Reality Check of TC Boyle's Terranauts

"Welcome to Ecosphere-2! We are going to have our first child, E-2's first child and we are absolutely thrilled!" (Dawn Chapman)….."There are 48 closures to come [of 2 years duration each] after this one and by then, in 97 years time I have no doubts we'll be doing this on Mars in earnest and for real, and all the children of E-2 (Ecosphere-2) like our son, will be pioneers to the stars." (Ramsey Roothoorp, Dawn's husband), Dawn and Ramsey proudly announced to the stunned reporters during mission two, the second 2 year closure in the ecosphere, revealing the unplanned birth of his and Dawn's baby during the "closure period". [1]
With "nothing in, nothing out", only using the hermetically sealed resources of the E-2 ecosphere and the support of their 6 fellow-terranauts i.e., 3 male and 3 female crew mates, this closely resembles the scenario of one of the Mars colonization plans predicted to happen within the next decades of our century.

This is the setup of Boyle's latest bestseller. It raised my interest from an space-operational point of view, because knowing Boyle, he has researched his subject very thoroughly and combined real occurrences with his own imagination to analyze and describe the terranaut's crew group dynamics behavior during the "next step" i.e., the giving of birth in a closed self-sustaining environment independent from Earth's.

This scenario has a very real background because the "Mars One" mission plans to establish a permanent human colony on Mars by 2025, promoted by the private spaceflight project led by Dutch entrepreneur Bas Lansdorp (see also Mission One description below). This has exactly all the ingredients which are discussed in Boyle's "Terranauts".
So let's see what the future space settlers can learn from the Biosphere-2 real missions and from Boyle's imagination – which in my judgement unfolds a very realistic scenario.

The real Biosphere-2
Biosphere 2 (or Ecosphere-2) is an Earth systems science research facility located in Oracle, Arizona. It has been owned by the University of Arizona since 2011. Its mission is to serve as a center for research, outreach, teaching, and lifelong learning about Earth, its living systems, and its place in the universe. It is a 3.14-acre (1.27-hectare) structure originally built to be an artificial, materially closed ecological system, or vivarium. It remains the largest closed system ever created.

Biosphere 2 was originally meant to demonstrate the viability of closed ecological systems to support and maintain human life in outer space, with a first mission of eight humans to be enclosed for two years in the Biosphere. Additionally, it served to explore the web of interactions within life systems in a structure with five areas based on biomes, and an agricultural area and human living and working space to study the interactions between humans, farming, and technology with the rest of nature. It also explored the use of closed biospheres in space colonization, and allowed the study and manipulation of a biosphere without harming Earth's. Its five biome areas were a 1,900 square meter rainforest, an 850 square meter ocean with a coral reef, a 450 square meter mangrove wetlands, a 1,300 square meter savannah grassland, a 1,400 square meter fog desert, a 2,500 square meter agricultural system, a human habitat, and a below-ground infrastructure. Heating and cooling water circulated through independent piping systems and passive solar input through the glass space frame panels covering most of the facility, and electrical power was supplied into Biosphere 2 from an onsite natural gas energy center.

Biosphere 2 was only used twice for its original intended purposes as a closed-system experiment: once from 1991 to 1993, and the second time from March to September 1994. Both attempts, though heavily publicized, ran into problems including low amounts of food and oxygen, die-offs of many animals and plants included in the experiment, squabbling among the resident scientists and management issues.

In June 1994, during the middle of the second experiment, Space Biosphere Ventures dissolved, and the structure was left in limbo. It was purchased in 1995 by Columbia University, who used it to run experiments until 2005. It then looked in danger of being demolished to make way for housing and

retail stores, but was taken over for research by the University of Arizona in 2007, the University of Arizona assumed full ownership of the structure in 2011 [2]

Boyle's fictional characters Dawn Chapman and Ramsey Roothoorp and the other six "Terranauts" mission-2 crew members were inspired by members of the real mission-1 crew, in fact Jane Poynter and MacCallum, who were dating when they entered Biosphere 2, married nine months after leaving it. [3]

The Mars One Mission

The Mars One organization has proposed to land the first humans on Mars and to establish a permanent human colony there by 2025.

Mars One consists of two entities: the not-for-profit Mars One Foundation, and the for-profit company Mars One Ventures. The Mars One Foundation, based in the Netherlands, implements and manages the mission. Mars One Ventures holds all monetization rights, including broadcasting rights.

The private spaceflight project is led by Dutch entrepreneur Bas Lansdorp, who announced the Mars One project in May 2012
Mars One's original concept included launching a robotic lander and orbiter as early as 2020 to be followed by a human crew of four in 2024 and one in 2026.

Organizers plan for the crew to be selected from applicants to become the first permanent residents of Mars with **no plan of returning to Earth**.

Partial funding options include a proposed television documentary program documenting the journey.

The project's schedule, technical and financial feasibility, and ethics, have been criticized by scientists, engineers and those in the aerospace industry.

In February 2015, the primary contractors on the initial pre-Phase-A contracts had completed all studies paid for by Mars One at that time. The current state of the Mission Plan Deliverables (either in the form of studies or actual hardware) will be tracked in a dedicated technology section. The Mars One organization is the controlling stockholder of the for-profit Interplanetary Media Group. [4]

The Terranaut's Operations Scenario

Crew Selection
- Professional crew selection according state-of-the art methods as used for astronaut selections are applied. Due to the nature of the Eco-mission a "crew bonding" technique was developed through long training and extended joint preparatory field and expedition periods in the rain forest and on secluded islands. However this could not prohibit "fall out" of the crew during critical periods.

Mission Management and Control
- Publicly funding and sponsors were used during the two real Biosphere-2 missions – with the described "real" funding and management problems, which might be very applicable for a mission like Mars One as well.
"On April 1, 1994 a severe dispute within the management team led to the ousting of the on-site management by federal marshals serving a restraining order, and financier Ed Bass hired Stephen Bannon, manager of the Bannon & Co. investment banking team from Beverly Hills, California, to run Space Biospheres Ventures. Some Biosphere-ites were concerned about Bannon, who had previously investigated cost overruns at the site". [see also 2]
- Due to resource problems a single tier crew assignment was used, the real Biosphere missions hand only a "single tier" assignment for all the tasks inside the ecosystem-2 with the appropriate problems. Redundancies or backup crews during a real Mars mission might not be planned either with the implication of creating similar problems.
- A "CapCom" as in human spaceflight missions is described in the book also, however this person is not entirely serving in the interest of crew but in the interest of Mission management to satisfy a successful interface with the sponsors and for PR reasons.
- An interesting feature was used for PR and "bonding" purposes between the crew and mission

control: during special occasions like the Christmas PR event, both the crew and the outside mission controllers played the same piece inside and outside of the Ecosphere for the visitors. In the book, the success does not become clear.
- A “reentry” problem “of the terranauts after completion of the mission for “cashing in the chips” (?) is described for the terranauts: They only have two options, they either might be able to stay within the system (not guaranteed) or try to market their “fame”. No provisions are foreseen by the management. Of course this problem does not exist for the Mars One scenario, however might apply for returning explorers like the missions to Mars planned by SpaceX [5]

Group Dynamics
- Emergency behavior: As experienced by the real crew-1, the “bonding” of the crew fell apart at the first real life threatening emergency (CO_2 level problems within E-2). This is also picked up by Boyle in a fictitious power emergency. This might also be a problem for potential “space settlers” which must not be underestimated.
- Romance, love and sexual harassment. A wide field-little explored so far – with the exception of a couple of published occurrences: one incident of sexual harassment was reported during the 110 days simulated trip to Mars in Russia (Sphinx 99 simulation). On December 3, 1999 Judith Lapierre, a 32-year-old Canadian health sciences specialist and astronaut candidate, arrived in Moscow to join two other prospective astronauts, one from Japan and one from Austria, who planned to spend 110 days in the module, alongside four Russian men who had already been inside for six months. She was the only woman. "We should try kissing, I haven't been smoking for six months," Lukyanyuk told her. "Then we can kiss after the mission and compare it. Let's do the experiment now." then attempted to yank her out of the line of sight of the two cameras. He aggressively kissed and manhandled her twice, even as she protested loudly. [6]
Or the “Oefelein” incident: Police in Orlando, Fla filed charges against Captain Nowak, saying they had evidence that Captain Nowak intended ”to do serious bodily injury or death” to Colleen Shipman, a captain in the Air Force, because she considered Captain Shipman to be a rival in her romance with a fellow NASA astronaut, Cmdr. Bill Oefelein. [7]

This is where the merits of the novelist Boyle come into play. Boyle weaves the known facts from astronaut training with the not suppressible human emotions like ambition, egoism, envy, dedication, friendship, romance, love, sexual longing which cannot be fathomed by the even most sophisticated crew selection processes into a plausible story culminating in the unthinkable: giving birth to the first baby outside our own ecosystem, the Earth.

It has to be said that the E-2 experience is not a complete “analog” simulation, because the possibility of “returning to Earth” was always an ultimate solution.

Therefore my final conclusion for the Mars One or any other mission for terraforming and settling planets is, it will not be sufficient to send “installation” and settling crews and start populating the new environment. Having survived the perils and dangers for the human body and soul of getting and landing on another planet – the unpredictable development of the specific group behavior will be another tough problem to be solved. My conclusion as derived from Boyle’s “Terranauts” scenario is, that in 97 years from now no other planet will be “settled” yet by humans– in particular not with a publicly sponsored mission like Mars One.

Boyle again delivered a bestseller about a very actual and relevant subject – not only interesting for literary oriented clients but also for the large eco- and environment oriented community, the space exploitation enthusiast and for readers concerned about the current environmental problems on Earth and the possibilities to influence our future for the better or just to get smarter on the subject.

However this book is dearly recommended to all potential Mars One candidates, and there are thousands – to read it thoroughly before they decide to embark on a mission like that.

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