A primer on eco-engineering [English Translation]

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1. Early Eco-Engineering

In first days of space travel, providing a food and oxygen to the human body has been one of the primary limitations. Early solutions mostly included just storing enough food/water/oxygen for a journey or providing simple chemical solutions for recycling oxygen. The first true attempts to maintain a compact, artificial ecosystem capable to sustain humans indefinitely was completed by Bayer-Bosch in 1952 with their "Kunstwaldprojekt" program. It focused mainly on specially bread ivory and certain types of fungi. Mono-cultural systems like these where at the back-bone of early colonization, but were very prone to infections and diseases and therefore needed constant maintenance. Furthermore, these early systems provided very limited food variety. This is why, since the 1970s, the general trend has been to integrate more and more lifeforms into these ecosystems and connecting the systems with each other. This process is known as Macro Eco-Engineering.

2. Micro- and macro-ecology

Eco-Engineering is generally divided into 2 categories: the micro and macro eco-engineering or micro-/maro-ecology for short. This divide is so substantial that, here on Mars, these two sciences count as two completely separate educational paths between which there is no shortage of good-natured rivalry.

While micro-ecology is mostly concerned with the development of new flora and fauna and integrating them into existing ecosystems and introduction of more efficient and more reliable tools to maintain climates and transport nutriments, macro-ecology concerns itself with integrating different ecologies with each-other and developing the infrastructure to isolate and connect these ecologies dynamically. While micro-ecology has a lot of overlap with medicine and chemical engineering, macro-ecology leans more into infrastructure development and distribution networks. It cannot be ignored that both of these are interconnected and to design and maintain a stable ecology, both these branches need to be in constant communication; perhaps more so than any other two sciences.

3. Hierarchy and Structure

For this last part, I wanted to briefly discuss the general operational structure of the martian ecosystem and highlight the complexity of introducing a simple new component. Since the whole nation is divided into MAZA (Cities/ Communities), so is the biosphere, on a certain level. Each MAZA will be self-sustainingin oxygen production and can be self-sustaining in basic food. Water needs to be distributed from a few centralized places over a dedicated and double-redundant pipeline system (and can be shipped by rail), but each MAZA has access to at least one year of water reserves in the form of ice. Even though each MAZA can provide food on it's own, food is usually transported around on the primary train network to provide adequate variety, with some places specializing in some, more complex food production.

Each MAZA has around a dozen different ecosystems which can be isolated completely. These are mostly compleate ecosystems with adequte diversity in their own right, containing flora, fungi and fauna. They can be auatic or terrestrial in nature and mimic different climates of Earth. These ecosystems are mostly completely closed of from each-other with tightly controlled transfer of atmosphere, water, soil and sometimes species occuring to control population growth of certain species. It is not unheard of that these exchanges can occur between MAZA as well.

Finally an ecosystem is divided into several subsystems. The number of these can range from 5 to a 100. These subsystems are mostly individual chambers/aquariums which are by default connected to each other, but can be isolated relatively quickly if needed. Micro-ecology divides these subsystems further into populations, cylcles and more depending on the type of environment but we will stop here.

I hope this gives a good insight into the rough nature of eco-engineering and the martian biosphere.