Autonomous Refuges via Ectogenesis for Mitigating Existential Risk

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Abstract

A number of studies propose mitigating existential risk with refuges, i.e. self-sufficient shelters populated by a small number of humans to repopulate and rebuild civilization after a global catastrophe. This paper introduces the concept of autonomous refuges via ectogenesis, or refuges that do not require any humans be present, yet can still repopulate humanity after extinction by using ectogenesis. With artificial wombs and robotic guardians, an autonomous refuge could recreate humanity many years after a complete extinction event. Autonomous refuges have a number of advantages over traditional refuges, most importantly their expected low recurring cost.

1 Introduction

As a last defense against existential risk, existential research has proposed refuges as self-sufficient shelters populated by a small number of humans to repopulate and rebuild civilization after a global catastrophe [1] [4] [7]. An example refuge would be a self-sufficient underground shelter or refurbished submarine [7].

To date, all refuge proposals require continuous habitation by living humans. We instead propose an autonomous refuge that, once activated, regrows human beings inside artificial wombs. This first generation can then go on to refound human civilization.

2 Components

The following elements are needed to build an autonomous refuge:

1. Shelter
   Shelter is needed for the autonomous refuge itself, and potentially also for the first generations after activation.

2. Ectogenesis Machine
   The ectogenesis machine is made up of artificial wombs, eggs, sperm, and the cryopreservation needed to preserve the eggs and sperm.

3. Extinction Detector
   The extinction detector is an automated method of detecting when humanity is likely extinct. This could be an active method, by checking for an expected signal sent to the refuge intentionally, or passive, by checking for signs of human life.

4. Support System
   A support system is needed for helping the first generations grow and thrive until their society is self-sufficient. Preprogrammed robots without artificial general intelligence could raise, feed, and protect the children of the first generation. Seeds could also be stored in case the robots cannot gather or hunt for food, such as after an ecological catastrophe.

5. Energy Source
   Energy is needed to power the ectogenesis machine, extinction detector, and support system robots. We propose using hydrocarbons or a gravity-based energy storage system.

With long-lasting electronics, the autonomous refuge could be completely isolated and self-sufficient. This may be possible if designed with custom electronics stored at low temperature. If long-lasting electronics is not

possible or cost prohibitive, then regular check ups would be needed, perhaps on the order of once a decade, to test and replace components that fail. Alternatively, a monitoring system could detect when components fail, and alert the managing organization to fix them.

3 Design

3.1 Shelter

To begin with, an autonomous refuge will need a shelter to contain its equipment. This shelter should also protect it from existential risks like nuclear war. It could also be used by the first generations as a home.

There are many Cold War era underground shelters that are unused and available for purchase. For example, one former missile silo was bought for $300,000 in 2008 and converted into "doomsday condos" near Witchita, Kansas [2]. Consequently, we propose an underground bunker or missile silo as the shelter.

3.2 Ectogenesis Machine

In order to restart humanity after extinction, the autonomous refuge needs an ectogenesis machine. This machine will store sperm and eggs cryogenically. When triggered, it should thaw and fertilize the eggs, then grow the first generation inside artificial wombs.

While artificial wombs are not everyday technology at present, they have been successfully used on large mammals like lambs, and it is probable that the technology will be used with humans in the 21st century. Practical uses include being used with premature babies, as an alternative to abortion, or directly creating babies without starting in a human womb. Given the large market for artificial wombs to serve premature babies, the cost for artificial wombs will likely be affordable [6].

Storing sperm and eggs over long periods of time is something fertility centers have experience with already. As long as the samples are cryopreserved at -196 C with liquid nitrogen, they should last virtually indefinitely. The liquid nitrogen, however, does not last indefinitely, due to heat transfer. There would need to be a machine to capture the liquid nitrogen and cool it back to -196 C, or an alternative method of cooling would be required. This would require an energy source, which will be discussed in 3.5.

3.3 Extinction Detector

Automatically detecting human extinction is a new requirement needed to make an autonomous refuge. In previous refuge concepts, it is assumed the humans living in the refuge would know when humans are likely extinct. Instead, the autonomous refuge needs to compute that in an automated way.

There are two main approaches: active and passive detections. Active detections require continuously sending an intentional signal that the refuge detects, for example a known signal on a specific AM frequency. This would be simplest to design, since it just requires a radio receiver with basic electronics to check for the known signal. The active detector could also be a physical switch that is expected to be pressed regularly when humans come to inspect and service the refuge.

Passive detections would check for general signs of human civilization. The simplest way to do this is likely checking a radio receiver for signals that appear like human voices or music. This is more complicated than checking for a known signal, but easily within current technology.

The extinction detector could have a delay to ensure civilization is likely extinct, and not just undergoing some temporary hardship. For instance, it could way hundreds of years, to ensure human radio does not reappear, before triggering revival.

3.4 Support System

Since babies cannot survive on their own, they'll need a support system. Developmental needs go beyond just food, water, heat, and shelter. Studies on abandoned children like those in Communist Romania's Institute for

the Unsalvageable show that bonding and affection are important for their mental development. We propose child-caring robots programmed to raise, care for, and instruct the children. These robots not be artificial general intelligence, just special purpose robots for the task at hand.

Given the advances in robots at present, and the huge potential market for child-caring robots, it is likely that child-caring robotics software will exist for purchase later this century. For autonomous refuges, these robots will need extra programming to work with in an underground shelter environment with neither adults nor civilization. This extra programming is not expected to be very complex nor require any advanced artificial intelligence.

The robots can be power charged and deployed upon activation of the autonomous refuge. Care must be taken to ensure their electronics do not degrade over long periods of time. It's likely this could add to the cost by requiring more advanced electronics, compared with an off-the-shelf purchased robot.

3.5 Energy Source

In order to operate, the autonomous refuge will need a long-term energy source. The requirements of this energy source are that it can store modest amounts of energy and that it can last over long periods of time with little energy loss.

Hydrocarbons are commonly used today as fuel for backup generators to generate power. Since hydrocarbons are long lasting, they could be used as a large energy source for the autonomous refuge, assuming there is some outlet for the exhaust to escape.

A generator could generate large amounts of energy, perhaps needed for the support system after the catastrophe. However, it's not ideal for ongoing power to detect whether a global catastrophe has occurred, or for other ongoing power needs before the revival event. For these cases, we propose using a gravity-based energy storage system. These work by storing large masses at some height, then generating energy by lowering the mass while capturing work done. This energy source is long lasting, environmentally friendly, and can be used gradually for ongoing power.

Another option is solar or wind power, however this would lessen the types of existential risk the autonomous refuge could protect against. For example, an environmental catastrophe could blanket the atmosphere, limiting the usefulness of solar power.

4 Discussion

An autonomous refuge in an underground bunker would protect against threats including asteroid impact, nuclear war, and pandemics, assuming the pandemic dies out after destroy all its hosts. It would not provide sufficient protection against hostile artificial general intelligence, since a hostile agent could seek out and destroy underground shelters, but the shelter would protect against the more likely scenario of humans being outcompeted to extinction. By analogy, many animals have gone extinct due to anthropogenic loss of habitat and pollution, even though humans did not explicitly hunt or kill them. An underground shelter may protect against this type of extinction risk.

If the parts used are long-lasting, autonomous refuges could be built without requiring any ongoing support or interaction with civilization. This is important because it makes them more resilient against certain existential risks. For example, a shelter with humans coming and going regularly is at greater risk of sabotage or accidentally harbouring a pandemic virus than one without any humans whatsoever. Second, they could be created by a small group in secret, with the group destroying all records of its location after the fact. This could help make the refuge more resilient against destruction from human adversaries such as a doomsday cult.

The idea of using embryos instead of humans to accomplish one's goals has been proposed in another research area: space colonization. Called ESCAPE, for Embryo Space Colonization to overcome the Interstellar Time/Distance Bottleneck, the plan is to send embryos to habitable planets, which can be used to start a new civilization [5]. This paper shares a lot of similarities with ESCAPE, but takes place on Earth for the purposes of restarting civilization after a global existential catastrophe.

5 Conclusion

Humanity's ever increasing technological capabilities are like a sword of Damocles threatening our survival: at any moment, a global catastrophe could destroy our entire species. One hedge against existential risk is the refuge, a self-sufficient shelter populated by a small number of humans to repopulate and rebuild civilization after such a catastrophe. Expanding upon the refuge, this paper proposed an autonomous refuge without humans, but with the capability to autonomously recreate humans via ectogenesis. An autonomous refuge presents certain advantages over human-populated refuges, including better protection against certain threats, and lower recurring costs. As of 2021, the technology needed to create an autonomous refuge is not yet developed, but is likely to be developed later this century. We look forward to the future when autonomous refuges can be built, thereby reducing the chance a global catastrophe would result in the permanent annihilation of humanity.

6 References

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