

Factors Affecting Human Performance in the Isolated Confined Environment of Biosphere2

After leaving Biosphere2, two of the scientists wrote and presented a paper about what they learned about living in an Isolated Confined Environment (ICE) for 2 years. Their evidence suggested several conditions that created problems within and among the Biospherians (inside the biosphere) and the Mission Control members (outside the Biosphere). Below are some excerpts from their paper that describes these problems.

“The Biosphere Diet and Crew Productivity”

The diet provided all nutrients required ...but was calorie restricted due to lowered levels of food production from low light transmission, cloudy winters and pest infestations. This led to weight loss, low energy levels, and contributed to the “irritability of the crew. There was also food stealing...”

“Lowered Oxygen and Personal Performance”

Lowered oxygen levels due to microbial respiration of the large amount of organic matter [in] the experiment’s soils, and subsequent absorption of the carbon dioxide into the concrete...led to hypoxia in several Biospherians, who reported fatigue, sleeplessness and shortness of breath....Other effects of hypoxia are difficulty in thinking and lack of judgment, both of which were reported by Biospherians when the oxygen was at its lowest (14%).

“Performance and Long Duration Isolation and Confinement”

One month past the one year celebrations the [Biospherians] reported having depression to the point of finding it very difficult to perform daily tasks that needed to be done, and several commented on a lack of motivation.... These Biospherians attributed the low point in their morale to feeling somewhat daunted or over whelmed by the prospect of entering another year’s cycle and the onset of winter. The low light levels occurring in the winter reduced food supplies and increased the rate of oxygen depletion.

Daily tasks were considered extremely monotonous, repetitive, and in some cases hard physical labor.... At least in part from being on duty 24 hours a day, seven days a week, the feeling of needing a vacation was in most people’s [thoughts] during that second winter and some reported feeling physically exhausted.

“Privacy”

In Biosphere 2 each Biospherian had a private room, which each person found very important. Each room was provided with a private phone line and e-mail, though some Biospherians felt that their communication lines were monitored by Mission Control and even resorted to encrypting their e-mail. It was understood that no-one entered someone else’s apartment without his/her prior consent”

“Mission Organization”

The mission was initially rather clear; test Biosphere 2. The management was patterned after the maritime system of a captain, boatswain, chief engineer, navigator, sailing master, mates and able-bodied seamen. The maritime management model is certainly one that in an emergency the crew of a ship on its way to another celestial body will need to [use] but it is not necessarily the best [model]. In Biosphere 2 several situations arose where this [type of management] seemed insufficient. For instance, problems arose with the functioning of Biosphere 2, as did medical questions concerning crew safety, each requiring miniature research programs to solve. Several Biospherians felt that a looser...structure allowing {better sharing of information} and independent action, would have aided the research.

“Factions Within the Crew”

Within six months after [entering Biosphere2] the Biospherians divided into two factions, management and science. [The management faction wanted to follow the original objectives, but the science faction felt that changing the objectives would result in greater scientific learning. This division...] negatively affected every aspect of the crew and was certainly the most significant problem faced by the crew. Infighting and the absence of a cohesive team reduced morale and stifled communication, thereby diminishing productivity and dangerously reducing safety.

“Stress Relief”

A necessary part of working in Biosphere 2 was finding sources of stress relief. Some engaged professional psychological advice and support... which they reported as being very effective in alleviating emotional and psychological stress. Festive occasions became an important means of boosting morale. Emotional support from friends and family was reported as crucial...Stress relief activities employed by Biospherians included creative endeavors such as writing, painting, playing music and interactive art events with participation from artists outside Biosphere 2. Most Biospherians appeared to pay greater attention to news from the outside world, and email was used ...to expand the network of people with whom they interacted on a day-to-day basis. Relieving stress was considered by many crewmembers to have a positive effect on performance.

The scientists concluded that the psychological aspects of living in an ICE were the most significant factors affecting crew safety and performance during the Biosphere 2 first two-year experiment.