romanesco, P. (2014). Van CEO naar tuinman. De rol van leiderschap in het nieuwe organiseren. Uitgeverij Atlas Contact.

Lanting, I. (2016, mei). Zegt de ene plant tegen de andere.... Roots , 05, pp. 80-82.

Pieters, D. K. (2017). The Near Future of Unmanned Vessels. A complexity-Informed Perspective. Hogeschool Rotterdam Uitgeverij.

Poelman, Y. (2015). De natuur als uitvinder, Miljarden jaren aan innovatie gratis beschikbaar. Amsterdam: Carrera.