Seasteading

A Practical Guide to Homesteading the High Seas

by Wayne C. Gramlich, Patri Friedman, and Andrew Houser

2002

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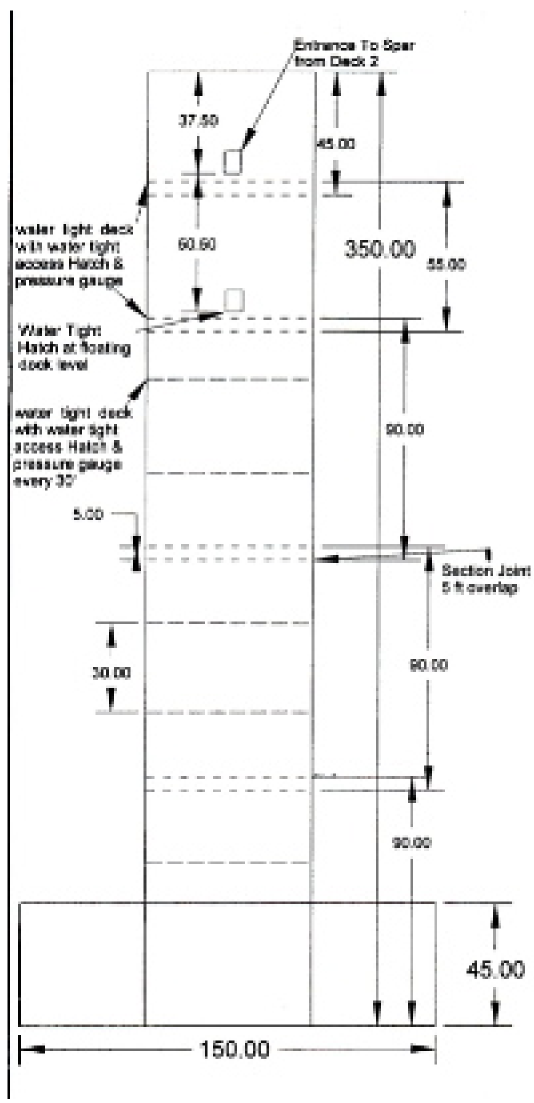


Seasteading: Title

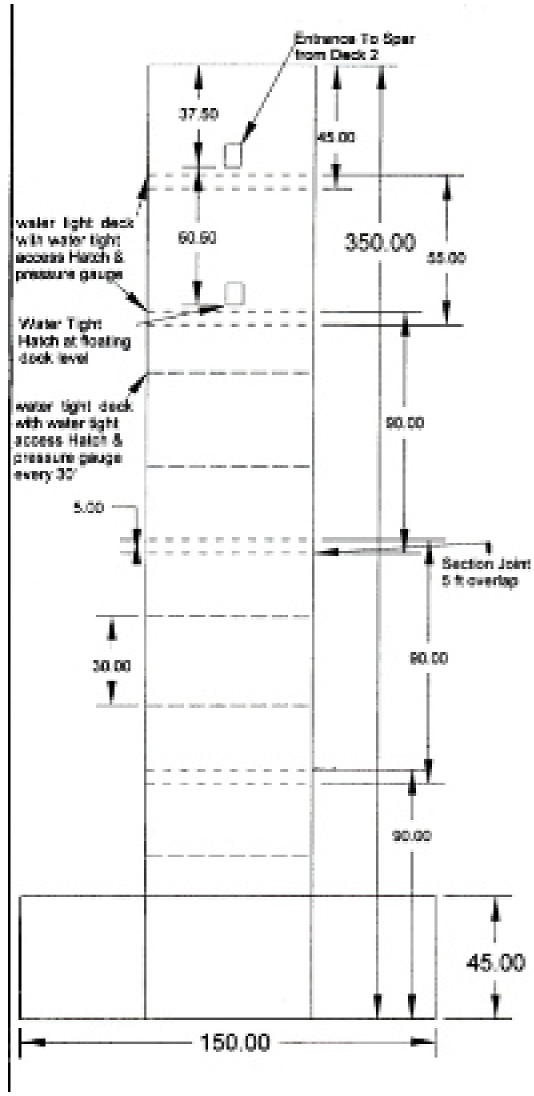
Seasteading: A Practical Guide to Homesteading the High Seas

by Wayne Gramlich, Patri Friedman, and Andrew Houser

Work in Progress, 2002-2004

Abstract

A seastead is a structure designed specifically for permanent living on the ocean's surface. There are many aspects to designing such structures, including motivation, engineering, infrastructure, and project planning. The primary motivations for living on these structures are a desire for political and/or religious freedom, a more environmentally sound way of life, and the sheer adventure of it all. A seastead must be able to withstand strong waves, winds, and currents. We describe previous attempts at ocean occupation and several possible designs. Our top choice is based on a hollow vertical tube, called a spar. A ballasted flotation hull is attached at the bottom and a living platform is attached at the top. The spar keeps the hull well below the waves and the platform well above them. The residents will also require food, water, and energy. Energy comes from a combination of solar, wind, wave, and diesel generators, water comes from collected rainwater, solar distillation, and reverse osmosis, and food from hydroponics and high density "victory gardens." We advocate an incremental development model based on niche markets and prototypes, rather than a single large and financially risky project. COMMENTS (3)



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{ Is this summary-type introduction too boring? Can it be spiced up, or should a different technique be used? I tried to keep it interesting by specifically mentioning some of the colorful aspects of later sections, rather than just meta-describing them. Did it work?} COMMENTS (0)

Introduction

General

Mark Twain: "Buy land. They've stopped making it." COMMENTS (0)

Seasteaders: "Memo: Production Resuming." COMMENTS (0)

In this paper, we'll demonstrate that a combination of technologies has finally given the lie to Mark Twain's famous line about the real estate business. Imagine the tremendous possibility of being able to create new acreage on the vast and empty oceans. The environment may be less friendly, but the increased freedom will appeal to a motivated minority who are fed up with terrestrial politics. These aquatic pioneers will settle civilization's next frontier through the unusual merger of green technology and free enterprise. Once there, they will experiment with new social, political, and economic systems, adding much-needed variety and innovation to the stagnant business of government. COMMENTS (0)

As the earth's population steadily increases, so does the pressure to open new frontiers. While the oceans have long been used for transportation, this book is an extended thought experiment about how they could support permanent settlements. Considering these issues will be invaluable no matter which way humanity next expands. In particular, the ocean bears some definite similarities to space: the final frontier, which will surely be an important part of our near future. COMMENTS (0)

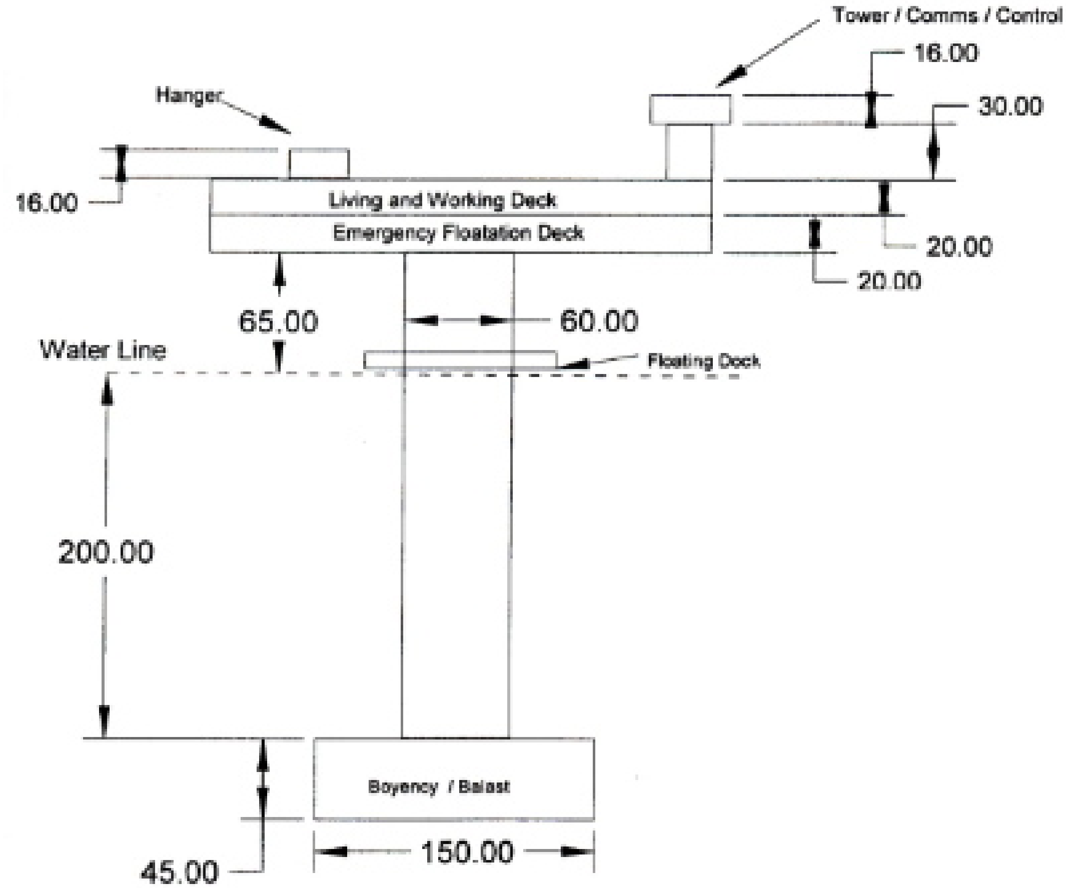
For background, we'll review the conventional water-based lifestyles like floating homes, sailboats, cruise ships, and oil platforms. You'll also learn about some of the other ways people have successfully leveraged international waters for political freedom, like the european pirate radio movement of the 60's and 70's. We'll describe some of the scores of colorful new-country projects proposed and attempted over the years. While the ideas are wide-ranging, including ships, reefs, spars, hexagonal cells, reeds, and tetrahedrons, they all share one thing in common - utter lack of success. COMMENTS (0)

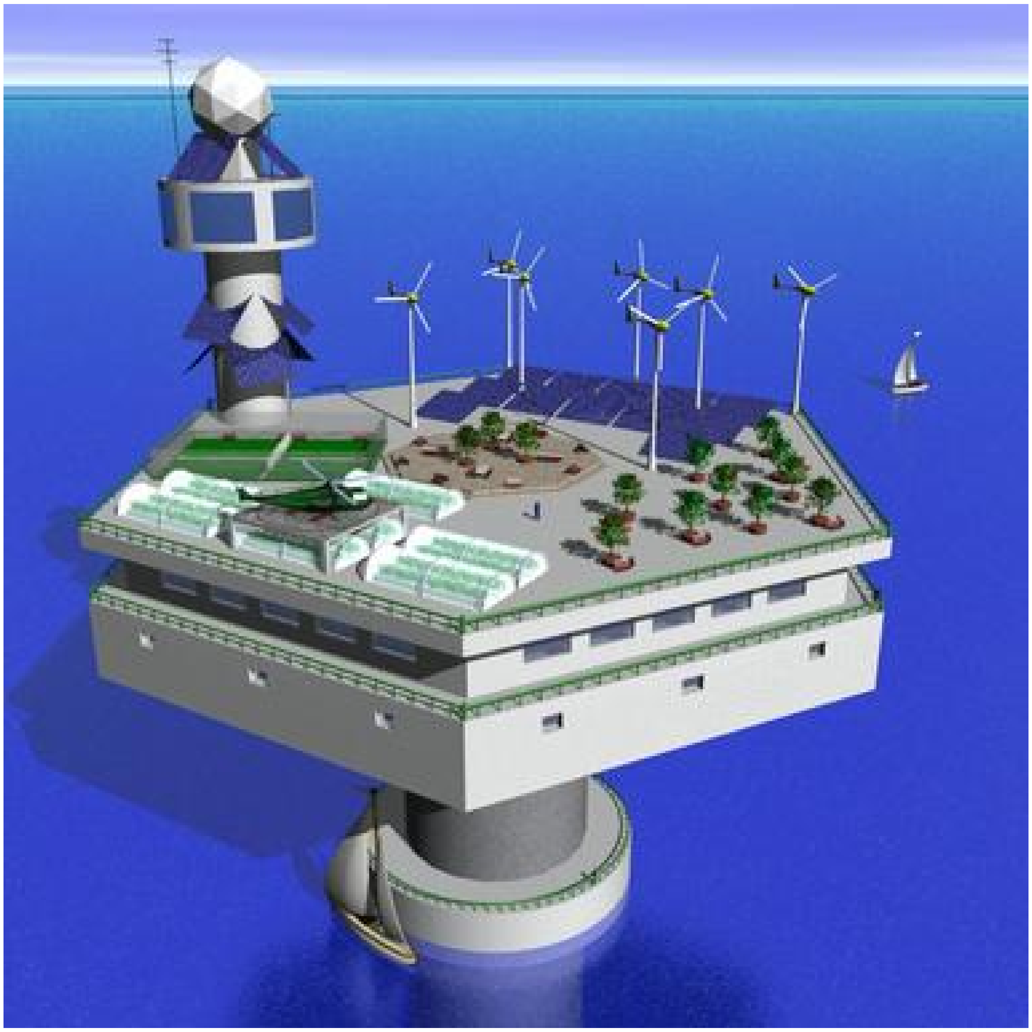
While this is an unfortunate trend, we'll explain how we've learned from these past mistakes. Far from being dreamy-eyed utopians, we are serious planners with realistic principles for bringing this strange vision to life. This realism dictates an incremental approach, modest political goals, reliance on mature technology, self-financing, and a willingness to make compromises. COMMENTS (0)

While we're practical-minded and most of this book is dedicated to the **how** of seasteading, its crucial to also explain **why** people are interested in small-scale sovereingty. In perhaps the most vital section, we'll outline the simple economic theory which suggests that ocean-based societies will actually work **better** than terrestrial ones. The relative ease of moving around entire buildings on the water means that political units will be dynamic, and so governments must be responsive and efficient or they will lose citizens. This effect will work automatically to improve institutions, regardless of the specific political system chosen. The ocean is not a booby prize. COMMENTS (1)

Before planning such a venture, it behooves us to understand the ocean environment. This includes fearsome waves like the so-called rogues, known as the "Monsters of the Deep". Scientists are finally acknowledging that this deadly phenomenon is not just an old sailor's tale. Contrary to what you may expect, tsunamis, high winds, and small-scale pirates will prove to be little danger. The tangled morass of international maritime politics and law is a far greater concern. While current nations are likely the greatest challenge to this new way of life, we'll sketch some promising solutions. We can't reassure skeptics completely, but there are reasons to be hopeful. COMMENTS (0)

Once our goals, motivations, and obstacles are understood, we can examine designs for meeting them. We'll cover a wide variety of structures for living on the ocean, from boats to oil rigs to undersea habitats. We'll also examine some of the basic design choices which must be made. These include whether a seastead should be free floating or fixed in one place, whether to use breakwaters or pillars to stop the waves, how to make floating-cities modular, and whether to purchase new or used structures. With these considerations in mind, we'll present more detail on our preferred design, the spar platform. This structure avoids the massive energy of ocean waves by keeping its platform above them and its flotation below. In between is a thin pillar which presents little cross-sectional area to the waves. COMMENTS (1)





For the engineers and home power hobbyists, we'll outline how to provide the amenities of civilization on a floating platform. From our unique angle, we'll review the field of self-sufficient technology like solar panels, wind turbines, reverse osmosis, satellite internet, and hydroponics. Along the way, we'll debunk the myths that floating cities can be cheaply and effectively built from a material called "seacrete" or powered by OTEC generators. COMMENTS (4)

However, solving these engineering challenges is meaningless unless we can solve the substantial business challenges as well. Sure, with enough money the ocean can be made habitable. But where will it come from? How will seasteads make money? Who will want to live there? Is there a big enough market? The lack of a good incremental plan has been a major flaw in other ventures, so we must address these crucial questions with a plan for getting from here to there through a series of realistic steps. COMMENTS (0)

Notes to the Reader

Technical Detail

We must note that this book was not only written to entertain and inform, but as a practical guide and a compendium of our research. These two purposes require very different levels of detail, and so we've had to compromise.

At some points, the casual reader may find the level of detail high enough to only interest those who are actually designing or implementing such systems. Rather than getting bogged down in the numbers, feel free to skim. While we know it can be boring at times, please reflect that our diligence is an indication that our ideas are realistic. The world is full of visions, but making them into reality requires spending a lot of time on the mundane.

More technically inclined readers may find our level of detail inadequate. Calculators at the ready, they cry "Forget Review and Motivation, where are the blueprints?" (or perhaps DXF files nowadays). Our thought was that this book is already targeting a niche market, and if it consisted of a complete design for every system onboard, only our chief engineer would actually read it. Additionally, the time and energy required to explore everything in detail would greatly delay the book's completion. So our main goal is simply to make sure each potential problem can be solved and get a feel for the solution. Such readers must console themselves with the thought that a more readable book will hasten the spread of our ideas and thus the progression to a stage that involves DXF files.

Political Agnosticism

While the authors come from a libertarian viewpoint, we want to stress that seasteading is politically agnostic. We're attempting to describe (and create) an enabling technology for small-scale sovereignty. This will give many viewpoints the autonomy to experiment with their theories. We find it very satisfying to be empowering all minority political groups, not just advancing our own vision.

Since this technology enables many alternative societies, we must expect that some of them will be very, very different from each other, so we're mostly trying to give an overview of the common elements. We do have to make some occasional assumptions about the type of society to do this. Rather than getting annoyed when you see political beliefs you disagree with, try to understand that this technology will give each of us a better chance to demonstrate how well our vision can work.

Reader Commenting

This book evolved from the internet tradition of collaboration and many:many communication, rather than the traditional one:many paradigm. Rather than simply being written and then published, drafts have been available online at every stage. Furthermore, each paragraph has a mechanism for adding user comments, just like a blog or LiveJournal. Thus the book has been a continuous dialogue between authors and readers.

NOTE: Commenting has been disabled, as it got attacked by spammers. We're working on a new commenting system for the next version of the book which will be more robust. Old comments are still preserved.

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Last modified: Mon Nov 14 23:23:32 PST 2005

Seasteading: Review

Review of Similar Projects

{CENG: prev par unclosed}

In order to set the stage, we'll discuss some of the previous projects and schemes for living on the water. This will include the real, the attempted, and the merely imagined. COMMENTS (0)

Living on water is a concept that has been around for centuries. One of the earliest seastead-like structures of which we're aware is the Aztec Chinampas raft: COMMENTS (1)

> *The floating gardens of the Aztecs of Central America, a nomadic tribe, they were driven onto the marshy shore of Lake Tenochtitlan, located in the great central valley of what is now Mexico. Roughly treated by their more powerful neighbors, denied any arable land, the Aztecs survived by exercising remarkable powers of invention. Since they had no land on which to grow crops, they determined to manufacture it from the materials at hand.* COMMENTS (0)
>
> *In what must have been a long process of trial and error, they learned how to build rafts of rushes and reeds, lashing the stalks together with tough roots. Then they dredged up soil from the shallow bottom of the lake, piling it on the rafts. Because the soil came from the lake bottom, it was rich in a variety of organic debris, decomposing material that released large amounts of nutrients. These rafts, called Chinampas, had abundant crops of vegetables, flowers, and even trees planted on them. The roots of these plants, pushing down towards a source of water, would grow though the floor of the raft and down into the water.* COMMENTS (0)
>
> *These rafts, which never sank, were sometimes joined together to form floating islands as much as two hundred feet long. Some Chinampas even had a hut for a resident gardener. On market days, the gardener might pole his raft close to a market place, picking and handing over vegetables or flowers as shoppers purchased them.* COMMENTS (0)
>
> *By force of arms, the Aztecs defeated and conquered the peoples who had once oppressed them. Despite the great size their empire finally assumed, they never abondoned the site on the lake. Their once crude village became a huge, magnificent city and the rafts, invented in a gamble to stave off poverty, proliferated to keep pace with the demands of the capital city of Central Mexico.* COMMENTS (1)
>
> *Upon arriving to the New World in search of gold, the sight of these islands astonished the conquering Spainards. Indeed, the spectacle of an entire grove of trees seemingly suspended on the water must have been perplexing, even frightening in those 16th century days of the Spanish conquest.* COMMENTS (0)
>
> *William Prescott, the historian who chronicled the destruction of the Aztec empire by the Spaniards, described the Chinampas as "Wondering Islands of Verdure, teeming with flowers and vegetables and moving like rafts over the water". Chinampas continued in use on the lake*

well into the nineteenth century, though in greatly diminished numbers. COMMENTS (0)

[HydroHistory]

This design is echoed in the artificial island called Los Uros, made from marsh reeds, which floats on Lake Titicaca in Peru. Its two thousand residents are mostly fishermen. COMMENTS (0)

Currently Active Water-based Lifestyles

Current aquatic lifestyles can be placed into the following rough categories: COMMENTS (0)

Floating Homes

A floating home is exactly what its name implies -- a house built on a floating platform. There are many growing floating home communities in places like Sausalito's Richardson Bay [FloatingHomes] (just north of San Francisco on the other side of the Golden Gate Bridge.) Patri has pictures and a report from a tour of this community [FloatingHomesTour]. The Netherlands, a country which is 50% below sea level, also has a large number of floating homes. This lifestyle typically start out as a clever technique for avoiding the high cost and restrictive codes of some housing markets, but inevitably the various government agencies figure out what is going on and start to enforce building codes, property taxes and the like. Eventually, the floating homes cost just as much as any other form of real estate in the area. COMMENTS (2)

Typically these structures don't have any on-board propulsion. Also, floating homes are designed for sheltered waters, so they don't need to worry about big waves. They can be considered the floating equivalent of trailer homes. While many floating homes are built in conventional fashion by companies like [IMF], there are plenty of unique and interesting exceptions. COMMENTS (2)

In his original seasteading paper, Wayne Gramlich suggested building floating homes using two-liter bottles for flotation [Gramlich1999]. This would provide a very cheap foundation, although its suitable only for calm waters. It turns out that Rich Sowa had already used this method to build a small island off the coast of Mexico which he operates as a tourist attraction [MotherEarth2001], [Sowa]. COMMENTS (0)

Artist Andrea Zittel built a concrete island home called the Pocket Property, and anchored it off the coast of Denmark. She describes the experiment in an interview: *"When I was looking for a house, it was much more important - the plot of land, and how big it was, and how it was situated - than the actual house itself. And I've also been really interested in how we create these little private universes...It's a prototype for a particular type of lifestyle. But if I were to extend that vision I would say that it's possible that some day something like this might exist, and that people would live in these community spreads...So it's an experimental living situation, but it's not utopian , or quite as idealistic as other ones that it might relate to historically...It's like I have this fantasy of being completely autonomous and independent and at peace, not having any of the day to day problems, but then there's also this sense of isolation that comes along with it."* [PBSZittel] COMMENTS (0)

House Boats

A more mobile method of water living is the houseboat [HouseBoats], which differs from a floating home in that it contains a motor, and thus is shaped more like a boat than a platform. Again, they are designed to be operated in sheltered waters so that they do not have to cope with significant waves. Most houseboats have all of the amenities of a modest sized recreational vehicle -- kitchen, living room, bedroom, bathroom, etc. They are in fact the aquatic equivalent of RV's. COMMENTS (0)

While most houseboats are used for recreational purposes, some people have moved into them on a permanent basis. For example, there is a small houseboat community called Knight's Landing on the Sacramento River. Discovery Bay and Redwood Shores, both in Redwood City, are two more marinas where houseboats moor in the San Francisco Bay. Europe, with its large network of navigable waterways, is home to many houseboats as well. COMMENTS (0)

Moored Villages

{ Trying to get permission for good pictures. }

There are parts of the world where entire villages have been built in shallow waters. One example is the Sulu Sea, a huge shallow area in the southwest part of the Phillipines. Around Sitangkai Island, a community larger than the island is built on stilts. Amusingly, the island is used for cemeteries, so only the dead there live on land. The aquatic portion calls itself "Little Venice of the South", although the name is belied by its ramshackle, makeshift nature. Ron Gluckman's article *Real-Life Waterworld* is an interesting discussion of the area [Gluckman1996] COMMENTS (0)

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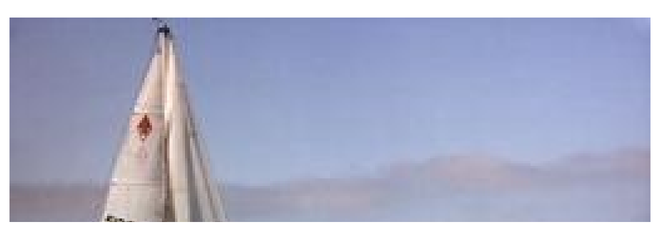
Sailboats



An ocean worthy sailboat is defintely large enough to live in. Rather than buy a house on land, some

people choose to purchase a sailboat and live onboard. Thus, when you go to a marina, there is a good chance that some of the boats in there are being used as full time residences [Moeller1977]. In many US marinas, live-aboards are limited to ten percent of all berths. COMMENTS (0)

When the boat owner has the time and resources, they can undock from the marina and go sailing. Indeed, with enough savings, they can live on the interest and spend all their time traveling [Hill1993]. COMMENTS (0)

By carefully managing energy needs and using the right mix of solar cells, trolling generators, batteries, and a backup generator, is possible for a sailboat to be completely energy self sufficient [Rose1979]. COMMENTS (0)

The next step, of self sufficiency for food, is much more difficult for most sailboats due to limited solar area. However, using a combination of growing small amounts of food and scavenging local seaweeds it is possible to reduce the amount of food you need to buy [Neumeyer1982]. COMMENTS (0)

While a carefully outfitted sailboat is capable of surviving months at a time on the open ocean, eventually some consumable resource will near depletion, and the sailboat will have to return to land. Also the cramped spaces and human need for social contact make most people desire periodic visits to port. We'll discuss the pros and cons of this method in more detail later when considering designs. COMMENTS (0)

Cruise Ships

The cruise ship industry has been growing rapidly for decades. There are a number of different companies that provide vacation packages for people to board a cruise ship for a week or two. While the budget accomodations are pretty spartan, the deluxe accomodations are luxurious. Extensive food and entertainment are provided. Many cruise ships have on-board casinos so that patrons may gamble, an example of profiting from the freedom of international waters. COMMENTS (0)

While cruise ships are large, ocean-worthy vehicles that can stand some serious weather, most customers do not like rough seas. Thus, a cruise ship will typically change its itinerary to visit alternate ports of call in order to sail around or entirely avoid a bad ocean storm. COMMENTS (0)

Although a cruise ship can rightfully considered to be a floating city, they are far from self-sufficient. The modern cruise ship is typically only capable of cruising for a week or two before its consumables need to be replenished. So while cruise ships support a significantly larger population than a typical sailboat, they can do so only for a limited time before they must return to port and replenish water, food, and fuel. COMMENTS (0)

Cruise Condos

A new development in the cruise ship industry is the idea of full time residency onboard. The ResidenSea Corporation has built a $265M cruise ship with 110 residences and 88 guest suites that allows wealthy patrons to live on the ship full time as it cruises around the world [ResidenSea]. It began cruising in March of 2002. Their waste policies are mentioned later. Unfortunately they targeted the ultra-luxury market just as the global recession hit, and for several years had troubles selling units. In late 2003 the residents bought the ship from the operating company to run it themselves. They report that sales have been increasing (although there are still many empty units). Still, it sounds as though the original financial backers did not get good results. Given that its already difficult to get funding for a new type of venture which requires substantial capital, the ResidenSea result makes it even harder. COMMENTS (5)

Oil Platforms

Since an oil platform is towed into its final locatation, it is more like an artificial island than a boat. Oil platforms are currently quite expensive, sometimes costing as much as a billion dollars. This expense is reasonable since a single oil well can generate millions of dollars of revenue in a single day [Helvarg2001]. COMMENTS (0)

Since oil platforms are not permitted to move from their location, they must be designed to withstand some incredibly severe ocean weather. While they prove that it can be done, cost reduction by several orders of magnitude is required to make ocean living practical. COMMENTS (5)

Islands

While not technically floating, private islands are often considered as a potential location for founding new societies. There is a substantial market for private islands [PrivateIslands], which can be found throughout the world. However, all of them are claimed by traditional jurisdictions, which have historically been loathe to part with their political control. As island real estate specialist Vladi Private Islands says: COMMENTS (0)

There's something special about a private island. An isolated piece of paradise, its beaches and forests yours alone to enjoy. A virtual private kingdom under the sun. While this is enough for most of us, for some, only a real kingdom (or republic, or principality, or ?) will suffice. For these folks, a private island is but a means to an end - the establishment of a new, independent country. But is such a thing really possible?

The short answer is a pretty conclusive ' no'. Since the early 20th century, every square

foot of dry land on Earth has been claimed by at least one country or another, which pretty much rules out discovering an unmapped tropical paradise, planting your flag, and setting yourself up as the local sovereign. Similarly, existing countries are more than a little reluctant to part with pieces of their national territory, no matter the financial incentives offered.
[PrivateIslands]

Sealand

The Principality of Sealand [Sealand] is arguably the most (perhaps the only) succesful new-country project in recent history. It was founded in 1967, when Roy Bates, a pirate radio operator, moved into an abandoned WWII anti-aircraft platform called Rough's Tower. The platform was located about 7 miles off the British coast, which was then in international waters. COMMENTS (0)

Several incidents have supported the Principality's claims of independence. Sealand fired warning shots at a nearby repair boat, who took King Roy to court over the matter. The ruling was that the tower was outside of the court's jurisdiction. Later, some German men briefly seized the platform by force, and were captured in a helicopter raid. One was kept as a prisoner for several weeks, during which period the German government appealed to the British government for help. However, the British Foreign Office said that the tower was beyond their jurisdiction [Strauss1984, p. 132-138]. COMMENTS (0)

More recently, Prince Roy has retired, and Sealand was leased to a company called HavenCo [Havenco] for several years as a data haven. Unfortunately, the experiment was ended in 2003 because of worries about the country being blamed for aiding terrorism. There have been suggestions of expanding Sealand by damming off and then draining an area around it. It will be interesting to see if this upstart country can continue to maintain its independence, and whether it can turn sovereignty into business opportunities. COMMENTS (0)

Attempted Projects

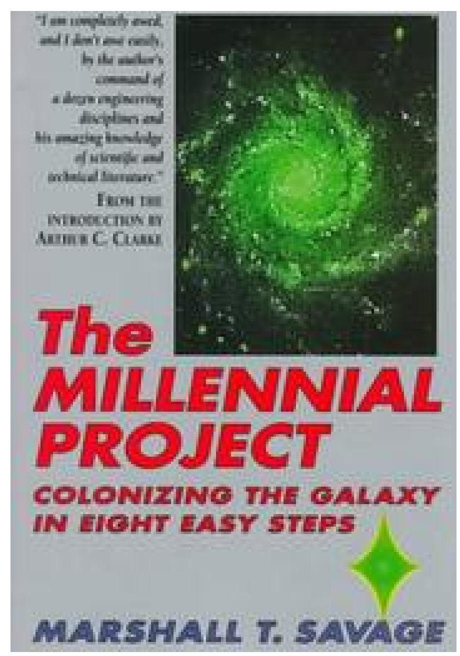
Those who do not learn from the mistakes of history are doomed to repeat them, and so we have studied what little material exists about attempts at seastead-like ventures. We find some of the following quite illustrative. Note that the distinction between "attempted" and "proposed" (the next category) is somewhat arbitrary. Since most nation-founding attempts don't get past the drawing board, our standards for what constitutes an attempt are fairly low. Also, some of these attempts are still ongoing. COMMENTS (0)

The Freedom Ship

The Freedom Ship [FreedomShip] is a proposal for a mile long "City At Sea" for 40,000 people. The chief architect is an engineer named Norman Nixon. The folks working on this one have managed to generate an extensive amount of press coverage (including Popular Mechanics and the Discovery Channel) and enlist dozens of volunteers. Construction cost, unfortunately, is in the neighborhood of **ten billion dollars**. While the large size makes the idea newsworthy, it also makes financing extremely difficult. This is especially true when ResidenSea, which was approximately 1/40th the cost, could not sell all its units. It seems fantastically unlikely to us that anyone will finance such a large project until smaller ones have demonstrated that the floating condo concept is viable. COMMENTS (0)

Indeed, no signs have yet been seen of this staggering sum, although the company has built an 11-foot long, 400 pound model, which puts them well ahead of the average project. A lack of transparency has been notable from the beginning, with interested but skeptical people complaining that their criticisms have all been deflected or ignored [Patri_FS]. However, rumour has it that they'll soon be selling copies of the huge amount of design work they've done. Only time will tell whether they can raise the funds for this gigantic project. While we are rather skeptical that it reach fruition in its current form, we would be delighted to be proven wrong. COMMENTS (6)

Aquarius Project



Another well-publicized venture during the 1990's was the Aquarius Project, based on the book *The Millenial Project* by Mashall Savage [Savage1992]. An organization was created called the First Millenial Foundation, which later changed its name to the Living Universe Foundation. Savage proposes building many large floating cities out of hexagonal cells made from a material called Sea-crete or alternatively Seament. They would be powered by OTEC generators, which operate on the temperature differential between surface and deep water. Income comes from mariculture, hydrogen, magnesium, and several other sources. Actually, only the first 100 pages of TMP are about Aquarius, and the remainder discusses the remaining 7 stages necessary to begin colonizing the galaxy. This is an excellent example of the viewpoint that ocean cities are a stepping stone to space colonies. COMMENTS (0)

Unfortunately, while the book is stuffed full of technical information, the basic ideas behind Aquarius are at the very least ahead of their time. They may even be inaccurate. We discuss the flawed calculations behind seacrete [Seacrete] and the currently nascent state of OTEC [OTEC] in more detail later, when explaining why those technologies are not currently part of our plan. In addition, Savage is overly ambitious, focusing on huge cities without any plan for starting with small ones. Unsurprisingly, without prototypes to demonstrate that the ideas were sound, there was not enough interest to build an initial Aquarius settlement.

Minerva Reef

A seamount is a not-quite island, an underwater mountain without enough oomph to make it to sea level. Like land, seamounts are geographically stable but politically problematic. They can act as breakwaters if they're close enough to the surface, which is quite useful since waves are one of the major dangers of the ocean. Also they can function as anchoring points or pillar foundations. However if they are raised above sea level, they are vulnerable to claim by land-based jurisdictions, as happened with the Minerva Reef. Since this incident exemplifies the reasons why free-floating sea structures are better politically, we will recount it here.

Michael Oliver, a Las Vegas real estate millionaire, made several nation founding attempts. At one point he focused on the Minerva Reefs, 260 miles southwest of Tonga, which were conveniently outside the territorial waters of any nation and below water at high tide. Quite large, they seemed perfect as a foundation for a new, sovereign territory. His plan was to build them up with sand and create a new island and a new country, and he hired dredges from Australia in 1971. After six months, he proclaimed the independence of the Republic of Minerva, which issued coins.

The only reaction he got was from the Kingdom of Tonga, Minerva's closest neighbor. A box of supplies was dropped on the new land which said "supplied and maintained by the government of Tonga", an action said to be supported by other nations in the area. His Majesty then ventured to Minerva with a gang of convicts and a four-member band. They planted the Tongan flag, played the Tongan national anthem, and claimed the sandy patch for Tonga. After they left, the forces of nature did their work, and the sand of Minerva returned slowly to the ocean from whence it had sprung. [Strauss1984 pp. 115-117].

This is a classic example of the lengths to which nations will go to preserve their cartel status - even a worthless patch of sand is seen as competition. If a new nation is created on land (no matter how small or undesirable), it is likely that the nearest traditional nations will claim jurisdiction. It may be possible to negotiate a treaty, but that is likely to be expensive and prospective nation founders are unlikely to have much to bargain with.

The Isle of Roses

The short-lived Isle of Roses offers another excellent example of the antipathy with which countries view nearby nation-founding attempts. As Strauss explains:

Giorgio Rosa was (or is) a professor of engineering in Bologna, Italy. In the early 1960's, he built a tower in the Adriatic Sea, in water less than 20 feet deep, about 8 miles off the coast of the Italian city of Rimini. This first tower was wrecked by a storm on February 13, 1965. A new one was built, with an area of about 4,000 square feet. It had a bar, a restaurant, a post office, a bank and a store, all surrounded by a promenade. The Italian authorities took no notice (since they only claimed 3 miles from shore as their territorial waters) until May 1, 1968, when the platform was declared to be an independent republic, whose official language was the artificial one Esperanto. The Italians invaded 55 days later, speaking vaguely of such things as "national security, illegality, tax avoidance, maritime obstruction and pornography." In the spring of 1969, Italian Navy frogmen dynamited the structure. At last report, Rosa did not plan to try again, saying darkly that "This country is all Mafia." COMMENTS (2)

Mafia or not, this illustrates the extent to which existing countries are willing to brush aside written law if they think a new-country project has the potential to seriuosly inconvenience them.
[Strauss1984, p 129-130]

COMMENTS (0)

Cortes Bank

Another brief example of the greed of traditional nations relates to the Cortes Bank, which lies off the coast of San Diego: COMMENTS (0)

The USS Abalonia was a concrete cargo ship, constructed for the purpose of becoming an independent nation. The company which built it hoped to anchor it in rich shellfish beds on the Cortes Bank, 100 miles off the coast of San Diego, and claim jurisdiction over the area. Shortly after the Abalonia's launch in 1969, it foundered and sank, nearly killing the crew. In the wake of the Abalonia fiasco, a second company began plans to build a platform on the Cortes Bank and declare it the nation of Taluga. The US government quickly gave notice that the Cortes Bank, as part of the continental shelf, fell within its jurisdiction.
[FootnotesToHistory]

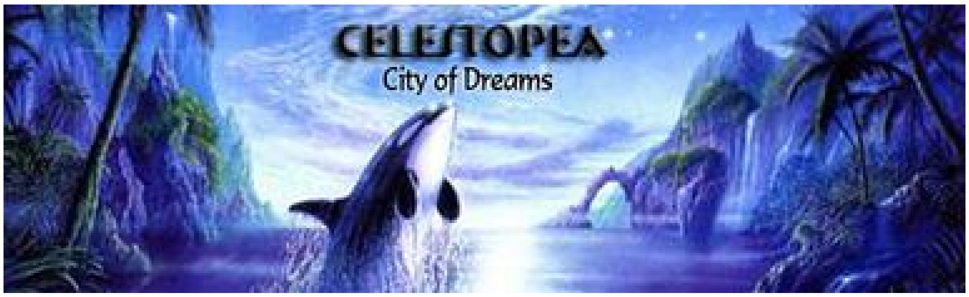
Laissez-Faire City

This Ayn Rand-inspired project began as an attempt to found a modern-day Galt's Gulch. The organizers placed a declaration of sovereignty and request for a host nation in several high-profile publications, including *The Economist* (6/10/95, 8/12/95). Media such as the London Times and BBC World Radio covered the story, and 3000 people from 108 different countries contacted the founding Trust. COMMENTS (0)

Unfortunately, the response from potential sites was less enthusiastic. The principals followed several leads without finding an acceptable locations (although their standards may have been a bit high - the shallow shoals which LFC turned down would be more than sufficient for our purposes). With no land in sight, LFC transitioned to seeking freedom in cyberspace, developing tools for digital freedom. COMMENTS (0)

Eventually, due to personality problems and poor business practices stemming from one of the founders and major financers of the project, LFC was dissolved. Their early experiences exemplify two of our claims about nation founding: that there is a large potential market, and that it is extraordinarily difficult to get sovereignty from existing nations. COMMENTS (3)

Celestopia



Their webpage states:

> *Dedicated to creating ecologically balanced, floating ocean communities and terra-formed, permacultured islands, grown from the mineral-rich waters of the tropical oceans. We wish to share our creations and technologies to help expand the unity, prosperity and quality of life, of all the people of Earth.*

COMMENTS (0)

This currently active project is based in Costa Rica, and the fact that its principals were willing to relocate there suggests that they are serious. Their website contains a timeline, including the steps they have completed. They are currently in the stage where they are beginning to need financing, which is a very difficult time for any project. While they pitch the seacrete + OTEC combination which we later debunk, they also acknowledge that seacrete is not ready for prime-time yet and plan to start with ferrocement. Their designs are partly based on the Monolithic Dome Institute [MDI], which is another good sign, as the MDI has helped construct hundreds of concrete domes. They believe, as do we, in teaching by example rather than rhetoric. Unfortunately they seem to be looking mainly to donations for initial funding. It seems to be the most mature environmentally motivated project. COMMENTS (0)

Proposed Projects

Now that we have covered the existing strategies for living in the middle of the ocean, as well as some methods that have been attempted, it is time to visit some ideas that so far remain merely visions. Some of the designs listed below are more practical than others. This list could be quite long, and is merely a selection of some of our favorites: COMMENTS (0)

Alexandisle

> This is one of the most recent new country projects [Alexandisle]. Created by Kevin Alexander, it is a haven for non-believers, where faith-based promotion is considered fraudulent. It has an unusual government structure: there are no taxes during an individuals lifetime, but upon death, no more than $200,000 can be left to any one heir (excepting spouse(s)). The remainder must be given to charitable organizations which perform all social services normally adminstered by modern governments. Anyone can found a new charity if they are unsatisfied with current ones. The founder believes that this prohibition on inheritance will appeal to independent, self-made individuals. COMMENTS (0)
>
> While we have serious doubts about the appeal and viability, of this system, the strength of the small-nation approach is that people can experiment with many ideas and see which work. Thus we wish them the best of luck. Additionally, Mr. Alexander is writing an upcoming book *Ten Thousand Nations*, which suggests *"that humanity is much better off with lots of small governments, rather than a few large ones"* [AlexanderUnp]. As we wholeheartedly agree with this idea, we look forward to this contribution to the tiny niche of nation-founding books. COMMENTS (0)

The Pelagic Project

> > *Pelagic: Adj. Free swimming, living in open ocean.*
>
> COMMENTS (0)
>
> While Wavyhill's time limitations have restricted this to a small (but informative) website [Pelagic] and a small scale model, we are still quite impressed with what we've seen. His philosophy is extremely realistic: COMMENTS (0)
>
> *"This is a geopolitical experiment on life in a floating oceanic habitat with no mandated societal structure beyond that of a loose, employee owned and operated enterprise. ... Many of these projects have been initiated by idealists, with no or vague business plan, expecting the rest of the idealists to rally to the cause and donate the required capital and effort. The pelagic project is not a utopian scheme, they never work. It's based on profitable enterprise, gradual growth, and being prepared for the worst from people and political organizations*

He has a well-thought out timeline based on an incremental approach, and discusses the problems of building, operating, and financing such a project. The basic structure is a large (50ft) ferrocement hexagon, divided into small interior hexagons using cellular concrete. We discuss this lightweight concrete in the design section. Since it floats on the surface, his structure is exposed to wave action, and without a breakwater we don't think it would be suitable for the open ocean. COMMENTS (1)

In 2003, Wavyhill actually made a 1/12th scale model of his design using a cheap homebuilt foammaker. This may not sound like much, but experimentation and a willingness to start with small prototypes is rare among nation-founders. This is unfortunate since we think its crucial to success. While this project is no longer active, we definitely recommend checking it out to see someone else's version of the incremental, realistic sort of approach which we are convinced is the most promising. COMMENTS (0)

New Utopia

The New Utopia [NewUtopia] project is a proposal to build a new country on an unused sea mount in the Carribean. Like the Freedom Ship, this project has been able to garner a significant amount of press coverage, especially at the beginning when it seemed viable. Former insiders report that there was significant business interest. Unfortunately, the leadership was not interested in tackling the hard problems that came up, preferring to sell a fantasy. Given what happened with Minerva Reef [Minerva], we are very doubtful that any sea mount raised above surface level will remain unclaimed by the existing sovereign nations for very long. More importantly, a number of more recent reports have suggested that the project has become little more than a scam [Patri_NU]. COMMENTS (1)

The Venus Project

Floating Cities are one part of Jacque Fresco's The Venus Project [VenusProject], which aims to redesign world civilization to be more in line with human and environmental concerns. This includes switching to a resource-based world economy. While we are a bit suspicious of their economic theories, Mr. Fresco has quite an impressive resume. He's also designed and built a research center for the project, which puts it well ahead of the plethora of similar-sounding visions. Unfortunately, they said we could not use any pictures from their site in this entry because our description was too negative, which is a bad sign. COMMENTS (3)

Spar Buoy

The Spar Buoy concept [Piolenc2001] is the brain child of F. Marc De Piolenc. The concept is to build a livable structure that is basically a long cylinder that is ballasted on one end to cause the cylinder (i.e. spar) to float vertically. Since the center of gravity is significantly below the center of buoyancy, it basically impossible to tip the structure over. In severe ocean storms, the cylinder bobs up and down with the waves and the cylinder occupants may get quite motion sick, but they should survive. COMMENTS (0)

Ballard's Ocean Watch Tower

More recently, Dr. Robert D. Ballard (of finding the Titanic fame) has proposed building a modest ocean habitat that has many similarities to F. Marc De Piolenc's spar buoy idea. The idea is to start with a ballasted spar and then place a somewhat larger habitat on top. Thus, the difference is that the living quarters are on top of the spar rather than on the inside of the spar. This proposal has the advantage of being quite modest and Dr. Ballard's obvious oceanagraphic experience would provide a great deal of credence to any investors. COMMENTS (0)

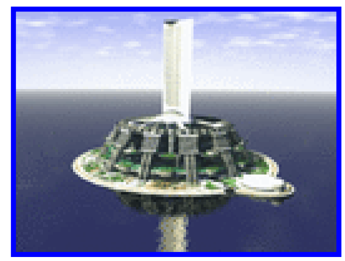
Reed Ship

Enrique Perez has come up with a novel idea based on ancient reed ships [Perez2001]. The basic idea is to make the whole flotation system flexible enough that it just bends and sways in severe ocean storms. He has come up with scripts that allow you to compute the costs and buoyancies. COMMENTS (0)

Atlantis Project

Another project out there for awhile was the Atlantis project [Atlantis1994]. This project has an above average number of pretty pictures, created by architect Jim Albea [ShadowMasons]. Indeed, it was this site that got Wayne Gramlich interested in the concept of seasteading. COMMENTS (0)

Seascape - A Floating City For The Mediterranean Sea



Many nation-founding projects and websites focus on pictures instead of planning. The Seascape [Seascape] site takes this to an extreme, as it consists almost entirely of pretty 3D rendered pictures and animations (along with a little flavortext). The result is to showcase artistic skills rather than present a practical proposal. As reader Glen Raphael comments: COMMENTS (3)

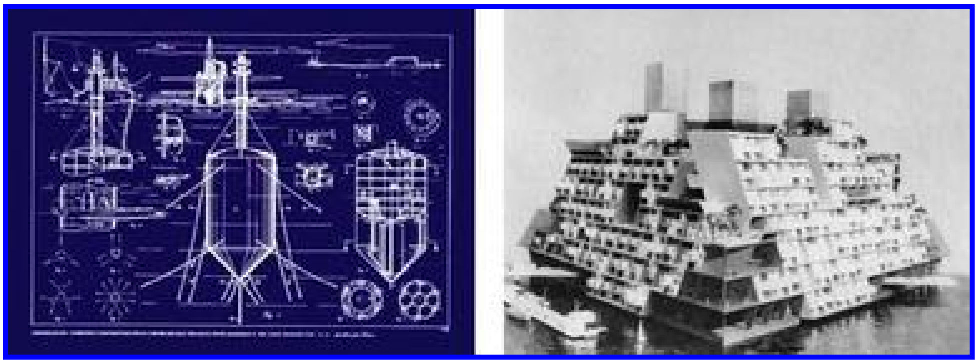
They never quite make it clear why having drink-dispensing robots following guests around the complex is an improvement over the usual alternatives. Sure, it could be cool in a sci-fi sort of way, but it's ludicrously inefficient. Wouldn't some combination of drink vending machines, water fountains and human waitpersons delivering your drink order to human bartenders work just about as well and be a lot cheaper, more energy efficient, and more reliable? ... One really does get the sense this is more about creating an interesting science-fictiony fantasy environment than it is about making something practical.

When asked for permission to use a picture with the text above, the project authors commented: COMMENTS (0)

The site you saw is only an inter-office overview. Seascape endeavors to provide an environment that is responsive to the individual- it makes no attempt to be practical (or impractical for that matter). Does your city know you? Is your city "interactive"? We urge you to "stay tuned" over the ensuing months to see if we distinguish ourselves. Good luck on your compendium of sea-faring environments. You may wish to re-read the "flavor-text".

Unsuprisingly, their website has not changed in the ensuing year. While there is nothing wrong with this approach per se, it makes it harder for those of us interested in the reality of floating cities to get taken seriously.

Triton City



> Buckminster Fuller designed a tetrahedronal floating city for Tokyo bay in the 1960's. He wrote:
>
> Three-quarters of our planet Earth is covered with water, most of which may float organic cities...Floating cities pay no rent to landlords. They are situated on the water, which they desalinate and recirculate in many useful and nonpolluting ways. They are ships with all an ocean ship's technical autonomy, but they are also ships that will always be anchored. They don't have to go anywhere. Their shape and its human-life accommodations are not compromised, as must be the shape of the living quarters of ships whose hull shapes are constructed so that they may slip, fishlike, at high speed through the water and high seas with maximum economy...Floating cities are designed with the most buoyantly stable conformation of deep-sea bell-buoys. Their omni-surface-terraced, slop-faced, tetrahedronal structuring is employed to avoid the lethal threat of precipitous falls by humans from vertically sheer high-rising buildings...The tetrahedron has the most surface with the least volume of all polyhedra. As such, it provides the most possible 'outside' living. Its sloping external surface is adequate for all its occupants to enjoy their own private, outside, tiered-terracing, garden homes. These are most economically serviced from the common, omni-nearest-possible center of volume of all polyhedra... When suitable, the floating cities are equipped with 'alongside' or interiorly lagooned marinas for the safe mooring of the sail- and powerboats of the floating-city occupants. When moored in protected waters, the floating cities may be connected to the land by bridgeways.
>
> [Banham1976]

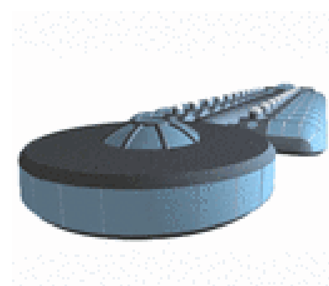
There are some similarities between Bucky's design for a floating city and our current plan. Both have buoyancy was located below the wave action, and both use slopes to give residents more solar area.

Ocean Base One

The Ocean Technology Foundation has proposed an undersea habitat called Ocean Base One as part of its OASIS research project [OASIS]. 3D images of the design have been featured on Tech TV and The Learning Channel, as well as in several print media outlets. Its main purpose is research, and it is to be funded by foundations, oil companies, the government, and other sources [Behar2002]. They expect to complete funding and begin construction in approx. 2007-2010 [Rappaport2002]. While such claims should be treated with some skepticism, there are a number of points in its favor. OTF is an established foundation, oil companies and government departments have lots of money, and the $75M budget is modest compared to gargantuan proposals like the Freedom Ship. COMMENTS (0)

Poseidon Undersea Resort



This project has been proposed by US Submarines, which has succeeded in getting a fair amount of media attention for its personal and tourist submarines. For example, a $20M model was listed in one of Neiman-Marcus's christmas catalogues. Poseidon is their concept of an undersea resort containing a restaurant, bar, kitchen, foyer, and 20 luxury suites. It would be in 30-60 feet of water, and locations being considered include the Bahamas, Uniated Arab Emirates, and Belize. The interior pressure would be maintained at one atmosphere. COMMENTS (2)

Historical Hacks

While political sovereignty is our interest, many past projects have taken advantage of the ocean's freedom in other ways. They demonstrate that "hacking the system" really can work. Its important to have this empirical evidence to show that there our ideas are not just based on theory. Many political movements have failed because they misunderstood the difference between theory and practice, words and actions, vision and reality. COMMENTS (1)

{ If you have any similar examples of using international waters to increase freedom, please let us know } COMMENTS (2)

Gambling Ships

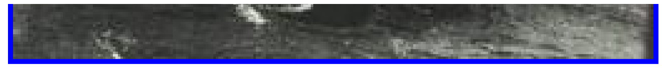
> Anyone who has been on a cruise ship knows that gambling in international waters continues to the present day. Its history near the United States, however, is a bit rocky: COMMENTS (0)
>
> Earl Warren...decided to advance his career by declaring war on the gambling interests. The operators responded by moving the casinos onto ships keeping the old mother-ship stations off the coast. The first reaction of Warren was just to go out and break up the casinos anyway, never mind that his lawful authority ended at the territorial limit. This is yet another caution to new-country organizers not to place overmuch faith in the written law. COMMENTS (0)
>
> However, the operators then went into Federal court...Roosevelt's Democratic Federal Regime wasn't very interested in helping him with his crackdown...when World War II broke out. The "war emergency" and ensuing near-panic on the West Coast were used as an excuse to shut down the ships summarily. After the war, a Federal law was finally passed making it illegal for a United States citizen or resident to own a gambling ship, or for anyone to transport people between the United States and a gambling ship...such a ban could likely be defeated on a challenge. But then other measures to harass the ship doubtless would be taken. In any case, with the spread of legalized casinos onshore, the long-term prospects for casino ships appear limited. COMMENTS (0)
>
> [Strauss1984, p. 140]

Despite this pessimisstic outlook, gambling cruises are still an active business. For example, a 2002 article on gambling in the southern US reports: "FLORIDA: Numerous gambling cruise vessels, ranging from ships carrying 1,800 passengers to yacht-size boats carrying 150, sail from the East and West coasts into international waters where gambling is permitted. The boats offer roulette, blackjack, craps, video poker and slots, with some of the larger cruise ships offering additional games." [McBee2002] COMMENTS (0)

Pirate Radio Boats/Platforms

> The offshore pirate radio movement is interesting both for its own sake and in relation to the ideas of seasteading. A summary of appears in Strauss: COMMENTS (0)

> In the 1960's, a new form of offshore activity emerged. Commercial radio as known in the United States didn't exist in Europe at the time. With few exceptions, all that was to be heard were staid government stations. Then a ship named *Veronica* dropped anchor just off the Dutch coast, with a transmitter beaming programing filled with the latest popular music. Advertisers eagerly bought up all the available time at premium rates, and



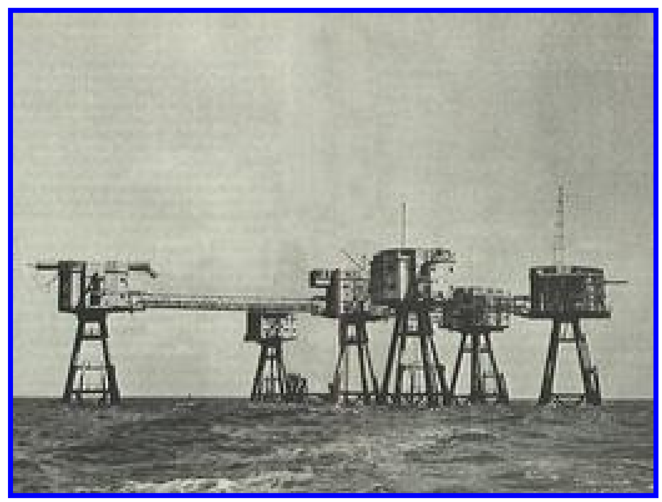
imitators soon followed in the Scandinavian and British markets...At first, there was considerable violence between ships; however, the practice of maintaining 24-hour watches soon reduced that greatly... COMMENTS (0)

The governments of Europe were outraged, and applied the pejorative term "pirates" to the broadcasters, a term with which they weren't entirely unhappy - due to its romantic connotations. Attempts were made to jam the ships' transmissions, but the public outcry was too great...International agreements were entered into to ban broadcasting from ships, but the African country of Sierra Leone chose to offer its flag as a flag of convenience rather than subscribe to the treaties... COMMENTS (0)

The British finally knocked their offshore broadcasters off the air by banning advertising on them by firms doing business in the United Kingdom...then the coup de grace was delivered: the opening of popular music stations on land. COMMENTS (0)

[Strauss1984, p. 141-145]

Various snippets from another chronicle of pirate radio's colorful history help fill in more detail: COMMENTS (0)



"badly needed a way to break the 'payola' monopoly enjoyed by the 'big four' recording companies Decca, Philips, EMI and Pye." COMMENTS (0)

"Only three weeks after it started the pirate station had an estimated 7 million listeners " COMMENTS (0)

"Tragedy occurred at Red Sands fort on December 16th when RADIO INVICTA co-owner Tom Pepper, engineer Martin Shaw and disc jockey Simon Ashley were drowned in very bad circumstances following the capsizing of their launch after having delivered supplies to the station " COMMENTS (0)

"The start of 1965 saw some 'big guns' lining up against the pop pirates when, on January 22nd, the governments of Belgium, France, Greece, Sweden, Luxembourg, Denmark and Britain signed a Council of Europe Agreement that not only banned broadcasts 'on board ships, aircraft or any other floating or airborne objects' but also banned anyone from those countries from supplying the pirates with materials, supplies or equipment. The stations were forced to obtain new sources of supply from either Holland or Spain, neither of whom had been party to the agreement...Caroline' was also in the happier position of being able to obtain supplies from Dublin or even the Isle of Man as the Manx government were reluctant to ratify legislation against the pirate ship due to the trade and tourism she brought to the island. " COMMENTS (0)

"On May 12th at 5p.m. the entire Beatles 'Sergeant Pepper' was played by Radio London, two weeks before its official release date, despite the fact that no promotional versions had been issued by EMI. The origin of the music has never been explained, although Paul McCartney's house had been burgled a fortnight earlier and among the items taken were two proof pressings of the disc...." COMMENTS (0)

"At midnight on 14th August 1967, The Marine etc, Broadcasting (Offences) Act came into force, which effectively banned all U.K. subjects from being involved with offshore broadcasting within territorial waters and rendering all the pirate radio station operators and personnel open to prosecution as soon as they came within the '3 mile limit'... RADIO VERONICA, being off the Dutch coast, was unaffected by the British Act but had its own problems in the Seventies when the Dutch government finally got around to passing a similar law...The last of the legendary Sixties offshore pirates still operating in its original form, RADIO VERONICA, finally succumbed to the Dutch Marine Broadcasting Act on August 31st 1974. " COMMENTS (0)

[SixtiesCityPR]

The history of pirate radio is fascinating and involved. While we've only briefly touched on it here, you've heard enough about pirate radio and gambling ships to see a common life cycle for such ventures. Government regulation creates a market. An offshore provider springs up to serve that market, and at first enjoys tremendous success. New regulations attempt to limit the industry, with mixed success. Finally, the onshore industry opens up - not as open as the pirates, but with a small enough difference that the extra costs and difficulties of offshore operation render the pirates uncompetitive. COMMENTS (0)

We'd like to point out that if the offshore provider's goal was to stay in business and make money forever, being co-opted like this indicates failure. But if the goal was a social movement like increasing freedom, it is at least partial success. We'd consider it a victory if building seasteads becomes unattractive because traditional governments become more dynamic and flexible. However, we think this is unlikely because of some key advantages of water over land which we'll talk about in the next section. COMMENTS (0)

Although pirate radio history is definitely relevant, there are some important differences between pirate radio and seasteading. First, note that these broadcasts targeted sovereign territory, infringing the government's right to control the signals on its land. This is a much more questionable activity than seasteading, and more likely to generate a strong reaction. Also, the government cracked down by making it illegal to advertise on pirate radio ships or sell them supplies. Advertising doesn't work unless you know what the product is, thus its easy to crack down on. Also pirate radio ships were not in the least self-sufficient. So stronger economic levers were available against this business than will be for opponents of seasteading.

Havenco

This was an internet server business run on Sealand, offering secure colocation facilities without government regulation. While its not clear exactly why the business failed, there are a number of strong possibilities.

In the beginning, they got a fair amount of publicity as a "data haven". However, they had to compete with small countries around the world also eager to profit from a low-regulation environment. They were founded just in time for the dot-com crash and associated global recession. A few years later, when the War on Terrorism got going, the owners of Sealand become worried about anti-terrorist blowback. Furthermore, as a somewhat amateur venture, Havenco was plagued with business problems, at least according to cofounder Ryan Lackey, who spoke at Defcon about the experience [Defcon_Havenco].

From his report, most of the time was spent dealing with the large amount of press stemming from a Wired magazine cover article, rather than on sales and customer service. The business was disorganized, lacking proper capital, and displaying a much better face to the world than the actual situation. Eventually, the business problems, and the issues between Sealand and Havenco led to the end of the company.

Many of these are important points for prospective seasteaders. If they are building a business, not just a home, it needs to be run like a business - which means a reasonable amount of financing and business experience for the job at hand. The difficulties in being reliant on the whims of Sealand's owners is an example of why it is better to find solutions that don't depend on a cooperative host country. And on a more optimistic note, HavenCo found it quite easiy to get a huge amount of publicity, which would have been invaluable if they'd had the other pieces in place.

The reason we include the busines here, rather than among failed projects, is that nowhere in that list of reasons is "significant interference from other states". Havenco successfully hosted online gambling sites through an internet connection to the UK, less than 10 miles away, which would not have been legal in that country. They were left alone, and not because they had a navy to match the UK's (an amusingly laughable fantasy), or because no one had heard of them (quite to the contrary!). Instead they just chose a business they could get away with and a location with reasonable historical precedents to be independent.

Women On Waves

Whether or not one agrees with their views, this pro-choice Dutch project is a good example of the potential for using international waters for political freedom. One of the founders of WoW had been a doctor on board the Greenpeace vessel *Rainbow*

Warrior, and was influenced by offshore pirate radio. They traveled to Ireland in 2001 and Poland in 2003. In their own words: COMMENTS (0)

Women on Waves is a non-profit organization concerned with women's human rights. Its mission is to prevent unwanted pregnancy and unsafe abortions throughout the world. COMMENTS (0)

Every year 20 million abortions are performed under illegal and unsafe conditions, resulting in the deaths of an estimated 70,000 women annually. In response to this medical calamity, Women on Waves has developed a mobile gynecological unit, the 'A-portable'. It can easily be loaded onto a ship, which enables it to travel to wherever it is needed worldwide. The 'A-Portable' can also travel by truck allowing it to go to countries where reproductive health services are legal but largely unavailable, for example due to war. COMMENTS (0)

With a ship Women on Waves can provide contraceptives, information, training, workshops, and safe and legal abortion outside territorial waters in countries where abortion is illegal . Working in close cooperation with local organizations, Women on Waves wants to respond to an urgent medical need, empower women to exercise their human right to reproductive health and legal, safe abortion and draw public attention to the consequences of unwanted pregnancy and illegal abortion. COMMENTS (0)

An Australian doctor proposed a similar plan in 2000 and 2001 for a "euthanasia ship" to legally help end the lives of terminally ill patients [Batty2001]. However nothing further appears to have been done. COMMENTS (0)

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Last modified: Mon Nov 14 23:24:09 PST 2005

Seasteading: Why Seasteading?

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Why Seasteading?

Motivation

While we hope that some readers will immediately see the appeal of seasteading, we expect many to be mystified as to why anyone would want to go live on a floating platform. So before proceeding with further technical discussion, we must motivate the project in general. We'll also take some time to explain the guidelines for our particular approach. COMMENTS (MANY)


A small but passionate minority is deeply dissatisifed with current political systems. These people seek the autonomy to live under and experiment with different political, social, and economic systems than currently exist. It is this search for sovereingty, for the freedom of self-government, which is the fundamental motivation for seasteading. Utopia is different for everyone, and so there are a wide variety of theoretical new systems and gripes with the old ones. We'll present only broad outlines of the most common schools, leaving the explanations of what the Problems are and how each philosophy is the Answer to the partisans themselves:

- Many people are interested in sustainable, environmentally friendly ways of living [Celestopia], which are well-suited for seasteading, where renewable energy generation and closed-loop gardening will be facts of life.

  > *The residents of these future cities, throughout the world, will show by exemplary actions that people of different races and divergent political, religious, cultural and social beliefs can live and prosper together while also being good stewards of the earth, respecting, and thereby benefiting all inhabitants and ecosystems of the planet.*[Celestopia]

- Capitalists want low taxes and regulatory freedom [Atlantis1994].

  > *There are tax benefits: no federal tax on coroporate profits, no state corporation tax, no social security tax. And any open sea facility is a free port. You can bring in any raw materials and ship out any finished products, without paying tariff duties. Outside government jurisdiction on the open sea, there are no regulatory agencies to contend with. You can dispense with the expense and bother of excessive paperwork, forms, and reports. You won't be ordered to waste your time appearing before government bodies. Licenses and permits will be things of the past. Government litigation and harassment, and the uncertainty caused by changing laws, regulations, and interpretations will be eliminated.*
  > [Fisher1985, pp. 48-49]

- Few opportunities remain for pioneers, and the oceans are the obvious next frontier for civilization.
- It seems likely that the next major frontier, after the oceans, will be space. We can look

at seasteads as a dry (er...wet) run for spacesteading:

> *If we are going to colonize space, it is best to colonize the easiest space first...Living in colonies at sea will teach us many crucial lessons about life in space. The isolation, self-sufficiency, and political autonomy of sea colonies are the same as those of space colonies. Both types will impose many of the same requirements on their inhabitants...The Moon is a harsh mistress; we would be wise to learn these early lessons while still in Earth's gentle lap.*
> [Savage1992 pp. 23-24]

> *If humankind is to survive, I see no alternative to expanding outward into space. And this doesn't just mean settling on other planets and moons. They will be just as vulnerable to doomsday weapons as the Earth, and there aren't enough of them to insure that some will survive an Armageddon. Only a large number of communities well dispersed in the volume of space seems likely to have a chance...The establishment of such communities space would constitute a Golden Age of new-country formation in the next few centuris. Those who gain experience in the new-country field now are the most liekly to be ready to seize the new opportunities when they arise -- or to see their children and their children's children in a position to do so.*
> [Strauss1984 p. 47]

COMMENTS (MANY)

- Devoted proponents of peace seek places where they can live without being taxed to fund violence. COMMENTS (MANY)
- Drug users care deeply about the freedom to ingest whatever chemicals they desire [Island]. In many current societies, they are subject to arrest, jail, and the confiscation of their property. COMMENTS (MANY)
- Individuals who are Environmentally Intolerant (EI), such as those suffering from Multiple Chemical Sensitivity, seek environments with minimal contamination from human chemicals:

> *Waterfront property offers some of the cleanest air anywhere by virtue of the high rate of ambient air exchange afforded by ocean or lake breezes. Even regions with relatively bad general pollution levels enjoy orders of magnitude cleaner air along the shore, as long as there are regular breezes. Unfortunately, few people can now afford such property - especially those who need it most. A floating home offers a potentially unlimited amount of waterfront real estate with no land cost. You can have as much as you can afford to build. There are no surrounding lawns and trees to generate pollen, no roads with cars to generate pollution -though,*

of course, boats are still a pollution issue albeit far less than automobiles. [Hunting]

COMMENTS (MANY)

Our personal motivation is the belief that monolithic, land-based societies are too big and too politically static. We think political flexibility and experimentation with many different political systems is the right way to find new and better ways to live. Seasteads would allow for a rich diversity in forms of governance because they lower the barrier of entry to the market of government. When it takes a revolution or millions of votes to take over a country, small groups have no opportunity for self-government. But if, for the cost of their houses, they can band together and create new sovereign territory, many will do so. While living their own ideal lifestyle, they will also be researching innovations in the basic institutions of society, which will increase our collective wisdom and benefit all humankind. These ideas are explored more under dynamic geography below. COMMENTS (MANY)

Whatever the specific motivations, the popularity of new country projects make it clear that there is a great deal of interest in this topic [Alexandisle, Atlantis1994, Celestopea, FloatingCities, FreedomShip, Freedonia, Island, LFC, NewUtopia, NewAtlantis, Nexus, Pelagic, ResidenSea, Salsbury1992, Savage1992, Sealand, Seascape, Strauss1984, VenusProject]. COMMENTS (0)

While few people are devoted enough to drop everything and go found a new society, we think that everyone is, to some degree, a revolutionary. After all, who was the last person you met who was completely happy with everything about their society? While utopia is not an option, we do believe there are some fundamental reasons why seastead societies are likely to work better than terrestrial ones. As experimenting with new social systems becomes cheaper and easier, it will be a viable alternative for an increasingly large segment of humanity. Seasteading is a realistic way to make a significant leap forward. COMMENTS (1)

Philosophy

There is no single "right" approach to seasteading. Thus we will present you with many ideas, exploring those we think are the most viable in the most detail. However, it does seem like there are some "wrong" approaches, as we can see from the many failures of projects with the same goal. What we've learned from the movement's (admittedly dismal) history has to a large degree shaped our philosophy. Because of this, explaining our approach goes hand-in-hand with identifying common points of failure and indicating how we think they can be overcome. COMMENTS (0)

The root cause of most of these failures seems to have been lack of realism. So our solution is simply to be as pragmatic as possible about our vision. Realism is our philosophy's foundation, and more specific polices are just the application of realism to various areas. Important areas include incrementalism, politics, technology, and finances. COMMENTS (0)

Incrementalism

One problem with doing things all at once is that there is a substantial "stone soup" aspect to seasteading. COMMENTS (2)

We believe that a realistic approch to the difficult problem of nation-founding must be incremental. Large, successful things usually start out small and expand organically, rather than springing forth full-formed like Athena from the brow of Zeus. Rome wasn't built in a day and a succesful business leverages each stage into the next. Big things (cruise ships, skyscrapers, factories) do get built all at once at times, but they are almost always proven concepts that were first demonstrated successfully on a smaller scale. For example, we bet that the first multistory building had exactly 2 stories. In our case, if there was a nation-founder with the financial resources to jump the intermediate stages and create a vast floating city, it would already exist. After all, there are plenty of people ready to design and build one as soon as the multi-billion dollar check gets cut. Since no such deus ex machina appears to be forthcoming, we recommend humbler methods. COMMENTS (0)

There are plenty of grand conceptual ideas out there, but we see a key link between **being grand** and **staying conceptual**. We find the notion that the first sea-city will be for ten thousand people is ludicrous. If you make the first step too high, you will never even get started, as the many participants who became frustrated with and dropped out of new-country projects can attest. Instead, we believe that almost all the focus should be on the current and immediate next stage, not on far-distant visions. Watch the path in front of you, not the sky. COMMENTS (1)

There is an inherent difficulty in getting people involved in something that has value only if people are involved in it. How do you start? Contingent contracts help, ie all participants sign something which says "I will pay for my share and move onboard if 99 other people also sign this contract". This approach is working for the Free State Project in its quest to get 20,000 libertarians to move to New Hampshire. In our case, however, there are difficulties. We think that its best to try out this new way of life with fewer people at first. Also it appears difficult to get enough interest for even contingent signatures on floating-cities without demonstrating viability. For these reasons, our plan includes a series of distinct stages, each involving a greater number of people. COMMENTS (1)

First we complete a design, and build an aquarium-sized model. Then a pool-sized version. Next we build a habitable Baystead prototype for 5-10 people, anchored in sheltered waters within US boundaries, to demonstrate our seriousness and our design. This is the first point at which we need other people's participation. We just need to find 5-10 people who are willing to live together, and don't mind the level of creature comforts that can be achieved on a fairly small platform. While it will require a rare level of dedication to the concept to join this group of aquatic pioneers, we don't have to find very many such people. COMMENTS (0)

Next we need to find 25-100 people (or the equivalent in timeshares) who weren't quite sure if seasteading was legit before, but seeing the demonstration by the first group, find it worthwhile to participate. They build the first deep-water, self-sufficient seastead. Next we find the 100 people who weren't quite convinced by the small group ... and so on. Smaller steps can be added if necessary. COMMENTS (1)

There is plenty of historical precedent for this strategy of zealots seeding settlements. North America, for instance, was colonized mainly by members of minority religions such as the Puritans seeking to escape persecution. These dedicated folk were willing to put up with the discomfort of pioneering in exchange for religious freedom. The result of this passionate committtment to a cause was, eventually, an increased level of civilization, and a beachhead for the less dedicated to follow. COMMENTS (1)

At every step in incremental development, the standard of living increases due to economies of scale, refinement of techniques, and the network effects of the larger community. Rather than convincing 10,000 people from the beginning, you just keep bringing in those at the margin, who needed things to be just a little bit better to get involved. As interest in seasteading steadily grows, more units are steadily built. Each may cater to a slightly different audience, or experiment with different engineering designs and social systems. They will be modular and eventually cluster together into the grand vision many have proposed [Atlantis1994, Nexus, NewUtopia, VenusProject]. COMMENTS (0)

With advanced technology, the pioneering cycle is much shorter nowadays. It doesn't take centuries to go from Conestoga wagons to skyscrapers, and we'll get to start out with electricity, hot running water, and satellite telephones. But at the beginning, we still must be pioneers. We aren't focusing on these humble first steps because we lack imagination, or don't think a huge luxurious floating city would be amazingly cool. That sea city is our ultimate goal, but it is our firm belief that a sea village must come first - and a single sea house before that. COMMENTS (0)

Political Realism

A major issue facing prospective attempts at autonomy is obtaining sovereignty, which terrestrial governments are notoriously reluctant to sell, or recognition, which they are reluctant to give. Examples can be seen in Minerva, Cortes Bank, and LFC, discussed in the review section. Thus we don't think a realistic project should depend on obtaining sovereign land. COMMENTS (0)

In the past, pioneers and malcontents would head to the frontiers, but few remain. The oceans, which make up 71% of the earth's surface, have always been a place for those seeking new ways of life. They are the last great unclaimed region. Ships are not well suited for permanent living (although there is a subculture of live-aboard boaters [Hill1993]), but by creating new land on the oceans we can attain a reasonable combination of freedom and comfort. COMMENTS (0)

Freedom of movement and self-sufficiency are both intimately connected with political freedom. Fixed locations such as seamounts, islands, and atolls are much more vulnerable to the whims of nearby governments, but a mobile seastead can always move if the political climate becomes unsuitable. While a seastead is likely to import many goods, being able to supply its own basic necessities will also add greatly to its independence. This is why seasteads are to some degree self-sufficient, and either roving or at least movable if necessary. This approach to nation founding reduces - but does not eliminate - the difficulty in finding sovereignty by operating in international waters. Further discussion of maritime law can be found in the Ocean Environment - Politics section. COMMENTS (0)

A crucial part of our political realism is modesty in our goals. We won't start out demanding recognition from other nations, acceptance of our passports, or a seat in the UN. We'll asl only to be left alone to experiment with our pioneering lifestyle in peace. Frankly, we think its absurd for projects in the planning stage to focus significant effort on these matters. Its like an american pioneering family who are planning their move west to an unsettled region thinking about how to get formal recognition as a state, when they should be worrying about cabins, crops, and packing their Conestoga wagon. The trappings of statehood can come later (if ever) when it is obvious that a group of seasteads qualifies as a country by any reasonable definition. COMMENTS (4)

Technological Realism

Several potential ventures [Savage1992, Celestopea, Nexus] have focused on the combination of two problematic technologies: OTEC and seacrete, which we feel exemplify the unrealistic "science-fiction" approach to floating cities. COMMENTS (0)

OTEC, or Ocean Thermal Electric Conversion, is a technique to generate energy from the temperature difference between warm surface water and the cold depths. Unfortunately there is little practical experience with the technology, and it scales down very poorly. Its a promising technology for the future, perhaps for governments soon, but not at all applicable to small ventures now. Some projects have treated OTEC as practically free energy for ocean cities, when it is quite expensive indeed. We discuss it further in our Infrastructure - Power section. COMMENTS (1)

If you dip a wire mesh in seawater and run electricity through it, a cement-like substance forms. Known as seacrete, many floating-city designs have been based on this wondrous source of free building materials. Unfortunately, there is a catch. The common cited figures for energy requirements are off by a factor of 40, and the electricity costs far more than just buying concrete. There are additional problems, as we describe in the design materials section. COMMENTS (0)

Seasteaders will not make the mistake of counting on an impractical technology to make their vision happen. Our concept is a big enough jump already, and the fewer jumps we make along with it the better. So while necessity has prompted some novelty in our designs, they are firmly rooted in standard engineering techniques. You'll see us examining a number of cutting-edge technologies, yet planning to use very few of them on early seasteads. Our power will come from solar panels, wind turbines, and fossil fuel backup generators, not OTEC plants. Reinforced concrete is an extremely cheap construction material, and we'll buy it from standard terrestrial sources. In short, our philosophy is to plan our initial designs around mature technologies and save the innovation for later iterations. COMMENTS (0)

Financial Realism

Many proposed ventures are impossibly large in scale. While grand visions are inspiring, they are difficult to make into reality, especially when the idea is novel and unproven. The Freedom Ship is a classic example [FreedomShip]. Their proposed mile-long design will cost ten billion dollars ($10,000,000,000.00). That sort of funding is not easy to get, to say the least, especially for a piece of property that might be destroyed by a storm (imagine the insurance premiums!). Things are made even worse because the only previous floating condominium ship, Residensea, lost a substantial portion of its quarter-billion dollar cost, even though it had sold many of its units in advance. It seems pretty unlikely that an investor will put up 40 times as much to try again. COMMENTS (3)

Our designs are much smaller, and thus the path to funding them is much clearer. Our current estimates suggest that a complete, viable seastead for around a hundred people could be built for one one-thousandth of the Freedom Ship's proposed cost, or about $100,000 / resident. Our platforms may not be a mile long, but which do you think has a better chance of getting built? We'll take modest and real over huge and imaginary any day. COMMENTS (3)

Past attempts to raise money from the community of nation founders have demonstrated the folly of depending on this small group. Those with substantial assets, usually older, are generally unwilling to drop their lives (homes, businesses, families) and move. Those with time and mobility, usually younger, rarely have the necessary cash. A viable project must find ways for both of these groups to participate. More importantly, it needs to draw interest from a much broader market. To put substantial effort into a nation-founding project, one must be a zealot of some type, and it is easy to ignore the less-zealous masses. The new territory must be interesting to more than the few eager separatists. **{CENG: prev par unclosed}**

We believe that seasteads will appeal to a large group of customers, for reasons explained in detail in the Market section. One key device is a timesharing system, which lets people participate without having to lay their lives, fortunes, and sacred honor on the line right from the start. We think a graduational transition from traditional ways of life to our pioneering one is required for it to appeal to a significant number of people. COMMENTS (0)

Transparency

A solid, realistic plan can stand criticism and review. It is the scams, the half-baked, the grandiose but insubstantial, which must hide behind a facade of mystery. In our experience, the less you see up front, the less there is behind. Sure, its possible that behind the curtain lies a complex and well-considered plan which is being hidden for some legitimate reason, but the odds are heavily against it. If it looks like the emperor has no clothes, he's probably got goosebumps. COMMENTS (2)

There is nothing wrong with playing the micronation game, imagining a country for fun. But the line between Micronation and genuine venture is a blurry one, in the minds of the principals as well as on their websites. Hinting at complex negotiations with mighty powers for far-off territory adds spice to projects on either side of the line. Yet the countless cycle of promises and failures cannot help but turn interested participants into weary cynics, exhausting the enthusiasm of each new generation. We'd much rather be open about what we have (now, a realistic plan, a rough design and a little financial commitment, later, we hope, a small but habitable prototype). We are trying hard to minimize the faith necessary, but there will be some, and we think honesty, not puffery, gives us the best chance to get it. COMMENTS (0)

Realistic Compromises

While our goal is to change the world, we believe that compromise is an important part of the process. We accept that seasteads will not have full freedom to choose their own laws. There will be substantial limitations on what the rest of the world will tolerate. Like it or not, the first seasteads will be tiny fish in huge ponds, and if they make the sharks angry, they'll never grow big enough to put up a fight. COMMENTS (2)

For example, Libertarian seasteads will probably be allowed to have low taxes and low regulation, but genuine bank secrecy may not be permitted because of worries about terrorist money laundering. We think its far better to get what freedom is possible than to fail because of a refusal to compromise. Environmental regulation offers another example where compromise will be necessary. Our political goals are a compromise as well in that we simply wish to be left alone by other states, we aren't seeking recognition, embassies, passports, and a seat in the UN like some projects. COMMENTS (0)

This willingness to compromise does not mean that our new way of life offers no improvements on the old. Its just that focusing our efforts on a few changes at a time is the most effective way to succeed. Even with the limitations of reality, there are still plenty of incremental improvements that can be made to current social systems. In our next section, you'll see the fundamental reason why life at sea may be an improvement of life on land. COMMENTS (0)

Dynamic Geography

{ This has been totally re-written, comments desired. Does it convey the essence of the DG argument? Is it too short? Too long? Suggested clarifications? - P } COMMENTS (0)

We chose the ocean as the best place to experiment with new social systems because it is the only unclaimed area left on earth (and space is still a bit expensive). It turns out, however, that its unique features will lead to a revolution in the quality of government, producing many small governments which are response to their citizen's needs. We'll first analyze why terrestrial governments are so unresponsive, and then show how things are different on the ocean. This is a summary of Patri's paper, see the original for more detail [PFriedman2004]. COMMENTS (1)

Land = Crappy Government

Lets consider government as an industry like any other. Citizens pay taxes, and in return they get government services. It turns out that its an absurdly uncompetitive industry for two reasons. COMMENTS (MANY)

First, the cost of switching service providers is very high, since it involves moving to another country. You have to leave your job, find a new one, sell your house, find a new one, leave your friends and relatives, and deal with a new culture. Compared to the cost of switching cellphone providers, ISPs, cars, or insurance agents, this is gargantuan. So its a great temptation to stay and hope things get better, or perhaps try to change them despite slim odds. The expense of moving reduces the potential impact of jurisdictional arbitrage (a fancy name for changing the system by voting with your feet, taxes, and citizenship). The result is that governments don't compete to do a good job - they don't need to. They focus on exploitation instead of innovation, because there is very little market feedback. COMMENTS (1)

One potential solution to the cost of moving on jobs and friends is an information economy with digital cash, where people can work and maintain social networks from anywhere. This idea has been championed by hi-tech libertarians, and described in the book *The Sovereign Individual* [DavidsonMogg]. While it has worked for a tiny minority of individuals, the other problems with moving (family, house, face-to-face contact with friends) remain. The number of information workers is growing, but this approach won't work for the huge numbers of people whose jobs involve some hands-on component. COMMENTS (0)

The second problem is that the cost of entering the governing industry is incredibly high. You basically have to win an election or a revolution to get a new government, both of which are very difficult! Economists call this a "high barrier to entry". While industries with low barriers to entry tend to be very competitive, with innovative firms competing to provide the best product, those with high barriers tend to consist of a few entrenched firms taking advantage of their position. The difficulty of getting into the government industry (on land) dwarfs that of almost any commercial industry. So its no surprise that we don't get small competitors serving niche markets. COMMENTS (1)

Taken together, we can see that governments do a poor job of serving their citizens, especially minority groups. Its an industry with little market feedback, little competition, little reason to perform well, and little opportunity for incremental improvement. COMMENTS (1)

Sea = Better Government

When we build countries from modular seastead groups, however, everything changes. Moving around huge buildings on the water is cheap - just look at cruise ships and oil tankers. On the ocean, you can expatriate and take your house, friends, family, and office with you. This dramatically lower cost of switching providers promotes market feedback. If the government announces an unpopular policy on Monday, by Tuesday there may be nothing left but the capital building. This is true for any pet topic - libertarians and taxes, drug users and drug prohibition, pacifists and military expansion, environmentalists and pollution. COMMENTS (2)

Furthermore, the barrier to entry is dramatically lower. Instead of the hundred-plus billion dollars its taking the US to enact a new regime in Iraq, any group with a few tens of millions can start a new country. They don't need to get it all at once either, they can add structures as resources and people become available. The result is to empower minority viewpoints of all types. Instead of huge, monolithic, unresponsive governments, we'll have many small, dynamic, innovative ones. Power will move downward towards the level of the smallest economically feasible platform (something like 10-100 people). We don't claim this will result in utopia, but it should increase the efficiency of any type of government.

These differences are intimately related to the difference between static and dynamic geography. You can grab dirt and hold it. Try to grab water, and it tends to fragment into tiny pieces and swirl away. What little you capture will slowly evaporate. This metaphor is an accurate one. Terrestrial governments control people because they can control territory and the immobile structures on top of it. On the ocean, control of the foundation has little relevance - a seastead can float anywhere.

One of the great things about this idea is that its a technological solution to a political problem. Humans are no good at changing human nature, and human nature, plus the nature of political systems, is why governments function poorly. Yet we are fabulous at solving engineering problems. Well, dynamic geography shows us that we can dramatically improve government merely by solving the engineering problems posed by seasteading. As cryptography makes it almost impossible to censor free speech and communication, seasteading will make it very difficult to exploit a trapped citizenry.

So as it turns out, the ocean is not a booby prize.

Summary

The problems facing prospective nation-founders are undoubtedly difficult, as evinced by the movement's historical lack of success. They can be overcome **if and only if** we rationally consider our options, then produce a design which is politically, technologically, and financially feasible. For the reasons which we will outline in this paper, we believe that seasteading meets these criteria. While there is a lot of planning and hard work ahead, there are no substantial leaps of faith required. We think that this makes our vision unique.

We cannot over-emphasize the importance of the economic analysis in Dynamic Geography. If one is trying to build a better (or different) society, it would be a great shame to boldly homestead the ocean frontier and have it turn into the same quagmire one was trying to escape. The other parts of our philosophy, and the rest of our paper, all deal with implementation, with the **how** of seasteading. It is Dynamic Geography that tells us **why** this new way of life will be different than the old. We are realists, and we expect that living with the same humans will result in many of the same human problems. But different systems can result in quite different results with the same people. While we will never reach utopia, we think we can make some fundamental improvements to current social systems, and in the real world, that is plenty to strive for. COMMENTS (0)

So if you are interested in its details, please continue reading. Just don't expect any "artists renderings" of sprawling sea cities, budgets using the word "billion", or dependence on impractical new technologies. Instead, you'll learn fundamentals like how we plan to put together old techniques in new ways, how we keep our costs down, and how to make seasteading financially viable. By the end, you should have a good grasp of what is involved in making this vision a reality. And perhaps, (we hope) an interest in being part of the process. COMMENTS (1)

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> *The ocean is a wilderness reaching round the globe, wilder than a Bengal jungle, and fuller of monsters, washing the very wharves of our cities and the gardens of our sea-side residences. Serpents, bears, hyenas, tigers rapidly vanish as civilization advances, but the most populous and civilized city cannot scare a shark far from its wharves.* *[Thoreau1906, vol. 4, p.188]*
>
> { Does this seem like a good introductory ocean quote? Any other suggestions? }

A seastead needs to survive and thrive in the ocean environment. In this section we'll describe that environment, its dangers, and our plans for avoiding them.. COMMENTS (4)

What is the ocean environment? Obviously, it consists of a great deal of salt water (about 3% solution.) The disolved salt causes two problems -- first, it causes many materials to corrode and second, it renders the water unfit for drinking. In addition to the water, the ocean environment has weather. This includes temperature variation, wind, humidity, rain, etc. Convection and Coriolis effects cause movement of the air (wind) and water (currents) in roughly consistent patterns. The wind causes the growth of waves which can become quite significant. COMMENTS (2)

The ocean is full of life, from tiny algae to the largest living creature: *Balaenoptera musculus* , the blue whale. The most dangerous marine creature, however, is *homo sapiens*, whose warships have teeth sharper than any shark. Correspodingly, the most complicated element of the ocean environment is the labyrinthine system of laws and regulations that humans have developed to govern it. COMMENTS (5)

Waves

Ocean Wave Basics

The high point of an ocean wave is called the crest, and the low point is the trough. The distance from crest to trough is of course the wave height, and the distance between successive crests is known as the wavelength. Waves are created by wind blowing on the oceans surface, which steadily adds energy to them. The size of waves thus depends on how hard and for how long the

wind blows. Because waves can travel long distances without losing much energy, they may appear when there is no wind, having been produced by some distant storm. COMMENTS (2)

While it may appear that waves consist of water moving linearly, in reality each water particle simply travels in a circle. The water transmits energy without being carried along. This is why small free-floating objects on the surface just bob up and down in waves. Even in huge waves, a piece of driftwood doesn't get broken, just shaken around a lot. COMMENTS (0)

However, our potential seastead designs are not like this. Objects that are large or heavy don't just roll with the waves, they resist and must absorb some energy. For them, the ocean is a much more hostile environment. The amount of energy stored in a large wave is quite scary, hence why they occasionally pulverize large ships. You'll first learn about the biggest waves, and then about our strategies for avoiding them. COMMENTS (1)

Tsunamis

Many people think of the tsunami as the most fearsome wave, but that's a landlubber's perspective. Generally driven by earthquakes, tsunamis are often unnoticeable in the deep ocean, where they have extremely long wavelengths and low wave heights (several meters at most, usually much less). COMMENTS (4)

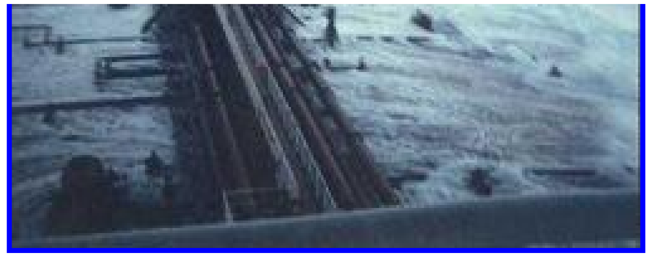
As this wave reaches a continental shelf, it piles up, becoming shorter and higher. Only then will it resemble the monsters of legend - and as usual, legend exaggerates. Tsunamis rarely result in giant breaking waves, but are more like very strong, fast tides [USGSTsunami]. While this is very dangerous for coastal structures (as the horror of the 2004 Asian tsunami demonstrated), even if a seastead was close to shore, it would just rise with the water level. The worst consequence would be the mooring system failing or being damaged. COMMENTS (0)

Now we'll see a case where the storytellers, not the scientists, turned out to be right. COMMENTS (0)

Rogue Waves

> *They were struck by a rogue wave - a monstrous wall of water that rose out of nowhere and slammed onto the deck like the fist of god. Ships often don't survive an onslaught like that. Many sink before anyone on board knows what's hit them.* [Lawton2001]

On the right is perhaps the only photograph of an elusive phenomenon known as a rogue wave. Not many people



would reach for a camera when struck by such a monster, but that's exactly what Phillipe Lijour did. He was onboard the oil freighter *Esso Languedoc* in 1980 when it was struck by a rogue. By his estimate, most waves were 5-10m, as you tell from the low seas in the background. The mast visible on the starboard side is 25m above sea level, and the wave is breaking from behind the ship. The wave was at least 20m high, perhaps 30m (since its trough, as well as crest, would be lower than other waves).

Scientists used to dismiss such tales of unusually large waves as mere folklore, like monsters or mermaids. But with the proliferation of oil and gas platforms, some of which record wave data, accumulated observations have finally led to mainstream acceptance of this seafaring "myth" [Lawton2001]. And recent data from the European Space Agency's ERS satellites has not only re-confirmed the existence of these waves, but indicated that they may be fairly common. Researchers with the MaxWave project computer-analyzed satellite photos from a three-week period in 2001 during which two ships were hit by 30m rogues. They found "*ten individual giant waves around the globe above 25 metres in height.*" [ESA2004].

These rogue waves are the real dangers in open water. Towering above their neighbors, they are unstable and break quickly, thus containing tremendous power. They sometimes come unexpectedly from a different direction than the prevailing swell, which adds to the surprise and danger. Rogues have been known to ravage coastlines as well, sometimes coming out of calm seas to sweep away unsuspecting victims. Emergency services have warned beachgoers in some areas to be aware of this danger [RogueWarning].

Understanding rogue waves is clearly quite important for marine safety. Hence while their existence has only been accepted for a few decades, a decent-sized body of academic work has sprung up. There was a Rogue Wave conference in 2000 [RogueWaves2000]. Theories about their existence include interference patterns (refraction/diffraction), current/wind interactions, and normal variations in the height of wave groups. These theories are problematic, however. Interference ought to produce a bell-shaped distribution, but high outliers occur much more often than that. Also, in the open ocean it is unclear what would cause an interference pattern. Current interactions don't explain the many rogue waves in areas without fast-flowing currents. Focusing effects of some type seem to be the most promising. They are difficult to analyze on messy real-life waves, but some non-linear mathematial models have produced focusing and shown promise at replicating the observed distribution [NorwayRogueGroup]. And the MaxWave team is starting a new investigation called WaveAtlas to further study the distribution of rogue waves.

The question of how big waves get and how often they hit is of far more than academic importance. Most offshore platforms and cargo ships have been designed assuming the standard distribution. This is why rogue waves are so dangerous - not just because they are big, but because they are **unexpectedly** big, and so structures are not designed to handle them. We can see that a seastead intended to last decades must be prepared to withstand these "Monsters of the Deep".

Wave Height

To design a safe and reasonably-priced seastead, we need to know what wave heights to expect. Most important is the worst-case height. Since this will depend on the exact region and seasons, we'll just give a general overview, as well as sources for additional information. Wave height is a function of wind strength and the "fetch", which is the distance over which the wave been building. Oceanographers use a statistic for wave height called the "significant height", denoted H_s. This is the average of the 1/3 highest waves (from crest to trough) over a given time period (20 minutes for [NDBC] buoys). One wave in a thousand is twice H_s, and about one wave in three-hundred thousand is a so-called "rogue" whose height is two and a half to three times H_s [Bascom1980]. However, this distribution may reflect out-dated assumptions about rogue rarity, and must be investigated further. COMMENTS (0)

The National Data Buoy Center [NDBC], part of the NOAA, is a good source for wave height information. Data from several hundred buoys (not all theirs) is accessible on their website, often with historical records. The highest waves ever recorded by the NDBC buoys were in the North Pacific, near the Aleutian Islands, and had an H_s of 18m. A rogue wave in that storm could have reached a staggering 48m in height. The location is no accident. While 100-foot waves in the North Atlantic are rare enough that it took a "Perfect Storm" to create them, David Gilhousen, a metereeologist with the NDBC, says that in the North Pacific "sea waves of that magnitude are something you would see every other year -- maybe every year" [Chui2000]. Not the best place to build a seastead. COMMENTS (1)

The highest wave ever accurately assessed at sea was seen from the USS Ramapo on February 6, 1933, and measured at 34m by triangulating on the crows nest. The ship was on passage from the Philippines to California during a hurricane with a wind force measured at 68 knots. The storm lasted 7 days and stretched from Asia to New York, producing strong winds over thousands of miles of unobstructed ocean. Other sources have reported rogue waves of 17.5m (Skourop, North Sea), 26m (1/1/95, North Sea), 28m (1943, North Atlantic, the Queen Elizabeth), and 29m (1995, North Atlantic, the Queen Elizabeth 2) [Lawton2001]. COMMENTS (1)

It not only takes strong winds to generate these monster waves, it also takes a long fetch. For this reason, sheltered seas like the Mediterranean and the Caribbean experience smaller waves even during severe storms. The doldrums around the equator, where winds are low, are another area with much smaller waves. Cautious seasteaders may wish to gain some experience in these places before venturing into rougher areas. COMMENTS (0)

Calamity

"One thing about the sea. Men will get tired, metal will get tired, anything will get tired before the sea gets tired" - A marine engineer's observation

about the tragic collapse of TT-4. COMMENTS (0)

The loss of Texas Tower Four demonstrates the disasters that can occur when a flawed structure encounters the tremendous power of the ocean. The tower was one of three manned radar platforms off the US Atlantic coast numbered Two, Three, and Four (One and Five were planned but never built). The tower, part of the nations air defense system, "was such a spectacular sight that ocean liners veered off course to permit passengers to glimpse it" [TexasTowersRD, p. 95]. Because it was a lonely post, the interior of each tower had libraries, gyms, and rec rooms. Music, movies, and even a daily ration of beer helped entertain the crew. COMMENTS (0)

Things began to go wrong with Four from the beginning. Built in a Portland, Maine shipyard, it was completed in June of 1957. While a convoy was towing it to its permanent location, a sudden storm struck and damaged the tower. (For those with an engineering bent, it tore off the diagonal cross braces on the legs). Because of the cost and time delays involved in towing it back for repair, the tower was installed anyway (the civilian contracter said that the damage could be repaired on-scene). This problem was especially serious because TT-4 had legs more than twice as long as the other towers and needed these missing supports. Divers later installed an extra piece to compensate, but it proved insufficient for the task. Even modest waves caused the structure to tremble (earning it the nickname "Old Shaky"), and over time the bracing was compromised. Again, divers attempted to repair it, but in September of 1960, Hurricane Donna destroyed the patchwork repairs with 132mph winds and 50-foot waves [Ray1965]. COMMENTS (1)

The towers lurching worsened and most of those onboard were evacuated, but a skeleton crew remained. They were there to protect the millions of dollars in radar equipment from the Russians, and to maintain the tower while more repairs were attempted. In January of 1961 there were 28 crew, half of them USAF personnel and half a civilian repair team. Warned by radio of an approaching storm, the next cargo ship offered to evacuate the tower, but orders from land said for the men to stay on the tower and the ship to stand by. The chain of command for the towers was poorly designed, and apparently the superior officer on land was unsure of his authority to evacuate the station. COMMENTS (1)

The storm arrived, and while it batterred the waiting cargo ship and the shaking tower with 85mph winds and 35-foot waves, the commander on shore finally decided to evacuate during the next lull. Helicopters from the Coast Guard waited to take off the moment the weather permitted, and the Towers crew frantically cleared off the flight deck. But the weather refused to slacken, and under the incredulous eyes of the cargo ship captain, the radar image of Texas Tower Four disappeared from his screen. All hands were lost. [TexasTowersRD] COMMENTS (0)

It was later determined that one of the three legs had broken under the strain, rendering the tripod of support unstable. Its important to note that Towers Two and Three survived this and many other Atlantic storms over the next few years, although they were evacuated a number of times to ensure that no repeat tragedy ocurred. Eventually currents weakened the foundations and they were decommissioned. (We'd like to note here that the TT's weakness was their supporting legs, which our design avoids entirely). COMMENTS (1)

The lesson is not that permanent manned sea structures are impossibly dangerous, but that the ocean does not forgive mistakes. Great care must be taken in the design and building of seasteads to ensure their absence from the annals of marine tragedy. This will increase their expense, but safety - a matter of life and death - is no place for shortcuts. COMMENTS (0)

Avoiding Waves

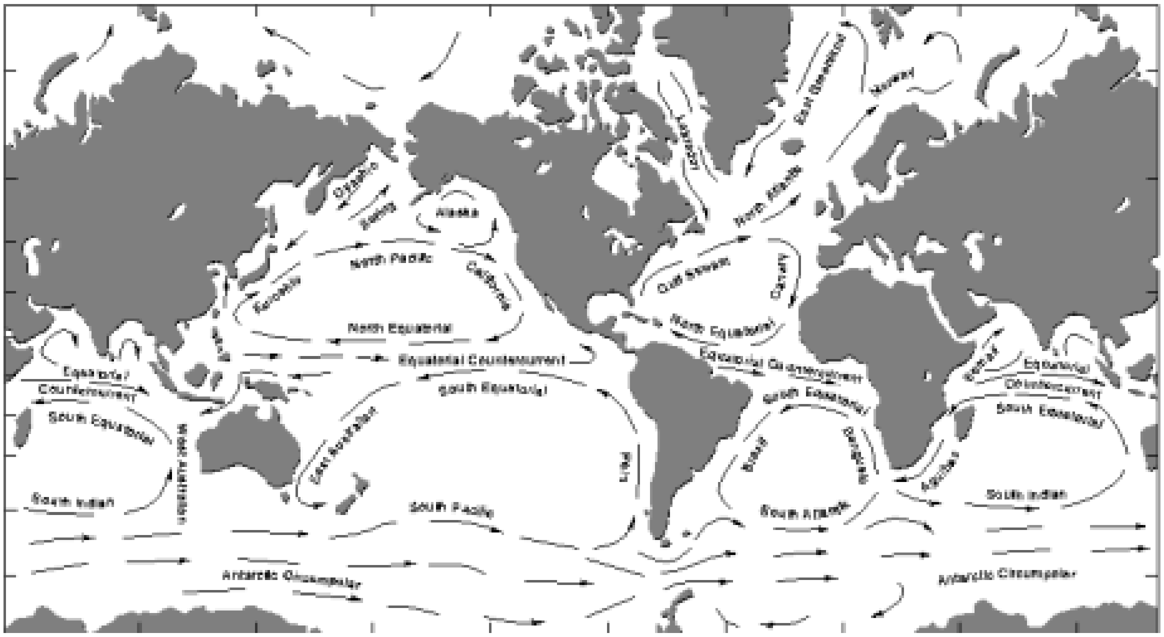
Because waves are so dangerous, we think its quite important to be able to avoid or nullify them. Our preferred design, the spar platform, handles this by lofting the living space above the waves on a tall pillar. While this keeps a seastead from being pummelled by the waves around it, it may also want to avoid big waves in the first place. Since a seasteads only place in the America's Cup race would be as a buoy, this requires planning well in advance. There are other methods for minimizing this danger as well. Here are the techniques we consider: COMMENTS (0)

- Build a pillared seastead (fixed or free-floating), with a sufficiently long spar that waves don't hit the platform. COMMENTS (0)
- Use natural or artificial breakwaters to protect structures from the waves. COMMENTS (0)
- Build underwater structures. COMMENTS (6)
- Choose an anchorage or roaming area without large waves, like the equatorial doldrums or a protected sea. Or, since storms tend to be seasonal, stay in these locations during the dangerous seasons. COMMENTS (0)
- Actively avoid storms by moving around. Small waves grow into large waves slowly, so thanks to metereological satellites and computer prediction, it is reasonable to expect around 5 days of advance notice in which to avoid bad waves [Chui2000]. This gives enough time for a sailboat fleet to run away, although not a lumbering platform. COMMENTS (0)

Currents

It is not only the oceans surface that is continually moving. Currents are everywhere as well, and unless we anchor they will push our platform around. Approaches to dealing with this are outlined in the Transportation section. COMMENTS (0)

Currents tend to consist of large cyclical formations with opposite direction of rotation in the northern and southern hemispheres. They range in speed up to about 2.5 m/s. They are caused by a number of factors, such as wind, convection, density differences due to variations in salinity, and the Coriolis force. The chart below will give you a general feel for the arrangement of currents: COMMENTS (0)



[Currently used **without** permission from a figure in Principles of Ocean Physics by John R. Apel, Academic Press, 1987].

However, it must be noted that these maps are deceptively simple. Ocean currents form many eddies and transient features, and vary from season to season and year to year. COMMENTS (0)

Wind

> *Pleasant it is, when winds disturb the surface of the vast sea, to watch from land another's mighty struggle.*
> Lucretius

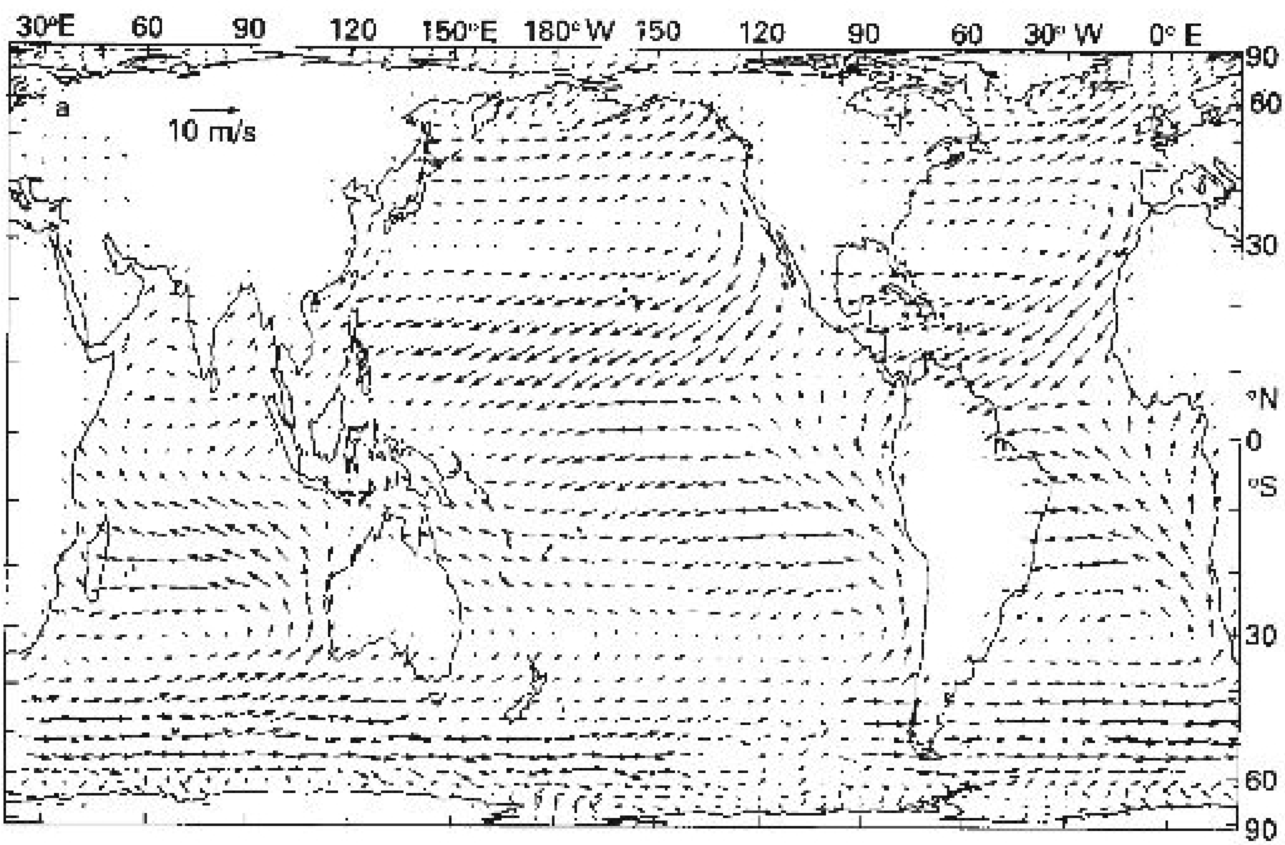
COMMENTS (0)

As anyone who has been in a sailboat or forgotten their jacket can tell you, air may be thin but it can still transfer a lot of energy. Because wind will move seasteads around, batter them during storms, and help them generate electricity, it is an important part of our ocean environment. There are basically two kinds of winds we need to worry about, the good kind which blow slowly and steadily, and the bad kind which swoop in occasionally and try to steal anything which isn't nailed down. COMMENTS (0)

General Circulation

As with currents, global forces cause wind to have consistent, large-scale patterns. The equator receives more heat, so the air above it is warm and rises. As a response, the surface air nearby (+/- 30° lat.) is drawn towards the equator to replace the risen air. Together, these form a classic convection cell. At the equator itself, since the air is rising (and new air coming in from both sides), there are no steady surface winds - the wind is vertical instead of horizontal. Since vertical wind doesn't generate waves, this area enjoys calm weather and is called the doldrums. COMMENTS (0)

Farther from the equator in both hemispheres (30-60° lat.), the Coriolis Effect dominates, making the winds blow from west to east relative to the earth's surface. Above the poles, the air cools and sinks, forming another pair of convection cells. COMMENTS (0)



Surface winds over the World Ocean. Annual mean for the period 1950-1979.

[from Tomczak, M. and J. S. Godfrey (1994), Regional Oceanography: An Introduction, Pergamon, Fig. 1.2.]

These steady winds will be quite useful for energy generation, as described in further detail in the Wind Power section, which also contains a map of worldwide wind resources. Their consistency makes them an excellent energy source, since storing energy is relatively expensive. Unlike solar energy, which arrives for half of the day at best, the trade winds blow around the clock. Wind speed and energy grow significantly with height (this is why wind turbines are on tall poles), and seasteads are already high up to avoid the waves. Though they may necessitate a sweatshirt when going on deck, the trade winds are our friends.

One downside of the constant winds is the salt spray they carry. This can result in salt accumulation on surfaces, which is undesirable for gardens, trees, and farm animals.

Ill Winds

{ This subsection is new and quite rough }

Tropical storms, cyclones, and hurricanes have strong winds that can destroy conventional buildings, as well as triggering strange dream sequences that go eerily well with Pink Floyd albums. Luckily, even a Category 5 hurricane will have trouble lifting concrete off to the Land of Oz. For instance, a concrete Monolithic Dome called the *Eye of the Storm* was built on an island in south Carolina to replace a home lost to Hurricane Hugo in 1989 [MDI]. It and other domes were in the news after the relentless hurricane season of 2004 [MDI_Ivan], which they weathered without a blink.

Hurricanes are rated according to the Saffir-Simpson Scale:

Category	Wind Speed	Examples
1	74 - 95 mph (65 - 82 kts)	Hurricane Irene, 1999
2	96 - 110 mph (83 - 95 kts)	Hurricane Bonnie, 1998
3	111 - 130 mph (96 - 113 kts)	Hurricane Fran, 1996
4	131 - 155 mph (114 - 135 kts)	Hurricane Andrew, 1992
5	More than 155 mph (more than 135 kts)	Hurricane Hugo, 1989, Camille, 1969

Storms of all sizes come with advance warning nowadays, thanks to the global network of weather satellites. Clouds are easy enough to see from space, and clever image processing even allows for estimates of wind and waves. As an article about the infamous "Perfect Storm" states: COMMENTS (0)

> *Back then, he said, forecasters had to rely on scattered readings from buoys or ship crews to gauge the state of the wind and seas. And the computer graphics that help them quickly grasp and interpret weather data were not as advanced...In the nine years since the Andrea Gail went down, computer models have improved to the point where forecasters can give people at sea five days' warning of severe wind and waves, compared with two days in 1991, said Joe Sienkiewicz, a senior forecaster with the National Weather Service's Marine Prediction Center in Camp Springs, Md. Satellites now sweep their radar and microwave eyes over the ocean surface, taking in swaths 930 miles wide, and beam back information on wind speed and direction.*

While the exact occurence and course of any storm are unpredictable, the general trend is quite consistent. There is a "hurricane season" in late summer and fall (which are opposite months in the Northern and Southern hemispheres). Storms usually move westward and at less than 20mph, so there is plenty of advance warning (although course tracking is imperfect). The most dangerous part of a storm is the quadrant where the rotational and translational velocities add. As with the trade winds, speeds increase as you rise above sea level, which means that seastead platforms will be subject to some pretty strong forces. Because of its shape, the upper part of a seastead will act like a wing, and its design must take into account these aerodynamic characteristics. COMMENTS (0)

While winds will be stronger blowing unobstructed over the oceans, a major advantage is that they will carry very little debris. Even at 150 mph, wind is much easier to withstand than tree branches. A University of Missouri-Rolla study confirmed this, saying "We concluded that the majority of damage didn't come from high wind pressures as many building designers originally thought, but from windborne debris impacts." [Kaiser2000]. Other experiments have confirmed this: COMMENTS (0)

> *Evidence from an experiment at Texas Tech University's Wind Engineering Research Center (Concrete Products, August 1998) seems to confirm the intuitively obvious: Of all commercial building materials, concrete provides the greatest resistance to extreme high winds and debris...The greatest inherent danger to people and property during the high winds of tornadoes and hurricanes is the debris carried in the high winds. Flying at such intense velocity, wreckage can cut right through a building wall and endanger the people inside. Tests conducted by Texas Tech University's Wind Engineering Research Center offer dramatic proof that concrete walls withstand flying debris from tornadoes and hurricanes-and outperform their wood and steel counterparts. To duplicate tornado-like conditions in the laboratory, researchers shot wall sections with 15-lb. 2 Yen 4 lumber "missiles" at up to 100 mph, simulating debris carried in a 250-mph wind. These conditions cover all but the most severe tornadoes.*
> [ConcreteProducts1998]

Flooding, which erodes foundations and washes through lower stories, causes much of the damage on land. This "storm surge", happens because the pressure from a storm piles up the water, increasing its level. However, it will have little effect on seasteads, which are already floating and will simply rise with the water (though there are some minor complications for anchoring [link to engineering of anchoring]). Listing (leaning to the side) due to wind forces is a not likely to be a major problem, even in high winds, as we explain in the relevant FAQ. COMMENTS (0)

Given that most damage comes from storm surge and debris, it does not appear to us that hurricane winds are a major danger for seasteads. Waves are the real danger. When it comes to wind, the seastead should actually have an easier time than coastal residents. Some precautions will still be required. COMMENTS (0)

Energy gathering may cease during a storm, with wind turbines taken down and PV panels ineffective. Generators will most likely take up the slack, although special turbines geared for higher velocities could be deployed during storms (perhaps a good time to test DIY Savonius rotors). COMMENTS (2)

As with waves, seasteads will need to be built to withstand the worst winds they may encounter. While pictures of smashed homes fill our television screens after a hurricane, these structures are generally small and cheap. In the US, government backing of insurance companies is likely part of the explanation for this choice. In many places, it is due to poverty. As the Texas Towers tragedy taught us, seasteads must be built to last. Like the third little pig, we'll choose a material that can't be blown down. COMMENTS (1)

Politics

{ Most of this section is new. Since politics is quite a complicated issue, its pretty rough too. Since there is so much to say, its a bit long and disorganized. We'd love to hear any clarifications from those with more than our scant knowledge of international maritime law } COMMENTS (0)

Political Situation

An unavoidable aspect of the ocean environment is the large body of international law which pertains to it. (For information about the law applying to islands, see [Dyke1999] and [Gjetnes2000].) Seasteads may be classified as ships (flagged or unflagged), installations, or artificial islands. The basic tenet of maritime law is that vessels and structures are considered to be under the jurisdiction of some country, as if they were its soil (much like embassies): COMMENTS (0)

> Under admiralty, the ship's flag determines the source of law. For example, a ship flying the American flag in the Persian Gulf would be subject to American admiralty law; and a ship flying a Norwegian flag in American waters will be subject to Norwegian admiralty law. This also applies to criminal law governing the ship's crew. But the ship must be flying the flag legitimately; that is, there must be more than insubstantial

contact between the ship and its flag, in order for the law of the flag to apply. American courts may refuse jurisdiction where it would involve applying the law of another country, although in general international law does seek uniformity in admiralty law. COMMENTS (0)

[LIIAdmiralty]

This system has the advantage that each seastead can seek the protection of any nation on earth, however distant. This competitive market and the ease of switching mean that we have a good chance to get better terms than any country's residents. Still, its important to realize the utter lack of rights held by individuals in international law, where only States count as entities. This is exemplified by the Boarding subsection. COMMENTS (2)

Several summaries have been written about maritime law as it relates to building floating cities, see [Fitzpatrick1998] and [Kardol1999]. Another interesting reference is is the Navy's summary of international law for ship captains [NWP-LAW]. COMMENTS (0)

It is worth noting here that we'll just be talking about what we are and are not supposed to do according to international law. For example, when we suggest that regulations on safety may be avoidable, we are not saying that no attention should be paid to safety. What we do believe is that different people will make different decisions about issues like safety. For this reason, we think its worthwhile to discuss legal constraints as a separate entity, one of many inputs to individual decisions. COMMENTS (0)

Another caveat is that for the most part we'll either be talking about international or United States laws and policies. There are far too many variations in other countries and regions to cover here. COMMENTS (0)

Political Zones

The first thing to note is the separation of the ocean into several types of zones, each with different usage rights. Here are the basic categories: COMMENTS (0)

Territorial Seas

Extending for 3-12 nm (usually 12), a country's Territorial Seas are an extension of its sovereignty over land. In fact, the 3nm original limit was chosen as the area which could be defended by cannonfire from land. While there are some exceptions (ie it is not allowed to block the passage of innocent ships), generally the country has complete jurisdiction. COMMENTS (0)

Contiguous Zone

According to UNLOS Article 33 [UNLOS], this is a zone contiguous to the territorial sea where the owner may exercise the control necessary to enforce its laws and regulations within the territory and territorial sea. For example, customs enforcement and drug interdiction are performed here. This creates similar problems to the territorial seas. Fortunately the total of territorial seas CZ may not extend more than 24 nm, at which point you might expect to be on the High Seas. In the old days, you would have been right. COMMENTS (0)

Exclusive Economic Zone

Stretching for up to 200 nm past the territorial seas, the EEZ was a customary norm by at latest 1975 [Gjetnes2000] and was formally introduced in the 1982 UNLOS convention. It is part of the trend towards expanding maritime limits stimulated by the desire to exploit offshore oil and gas resources. The definition of an EEZ is: COMMENTS (0)

A maritime zone seaward of the territorial sea with an outer boundary that may be up to 200 miles out from the territorial sea's baselines. Within this, a coastal state may regulate: (1) nonliving resources, including the seabed, subsoil, and superjacent waters; (2) living resources, including fish, crustaceans, and plants; (3) other economic resources, such as the production of energy from the water, currents, and winds; (4) artificial islands, installations, and structures; (5) marine scientific research; and (6) pollution control. [IntLawDict]

Some states, such as the United Kingdom, have only claimed jurisdiction over living resources, thus an "Exclusive Fishing Zone" rather than an EEZ, which is more compatible with the seastead way of life. We are not sure if coastal states with EFZ's claim the right to regulate artificial structures. Let's examine each of these provisions: COMMENTS (0)

1. This is not really a problem, seasteads aren't trying to steal oil. COMMENTS (0)
2. Seasteads also aren't trying to steal fishing rights. However, they will want to do mariculture. Thus the question of whether the coastal state can regulate living resources entirely produced, rather than harvested, is important. COMMENTS (0)
3. This is certainly a problem, although it seems rather unfair. If seasteads capture some solar or wind energy, this does not cost the coastal state anything. The clause was probably meant to make sure that if large off-shore power generation becomes cost-effective, states can control it. It seems politically unlikely that seasteads would be prosecuted for generating power in a clean and sustainable fashion, but further research is necessary. COMMENTS (0)
4. This is the most clearly relevant clause. The exact legal differences between ships and artificial structures will be relevant, and seasteads may be able to sidestep this restriction by being ships. If not, this clause makes it pretty clear that coastal states can regulate seasteads in their EEZ. COMMENTS (0)
5. Again, this seems unfair, and politically unlikely to be enforced. If seasteads want to do marine scientific research, they will probably be allowed to. However it is something to keep in mind in case the research is somehow politically sensitive. COMMENTS (0)
6. This gives the coastal state some right to regulate pollution from a seastead. Since we expect seasteads to be very clean, this should not be much of a practical problem. Coming to reasonable agreements with the state should not be hard. However, if there is political tension, the state could impose unreasonable demands through this clause as a means of attack. COMMENTS (0)

Its worth noting that the EEZ is essentially concerned with resources. The law of the coastal state does not apply in the EEZ, and it does not have general enforcement rights. Other than as regards resources, EEZs are counted as the high seas. COMMENTS (0)

Interestingly enough, the US is one of the major objectors to the EEZ system. They are worried that EEZs could become special security zones which restrict the passage of American warships. This could occur through steadily creeping jurisdiction. For example, while pollution controls don't currently apply to warships (gorillas don't need table manners), this could be one route to regulation. They also worry that international straits - narrow passages in key locations - will be regulated. The right of free passage through places like the straights of Gibraltar is key to international maritime trade. COMMENTS (0)

The 200nm EEZ may soon go the way of the 3nm territorial sea. Article 76 of UNLOS suggests that EEZ's may sometimes be extended up to 350nm, or the 2500m isobath, based on the continental slope and sediment thickness of the seafloor. In addition, the 1982 UNLOS and 1994 extension authorized the creation of the International Seabed Authority. The ISA, which began operation in 1996, has authority over the resources of the seabed of the entire globe. COMMENTS (0)

There are other worrisome signs of this "creeping jurisdiction". After the 1989 Exxon Valdez disaster in Alaskan waters, Chile passed a controversial law in 1991 extending its ocean boundaries 2,000 miles west to Easter Island and south to the Antarctic. So Chile is now unilaterally claiming approximately 1/5th of the Pacific Ocean [StrategicOCeans, p. 3]. COMMENTS (MANY)

It is no surprise that, when there are valuable resources present, nations attempt to extend their authority. After all, there is no one there to object. This makes it imperative that the seasteading movement develop before too much of the ocean is claimed, and certainly before too much of it is being actually exploited. Otherwise our legal and political position will be more tenuous, and possible locations more limited. Also, this strengthens the case for mobile seasteads, which have the option of moving if political conditions change. COMMENTS (0)

Exclusive Fishing Zone

Some states, rather than claiming full EEZs, only claim Exclusive Fishing Zones. EFZs don't include mineral rights, however we are uncertain whether they include the other regulatory rights. The Mediterranean appears to consist mostly of EFZs rather than EEZs. COMMENTS (0)

High Seas

Finally we get to the high seas, that last bastion of freedom. Subject to some caveats regarding the deep seabed, "In the high seas, the freedom to construct artificial islands and installations is given to all States, whether land-locked or coastal." [Fitzpatrick1998]. While this is nice, it doesn't say anything about the rights of non-States. One can interpret various UN articles to derive that any group of people has the right to form a state [Kardol1999], but this rests on somewhat shaky ground. COMMENTS (0)

To be in the high seas, one must avoid EEZs entirely. The hard way to do this is to be 200 nm from anywhere, which will have a negative impact on many areas of the seaconomy, especially trade and tourism. The easier method is to take advantage of areas, such as the Mediterranean Sea, where EEZs are much smaller or nonexistent.

Special Zones

There are also numerous special cases. A continent-sized example is unsettled Antarctica, which has been portioned out according to an international treaty.

International boundaries are oft disputed and always complex. There are some commercial Geographic Information Systems (GIS) databases containing maritime claims data. These tend to be a bit expensive because they are sold only to governmental organizations, as well as being difficult to produce because of the morass of varying claims. This makes location planning somewhat difficult, although the general distance guidelines help. Seasteaders will probably wish to obtain or make use of these before making any final decisions about location.

A rough idea of EEZs can be seen in [SeaAroundUs], though it does not differentiate between EEZs and EFZs. A list of maritime claims can be found in [MaritimeClaims]. A commercial GIS database of maritime claims is sold by Veridian for $1500/year [GMBD].

Ships

Erwin Strauss summarizes the situation for ships in the book *How To Start Your Own Country*:

> Although many countries are expanding their claimed territorial waters, there are likely to be wide areas of the oceans that will remain open to ships of all nations for some time. Treaties that are accepted virtually universally require all ships to fly the flag of an existing nation. Those that do not are defined as pirates, and are subject to treatment as such by any nation's warships. Most nations require ships flying their flag to employ their own nationals, and generally subject them to the onshore laws of that country. However, there are certain small nations that specialize in granting ships the permission to fly their flags with a minimum of restrictions. In return, these countries receive annual fees in the range of a few thousand dollars per ship or less. These flags are called "flags of convenience," and the owners of ships flying those flags are allowed to hire anyone they want, and generally do just about anything they want. Certain international treaties banning piracy, the drug traffic, the slave trade, etc., still apply, but the countries involved are small and can hardly police their worldwide fleets - and aren't really interested in doing so.
>
> [Strauss1984, page 24]

Artificial Islands / Installations

Since we're dealing with the law, we need a precise legal definition for these terms: "Artificial islands and installations are man-made, surrounded by water from all sides, above water at high tide, supposed to stay at a specific geographical location for a certain span of time, and stationary in their normal mode of operation at sea." [Fitzpatrick1998]. So anchored seasteads clearly fit the definition and powered seasteads which move constantly do not (they'd be classified as ships). Its not clear from this how we'd classify drifting seasteads (unpowered, unanchored).

Next we have the difference between artificial islands and installations: "Artificial islands can be distinguished from installations, by asking whether the whole artifact can be moved from its location at sea without losing its integrity, If it can be moved, it qualifies as an installation. If it is impossible to move it qualifies as an artificial island." [Fitzpatrick1998] From this we see that of the two choices, our seastead design is an "installation". Platforms on pillars connected to the ground would be artificial islands.

Only the coastal state may build artificial islands and installations in its territorial sea. Only the coastal state can build artificial islands in its EEZ, as well as installations which serve an economic purpose. On the High Seas, however, any state can build artificial islands and installations. This does not extend its maritime zones, nor are such artificial islands and installations entitled to a territorial sea. They can, however, claim a safety zone of up to 500 meters where they can regulate traffic and navigation [Fitzpatrick1998], from [UNLOS, Articles 60(4) and 80]. Such installations are not entitled to an EEZ or continental shelf claim (and neither is an island which "cannot sustain human habitation or economic life of its own" [UNLOS, Article 121.3], interpreted in [Gjetnes2000, pp. 48-73]).

An internet encyclopedia discusses the political problems with artificial islands:

> Legal quandaries similar to the statehood of Sealand are no longer possible today. Since the third conference on the laws of the sea, the nearest neighboring state is now required to consent to the construction of any artificial island pursuant to the convention on the laws of the sea of the United Nations on December 10, 1982, in Montego Bay. Moreover, this convention requires the neighboring state to pull down the artificial constructions immediately after use or to have them removed.
>
> According to this convention, there is no transitional law and no possibility to consent to the existence of such a construction which was previously approved or built by the neighboring state. This means that it is unimaginable that a case like Sealand will ever occur again. An artificial island can no longer be constructed and then claimed as a sovereign state, or as state territory for the purposes of extension of an exclusive economic zone or territorial waters.

[Wikipedia-Sealand]

It is not clear whether non-states have the right to construct artificial platforms, since international law only makes reference to states. COMMENTS (1)

SOLAS

The set of rules relating to maritime safety is the International Convention for the Safety of Life at Sea, known as SOLAS [SOLAS]. It was first created in 1914 in response to the Titanic disaster, and has been under the auspices of the International Maritime Organization since it was created in 1960. While the latest Convention was adopted in 1974, it has been amended and updated many times since this. It sets standards in many areas, including compartment subdivisions (II-1), fire protection (II-2), lifesavers (III), and dangerous goods (VII). SOLAS mandates the international Safety Management (ISM) code, which can be tedious to comply with. COMMENTS (0)

UNLOS

Currently, the closest to a unified body of rules governing the oceans is the United Nations Law of the Sea [UNLOS], a convention negotiated between 1973 and 1982. While it has been signed by 157 states (as of 2003), the number of signatories to later modifications is much lower. Also, the current global superpower, the USA, never signed the original treaty due to disagreements about the deep seabed mining provisions [Reagan1983]. However, these portions of the UNLOS have been modified by the *Agreement relating to the implementation of Part XI of the Convention* . The US has agreed to the revision (along with many other nations). COMMENTS (1)

Enforcement

Enforcement of this morass, however, is pretty spotty. Its not like there are international safety officers on board every ship, and its hard to monitor the ocean or every ship in it. Organizations like the IMO which help make the rules have no enforcement power. As one source says: *"both the IMO and the UN are bereaucracies without the resources to enforce the laws and actually prevent such abuses."* [StrategicOceans, p. 4] COMMENTS (2)

Its mostly up to flagging countries, and no one has much incentive to enforce the rules. To address the lack of oversight by flaggers, more power is being given to ports. Fortunately, most seasteads won't need to call at ports, and so they can sidestep this control. COMMENTS (0)

Boarding, Arrest, Search, Seizure

{ we are still researching this section, its under construction - P }

The basic rules for boarding and search are that permission of either the captain, the owner, or the flagging country is necessary. There is also the "right of approach and visit", which allows a nation to approach a vessel to verify its nationality. It can then board when it has reason to question that nationality, the vessel is without nationality, or engaged in piracy, slavery, or unauthorized broadcasts [UNLOS, art. 110]. A country can also do whatever it likes in its territorial waters and contiguous zone. Outside, when dealing with ships flagged by other countries, its rights are much more limited: COMMENTS (1)

> Maritime law enforcement action may be taken against a flag vessel of one nation within the national waters of another nation when there are reasonable grounds for believing that the vessel is engaged in violation of the coastal nation's laws applicable in those waters, including the illicit traffic of drugs. Similarly, such law enforcement action may be taken against foreign flag vessels without authorization of the flag nation in the coastal nation's contiguous zone (for fiscal, immigration, sanitary and customs violations), in the exclusive economic zone (for all natural resources violations), and over the continental shelf (for seabed resource violations). In the particular case of counter-drug law enforcement (of primary interest to the Department of Defense), coastal nation law enforcement can take place in its internal waters, archipelagic waters, territorial sea, or contiguous zone without the authorization of the flag nation. Otherwise, such a vessel is generally subject to the exclusive jurisdiction of the nation of the flag it flies. Important exceptions to that principle are... COMMENTS (5)
>
> [NWP-LAW 3.11.2.2]

Note that outside the contiguous zone, only natural resource and seabed violations may be unilaterally investigated. COMMENTS (0)

It is worth noting that the US Coast Goard (aided by the Navy) does not even stick to these permissive rules. They board and search suspected drug-runners without bothering to get permission in advance. This reminds us of the 800-pound gorilla in the old joke: Where does he sit? Anywhere he wants to... COMMENTS (3)

An excellent and depressing review of US legal precedent can be found in [Kopel2001]. We reproduce the key sections here: COMMENTS (0)

> The *Svesda Maru* was spotted by a U.S. Customs airplane, stopped by a U.S. Navy Guided Missile Frigate some 1,500 miles from U.S. shores and boarded by an accompanying Coast Guard Law Enforcement Detachment (LEDET) who searched the ship for five days before being relieved by an actual Coast Guard Cutter, whose crew found the drugs. COMMENTS (0)
>
> The U.S. Code (Title 14, sect. 89) gives the Coast Guard the authority to "At any time, to go on board of any vessel subject to the jurisdiction, or to the operation of any law, of the United States, address inquiries to those on board, examine the ships documents and examine, inspect and search the vessel" In other words, Congress has repealed the Fourth Amendment for everyone on a ship. COMMENTS (1)
>
> The Coast Guard can come onboard and snoop around whenever it wants. Recreational boaters in coastal waters tell numerous stories about the Coast Guard inviting itself onto fishing boats, sailing sloops, and every other kind of boat, in order to start looking about for a stray joint, as a pretext to seize ship. Federal forfeiture laws promote this form of legalized piracy. COMMENTS (0)
>
> "Coast Guard" naval operations have put the Coast Guard very far from America's coast: in Ecuador, Guatemala, and even on the rivers of land-locked Bolivia. (Likewise, the United States *Border Patrol* has also been sent to Bolivia.) The Coast Guard gets the credit for the bust, but it is the Navy and the Navy's drug interdiction budget that runs the drug war at sea. COMMENTS (0)
>
> One of the authors, Mike Krause, served in the Coast Guard from 1989-1991, including five joint agency Caribbean patrols on the Coast Guard Cutter Hamilton . If the Hamilton wanted to board a foreign vessel in international waters to look for drugs, the crew would simply ask. Now why would the master of a ship, outside U.S. territorial waters, consent to the U.S. Navy/ Coast Guard boarding his ship? Because it is more coercion than consent. COMMENTS (0)
>
> The Hamilton was 378-feet long and in addition to her main 3-inch gun and an array of M-60 machine gun mounts, she carried six harpoon missiles on her bow. The captain of a ship in the middle of the ocean would be hard-pressed to turn down a request from a warship capable of blowing him out of the water. This would be similar to a squad of police on your front porch pointing guns in your general direction, then "asking" to come inside and look around. COMMENTS (0)
>
> But even if a ship's captain refused, it really doesn't matter. The Coast Guard already has blanket permission from some nations to board foreign flagged ships. COMMENTS (0)
>
> The *Svesda Maru* was caught in the "Transit Zone", a six million square mile area that includes the Caribbean Sea, the Gulf of Mexico, and the Eastern Pacific Ocean, over which the U.S. seeks to enforce international anti-smuggling laws, even over foreign vessels and in cooperating nations' sovereign waters. COMMENTS (0)

Only the flagging state, not the owner or captain, can question whether a boarding was appropriate. (Only States have rights in international law, not people.) COMMENTS (1)

> Persons charged with a crime under section 1903 do not have standing to raise issues of international law. See 46 U.S.C. app. ? 1903(d). By enacting section 1903(d), Congress intended to eliminate jurisdictional impediments to convictions under the statute. See S. REP. NO. 99-530, at 16 (1986), reprinted in 1986 U.S.C.C.A.N. 5986, 6001. As set forth in the Senate Report: COMMENTS (0)
>
> "In the view of the Committee, only the flag nation of a vessel should have a right to question whether the Coast Guard has boarded that vessel with the required consent. The international law of jurisdiction is an issue between sovereign nations. Drug smuggling is universally recognized criminal behavior, and defendants should not be allowed to inject these collateral issues into their trials. COMMENTS (0)
>
> ...
>
> The exact timing of a flag nation's permission is not a condition to consent under subsection (c)(1)(C). A defendant may be tried for an offense under the statute if the flag nation acquiesces after a vessel is commandeered. See Greer , 223 F.3d at 55 (finding that the United States had jurisdiction over a vessel even when the flag nation consented five years after the completion of the offense). COMMENTS (0)
>
> [USAvBustos]

Warrants are unnecessary for ship searches under US law because ships are mobile and so could be moved while the warrant was being sought. However, probable cause is still required. COMMENTS (3)

We must note that many of these boarding issues are only likely to be worries if drugs are permitted on board. We'll discuss this touchy issue more later. "Although neither convention explicitly says so, it also appears that any warship may seize a merchant vessel that has no nationality. In United States v. Cortes, for instance, the United States Court of Appeals for the Fifth Circuit held that the Convention on the High Seas conferred no rights whatsoever on stateless vessels and upheld the seizure of an unregistered ship found by the Coast Guard to be transporting marijuana." [WMDLegal]

Interference

{CENG: prev par unclosed}

We'd like to admit here that there is a definite danger of other nations interfering in the internal affairs of a seastead. People have quite different viewpoints on how much of a problem this will be, so we'll make our point in two opposite contexts. COMMENTS (0)

First, there are those who ask whether anyone would dare interfere. Will the nations of the world really put up with it? Won't they be worried that they'll be next? Unfortunately, history has made the answer clear. When the meddler is a major world power, there may be squawks but real resistance is unlikely (remember that gorilla). There is always some clever way to spin things, and it will be easy enough to brand seasteads as Communists or Terrorists to justify interference. The big boys have always done what they want, and while we sure hope that seasteads are a long-term threat to that power structure, in the short-term they have no chance. And don't even think about WMD's as the answer [Strauss1984, 18-24]. Developing them is expensive, and in the current political climate they're a fast track to satrapy for states and incarceration for individuals. In short, this is a nice time to take a deep breath, let those macho urges subside, and reiterate our philosophy of compromise. COMMENTS (0)

On the other side are those who ask what the point of seasteading is. "They'll never let you have any freedom", say these doubters, often libertarians bitter over the steady growth of government power. We think the best answer to this is exactly the same as last time: compromise. "Live free or die" may be romantic, but the land claimed by its adherents generally lies about six feet deeper than they intended. Our goal is not absolute freedom, but whatever degree we can reasonably get. We find the following to be an encouraging exercise for libertarians about just what level is attainable: COMMENTS (0)

Look at current states and consider the union of available freedoms. For example, there are countries in Europe (Switzerland, The Netherlands) with fairly lax drug laws and enforcement (social freedom). There are tax havens (Luxembourg, Bahamas) with very low tax rates (economic freedom). Unfortunately, the drug-tolerant countries tend to be left-wing and have high taxes, while tax havens are more right-wing and socially conservative. We feel that the combination of these two types of freedoms is worth striving for, even if both are restricted to the levels currently being tolerated by the powers-that-be. COMMENTS (0)

Its true that these countries are larger than we'll be, but while this means decreased defense, it also means decreased offensiveness. While things are admittedly easier for established members of the nation-state club, they are not impossible for outsiders (and a country's gotta start somewhere...) COMMENTS (0)

Trouble Back Home

There are a host of reasons why international waters are not a panacea: here is yet another. The Unites States government claims authority over its citizens worldwide, no matter where they are, no matter where they live, no matter where they have been living. Being in the jurisdiction of another country or in international waters is irrelevant. Even if it chooses to ignore your actions while abroad, it may take action when you return - or forbid your doing so. COMMENTS (0)

This is potentially a serious problem for the seastead tourism industry. However, it is worth noting a few points in our favor. First, monitoring the actions of its citizens will be difficult onboard a seastead. Second, the precedents appear to be fairly positive. Donating to a terrorist organization and fighting on the wrong side of a war have caused the US to take action against its citizens in the past. Smoking dope in Amsterdam and getting unlicensed medical treatments in Mexico have not. Steve Kubby may not have been allowed to ease his rare adrenal cancer with medical marijuana in the US, but they have not stopped him from doing so in nearby Canada, where he is formally seeking political asylum from a California drug possession conviction. COMMENTS (1)

Even permanent residents of a seastead will probably want to travel to the mainland to visit relatives, go to conferences, vacation, etc. As usual, the zealot's response - "Renounce your citizenship and don't go back!" - is not only impractical for the masses but no real protection. Contrary to what you may think, it turns out Americans can't just renounce their citizenship and stop paying taxes. The US reserves the right to keep bleeding its former citizens for up to 10 years if a principal purpose of their expatration was to avoid taxes. Certain levels of wealth ($500K) and income (avg. greater than $100K over past 5 years) cause an automatic assumption of tax evasion [HIPAA, Title V, subt. B, sec. 511]. COMMENTS (2)

Like many governmental policies, the result is to remove the honorable option. No longer can you simply say "I am done here. I would like to start a new life elsewhere. I owe you nothing, please leave me alone." Instead, the choice is to remain part of a system one abhors or sneak away. If you decide the latter, it can be hard not to feel like a thief in the night - even if a house running away from an expected burglar is a more appropriate metaphor. COMMENTS (0)

One must also remember that countries can and do take action against non-citizens as well. An example is the Russian programmer Dmitry Sklyarov, who in a reversal of Cold War stereotypes was arrested and jailed when he came to the US to give an academic talk (he was eventually acquitted) [CNET_Sky_02]. The relevant comparison we need to make is not "The consequences of doing X on a seastead for an american citizen" vs. "No consequences", because the latter is not an available option. It is "The consequences of doing X on a seastead for an american citizen" vs. "The consequences of doing X on a seastead for a non-american citizen". Citizenship is irrelevant to many of the things that the US is interested in stopping people from doing outside its borders, like terrorism. (Taxation is a notable exception.) COMMENTS (0)

In many areas citizenship offers more protection, not more danger. A dramatic example comes from the differing treatments of american citizens like the "Portland 6", who fought for the Taliban and were kept in domestic american jails, and the foreign prisoners held in the military prison at Guantanamo Bay without access to lawyers or family. The former were given courtroom trials, the latter will get military tribunals at best. COMMENTS (1)

The actual domestic legal consequences of performing various actions onboard a seastead will vary widely, and it will be wise for potential residents to discuss them with an appropriate legal specialist. Simply being in international waters does not justify all actions, and some expressions of personal freedom will cause trouble back home. In the short-term, there is not much we can do about it. Continuing to reside in and support such systems, however, only strengthens their stranglehold. While seasteads may not be magical Zones Without Consequences, they can still offer concealment, refuge, and acceptance. Most importantly, in the long-run, they give us a chance for a better way of life. COMMENTS (0)

Drugs

Drugs have a special legal status: **{CENG: prev par unopened}**

> All nations are required to cooperate in the suppression of the illicit traffic in narcotic drugs and psychotropic substances in international waters. International law permits any nation which has reasonable grounds to suspect that a ship flying its flag is engaged in such traffic to request the cooperation of other nations in effecting its seizure. International law also permits a nation which has reasonable grounds for believing that a vessel exercising freedom of navigation in accordance with international law and flying the flag or displaying the marks of registry of another nation is engaged in illegal drug trafficking to request confirmation of registry and, if confirmed, request authorization from the flag nation to take appropriate action with regard to that vessel. Coast Guard personnel, embarked on Coast Guard cutters or U.S. Navy ships, regularly board, search and take law enforcement action aboard foreign-flagged vessels pursuant to such special arrangments or standing, bilateral agreements with the flag state. (See paragraph 3.11.3.2 regarding utilization of U.S. Navy assets in the support of U.S. counterdrug efforts.) COMMENTS (0)
>
> [NWP-LAW, 3.8]

Note that permission of the flagging state is required. Seasteads, if they use a flag, may wish to pick a country which does not have such a standing agreement with the US. COMMENTS (0)

There are many activities, illegal in most of the world, which seasteaders may want to use their freedom to engage in. Recreational drugs, however, bear special mention. On the one hand, local production and use of drugs does not hurt the rest of the world. Producing drugs takes relatively little capital and can produce huge profits. Because of the widespread prohibitionism in the world today and the huge demand for recreational drugs, they are a potentially appealing amenity to enhance the unique seastead experience. COMMENTS (0)

Unfortunately, the political problems involved are huge. The "War on Drugs" is at the forefront of eroding civil liberties, partly because the "war" metaphor suggests a need to win at all costs. Ordinary considerations of property, due process, privacy, and sovereignty go out the window. For example, most of the flagrant, marginally-legal boarding/search/seizure discussed earlier is done to prevent drug smuggling. COMMENTS (0)

While this is a depressing state of affairs, the fact that a single type of activity is responsible for so much state interference suggests a strategy. Namely that by avoiding or restricting that activity, seasteads reduce a large part of their political liability while reducing only one facet of their freedom. Purists will find this unacceptable, and indeed some of your authors have rather strong feelings on the subject. Along with many potential seasteaders, we see legalized drugs as a definite positive. However, we would much rather have a viable seastead with prohibition than to see the project fail because of this political hot potato. Remember our philosophies of compromise, incrementalism, and political realism. COMMENTS (6)

There will be some difficult decisions to make on the drug issue, as with other areas of seastead freedom. There are many potential compromises available. The political feasibility of drugs may be strongly location dependent. For example, it is likely that a drug-legal seastead simply cannot be located in the Caribbean, because of US paranoia. On the other hand, DeepSeasteads will probably be fine. Seasteads near populated but less anti-drug-crazed areas (ie Europe) may also be alright. The separation of risks strategy we mention later can be applied to the drug issue.

Another possibility is centered on the observation that nations care much more about drug smuggling than drug use. Their goal is more to make sure their laws are enforced than to inflict those laws on others. Even those who think drugs ought to be legal may have some acceptance of states' desire to enforce their own laws on their own citizens. Seasteads could thus allow personal use, while banning large-scale production. This is the approach taken by the more liberal European nations, hence it may well be acceptable nearby. The seastead could even take on some of the enforcement burden with a technique like using drug-sniffing dogs on people as they exit. A *"Do It Here - And Leave It Here"* sort of policy.

Unfortunately, we must add that the sequal to the War on Drugs, namely the War on Terrorism, may add another politically incorrect activity. Libertarian seasteads are likely to be anti-taxes and pro-bank secrecy. Banks with high secrecy can be used for money laundering by terrorists, hence the US may choose to interfere forcefully. The same approach should be taken: identify and evaluate the risks, compare the risks to the gains, look for compromises, and act accordingly.

Political Approaches

{ Should this be moved into more of a "do" section rather than a "describe" section? ie maybe in "Making Things Happen"? Or is it good to talk about both things at once? }

Erwin Strauss summarizes the importance of this issue, as well as how often it is ignored:

> When people begin to dream about starting a new country, usually one of the first things they think about is how the country is going to be structured internally...it can at least be said that people are thinking about these problems, which is more than can often be said about some other problems of new countries; problems which have proved fatal to new countries far more than problems of internal organization.
>
> The problem that is most fundamental to a new country is simple survival. The greatest threat to a new country (assuming that its organizers are able to get it off the ground in the first place) is already-existing countries. How can a new country avoid being snuffed out by the established countries as soon as it comes into existence, or shortly thereafter? Grappling with this problem falls into the sphere of human activity known as diplomacy. But diplomacy is a complex business. It is very hard to understand what is going on in the diplomatic world at any time, especially for someone who is not a trained and experienced diplomat.
>
> [Strauss1984, pp. 4-5]

Strauss also discusses why existing countries are likely to dispute claims to territory:

> If a new country stakes a claim and is allowed to get away with it, it shuts out the interests of not just one or two nations, but all nations. If such a precedent were allowed to stand, the entire seabed or continent of Antarctica or space itself could be nibbled away by various freelance claimants, leaving the established nations with nothing in those areas. Thus new countries moving into those areas are moving against the interests of the whole body of established nations. COMMENTS (0)
>
> [Strauss1984, p. 9]

While its hard to argue with this analysis of the incentives of new nations, we think that the unique nature of seasteads offer a chance to work around the problem. If seasteads only have jurisdiction over their own mobile structure, not claiming any "real" territory, it is possible that they will not be seen as a threat. After all, they can always be forced to move. If this seems far-fetched, consider that the tonnage of ships plying the world's oceans has been increasing steadily without nations worrying that the oceans are being taken over. The ships are perpetually moving, and they claim no territory - the same can be true of seasteads. COMMENTS (0)

Which Zone?

Territorial Seas

> Unless they can achieve an unprecedented treaty for sovereignty, this area is pretty much out for sovereign seasteading. It is a good place for non-sovereign platforms. COMMENTS (0)

Contiguous Zone

> This is much the same. COMMENTS (0)

Exclusive Economic Zone

> While states' rights here are limited, As described in the definition of EEZ, the clauses do create some problems for seasteads. he assistance of a legal expert will be necessary to determine how serious these are. Seasteads may qualify as regulated artificial installations, they will certainly want to capture some energy, probably do some marine research, and will have to emit some (probably tiny) amount of pollution. COMMENTS (0)
>
> Still, the EEZ is the first point at which real autonomy is possible. Although the coastal state does have jurisdiction over resources, it does not have total sovereignty over these waters. "other States have the freedom of navigation and overflight and of the laying of submarine cables and pipelines, and other internationally lawful uses of the sea related to those freedoms" [Gjetnes2000] citing [UNLOS, Article 58]. Thus mobile seasteads are clearly allowed to pass through EEZ's. (Its unclear whether drifting counts as "navigation".) In some ways, this approach parallels the idea of "Perpetual Tourism", an approach used by some freedom seekers. It consists of moving from country to country frequently enough (a few months or years) to never be considered a taxable resident anywhere. This takes advantage of a status intended for temporary travelers to form a permanent lifestyle. COMMENTS (0)

Even for anchored seasteads, things are "EEZier" in this zone. While sovereignty treaties are difficult and have little precedent, Sean Hastings has pointed out that resource usage agreements are much more conventional. While it definitely complicates matters, it may well be possible for a seastead to negotiate a treaty to anchor and harvest renewable resources for some reasonable fee. Its tough to argue that small-scale wind generators or PV panels impose any real cost on nearby states. The main point of EEZ's and continental shelf claims is to control valuable natural resources (oil, gas, minerals). By giving up all such rights, seasteads can co-exist peacefully with other uses, and thus any revenue from them represents pure profit for the coastal state. Of course, political considerations may weigh more heavily than economic ones. COMMENTS (0)

Exclusive Fishing Zone

The suitability of these zones depend on which of the rights they claim. If its fishing onlt, then this is a great location for a seastead. But if they claim some of the other rights (ie everything but minerals/oil), they would be no better than EEZs. COMMENTS (0)

High Seas

This is the least politically problematic place for seasteads. Unfortunately, its also the toughest economically, as they'll be far away from the land-based economy. And while States don't have specific interference rights in the high seas, there is nothing prohibiting them from doing whatever they want to an unflagged ship, or with the flaggers permission. And as we'll mention later, that permission can come later (even years later) to render their actions legitimate. COMMENTS (0)

{CENG: prev par unopened}

Special Zones

Seasteads have to watch out for these cases, but a carefully selected one could also prove the key to achieving freedom at less than 200nm from land. COMMENTS (0)

Flag Of Convenience

The Outlaw Sea describes the colorful history of FOC's: COMMENTS (0)

The system in its modern form, generally known as "flags of convenience", began in the early days of WWII as an American invention sanctioned by the US ogvernment to circumvent its own neutrality laws. The idea was to allow American-owned ships to be re-flagged as Panamanian and used to deliver materials to Britain without concern that their action (or loss) would drag the US unintentionally into war. Afterward of course, the US did join the war - only to emerge several years later with the largest ship registry in the world. By then the purely ecoomic benefits of the Panamanian arrangement had become clear: it would allow the industry to escape the high costs of hiring American crews, to reduce the burdens imposed by stringent regulation, to limit *the financial consequences of the occasional foundering or loss of a ship. And so an exodus occurred. For the same reasons, a group of American oil companies subsequently created the Liberian registry (based at frist in New York) for their tankers, as a "development" or international aid projct. Again the scheme was sanctioned by the US government, this time by idealists at the Department of State.*

For several decades these two quasi-colonial registries, which attracted shipowners from around the world, maintained reasonably high technical standards, perhaps because behind the scenes they were still subject to some control by the "gentleman's club" of traditional maritime powers - principally Europe and the US. In the 1980s, however, a slew of other countries woke up to the potential for revenues and began to create their own registries to compete for business. The result was a sudden expansion in flags of convenience, and a corresponding loss of control. this happened in the context of an increasingly strong internationalist democratic ideal, by which all countries were formally considered to be equal. The trend accelereated in the 1990s, and paradoxically in direct reaction to a United Nations effort to impose order by demaning a "genuine link" between a ship and its flag - a vague requirement that, typically, was subverted by the righteous "compliance" of everyone involved.

These developments were seemingly as organic as they were calculated or man-made. For the shipowners, they amounted to a profound liberation. By shopping globally, they found that they could choose the laws that were applied to them, rather than haplessly submitting to the jurisdictions of their native countries. The advantages were so great that even the most conservative and well-established shipowners, who were perhaps not naturally inclined to abandon the confines of the nation-state, found that they had no choice but to do so. What's more, because of the registration fees the shipowners could offer to cash-strapped governments and corrupt officials, the various flags competed for business, and the deals kept getting better. The resulting arrangement, though deeply subversive, has an undeniably elegant design. It constitutes an exact reversal of sovereingty's intent and a perfect mockery of national conceits. It is free enterprise at its freest, a logic taken to extremes.
[Lange2004, pp 5-7]

Thus we see several possible courses of action, under current international law. The traditional method would be to buy a flag of convenience (FOC), shop around for a country that has the least objectionable laws and rates, and count on the seller's apathy to minimize restrictions. A seastead is potentially high-profile, and if it proves a serious embarrassment to a registrar it may lose its flag. On the other hand, despite several serious incidents like major oil spills, the small and enterprising nations have continued providing such services. And because flagging is a "virtual"market, that is one in which any country in the world can provide the service, there is a decent chance of finding a reasonable deal. While this is not ideal, it is at least a firmly established political category, and thus fits with our general principle of minimizing novelty. Any group is clearly allowed to build a ship and move it around the oceans. COMMENTS (8)

There are a large number of agreements, treaties, and conventions regarding issues as diverse as environmental protection, resource use, crew safety, minimum wage, holidays, record-keeping and contributions to Seafairers' Welfare Funds. Many nations have signed these, many have not, and they are erratically enforced (it is up to the flagging country to do so). Complying with all these laws would be an onerous process for a project whose goal is freedom, and it is unclear to what degree it will be necessary if we follow the FOC approach. The answer is probably "very little". One Maritime Law consultant writes:

> "The Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) establishes internationally recognised minimum standards for seafarers. Nearly all the flags of convenience countries listed on the ITF list are parties to this Convention. The Convention establishes standards for the deck department, engine department and radio department and deals with all members of the ship's complement...despite their participation in the STCW, open registers are less than rigorous in their application of standards and their monitoring of conditions on board the ship....many of them will accept certificates of competency, which meet very low standards. "
> [Ozcayir2000]

Another article says "the operation of flag of convenience fleet is largerly uncontrolled and unmonitored...For many States, there is a wide gap between intentions and enforcement" [StrategicOceans, p. 8]. Further evidence of the spotty enforcement by FOC nations comes from the complaints about the system:

> Environmentalists and trade union leaders...want an end to the "Flag of Convenience" (FOC) registry system for fishing vessels which, they say, allows widespread illegal and unreported fishing....the owners of some fishing vessels register them with countries that do not enforce international labor, and environmental regulations. Often these vessels will fish in waters under the jurisdiction of developing countries which do not have the resources to enforce existing regulations and the ability to patrol their offshore waters, environmentalists say.
>
> Greenpeace, the International Confederation of Free Trade Unions, the International Transport Workers' Federation and other unions released a report titled: "Troubled Waters: Fishing Pollution and FOCs."
>
> "The FOC problem has reached a point where it is threatening the sustainable development of maritime transport, the protection of the marine environment and the sustainable utilization of marine living resources," it said...
>
> "The way the FOC system works is basically that a country says pay us a fee, we'll register your fishing boat and you're free to fish anywhere, anyway you want to, no questions asked," added Gianni.
>
> [IPS1999]

The choice of FOC country should not merely be a matter of convenience. US law gives the US jurisdiction over "a vessel registered in a foreign nation where the flag nation has consented or waived objection to the enforcement of United States law by the United States." Id. 1903(c)(1)(C). Thus it may be quite important whether or not the flagging country is willing to stand up for us, particularly if the seastead does not have a drug prohibition policy. Because ships have international rights only through their flagging nations, a good relationship is important for many reasons. COMMENTS (0)

Another possibility would be to obtain a flag from a country which formally agreed to a hands-off policy. The seastead would agree to be bound by the flagging country's laws in its interactions with other ships, but would have autonomy for internal affairs. Which affairs are internal and which external, of course, is a matter for eternal debate. While attractive, this sounds rather like a treaty for sovereignty, and may be correspondingly difficult to obtain. COMMENTS (2)

Yet another possibility, suggested by a reader, is to separate seasteads by political risk. The larger platforms, with substantial capital cost, would avoid high-risk activities such as drug production. Much smaller, perhaps even temporary platforms could be used for these risky activities. When people have the urge to do these things, they go off from the main colony so as to separate the activity. The smaller platforms could even fly a separate flag, making it clear that they are different legal entities. COMMENTS (1)

Flagless

> Vessels which are not legitimately registered in any one nation are without nationality and are referred to as "stateless vessels". They are not entitled to fly the flag of any nation and, because they are not entitled to the protection of any nation, they are subject to the jurisdiction of all nations. Accordingly, stateless vessels may be boarded upon being encountered in international waters by a warship or other government vessel and subjected to all appropriate law enforcement actions. COMMENTS (0)
>
> Vessels may be assimilated to a ship without nationality, that is, regarded as a stateless vessel, in some circumstances. The following is a partial list of factors which should be considered in determining whether a vessel is appropriately assimilated to stateless status:
> a. No claim of nationality
> b. Multiple claims of nationality (e.g., sailing under two or more flags)
> c. Contradictory claims or inconsistent indicators of nationality (i.e., master's claim differs from vessel's papers; homeport does not match nationality of flag)
> d. Changing flags during a voyage
> e. Removable signboards showing different vessel names and/or homeports
> f. Absence of anyone admitting to be the master; displaying no name, flag or other identifying characteristics
> g. Refusal to claim nationality. COMMENTS (0)
>
> [NWP-LAW, 3.11.2.3-4]

More daring seasteads may choose to go flagless, qualifying as artificial islands or installations, or trying to carve a new niche in maritime law. COMMENTS (0)

It is worth noting that some people feel strongly that this is the right course of action. Sean Hastings, former CEO and founder of HavenCo, believes that its important to differentiate these types of structures from existing ones. Flagging a platform puts it into a conventional category of "ship" from the beginning, thus losing valuable initiative. Instead, make it clear that this is a new way of life and new legal categories are needed. COMMENTS (3)

Another approach implied by this philosophy is to ignore EEZ's. If depletable resources (fish, oil) are not touched, and the seastead just anchors itself in an EEZ and only harvests renewable resources, it has a pretty good case that it is not causing any economic harm to anyone. Getting treaties for these things may set a bad precedent. (It will of course be wise to pick the right nation's EEZ.) COMMENTS (0)

While our first inclination is to start out making as few waves as possible, Sean could be right that this will cause problems in the long-term goal of seastead sovereignty. Advice from appropriately specialized lawyers and the aggressiveness of the inhabitants will determine which course is chosen. COMMENTS (0)

The process will definitely take a lot of time, as "the nature of international legal processes does not support the possibility of swift changes. On the contrary, the development of rules in international law is a time-consuming process" [Gjetnes2000]. The acceptance of a flagless seastead will be a major advance for the seasteading movement and the cause of political freedom. Unfortunately, since this is not in everyone's interest, there may be a lot of pressure brought to bear against it happening by the powers-that-be. The only clear thing we can say about the results is that all the wrangling is sure to make some international maritime lawyers a big pile of money. COMMENTS (0)

Non-Sovereign

Sovereignty of some sort may be the main motivation for seasteaders, but it is not the only one. Some goals will be adequately served by platforms within the territorial waters of some country. As oil platforms serve the simple commercial process of profiting from natural resources, so lower-priced seastead platforms may be useful for fishing bases, industrial processes, military bases, tourism, and so forth. COMMENTS (0)

While this decreases the appeal of a seastead, it drastically eases the political problems as well. Its not an approach that we are passionate about, but we'd like to point out that building seasteads - any seasteads - will result in experience, income, and reputation with which to pursue the more satisfying, long-term goal of sovereignty. It may not be as romantic or exciting, but the cheaper and more ubiquitous seasteads become, the more likely they are to achieve successful self-government. COMMENTS (0)

A governmental viewpoint on these matters is given in the 1969 Stratton report, which (among other things) led to the creation of the National Oceanic and Atmospheric Administration (NOAA), part of the US Department of Commerce. It even uses the term "Seastead", drawing a parallel with

19th century homesteading:

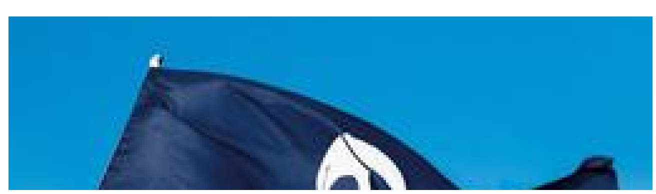
> **A Plan for "Seasteads"**
>
> Finally, coastal zone policies should recognize the desirability of providing an outlet for the energy and innovative talent of individual entrepreneurs. There are many ways in which these energies might be applied, including aquaculture projects and underwater tourism. Under existing law, uncertain and cumbersome procedures for approval of such enterprises effectively foreclose them in most States. Simple, inexpensive procedures are needed to permit individuals and small companies to lease submerged real estate and water rights when consistent with the overall plan of the State Coastal Zone Authority. State action is required most urgently for development within internal and territorial waters. As development extends farther offshore and international legal arrangements are clarified, leasing to permit diversified, nonextractive seabed activities may become feasible.
>
> The suggestion has been made that underwater leases might capture some of the excitement and public interest ignited by the Homestead Act of 1862. Such "seasteads" might be offered for extended periods on attractive terms, contingent upon the useful development of the marine tract in a manner that would safeguard necessary navigation, fishing, and other uses of the superjacent waters and would be integrated with the overall plan for development of the coastal zone. Oil, gas, and mineral rights would not be conveyed through a "seastead" plan.
>
> [Stratton1969, p. 72]

Approach Summary

We think a good approach is a balanced one. First, seasteads will fly obscure or convenience flags. They will attempt to find flagging countries willing to offer reasonable deals. While growing and establishing themselves as non-threatening, they will occasionally petition for a change in the international law. At the appropriate time, and with good publicity, one or more seasteads will choose not to renew their flags. They'll announce that they aren't bothering anyone, and ask not to be treated as pirates. Their members will actively attend maritime law gatherings and agitate for changes redefining pirates, restricting boardings to real criminals, not harmless pioneers of the new frontier, and so forth. Eventually, and with the help of public opinion, the rules will change.

Piracy

Piracy is still a problem on the high seas, but does not seem particularly worrisome for a seastead. Much of it is small-scale theft - for example, of the 335 attacks



reported in 2001, only 73 involved guns. 16 ships were hijacked, and 21 people killed (all but one in asian waters) [ICC2001]. Being above the waves and strong enough to withstand them, in addition to a small number of firearms, will make a seastead a rather difficult target for this kind of criminal. Also, since seasteads are residential vessels, they have a much higher population density than a pirate's usual target. If the seastead uses a tugboat, the tug will be much more vulnerable, and should be watched. COMMENTS (3)

Some piracy is done by large organized groups who capture entire ships and their goods (often tens of millions of dollars worth) to be fenced. They use forged documents to obtain a new load of cargo from legitimate shippers, and then steal it too. A seastead should not be valuable enough for this type of theft, as it is not a cargo ship, and would be rather conspicuous in port. Why attack a platform of people who would be defending their homes when you could attack a cargo boat with lightly armed sailors who would much rather not die to protect some corporation's cargo? COMMENTS (1)

The armed and organized groups which seasteads should be the most worried about are the navies of traditional governments. Seastead defense is discussed in the infrastructure section. COMMENTS (0)

Biofouling

As we were researching sea structures we ran across the book *Materials for Marine Systems and Structures* edited by Dennis Hasson and C. Robert Crow [Hasson1988]. This book devotes an entire chapter to the topic of biofouling -- plant life attaching itself to your flotation device. In other words -- barnacles on your bottom! Basically, biofouling occurs in two steps -- microfouling followed by macrofouling. Microfouling is the attachment of single celled organisms to the surface. Macrofouling is the attachment of larger organisms such as barnacles and mussels. Macrofouling is strongly dependent on proximity to the shore, so the further you are from shore, the less of a problem it is. COMMENTS (0)

Biofouling has a number of negative consequences. Barnacles increase drag (from moving, or from currents while anchored), which creates additional structural stresses. Some secrete corrosive acids which are concentrated because they are trapped in the area under the barnacle. They make it difficult to inspect or to re-coat a surface, both of which are very important in the harsh ocean environment. COMMENTS (1)

Some offshore structures just add thickness to offset the corrosion expected during the structures lifetime. Since we'd like seasteads to have very long lifetimes, this is problematic. Another option is anti-fouling coatings, such as paints and metal alloys. The paints only last a couple years, so the alloy coatings (copper-nickel is popular) are a much better option. While these coatings are somewhat harmful to the environment, they are not as bad as the previous tin-based coatings.

Research is underway to find new compounds, based on marine life, which are even more environmentally safe. COMMENTS (MANY)

Another option is to periodically use a biocide like chlorine: COMMENTS (0)

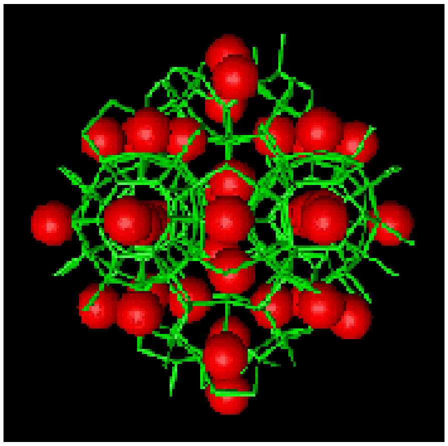
> There is no consensus about the concentration of chlorine needed to control macrofouling. Similarly, no agreement has been reached about the relative advantages of low-level continuous chlorination compared to intermittent chlorination and the application rates depend on a variety of factors, including the predominant organisms, growth rates, location, season, and water temperature. In general, the soft macrofouling organisms can be controlled by intermittent chlorination at a level of 1.0mg/L residual chlorine for one hour out of every eight hours. Hardshelled foulers including barnacles and mussels, require continuous discharge of low-level chlorination -- 0.25-0.5mg/L of free residual chlorine.
> [Hasson1988], p 115

If biofouling becomes a major problem for the seastead, a system for chlorinating the water around the seastead may need to be developed. Since chlorine is a nasty chemical to deal with, we hope that macrofouling does not become a problem for the deep seastead. This method also poses problems for seastead aquaculture. COMMENTS (MANY)

Reader W.E. Johns suggests that biofouling might be turned to a benefit. If the seastead can be made corrosion-resistant (rather than poisonous), the growth of a little ecosystem might help aquaculture, attract fish, etc. And there is no drag on a drifting seastead. Another reader suggests encasing the submerged portion of the platform in a plastic bag that could be occasionally replaced. COMMENTS (1)

Sewer Ice

[USGSHydrates] [NMHP]



{ I don't think seasteads actually need to worry about this stuff much. But its an interesting weird science-fictiony true phenomenon, and I think that sort of thing adds some nice flavor - P} COMMENTS (0)

Methane hydrate is a crystalline solid that consists of methane surrounded by a cage of water molecules. It looks much like water ice. This strange substance, found in vast quantities in permafrost and on the ocean floor, has a fascinating history. Natural hydrates were first found in the 1930s when chlorine hydrate (a similar material with chlorine instead of methane) plugged natural gas pipelines. Most research focused on preventing their formation.

COMMENTS (0)

In the 1960s, scientists discovered naturally occuring methane hydrate in Siberian gas reservoirs. Before this period, methane hydrate was thought of as an unusual and unnatural substance that only occured in chem labs and gas pipelines. No one suspected that it was common in nature, let alone in the vast amounts which we currently estimate. Stable at depths greater than 300m, it melts quickly when removed from its natural environment. Because of this, it was not actually seen until 1974, when Soviet scientists successfully recovered nodules from the floor of the Black Sea. COMMENTS (0)

Methane is the byproduct of bacterial breakdown of organic matter (ie "rotting"), which also creates hydrogen sulfide, which our noses recognize as sewer gas. Since organic material constantly falls to the ocean floor, in retrospect it makes sense that bacteria there digest it. On land, methane escapes into the atmosphere, but on the ocean floor, low temperatures and high pressures trap it into sewer ice. COMMENTS (5)

The oceans have been around for quite awhile, and the earth's reserves of this previously unknown substance are staggering. Methane hydrates are conservatively estimated to contain twice as much carbon as all other known fossil fuels, and this discovery means that scientists need to re-think the global carbon cycle. It has naturally been considered as a possible fuel, and a number of governments are digesting this possibility. Fantastic though it sounds, frozen flatulence may fuel the future! COMMENTS (0)

More seriously, this discovery poses some serious worries on the global warming front. Methane is ten times more effective a greenhouse gas than carbon dioxide, and so much of it is trapped in hydrates that it could have a major effect on our climate. This might happen through a dangerous feedback loop. First, some other effect causes a slight warming of the earth, including its oceans. This melts some methane hydrate, releasing methane into the atmosphere. This adds to the greenhouse effect, making temperatures go up more, and the cycle repeats. In fact, Dr. Euan Nisbet of the University of Saskatchewan thinks this effect may have been behind the rapid climate change which followed the last glaciation [Nisbet1990]. COMMENTS (3)

The most recent twist in this strange tale comes from Monash University in Australia. Researchers there have theorized that some unexplained ship sinkings may have been caused by giant bubbles of methane. These bubbles are released occasionally when methane hydrate melts. If one of these bubbles comes up underneath a ship, the ship will briefly lose buoyancy (since its sitting on gas instead of water). Depending on the location of the bubble (experiments suggest that off to one side is the most dangerous), the ship may capsize. In fact, a sunken vessel has been found in the North Sea in the center of a large methane eruption site called the Witches Hole. As if drowning isn't bad enough, imagine your last sensation being the overpowering smell of rotting eggs... [Fox03] COMMENTS (2)

To avoid this awful fate, permanently moored seasteads should be aware of any methane hydrate deposits beneath them. Travelling platforms may just take it in stride as one of the many "hazards of the sea", although its also possible that clever engineering or warning systems could reduce the danger. Future seasteads may find methane hydrate mining to be a profitable activity. This could be a huge industry, as it seems quite possible that it will be the next generation of fossil fuels - although if so, we're going need a whole new generation of noseplugs! COMMENTS (2)

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Last modified: Mon Nov 14 23:23:54 PST 2005

Seasteading: Structure Designs

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Structure Designs

{This section feels a bit incomplete. We've had to leave out a lot of engineering information, as there is neither space for us to describe everything in detail, nor time for us to finish all plans to completion now. But we still want to hit all the major points, so let us know if we've missed something that seems crucial to you. } COMMENTS (1)

There is no one correct design for a seastead, since the best choice depends on your goals, budget, and location. For this reason we'll give a broad overview of the many types of structures which have been suggested and some of the necessary tradeoffs. Then we'll delve into detail on our favorite design, the spar platform. COMMENTS (0)

The most important design criterion is that the seastead be safe in the harsh ocean environment, with its wind, waves, and currents. Thus all of these designs will need to use some of our wave avoidance techniques. Besides safety, the structure must be reasonably cost-effective, or it will never be built. Cost may well be the main barrier which has prevented people from becoming seasteaders. Its also important that the design scale well to different sizes, so that we can apply our incremental approach. Dynamic Geography tells us that physical modularity is also very desirable. COMMENTS (0)

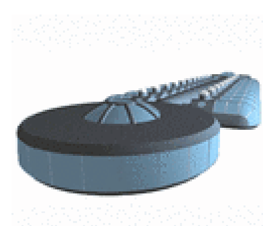
Seastead designs break down into three rough categories, depending on their location relative to the water's surface. COMMENTS (0)

Underwater

While there are some neat benefits to an undersea structure, there are a large number of disadvantages and engineering challenges as well. COMMENTS (1)

Advantages

- Protected from the elements: No waves or wind. COMMENTS (MANY)
- Scenic: Will have a great view if its in the right location. COMMENTS (0)
- Unique: Underwater resorts draw customers. For example, Jules Undersea Lodge off Key Largo, Florida, charges $300-$600/night. COMMENTS (0)
- Hidden: Can be very isolated, defensible and hard to find, if desired. COMMENTS (0)
- Cheap to expand: By using clever construction methods, expanding the colony volume might be fairly inexpensive. A variation on the technique used to build Monolithic Domes seems promising [MDI]. Fill a plastic form with water, then spray or layer on concrete and insulation. When the concrete has set and can take the pressure, pump the water out and pump air in, and you have a new airspace. If the colony is not very deep (so water pressure is low), the form can simply be inflated with air from the beginning. COMMENTS (0)



Disadvantages

- Bad failure mode: If other seastead designs fail, residents end up on top of the ocean. If an underwater structure fails, the ocean ends up on top of them! COMMENTS (0)

- Additional engineering difficulties: Building a seastead is already difficult. Building an underwater one will be even harder, especially at any significant depth (more than 200 feet or so). COMMENTS (0)
- Difficult to get in and out: If the structure is kept at atmospheric pressure, it has additional structural stresses. If it is kept at the appropriate pressure for its depth, residents have pressure-adjustment problems going to the surface. Either way, complex airlocks are required, or a tube to the surface which is vulnerable to the waves. Not only is this a problem for people, but it makes shipping goods difficult as well. COMMENTS (0)
- Limited access to energy sources: The water blocks the sun and waves. While enough sunlight filters down to support plant life in the first couple hundred feet, much of the energy is being absorbed by the water. It might be possible to mount wind turbines on pillars, use currents, or geothermal energy. Still, this makes an already-challenging problem even harder. COMMENTS (0)

Note that the positive scenic aspect can be achieved just by having a small undersea portion of a structure which is mostly above the water. (Although many seastead locations will just not be very scenic). On net, it does not seem worthwhile to start with an undersea structure. Those interested in more ideas about living underwater should see [Fisher1985, pp. 64-73] COMMENTS (0)

On The Water

This category of designs consists of structures which float directly on the ocean's surface. Since waves are dangerous, these methods will need to somehow avoid them. We'll start with options based on modifying existing designs, and move on to more novel ideas. COMMENTS (0)

Sailboat Fleet

> *"A boat is a hole in the water into which you throw money."*

While we have not found any published literature on this concept, it is unlikely that we are the first to think of it. The concept is that a group of like minded people could purchase a bunch of sailboats different sizes and costs and sail around the ocean together. The standard self-sufficiency technologies described later would be used to provide electricity, fresh water, etc. COMMENTS (0)

There are several advantages to this idea. Obviously sailboats are a mature technology, with a large number of types, repair facilities, books and so forth available. They are extremely mobile using renewable energy, and can thus travel all over the world living in "endless summer". While they are not built for extremely rough seas, they are mobile enough that with advance planning they should be able to avoid such situations. And a fleet of sailboats is both modular and scalable. They can even grow some food, as described in *Sailing the Farm* [Neumeyer1982]. Unfortunately, there are serious drawbacks. COMMENTS (0)

Boats tend to be built from expensive materials, and are costly to build and maintain. They are optimized for movement, so they have have small deck areas (tough for solar panels and greenhouses) and cramped interiors (tough for living in). Nor are they particularly comfortable in significant waves. The marketing/publicity angle is more difficult because it doesn't seem like a new way of life. We cover these problems in more detail in the FAQ question Why not just buy a boat?. COMMENTS (0)

There are definitely some nice aspects to a fleet of sailboats, such as not having to design a new structure. It would be a relatively easy way to start living on the water, since there are people already doing it. But boats are designed to travel from place to place across the ocean, not to live in. The difference between a sailboat and a seastead is like that between a house and a car. Sure, you can live in a van or RV, but its just not that comfortable. The residents would be more wandering nomads than permanent settlers. There is nothing wrong with this lifestyle, but its not what we think of as true seasteading. COMMENTS (1)

Big Boat

Many people have suggested that rather than designing a unique structure, seasteaders could just purchase and retrofit a large used vessel such as an oil tanker or cargo ship. Again, the standard self-sufficiency technologies would be used to provide infrastructure. As evidence that big boats make decent floating cities, we need only look at the cruise ship industry. One way to think of this concept is as a low-budget, do-it-yourself cruise ship. COMMENTS (2)

Obtaining a used boat would reduce costs, and it would already contain many useful systems like propulsion and navigation. The propulsion could be used occasionally, although the ship would mostly drift to conserve fuel. Large vessels are less responsive to the waves than small ones and so more comfortable to be on during storms, as well as safer. COMMENTS (0)

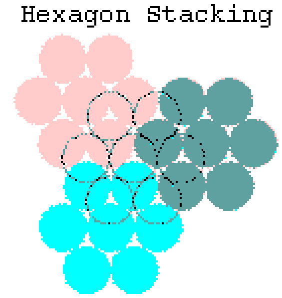
Unfortunately, large boats are not exactly scalable, so it would take a sizeable initial group to purchase one. They are also not reconfigurable or modular (although an assembly of multiple ships would be). They have many of the same drawbacks as sailboats, like limited solar area and not seeming like a new way of life. We've basically traded modularity and low starting cost for seaworthiness and some interior volume, without really gaining any ground. Like the sailboat fleet, the idea certainly has some merit, but we don't think its the most promising option. COMMENTS (1)

Some of these issues can be addressed with a hybrid combination of a cargo ship and some of the platform types described below. The cargo ship would take the materials to some remote island or atoll, and the colony would be deployed. In the event of political problems, bad weather, or simple boredom, the colonists would load everything back onto the boat and move someplace new. COMMENTS (0)

Simple Platform

In waters that are naturally calm or somehow protected, there are many simple systems that can be used to turn water into land. Each consists of some sort of buoyant foundation on which to put whatever structure is desired. While we'll be recommending a different approach, this one is quite promising as well. In an area without large waves, it would be quite cost-effective, and should be strongly considered as an alternate design. COMMENTS (0)

2 Liter Bottles



One of the simplest systems was suggested by Wayne Gramlich in his original seasteading paper [Gramlich1999]. It utilizes plastic 2-liter beverage bottles, which are extremely common, incredibly cheap, and resistant to sea water. These bottles can be banded together into hexagonal grids of 7 bottles each. The grids are then stacked and layered to form a buoyant lattice. Alternatively, one can use Rich Sowa's method of filling nets with the bottles. Some sort of rigid surface then needs to be placed on top of the flotation. COMMENTS (4)

Inverted Cylinder

Another simple technique is to have an inverted cylinder, open at the bottom, containing air. This idea was used by Sea Structures Inc. for their SeaCell system [SSI]. A disadvantage with open containers is that as depth increases, the air is compressed and displacement goes down. This flotation is cheap to manufacture, and can be stacked for easy transport. Again, some sort of rigid platform needs to sit on these cells. COMMENTS (0)

Concrete Slabs

Yet another simple method is concrete slabs such as those manufactured by IMF [IMF]. These are hollow boxes of reinforced concrete, with enough buoyancy from the interior airspace to support the concrete as well as a structure. IMF's designs include shock-absorbing connectors, integrated structural cleats and pile rings, and integrated utilities. Because the structures are monolithic and sealed, they cannot take on water and are unsinkable unless broken. And ferrocement is cheap. Most floating homes in the USA nowadays are built on such slabs. They'd be fairly easy to connect to one another, and small ones could be easily built onboard. We think this is the most promising aquatory technology for protected waters. COMMENTS (2)

Pneumatically Stabilized Platform

One interesting possibility is the PSP designed by Float Incorporated [FloatInc]. It consists of a number of inverted hollow cylinders, as described earlier, but with a clever addition. Imagine what happens as a wave rolls under these cylinders. The water in each cylinder moves up and down, and the air pressure in the trapped airspace changes. In a PSP, these spaces are connected through pneumatic lines and valves, so that these pressure changes result in air moving between cells. This dampens the waves and distributes their force so as to reduce peak load on the structure. If air turbines are attached to these lines, it becomes a wave-powered electricity generator. COMMENTS (0)

The PSP has some characteristics of a platform (it can support loads) and some of a breakwater (it attenuates waves). It is built out of concrete, our favorite construction material, so its relatively cheap. Its very modular and fairly reconfigurable. Cost estimates are $5M - $7.5M an acre ($115-$160/ft^2 in the open ocean. However the inventors have not been able to find a major purchaser, so this is an unproven technology. We have some concerns about the design's ability to withstand (or block) severe storms, with waves large enough to wash over the edge of the platform. Still, it is a promising system. COMMENTS (0)

Cargo Containers

{ this section could use some trimming - P }

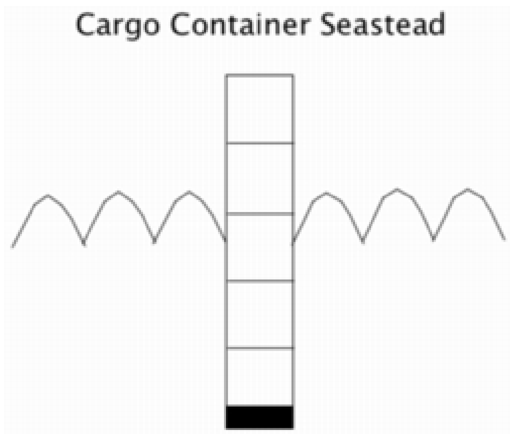
The ideal seastead technology is safe, inexpensive, and modular. Here we'll consider whether structures built out of converted freight containers qualify. COMMENTS (0)

The shipping industry has been revolutionized by these containers. Freight containers can be moved between trucks, ocean freighters and trains without requiring that the container contents be changed. Their popularity has made them cheap and plentiful. Used 40 ft freight containers can sometimes be obtained for less than a thousand dollars. A similar alternative is large propane tanks, which are much stronger because they're built to hold pressurized gas. They cost several thousand dollars (used), but this may be worthwhile for safety. COMMENTS (2)

The table below summarizes a number of common container sizes:

Container	**Length (ft'in")**	**Width (ft'in")**	**Height (ft'in")**	**Volume (ft^3)**	**TARE (lb)**	**Payload (lb)**	**Max. Gross (lb)**
20' Dry	19'10.5"	8'	8'6"	1,173	5,160	47,740	52,900
40' Dry	40'	8'	8'6"	2,391	8,730	58,470	67,200
40' Hi Cube	40'	8'	9'6"	2,692	9,150	58,050	67,200
48' Domestic Dry	48'	8'6"	9'6"	3,463	9,700	57,500	67,200
53' Domestic Dry	53'	8'6"	9'6"	3,830	10,280	56,920	67,200

Since the weight of 1 cubic foot of water is 62.4 lb., a sealed container can generate a substancial amount of bouyancy. For example a 40 foot high cube container generates 62.4 × 2692 - 9150 = 158,831lb or almost 80 tons of bouyancy. COMMENTS (0)



Since freight containers are not designed to float, some effort must be expended to convert them. The basic concept is to weld all holes and vents shut, along with the access doors, and to install a seaworthy access port. It must also be sandblasted and coated with seaworthy paints. It may need some structural reinforcement, as the corrugated steel skin is not meant to withstand much force. COMMENTS (0)

Once the container is seaworthy it is ballasted on one end to force it into a vertical orientation with 1/2 to 2/3 of the container submerged below the water line. This reduces interaction with waves. In a storm with large waves, the structure will basically move up and down with the waves with relatively little rocking motion. Because its small enough to bob, it doesn't absorb much wave energy. In addtion, by submerging a significant fraction of the structure below the water line, there is less swaying due to high winds. This is similar to Marc Piolenc's spar buoy. In a severe storm, the occupants of a container will definitely be pushed around. However, as long as everything is properly secured inside the container, about the worst that will happen is a severe case of sea sickness. COMMENTS (0)

Even though the freight container should be relatively safe in pretty severe weather, it is still prudent to plan on situating freight container seasteads in areas that do not often experience severe weather. It is further prudent to have a means of moving a freight container seastead out of the way of an approaching severe storm. A basic outboard motor should provide the means to move a modest distance even though a freight container is hardly shaped for optimum traversal through water. COMMENTS (0)

One nice characteristic of this design is that it can be easily purchased, stored on inexpensive property during conversion, converted, and then shipped off to an ocean deployment location. Freight containers are designed to be moved around, so it is relatively easy and inexpensive to do so. Ballasting may need to weight until the final site, as it will make the container heavy and unbalanced. COMMENTS (1)

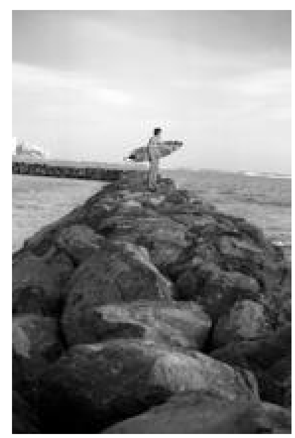
Since its oriented vertically, we can divide the container into floors. Assuming a 40 foot container on end with approximately 8' ceilings yields 5 floors. The bottom floor will be partially occupied with ballast, so it should really be thought of as a cramped storage compartment rather than a full livable floor. Using a 48' container provides an additional floor and a 53' container might provide two additional floors. Since the dimensions are 8' by 9.5', each floor is 76 ft^2. This is not luxurious, but for some people it will be adequate. The total area of 300 ft^2 actually compares favorably with the floor area of a sea worthy sail boat. For more space, multiple containers can be welded together into larger units. COMMENTS (0)

Giving the limited top deck area, we need some creative solutions to provide an adequate supply of food, water, and power. Just like the larger structures we'll propose later, there is no reason why a container seastead can't have a cantilevered upper platform to provide additional solar area. During bad weather, anything kept up here can be stored safely inside. Another simple solution is to tether inexpensive inflatable floats to the seastead. These could support solar distillers, PV panels, and small greenhouses. Again, in bad weather these are deflated and brought inside. COMMENTS (0)

The primary reason to think about freight containers is to propose alternatives that further lower the cost of bootstrapping seasteading into existance. Will a freight container seastead be as safe in severe weather as one of its larger cousins? Almost certainly not. However, it is probably safe enought that it can seriously be considered as a potential start. As the seastead community gets larger, the need for this design may well diminish as people switch to structures designed specifically for seasteading. Thus, freight container seasteads should really be thought of as a bridging technology between what is available now versus what we can build eventually. Alternatively, they may continue on as low-income housing, much like trailer homes on land. COMMENTS (0)

Breakwaters

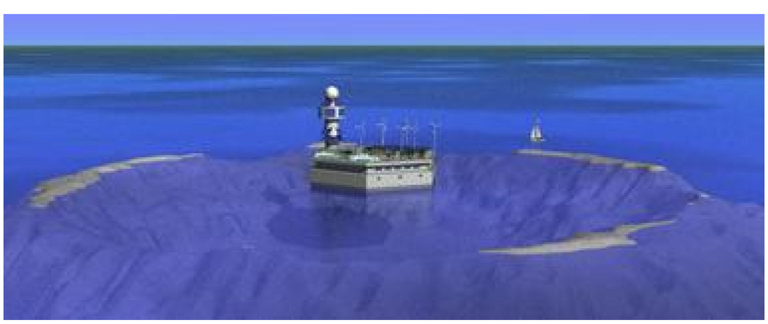
> *"Any structure or contrivance to break the force of waves, and afford protection from their violence."*



A simple example of a breakwater is any island or reef, which acts as a natural barrier for its lee shore. Artificial breakwaters can be seen surrounding the entrances to any marina, usually consisting of concrete piers or piles of rock. COMMENTS (0)

The advantage of using a breakwater is that it eliminates all the problems caused by waves. Structures become much cheaper, safer, and easier to expand, seaplanes can land and cargo is easier to offload. But to do this, you must dissipate the tremendous energy found in ocean waves, and do it continuously, for years on end, even during severe storms. If the breakwater fails, suddenly your structures must face waves they were not designed for, which may be disastrous. We'll outline a number of the different methods that could be used to build such breakwaters. Later we'll explore the question of when this is the best way to deal with waves. COMMENTS (0)

Natural Breakwaters



Any landmass which reaches close to or above sea level acts as a natural breakwater. Rock is tough stuff, and it takes quite awhile for the ocean to grind it into sand. There are basically two options: we can shelter by a large landmass (which will almost certainly be inhabited), or a small one. Large landmasses have political difficulties, as we will be fairly close to existing nations. It is difficult to be protected on all sides yet still be in international waters. Still, there are some possibilities if we are willing to accept moderate waves, such as seas like the Mediterranean. COMMENTS (0)

Smaller breakwaters include atolls, reefs, and seamounts. An atoll is a special class of island that is formed when the ocean has worn a volcanic peak down to a roughly circular shape. As a result, they basically consist of a breakwater surrounding a calm lagoon. Because so many islands are volcanic in origin, atolls are quite common, and many are uninhabited. One of the more famous is the Bikini island atoll in the Marshalls, where the US conducted nuclear testing [Bikini]. These lagoons range in size from tens of thousands of acres down to almost nothing. COMMENTS (0)

Yachtsmen, encountering unexpected storms, have weathered gale-force winds by anchoring in such lagoons, so atolls definitely act as a wave barrier [Fisher1985, p. 52]. Unfortunately, the fact that atolls contain land means that they are all claimed by an existing country. While an abandoned atoll could doubtless be used for awhile before anyone noticed, our goal as seasteaders is to create a stable way of life. We want to be pioneers, not outcasts. This renders claimed atolls unsuitable for frequent use. COMMENTS (0)

The obvious solution is to look for submerged atolls or reefs, which do not count legally as land. After all, a breakwater does not need to extend above water to provide significant protection, it need only come close. These submerged reefs and rocks, formerly only known as hazards to navigation, can be used to protect our new way of life from the elements. While the Minerva incident indicates that nations do not always respect these rules, our chances are much better if we follow them. COMMENTS (2)

Unfortunately, suitable geographic features are likely to be rare. Any rock above water creates a zone of 3-24nm around it of sovereign waters. So we need a reef which is not within that distance of any above-water reef. It can't be too far below water, or it won't be a useful breakwater. So we need an area where the reef comes quite close to the surface, yet never rises above it, and the odds are against this happening. COMMENTS (0)

An additional advantage to such natural breakwaters (if we can find them) is that they provide for cheap and easy anchoring. Also, they are likely to have pretty underwater scenery. A disadvantage is that the colony is tied to one physical location, which means that it cannot easily avoid political problems, move with the seasons, etc. COMMENTS (0)

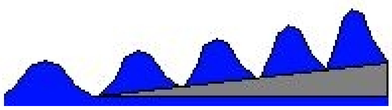
An alternative to finding a submerged breakwater is to be close enough to some appropriate landmass that it can be used for shelter during severe storms. While the waters would be legally controlled by another nation, the use would only be occasional and its unlikely that anyone would be paying attention. Still, satellite photos could be used later as part of some legal maneuver. In an emergency this solution is fine, since any court is more forgiving than Davy Jones Locker, but it seems a poor idea to depend on it. COMMENTS (0)

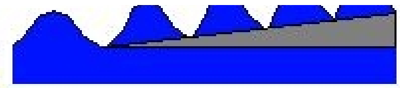
Artificial Breakwaters

Artificial breakwaters have a long history of use to protect harbors, marinas, and coastlines. There are numerous breakwater designs, and they are fairly simple in principle, so we won't cover them in detail. Most rely on big pieces of concrete, although there are many alternative methods. Most designs are meant to rest on the seafloor, or at least be tethered to it. While this is fine for shallow water (perhaps on a seamount or reef), it won't work in any significant depth. Hence we need a floating breakwater. COMMENTS (0)

Ocean waves can be very large, hence a traditional design would need to be very large. Rather than absorbing all the energy, perhaps we can simply get it to dissipate harmlessly. This may sound difficult, but this can be seen on any beach with a wave break. The incoming waves, reaching shallow water, begin to pile up. They reach an unsustainable height, form the familiar whitecaps, and break, collapsing on themselves. Only a gentle wash reaches the shore. The soothing sounds and pretty patterns on the sand are all that remain of the wave's energy. COMMENTS (0)

This effect could be simulated by submerging a long triangular breakwater. As waves reach it, they will pile up and eventually break. This breakwater does not need to be particularly





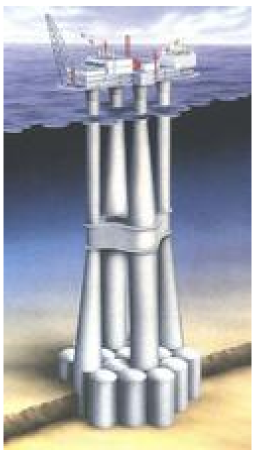
strong, because this aikido-like method never takes the brunt of the force. Still, it will need to be be quite large, and will not be cheap or easy to build.

Any non-anchored breakwater will be steadily pushed by the waves towards the center colony, so the two must be strongly connected. Many breakwater designs such as the simple concrete wall, the aikido breakwater, and the PSP could be used in such a configuration.

Above The Water

The final option for avoiding waves is to place our structures above water level using pillars made of steel or concrete. Many permanent marine structures, such as oil platforms, use this technique. These "spars" present little cross-sectional area, so that waves pass through without imparting much energy. The extra engineering problems posed by spars are more than balanced by not having to endure the bashing of waves.

Pillar Platform



If the water is shallow enough, the pillars can rest directly on the sea floor. Thus there is no movement due to currents, wind, and waves. Unfortunately, pillars are not well-suited to dynamic geography, and they have all the political dangers of a fixed location. While oil rigs can have pillars as deep as 3000 ft., they also have budgets in the billions, and it will take much shallower waters for a pillared seastead to be cost-effective.

Troll deck floating before assembly.

The most impressive example of this type of structure is the massive Troll A gas platform, located in the North Sea off the coast of Norway. Only a handful of skyscrapers and oil rags are taller, and it became the tallest structure ever moved over the face of the earth when it was towed 174 nautical miles to its operating location. It is built from ferrocement, our material of choice.

Statistics

Height	472m
Expected Lifetime	50-70 years
Total Weight	1,050,000 metric tonnes
Deck Area	8,670 m^2
Water Depth	303m

The deck and pillars were built separately and united while floating in a fjord. Norske Shell describes the process:

- *On 25 January 1995 the deck and concrete gravity base were mated by the Aker Companies Norwegian Contractors (NC) and Aker Stord.*
- *Tugboats towed the deck into position in front of the four legs of the concrete base, which were submerged with only 6.5 metres of freeboard*
- *The barges were drawn in towards the gravity base the last few metres by means of cables*
- *The most critical phase was positioning the deck on top of the four legs with millimetre precision and transferring the weight from the barges to the gravity base*

- *Gradually ballast water was pumped out of the base, the barges were removed and the deck gradually rose to 30 metres above the surface of the water* COMMENTS (0)

[NorskeShell]

The design, assembly, and towing of this platform validate a number of our design features which you'll see later. Hence we don't need to demonstrate that such structures are possible, but merely that they can be built cost-effectively. COMMENTS (0)

Tension Leg Platform

Another option is to have pillars which are buoyant and floating, but anchored to the seafloor with tensioned lines. These lines prevent vertical movement, but allow for some horizontal motion. Unlike fixed pillars, a TLP can be detached and moved to a new location. They can operate as deep as 7,000 feet, although the tensioned lines are very expensive. COMMENTS (0)

{ Not sure what else to say here } COMMENTS (3)

Semisubmersible Barge

A seagoing, self-propelled barge that rides at anchor, stands on partially submerged vertical legs on submerged pontoons, and serves as living quarters and a base of operations in offshore drilling. [AHDE4] COMMENTS (0)

This is a standard barge design for places where good weather is infrequent. It has a much lower response to waves than a normal ship, because the waves sweep through between the columns. This allows it to operate in rougher conditions. The disadvantages are related to the weight balance required for stability. The topside cargo capacity is much lower than a ship, because too much weight causes stability problems (the barge becomes topheavy and tips). It needs sophisticated ballast controls, like a submarine, which adds expense compared to a ship. COMMENTS (2)

However, a seastead doesn't have large load requirements, so this is not as much of a problem. This closely resembles our preferred design. COMMENTS (0)

Floating Spar Platform

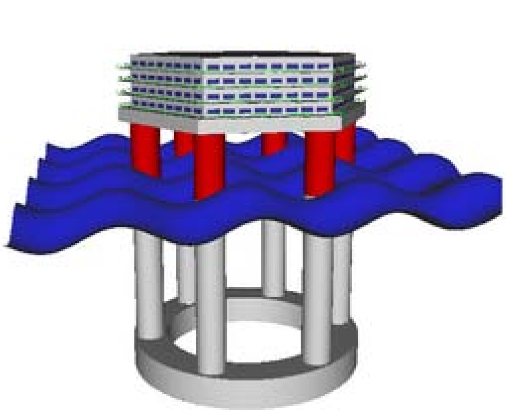
The problem with the pillared platform is that it is immobile, and in deep water it requires very long, expensive pillars. The problem with the semisubmersible is that much of its flotation is close to water level, and its platform is not high enough to avoid all waves. So it escapes some wave force, but not enough. The logical solution is to make tall thin legs, like a pillared platform, but to have them resting on submerged buoyancy, like a semisubmersible. We call this a floating spar platform. COMMENTS (0)

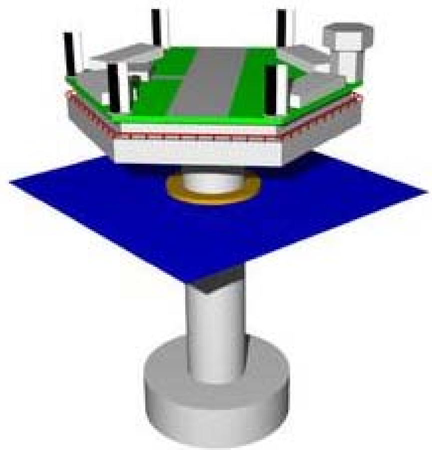
The simplest version is Marc Piolenc's spar buoy concept. This consists of a vertical cylinder ballasted at one end. Essentially, the structure is all spar and nothing else. The ballast must be considerable in order to make the structure float vertically, especially if a substantial portion of the spar is above water. The spar is a suitable design for weak building materials such as seacrete, which cannot handle cantilevered loads.
{ Picture } COMMENTS (0)

There are some disadvantages to this system, however. Solar area is very important for PV panels, growing food, heating water, etc, and the tip of the spar doesn't give us much. We don't have much living volume either, just what's inside the spar. So its natural to stick a platform on top of the spar, to get a lot more solar area, and make that platform several levels high to get more volume. COMMENTS (0)

Unfortunately, this makes the structure a little more topheavy. Now we need more flotation and ballast to compensate. As we add them to the bottom of the spar, it begins to get very long. The point of the spar is to present a thin front to the waves. This means that once you get below the bottom of the waves, its not really necessary to use a spar shape. We can simply widen out into a larger flotation chamber. COMMENTS (0)

Combine these observations, and you get our preferred seastead design, which looks somewhat like a dumbbell, possibly with multiple spars: COMMENTS (1)





Having several pillars is necessary for large seasteads, since you can only project the platform out so far. But for smaller platforms, its easier to just have one spar, since the cantilevering is not as expensive as the multiple spars and connections. This also allows for more modularity. We can build multiple single-spar platforms, and assemble them together to get a multi-spar system. COMMENTS (1)

Later in this chapter we'll present lots more detail on this design. COMMENTS (0)

{? Show William Barkley's ReefHome too?} COMMENTS (0)

SWATH

{ not sure if this should go here, SWATH's aren't quite above the water. But they use the same spar design principle }

When the same concept for avoiding waves is applied to boat design, the result is a Small Waterplane Area Twin Hull, or SWATH. As you can see from the picture of the *Frederic G. Creed* on the right, such boats have two submerged, torpedo-like hulls with hydrodynamic struts above them. So the drag mostly consists of laminar flow along these hulls, rather than drag from waves at the waterplane (there is no waterplane). This makes the hull a little slower in calm water, but much more stable in heavy seas [SWATH]. COMMENTS (0)

While a monohull version was patented in 1880 and a SWATH design in 1946, the first ships were not built until the late 1960's and early 1970's. Although there are only about 50 worldwide, several are notable. For example, in 1992 Radisson built the *Diamond*, a 20,000 ton SWATH cruise ship. The design gives this 350-guest ship much less rolling motion than other cruise ships of similar size. While it looks somewhat like a catamaran above the water, below the water the *Diamond* features the same torpedo-like pontoons as the *Creed*. COMMENTS (0)

In 1993, the public learned about the US Navy's *Sea Shadow*, a futuristic-looking A-Frame SWATH vessel which had previously only been operated at night. This 160-foot long stealth ship was manufactured by Lockheed-Martin in Redwood City, CA as a test platform for various technologies. It features a low radar signature, and while only capable of 14 knots can operate in extremely rough conditions. COMMENTS (1)

Used Oil Platform

As we've mentioned, oil platforms are an excellent example of a pillared marine structure built to withstand the battering of the ocean. A number of people have suggested that rather than building some unique new structure, a group simply find an old oil platform and use it. While platforms are expensive to build, there is not much reason to charge a lot for an old one. In fact, the group could even be paid to dispose of it. There are thousands of oil platforms, and disposing of them safely is required and costly. COMMENTS (0)

There are obviously both advantages and disadvantages to this technique. You get the building material much more cheaply. However, its part of a structure that was not intended as a permanent residence, so considerable retrofitting will be necessary. Having exceeded its expected lifetime, there are likely to be structural concerns. For example, sacrificial coatings for biofouling will be worn through and sacrificial anodes will be dissolved. Further investigation by experienced marine engineers is necessary to determine whether this is a feasible option. COMMENTS (1)

Design Issues

When evaluating these designs, there are several issues which come up frequently. COMMENTS (0)

Fixed-Position vs. Free-Floating

Our main concern with fixed-locations is political insecurity. If some country claims that you don't have the right to be there, the colony is screwed, as relocating is likely to be very expensive. Colonists may not be willing to move there in the first place because of this risk. A free-floating design can always just move on. When you're talking about an expensive capital outlay (analagous to a house plus part ownership of the local utility company), the residenst are going to find that level of security invaluable. COMMENTS (2)

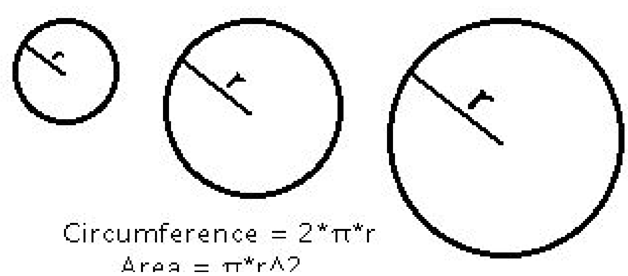
One could point out that the same pair of options is true today in normal countries, yet we usually choose to live in buildings rather than RVs because the political inflexibility is worth the extra room. But at sea, the tradeoffs are quite different, because the cost of moving buildings is so low. It is possible to have a house-like amount of space with car-like flexibility. Additionally, the potential dangers are more serious because of the uncertain political position of seasteads. Hence the fixed strategy is much less attractive. COMMENTS (1)

Admittedly, there are advantages to a fixed location. One can discover and exploit local resources. Building costs will be cheaper. The colony can establish trade routes, and lay fiber optic lines. More long-term planning based on weather and local resources becomes possible. Pollution and bad waste practices are less likely. For these reasons, some groups may choose this route. However, we see political freedom as the fundamental motivation for seasteading, and freedom of movement is an important part of getting and keeping political freedom. COMMENTS (4)

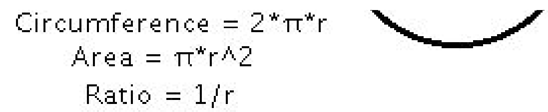
Breakwaters vs. Pillars

Besides the underwater solution, which we find unattractive, there are three basic ways to deal with waves. We can avoid them geographically (doldrums), stop them with breakwaters or rise above them with pillars. We'll focus here on comparing the latter two methods. COMMENTS (0)

The crucial difference lies in how the two methods scale. A breakwater for ocean waves must be massive, it can't be built on a small scale. On the other hand, if you think of the breakwater as forming the perimeter of a circle with the colony inside, you can see that as the circle grows, the size of the breakwater grows with r, while the enclosed area grows with r^2. This means that the ratio (how much breakwater is needed per unit area) falls with 1/r, which is a huge economy of scale. So for large colonies,



breakwaters will be cheap, for tiny colonies they'll be tremendously expensive. COMMENTS (0)



Pillars, on the other hand, have no such economy of scale. If you want to build another unit of area, you need the same amount of pillar as before. However, each individual pillar is fairly small, a small platform only needs one, and their cost is not out of reach of a new project. Thus pillars are well suited to our incremental approach. Still, one of the great things about the ocean is that there is plenty of room. So the high marginal cost of pillars is somewhat unfortunate, in that it makes using this space expensive. COMMENTS (0)

This suggests to us that for small, initial seasteads, the pillar is a much better method. As the communities grow and become city-sized, they will reach a point where breakwaters become cost-effective. So while breakwaters are not suited to the initial stage which we're focusing on, they will be a crucial way to bring down costs later, and let us expand into all that cheap, unused real estate. COMMENTS (0)

There are several other factors to note. Breakwaters can be used to obtain energy while damping waves. It is easiest to build them in fixed locations, which is problematic as described above. However it is possible to build a floating breakwater with a rigid connection to the colony, so the problem is avoidable. COMMENTS (0)

Another worry is that by fencing off a fixed area, breakwaters may lead to a static geography. That is, if a single government has control of the area, they are a monopoly. Because of the economies of scale, residents can't just leave and start their own colony cheaply. This is not insoluble, but it is something to be aware of. COMMENTS (0)

Modularity

The level of modularity in our designs varies greatly. Sailboat fleets, for example, are quite modular. Individual boats can leave or shuffle around as they wish. A huge cargo ship, on the other hand, is monolithic. Modularity is important for two reasons. COMMENTS (0)

The first is dynamic geography. In order for DG to function, small groups of residents must be able to move their personal space. We think this is crucially important to making this new way of life better than the old. Hence we are skeptical of fixed-geography designs. COMMENTS (0)

The second reason is to allow for incrementalism. A modular structure is likely to be amenable to an incremental approach where one module at a time is built. We think this approach is vital to actually making a floating city happen. Thus designs which require a large initial capital outlay do not seem promising. COMMENTS (0)

New or Used

Just like a car buyer, seasteaders must ponder this age-old conundrum: lay out the dough for something new, customized, with a long life ahead of it, or thriftily convert someone else's throwaway. While we tend towards the new approach, the issue is certainly not clear cut. A new, strange-looking seastead will feel to the world like a different way of life. This helps our political ends, as well as marketing appeal to prospective residents. It can be designed specifically for a permanent, comfortable, settled ocean life - which is not true of any existing structure. On the other hand, there are many large boats and oil platforms which are no longer useful for their original purpose, and can be bought quite cheaply considering the materials which have gone into them. Avoiding design work may lead to an imperfect solution, but at least it gets there sooner. COMMENTS (0)

What tilts the balance for us is the surprisingly low cost of the structural portion of a seastead. (Renewable energy technologies are more expensive, but they would be needed in any design). Because designing and building a seastead is not that expensive, we see less reason to go the cheap route. COMMENTS (0)

Materials

Our preferred material is ferrocement, which is cement reinforced with iron rebar. However, a large number of previous ventures have proposed using an interesting material called seacrete. Our skepticism of this substance bears explaining. COMMENTS (1)

{ Should we also explain other engr. mat. considerations in the marine environment? ie stainless, coatings, sacrificial anodes, plastics... } COMMENTS (1)

Seacrete

Professor Wolf Hilbertz came up with the fascinating idea to create a material by submerging an electrified wire mesh in seawater. Minerals are drawn out of the water by the current, and a cement-like substance is slowly grown by accretion. Eric Lee [Lee] has done a very complete analysis of the use of seacrete as a marine construction material. COMMENTS (0)

The number of 4.2 lbs / kWhr (1.9 kg/kWhr) cited for seacrete energy requirements in places like [Savage1992], if correct, would make it quite efficient. Unfortunately, this figure has two serious flaws. First, it is based on a single experiment [Hilbertz1979]. Second, it is off by a factor of 42 due to a computation error, as Eric Lee has demonstrated. Rather than integrating power over time to get energy, the power used was taken as the energy. The process took 42 hours, hence the error. In fact, at maximum theoretical efficiency the rate is only 1 kg/kWh, and practical efficiences are much less than this. Hilbertz's published experiment produced only 0.046 kg/kWhr. At this rate, the energy alone costs well over an order of magnitude more than just buying cement. COMMENTS (0)

There are additional problems. The major power loss is resistive heating of the forming seacrete. This is because the electricity has to get from the mesh through the seacrete to the seawater, and the seacrete is not a very good conductor. So of course the thicker the seacrete gets, the worse these losses will be. If you want to make structural walls for a sea colony, this is a definite problem. You can reduce resistance using a 3d wire mesh, but such meshes drastically increase the cost. COMMENTS (0)

Because you are trying to replace such a cheap material (ferrocement), it doesn't take much to make seament uneconomical. In fact, there are some ways in which the ocean is the worst place to use seament. Its a place where energy is expensive and transportation is cheap. Using seacrete instead of importing cement is choosing to use energy instead of transportation - a poor tradeoff. COMMENTS (0)

Marc Piolenc has suggested one interesting way of making seament worthwhile. You could set up a structure and some renewable energy scavenger in a remote place, then leave it for years to do its work. Even though the process is inefficent, you can replace efficiency with time if your source of energy is the kind which keeps on producing. COMMENTS (0)

However attractive the idea of turning seawater into cement, seacrete appears to be a poor choice as a construction material. In practice, it is probably easier to use boring concrete and steel to build economical marine structures. COMMENTS (0)

Ferrocement

{ how much should we say here? } COMMENTS (0)

Our building material of choice is reinforced concrete, also known as ferrocement. It is a composite of two materials: steel rebar and concrete (which is made from cement and gravel). The steel has a very high tensile strength (its hard to break by pulling), and the concrete has very high compressive strength (its hard to crush). The combination is a material which is strong under many loads. Since its mostly made out of rocks (which are plentiful) its extremely cheap. COMMENTS (0)

In the image you can see the framing system used for ferrocement construction. First a rebar mesh is built, then concrete can be troweled on, or forms

can be built and the cement poured in. One advantage is that once a set of forms has been built, they can be re-used many times. Also, since this is an extremely common building material, there are a huge number of ferrocement books, supplies, consultants, and contractors. COMMENTS (0)

While it is not as popular as steel and fiberglass, ferrocement has a long history of use in the marine environment. It does require some special treatment, however. Over time, structural stresses create small cracks in cement. While this is not a problem on land, in the marine environment saltwater can seep in and corrode the rebar. For this reason, all surfaces will need to be carefully sealed. In our case, this means two layers of sealant. First will be Ashford formula, which makes it very difficult for water to penetrate the concrete. However, pressure over time will cause water to slowly seep through this, so an additional coat of epoxy will be used on the outer surface. Internal surfaces will only be exposed to humidity, not pressure or direct water, so the Ashford formula alone is sufficient. COMMENTS (5)

An alternate possibility is to use a treatment like Xypex, which fills the pores and capillary tracts of concrete with impermeable crystals. Also, fibers can be added to the cement mix to add extra strength against cracking. Whatever system is used, it will be important to check occasionally to ensure that corrosion has not occured. The easiest way to do this is with a commercial device which examines the electrical resistance of the rebar lattice. COMMENTS (0)

Cement Lite

For interior, non-load-bearing surfaces, the full strength of ferrocement is not required. There are several alternate concrete formulations which are not suitable for holding up buildings, but feature the same durability and convenience. There are two basic ways of making them. COMMENTS (0)

The first is to bulk up ordinary cement by adding foam. This can greatly reduce the cost per unit volume when strength is not a priority. One method is to add 1-20 pounds of powdered aluminum per ton of concrete to the mix. The alumnimum foams up into gas, and can double the volume of the resulting product [TechTopics2000]. Another technique is to generate foam from soap such as dishwashing liquid. This can be done with a cheap homemade device and an air compressor, and the result also has about half the density of ordinary cement. Plans for such a device can be found at [Pelagic], and a picture of Wavyhill's experiments is shown at right. COMMENTS (0)

The second method is to substitute a weaker, lighter, cheaper material for the gravel constituent of concrete. One example is "papercrete", which is a form of concrete using paper instead of gravel. The paper is mixed with sand, cement, and water to form a material which can withstand 300 psi and has an insulation value up to R-2. While papercrete holds its shape and is reasonably strong even when wet, it is not suitable for very wet environments (like exteriors or bathrooms) as it soaks up water quickly and dries slowly. When free paper trash is available, papercrete is even cheaper than ordinary unreinforced cement [MotherEarth2000]. COMMENTS (0)

Shotcrete

While concrete is normally poured into forms, it can also be sprayed into place using a mixture known as shotcrete. This can make construction much easier. For example, it is a key part of the construction technique used to build monolithic domes like the Eye Of The Storm mentioned earlier. These structures are cleverly made by inflating a large plastic form, building a rebar lattice, and then spraying on shotcrete. This avoids the need to build house-sized forms, since the inflated plastic provides the shape. As we'll describe later, similar techniques may help us build seasteads without a shipyard. COMMENTS (2)

{ Should we describe MDI process in more detail here? What should we say? }

Our Design's Details

Our preferred design for initial seasteads is the free-floating dumbbell. Some of its advantages: COMMENTS (0)

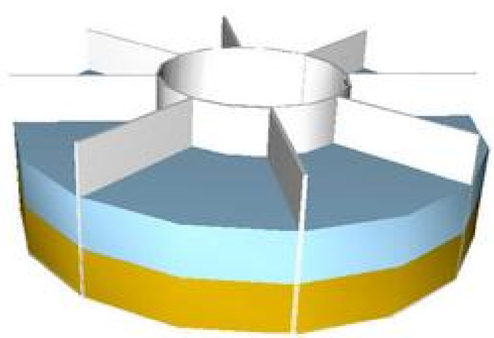
- Free-floating, although it can be anchored in one place. COMMENTS (2)
- Pillars are used for wave protection, which allows for relatively inexpensive small initial colonies. COMMENTS (0)
- The system is modular, with each platform representing a module. So while an individual platform is not modular, a collection of many platforms is. COMMENTS (0)
- Submerged flotation and pillar system means that the platform will feel steady to residents, not rocking like a boat, even during severe storms. COMMENTS (0)
- Built from ferrocement, which is extremely cheap and durable. COMMENTS (MANY)
- Novel shape provides good publicity value. COMMENTS (0)

There are a few disadvantages as well: COMMENTS (0)

- Since its a new design, it will take longer to design and build than simply purchasing and retrofitting an existing structure. COMMENTS (1)
- As we build more, there are some economies of scale (ie don't have to redo design analysis), but not as many as with breakwaters. So new land will always have substantial additional cost. COMMENTS (0)
- Because stability is provided by ballast, it requires a long spar and lots of ballast, and cannot handle large topside loads. COMMENTS (0)

While we feel that the spar platform is the best combination of safety and cost-effectiveness, others may disagree. Some people are quite emphatic that this is too expensive and sailboat fleets, cargo ships, or dirt-cheap concrete slabs are the way to go. If that describes you, don't worry. As you've seen in Ocean Environment, we discuss many topics of general interest for any ocean-worthy floating home, and this will continue to be true as we talk about infrastructure and further issues. COMMENTS (0)

Flotation



On the right you can see the seastead hull with the top and outside wall removed. The central spar is inserted into the center. The torroidal floatation hull is divided into several equal sized compartments. Each compartment has a fixed amount of relatively dense ballast (e.g. lead, steel) represented as brown. In addition, ocean water is used as a variable ballast which is pumped in and out to change the displacement; this is represented by the light blue in the diagram above. The hull is made from ferrocement. COMMENTS (2)

As an additional safety factor, the seastead will have additional floation right below the bottom of the living platform. This may take the form of cheap flotation like 2-liter bottles, or the platform itself may be designed as a hull. If, for some reason, the submerged flotation or spar should entirely fail, the seastead would sink only to the bottom of the living platform. During construction, and certain engineering operations involving the spar, we may lower the seastead so its resting on this safety hull. This requires calm weather, since the living platform is not designed to take substantial waves. COMMENTS (0)

While our current plans call for a symmetrical hull, another option would be to make the hull more oblong in shape. During transportation, the seastead would be oriented to move towards the narrow end, thus reducing drag. The hull would also act as a keel. COMMENTS (0)

Ballast

Material	Weight (g/cm^3)
Water	1.0
Concrete	2.3
Iron, Steel	7.0-8.0
Lead	11.3
DU	19

A large quantity of ballast is required in order to make the structure stable (as we explain later). This is what the yellow area in the flotation hull diagram represents. This ballast needs to be very dense, because only weight in excess of the weight of water counts towards its effect - and water is pretty heavy stuff. The weights of some potential ballasting materials are shown on the right. COMMENTS (0)

As we can see, concrete is just not dense enough. Almost half its weight does not count underwater. Iron, steel, and lead are all of good ballast density. Ballast is actually one of the biggest structural costs of a seastead, because our design needs such huge quantities (200 tons for even a small coaststead). Since all we care about is weight and density, we should use scrap. We want to minimize our cost per pound of a material with the appropriate density. Lead is several times more expensive than scrap iron and steel, so is a worse material, although it does have the advantage that scrap can be easily melted into ingots. COMMENTS (6)

One interesting possibility is depleted uranium (DU). It is extremely dense, and sealed into concrete its tiny amount of radioactivity would not be dangerous. Water stops what little radiation it has extremely quickly. Since its expensive to dispose of, we might possibly even get paid to take it, which would be a big cost savings. It would also be a "swords to plowshares" conversion - using a byproduct of the weapons industry to start a new way of life. However, not everyone may see it that way, and there could be negative political consequences, so using DU should be considered carefully. COMMENTS (0)

Reader W.E. Johns suggests that if the seastead's power systems use conventional lead-acid batteries, the battery bank itself could form part of the ballast. This makes the weight a benefit rather than a cost. On the other hand, it adds distance and thus transmission loss, as well as making maintenance more difficult. COMMENTS (0)

Spar

The main criteria that go into designing the spar are its height and the total amount of weight it must support. The choice of the height depends upon the anticipated worst case waves expect to hit the tower during the expected lifetime of the spar. It is potentially a matter of life and death that our structure be safe, but given that constraint, we wish it to be economical. COMMENTS (0)

At right is a cutaway view of the spar, which is compartmentalized up its length to provide a number of individual water tight compartments. If any compartment springs a leak, the remaining compartments will continue to provide bouyancy. Additionally there is an access ladder that runs the length of the spar with water tight doors between the compartments. Thus, somebody can go all the way down to the flotation hull from inside the spar. COMMENTS (0)

The spar is hollow for several reasons. First, we do want to have some flotation area at the waterline, otherwise the seastead will be totally unstable in terms of vertical height, and difficult to maintain at a desired height. Also, having some of the flotation be in the spar moves the center of buoyancy up, which makes it easier to get the center of gravity under it for stability. Of course, the downside of spar flotation is additional sensitivity to waves in both vertical and horizontal motion. COMMENTS (0)

It is probably desirable to have at least a small habitable underwater room with viewports. The lowest section of the spar would be an appropriate place, and in clear water the view would be well worth the additional cost. Lower spar sections can also be used to store rarely used items. Some of the upper spar sections, well above the water level, can be used as regular rooms. COMMENTS (0)

The upper and lower joins between the spar and the hulls must to be able to handle the necessary stresses. One option is stress risers. More elegant is to have a smooth transition, so that the spar simply widens and blends into the bottom of the platform and the top of the flotation hull, like a champagne glass. { Need Picture }. COMMENTS (0)

Superstructure

The living platform is basically a building sitting on top of the spar. Since the purpose of the spar is to keep any wave crest from ever reaching the tower, the construction of the platform is fairly straightforward. It can be built out of wood like a house, although in the marine environment the wood needs to be water-sealed and regularly inspected. We prefer various forms of concrete, especially the lightweight ones mentioned earlier.

There is not much to say about decks, except the top deck (the "roof"). Since the easiest way to collect water is to capture and collect rain, the top level will be plumbed for this purpose. Things which need sunlight, like solar panels and greenhouses, will be located here.

An intriguing alternative way to build the top decks is to hang them from a central mast. Buckminster Fuller pioneered this design, which was used in his Dymaxion house and other designs. It requires less materials, since the platform does not have to be cantilevered or as stiff. And a lighter platform means we need less ballast and flotation, so its a big win. While this is worth considering, it may be a bit experimental for early models.

Shape

There are a number of different shapes the platform can take. its important to consider how they will interact when multiple steads are joined. The simplest shape is a box where the levels are all the same:

```
xxxxxxxxxx xxxxxxxxxx
xxxxxxxxxx xxxxxxxxxx
xxxxxxxxxx xxxxxxxxxx
    xx         xx
```

{CENG: prev par unclosed}

However, this results in most of the interior space not getting any sun. This is especially true when you connect multiple steads - now only the top deck gets sunlight, because the exterior windows look right into your neighbors window. One way to get interior sunlight would be something like:

```
xxxx  xxxx xxxx  xxxx
xxxx  xxxx xxxx  xxxx
xxxxxxxxxx xxxxxxxxxx
    xx         xx
```

{CENG: prev par unclosed}

But this still doesn't help much unless the sun is close to overhead. The key is to add reflected sunlight through a wine-glass design like:

```
xxxxx        xxxxx xxxxx       xxxxx
  xxxxx    xxxxx     xxxxx    xxxxx
    xxxxxxxxxx         xxxxxxxxxx
        xx                 xx
```

{CENG: prev par unclosed}

Not only can light reach all the levels from above, but sunrise/sunset and light reflected off the water can reach the levels from below. This remains true even when steads are joined together. This design is more visually appealing as well. The area at the center is ideal for communal space. The platform increases its solar area. A downside is that it may raise the center of gravity by making the floors at higher levels larger. However, these effects are small because we're already pretty far from C_g, so the changes are relatively small.

```
   x       x
```

```
  XXX      XXX
 XXXXX    XXXXX
XXXXXXX  XXXXXXX
```

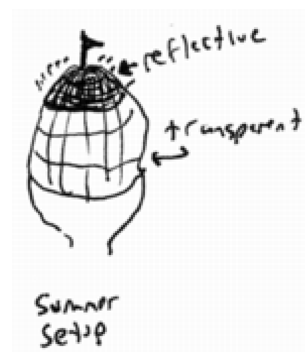
{CENG: prev par unclosed}

Another option is to use a pyramidal shape, as in Buckminster Fuller's Triton City design. The problem is that the inner core of the pyramid is a large area without sunlight. Also while exterior units get sunlight during at least half the day, they aren't getting reflected sunlight. It does keep center of gravity down. This has the disadvantage of a smaller top deck, which means either less greenhouses and solar panels, or distributing them among floors, which is a lot more effort. COMMENTS (0)

Mast

We think it desirable to have a mast as part of the design. After all, its a proven bit of nautical technology. We can put decorative items such as a flag on there, and a crows nest for a good view. In the modern age, the crows nest can even have a webcam to spare us the long climb. This might be an appropriate place to mount wind generators. And finally, it enables a useful additional structure: COMMENTS (0)

Skin



We can hang a hemispherical skin of transparent plastic from the mast, covering the seastead's top deck. This has a number of advantages: COMMENTS (0)

- It makes collecting rainwater easy (just add a gutter) and shields the top deck from rain. COMMENTS (5)
- Keeps salt spray from accumulating. This helps protect any equipment on the top deck from corrosion, as well as any plants such as trees which have exposed soil. COMMENTS (0)
- Temperature control. When its too cold out, the skin will act as a greenhouse to trap warm air. When its too hot out, we can add a reflective Mylar cap to block noontime sunlight, as in the sketch on the right. Also, we'll open a hole in the top as well as around the base, so that warm air will continuously escape and cool air will be brought in by convection. COMMENTS (0)
- Essentially, the top deck becomes a big greenhouse which is protected from the salt. This makes it easier to have trees, flowers, berries, and so forth to make the space feel lush and verdant. This is important because seasteaders can't just go to the local park - this is the only outdoor space they have besides the bare ocean. So its important that it be an enjoyable space to spend time in. COMMENTS (0)

This skin has a lot of sail area but not much strength, which means that it is vulnerable to high winds. During hurricanes, it will need to be removed. Also, the skin means that we can't have a runway or helipad on the top deck. For smaller prototype seasteads like Baystead, this is not a problem, as they don't really need such facilities. However, larger platforms will need some transportation infrastructure. We can use their size to have both - make part of the deck a solarium, and put the runway on the uncovered area. COMMENTS (1)

Runway / Helipad

Larger seasteads will need an STOL runway or a helipad, as described later under transportation. Helipads are fairly small, but runways take up a fair bit of area. Even large structures like Seastead Lite will only be able to accomodate Short Take-Off and Landing aircraft (STOL). Not until many spar platforms are connected, with their runways lined up, or breakwaters are used, will normal aircraft be able to land onboard. COMMENTS (3)

Because the runway takes up a lot of area, we may wish to use an elevated runway which is partially transparent to light (ie made out of a grating). This would let us put crops underneath it. (Or this might be more complex than its worth.) COMMENTS (0)

Misc

Dock

All seasteads will probably want to have a floating dock. This would be loosely connected to the central pillar, but able to rise with the tides and as the seastead's waterline changes. A very simple design is simply an annulus around the pillar, unconnected. During bad storms, the dock could be hoisted all the way up to the bottom of the main platform to avoid the waves. Otherwise, the waves will be repeatedly slamming the dock against the central column. It might be possible to use some sort of rollers so that the dock could move vertically, but still be braced against the waves. COMMENTS (3)

Several people with nautical experience have expressed are serious worries about transferring any substantial cargo from such a dock. While the seastead will be steady, the dock and boat will be moving quite a bit in anything but glassy seas. This makes moving things, even with cranes or hoists, very difficult. While non-surface transfer via submarines and helicopters avoids this problem, it is also very expensive. COMMENTS (2)

The best option is probably a small breakwater. It would protect a small area from waves in a particular direction, might well be temporary, and only meant to handle smaller waves. In calm weather, it would be deployed to facilitate cargo transfer. The rest of the time it would either be submerged or hoisted. A v-shaped pair of walls extending from the spar should do the trick, preferably fairly narrow. Cargo should also be packed in small containers, and off-loaded only in calm conditions. This issue is a disadvantage to the pillar design, as a full-sized breakwater would of course create a calm cargo loading area. COMMENTS (0)

Elevator

The seastead will need some way of getting large objects from sea-level up to platform level. Some sort of hoist or crane is probably the way to go. We may want to locate it close to the center so as to put minimum torsional stress on the structure. COMMENTS (0)

Design Issues

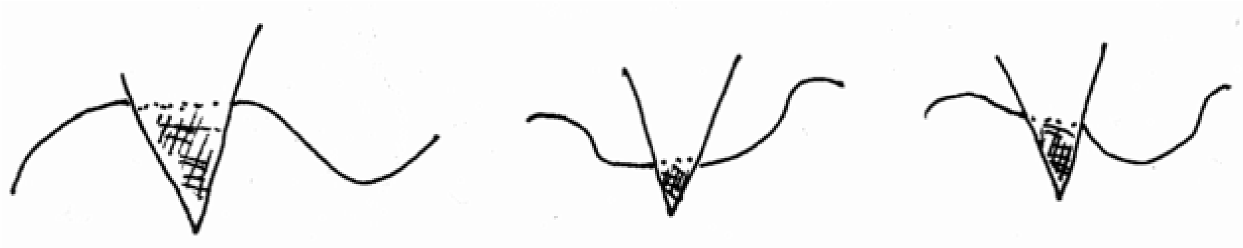
There are a number of things we must take into account as part of this design and that people wonder about. COMMENTS (0)

Bobbing

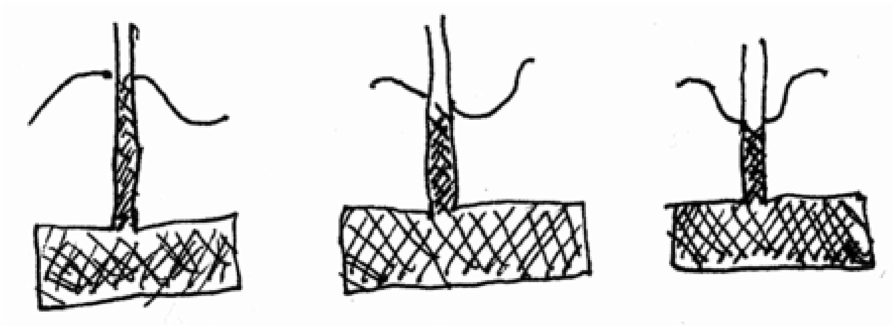
The question we are probably asked the most is: will the platform bob in the waves like a boat? The answer is a clear "no", although to explain why we'll have to delve into some of the physics of flotation. COMMENTS (0)

Boats float because their hulls are filled with air. This air is lighter than the water, so it has buoyancy. As a boat settles into the water, more and more air is below the waterline, so it has more and more buoyancy. Eventually the buoyancy is equal to the weight, and it is stable. This has the nice effect that if you increase the weight on a boat, it will just drop a little lower until the extra buoyancy has compensated. COMMENTS (0)

Now consider the effect of waves. When the waves go up, the water line has gone up, so the boats displacement has increased, so it has more buoyancy, so it lifts. When the waves go down, the water line has gone down, so the boat has less float and drops until things equalize. It is this large difference in buoyancy caused by a small difference in water level that makes boats rock up and down so much. COMMENTS (0)



On a seastead, however, things are quite different. Most of our flotation is submerged way below the surface. So as the waves bob up and down, the displacement hardly changes: COMMENTS (0)



Boats also move laterally in the waves, for a different reason. While boats have narrow bows, they have long sides. The impact of the waves against that large surface transfers energy. But a seastead only has that central column which presents a small front in all directions. Thus it gets less lateral forces than a boat. COMMENTS (0)

Stability

There is another matter of physics we have to worry about, and that is stability, ie whether the seastead floats upright or falls over. In order to be stable, when there is a shift in weight, a restoring force needs to act to counterbalance it. When a boat begins to lean, it dips farther into the water on that side. This increases the buoyancy on that side, providing a restoring force. So unless it tips so far that the edge goes underwater, it will reach an equilibrium. [Fay1991, Chapter 2 - Static Equilibrium] COMMENTS (0)

Unfortunately, the same submerged flotation that gives seasteaders a comfortable ride means they lack such a restoring force from their flotation. If an unballasted seastead began tilting sideways, it would just fall over. It is naturally unstable, because the heavy top wants to fall and the light bottom wants to rise. Here is a brief and approximate explanation of the physics of seastead stability: COMMENTS (1)

[image stability_expl.jpg missing, sorry]

There are two important points, the center of buoyancy C_b and the center of gravity C_g. The center of buoyancy, on the left, is the center of mass (basically the two-dimensional average) of the part of the seastead which provides buoyancy. This area is shaded, and consists of the airspace below the water line, both in the spar and in the hull. The center of gravity, on the right, is the center of mass of the solid parts of the seastead, such as the greyed-in top platforms, the structures walls, and the ballast at the bottom. We can model a floating object as a rod connecting these two points. The C_g feels the effects of gravity and wants to go down. The C_b feels the effects of flotation and wants to go up. Depending on which is higher, you get one of these two configurations. COMMENTS (0)

[image unstable_fbd.jpg missing]

Unstable Configuration
When C_g is above C_b, the structure is unstable - the top wants to go down and the bottom wants to go up! It will start to flip, and end up lying sideways in the water.

[image stable_fbd.jpg missing]

Stable Configuration
When C_b is above C_g, the structure is stable. Any small rotation will be resisted, as the top will try to rise and the bottom will try to fall.

You can probably see now why we need the ballast. The long spar platform has substantial mass way up high (the living area) which must be offset by mass way down low. It is also aided by having a significant part of its buoyancy be in the spar area, which moves C_b up. The design must calculate these factors so as to achieve the stable configuration. COMMENTS (0)

The lower the ballast is located, the more it pulls down the center of gravity. Currently we have it at the bottom of the flotation chamber. Another possibility would be to have the pillar extend farther down, and have a seperate ballast area. { picture} This would add spar length, but require less ballast to achieve the same stability. It would also add the worry that a structural failure between the ballast and flotation would cause a loss of ballast only, thus making the structure rotate unpleasantly to the horizontal. (Whereas if ballast and flotation are lost together, the platform simply drops down onto the safety hull.) COMMENTS (0)

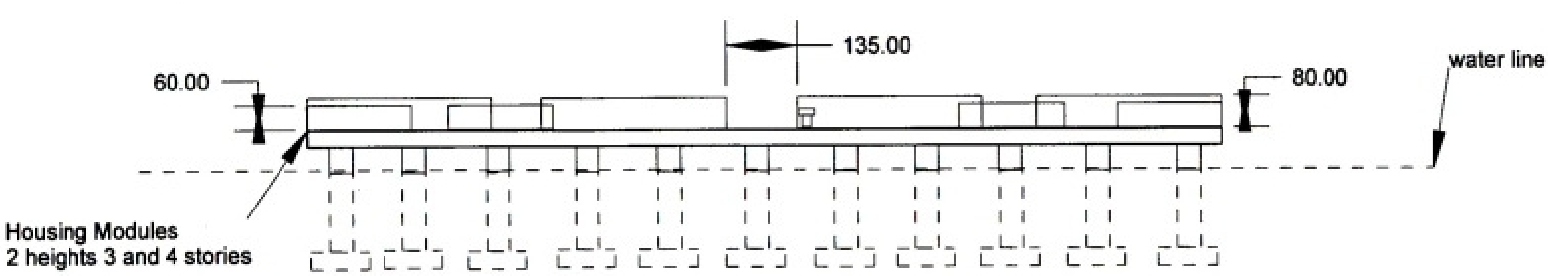
Tilting

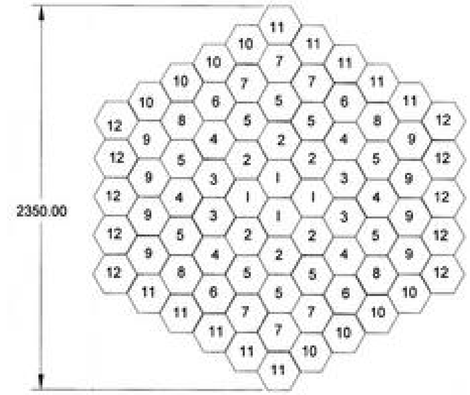
Another frequent question is how much the seastead will tilt in strong winds, such as from a hurricane. Despite what most people think, the answer is "very little". This is nonintuitive because our intuition is based on boats, particularly sailboats, which are very light and have a lot of surface area. Thus they heel over quite easily. But air is really quite thin, while concrete is quite heavy. COMMENTS (3)

Consider a standard concrete block with one side sealed. Now visualize it floating in a pool along with a little model sailboat. Imagine trying to tilt the concrete block by blowing air on it. Its an almost impossible job, because the thing is so heavy. The long lever arm of our pillar does give the wind a mechanical advantage, which may be as high as 5-10 (technically its the ratio between our righting arm, which is the distance between the center of gravity and center of buoyancy, and the winds lever arm, which is the distance from the center of gravity to the surface it is pushing on, which is the top platform). However, as the platform tilts, the righting force increases, so it is unlikely to tilt much. { should we diagram this? } Note that this slight tilt will only be for an anchored seastead. An unanchored seastead will simply be pushed. COMMENTS (3)

For those who prefer less technical explanations, the children's tale aboout the Three Little Pigs tells us all we need to know. The houses made of straw and sticks were easily blown down. The house made of brick didn't move. End of story. COMMENTS (0)

Multiple Platforms





Part of the modular nature of this design is that individual seasteads can be connected to form larger units. If the platform is made in a hexagon, it can be packed in a nice hexagonal grid. This has the disadvantage that platforms must be the same size, since hexagons cannot be subdivided or composed into hexagons (as reader Otto Drachen pointed out). Squares might be a better shape from this standpoint. However, with loose enough attachments, hexagons do tile, as a group of 7 looks much like a jagged-edge hexagon. A large hexagon can be fit in at the cost of some triangular gaps. COMMENTS (6)

The interconnections must be somewhat flexible because of the dynamic forces operating on the seasteads. For example, as waves pass through, there will be continuous small fluctuations in the relative buoyancy of platforms. On a longer time scale, differences in weight onboard may cause platforms to want to rise or fall relative to each other. Good buoyancy control is very important because these differences will put great stress on the joints. A particularly tricky problem is mooring interconnected platforms, especially in areas with changing tidal currents. COMMENTS (1)

Note that if the spars are small relative to the gaps between the platforms, our flotation design allows for a clever way of removing a single platform from a large collection of seasteads. Disconnect it, then reduce its flotation a little so that the platform drops beneath the level of the other platforms. Now it can be towed out between the spars, under the other platforms { 3D animation? }. The extra space between the edges of the platform and the forest of spars through which it travels is the same as the distance between adjacent platforms (the size of the interconnecting joint), minus the radius of the spars. So we'd best tow slowly. Still, its quite nice for modularity and dynamic geography for platforms to be able to leave without needing special gaps in the grid, or for other platforms to move out of the way. COMMENTS (1)

It seems likely that standard utility interconnects will be developed to allow infrastructure sharing between platforms. A benefit of multiple platforms is longer runways, to allow larger, non-STOL planes to land. COMMENTS (0)

Another option is to pack less closely. COMMENTS (MANY)

It is unclear whether seasteads will be linked closely or loosely. A closely connected mass of platforms will be easier to anchor, and to keep together while drifting, and has less travel time between platforms. Doug Reeder points out that you can run infrastructure between platforms that connect only at a point, and that gives you more personal platform space as well as better window views. However, loose connections make mooring even harder. But some people may want distance, and use separate anchoring systems, or trail downcurrent off long cables. COMMENTS (2)

Construction

Ferrocement construction is fairly simple. The rebar lattice is set up inside appropriate forms, and the concrete is poured in. There is additional complication for a seastead because (unlike a building) its construction spot is not its final destination. Given the mass of a seastead, this is no light matter. There are two basic solutions: build in a drydock or build on the water (using clever floating docks). **{CENG: prev par unclosed}**

A drydock is an enclosed area below sea level which is contiguous with the sea. It has gates to the ocean, and the interior area has pumps. Construction or maintenance can be performed there on dry land. When it is complete, water is pumped in to match sea level, and then the gates open and the ship is floated out. While drydocks are effective, they are very expensive to rent, so early seastead prototypes may wish to use alternate methods. COMMENTS (1)

The marine environment makes working with huge concrete pieces much easier. This is because clever use of buoys and pumping air/water around can be used to raise, lower, and flip all the various segments. The power of displacement does all the heavy lifting for us. By combining this insight with the shotcrete/ airform technology discussed earlier, an entire seastead could be built in-place on calm waters. Let's imagine how this would work for a small (but heavy) baystead. COMMENTS (0)

First, we build a simple foundation, a very cheap, flat floating platform. Plywood on top of 2L bottles is about the right technology level. On top of this, we build the form for the seastead's flotation hull . This may consist of an inflatable airform, or a more conventional wooden form. We set up the rebar, spray shotcrete, and let it dry. When ready, we can remove the flotation from the foundation until the hull is resting on the water. The initial foundation need only be strong enough to support this part of the structure. In fact, we could even do a two-step process, first pouring the bottom half of the flotation hull, then removing the foundation, and doing the rest of the work supported by the new hull. COMMENTS (0)

Once this hull is complete, it can serve as the base for the rest of our work. We make a spar section mold, and pour the spar in sections. To get a section off, we pump water into individual chambers in the flotation hull to lower and tilt it. We can tether the new spar sections nearby. Next we build the upper hull on the flotation hull, just as we built the flotation hull on the foundation. COMMENTS (0)

We can also pursue a combination strategy. For example, the flotation hull could be built in a drydock, and the rest of the seastead built on top of it. A great advantage of this method is that it may enable seasteads to "reproduce" without requiring land-based facilities (although they will need raw materials). COMMENTS (0)

Maintenance, Lifetime

Most biofouling occurs close to shore, which is why its a problem for ships. A ferrocement seastead which stays in the open ocean will require very little hull maintenance. COMMENTS (0)

Most of the World War II era structures built with concrete are still strong, and waterproofing technologies have advanced since then. As long as the rebar is protected, the hull life should be at least a century. If we skimp on maintenance and design, the hull will still last 30-50 years. COMMENTS (0)

Cost

One of the most important elements of any seastead design is its cost. Oil platforms prove only that the ocean can be withstood, not that it can be settled. Since we have only rough sketches, not a complete blueprint, our cost estimates are tentative. The cost is approximately \$50/ft^2 of area, which is \$150/ft^2 of solar area (topside) with our three-story design. This includes labor, materials, and basic infrastructure (power/water/waste). It does not include more advanced components like communications, nor comforts like furniture, panelling, or carpeting. COMMENTS (1)

While this number could be off by a factor of two or so, we still find it encouragingly low. The main reason is the cost of the materials used - cement and rebar are extraordinarily cheap. Ballast costs more than the rest of the structural materials combined, hence there is potential to be even cheaper if we can get a good deal on scrap metal. Another factor that throws people off when comparing this cost to a house is the house gets a yard and perhaps some garage space as well. On a seastead, there ain't no such thing as a free inch. So 10,000 ft^2 will be less roomy than a house of the same size. COMMENTS (3)

Design Summary

While there is no single seastead design that is correct for all situations, there are certainly some that are better than others. For individuals who already lead a sailing lifestyle, the sailboat fleet is an easy transition. By becoming gradually more self-sufficient and joining with other like-minded individuals, live-aboarders can become true ocean nomads through an incremental process. COMMENTS (0)

For those starting from fresh, however, we think a platform-based approach is more promising. If a location can be found which is politically and economically feasible, and is protected from the waves (perhaps on the equator), simple concrete slabs will serve. For most locations, however, a spar platform will be required to reduce wave impact. COMMENTS (0)

Eventually, as interest in seasteading grows, it will become cost effective to build huge breakwaters to create protected lagoons, allowing a slab-based floating city to be built anywhere. COMMENTS (0)

One concept seastead communities may want to explore is mixing various designs. For example, the community centerpiece might be a large spar platform, surrounded by a mixture of boats and freight containers. People could congregate in the larger facility for community activities, but actually sleep in individually owned and maintained freight container seasteads or sailboats. The big structure would be an emergency shelter during storms. Containers could be hoisted up under the large platform to escape really bad surface conditions. COMMENTS (0)

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Last modified: Mon Nov 14 23:22:44 PST 2005

Seasteading: Basic Infrastructure

Basic Infrastructure

The necessities of life on a seastead: food, water, power, transportation, and so forth, present special challenges. Fortunately most of these challenges have been met in other contexts, and we can build upon those solutions. Thanks to the growing movement towards resource conservation, there are lots of commercial products which use resources efficiently and are thus well-suited for seastead life. Numerous books have been published on the topic of being self sufficient and living off the land. We used *Building for Self Sufficiency* by Robin Clarke [Clarke1976]. COMMENTS (0)

Seasteads can choose their level of self-sufficiency based on factors like size, distance to land, initial capital available, and desired levels of trade and luxury. The initial seasteads will probably be small and less self-sufficient. The variety of goods used in modern life is staggering, and it will simply not be feasible to make them all onboard. This is especially true because the ocean is a demanding environment, and it will be difficult to meet its challenges without some serious technology. Fortunately water transport is quite inexpensive, which makes importing many goods feasible. Thus we expect needs will be served by a continual series of compromises between local production and trade. COMMENTS (3)

Different perspectives on self-sufficiency will yield very different choices. We've had libertarians and futurists scoff at the idea of growing their own food rather than just importing it, and we've had environmentalists who thought our ideas of self-sufficiency still depend way too much on the outside world. There is no "correct" solution, since the optimal seastead for someone who sees local, do-it-yourself production as a plus is different from the optimal seastead for someone who sees it as a minus. This may cause difficulties (and require compromises) on the first seastead or two, at which point the groups will probably split. Our exploration of these technologies is biased by our particular viewpoint on a good level of compromise, but keep in mind that more or less trade are always available options. COMMENTS (2)

Similarly, there are a wide variety of lifestyles in the world. The right seastead for a billionaire will not be the right seastead for a simplicity-oriented group. It would be difficult for us to cover this entire range. Still, some technologies are better suited to the ocean than others, and the differences between groups will mostly be a matter of degree. Catching rainfall is a good way to get water - but different groups will use very different amounts of water. So reporting on methods is useful to everyone. COMMENTS (2)

To get actual figures and guide our research, we had to use some target market. We tried to use the first-world environmentalist movement whenever possible. Environmentalists because they are efficiency-oriented, as we will be. First-world because frankly, its going to take that level of income to get the movement started. We think seasteading will be in reach of many Americans at the beginning, but not the third world. This does not mean that our movement will not help poorer people. We believe that a good way to bring cutting-edge technology to everyone is to start out selling it to the high-end markets, then let experience and economies of scale bring down the price. COMMENTS (2)

There are two major differences that must be dealt with as self sufficiency books are applied to seastead technology. First, even though the seastead is surrounded by water, fresh water is going to have to be tightly managed. We do not have the option of tapping into a stream or drilling a well to get unlimited supplies of fresh water. Fresh water management is covered in greater detail in the water section below. Second, surface area will be at a premium. Large meandering structures that occupy lots of space are not going to be viable in early seasteads. COMMENTS (0)

We should comment that most of these self-sufficiency books start out with a preface that we will paraphrase as "humanity is running out of energy and resources; thus, we must change our evil high technology ways and go back to basic living off the land." These statements should not be taken at face value, because many of them are not supported by scientific evidence. For example, books written in the late seventies, during the energy crisis, predict that energy costs would only get worse - when in fact they got (and have remained) much better. COMMENTS (0)

More generally, the inflation adjusted cost of energy and resources have continually declined when measured over periods of greater than ten years. Contrary to the theory that increased population causes a decrease in material wealth, the twentieth century saw a dramatic and consistent increase in population along with a dramatic and consistent increase in material wealth. A more balanced view of energy and resources can be found in *The True State of the Planet*, a compendium of papers written by ten environmental scientists who publish in peer reviewed journals [Bailey1995]. A number of the energy books we reference below suffer from the same basic flaw, however, once you get past the preface and first chapter of these various books, they tend to be pretty reasonable. COMMENTS (0)

An interesting counter-argument is that while people on land may have plenty of energy and resources, seasteads will not. The doomsday-type analysis which assumes limited and expensive resources is actually more applicable to our environment than the one it was written for. (To be fair, it is also somewhat applicable to remote pieces of land). So even those seasteaders who agree with our skepticism about apocalyptic claims should not dismiss such viewpoints completely, as they are relevant to this new frontier. COMMENTS (1)

Water

{Patri - check whether PV/RO or distillation makes more water from a given amount of solar area.}

Despite being in the middle of an ocean, obtaining and retaining an adequate supply of fresh water is going to require some careful thought and implementation. There will be a continual loss of fresh water due to evaporation and other factors, so fresh water needs to be replenished. There are several possibilities for water replenishment -- rain water collection, distilling sea water into fresh water, reverse osmosis of sea water into fresh water, and importing fresh water. Of these, importing fresh water seems the least practical and rain water collection seems the most practical.

How Much Water Do We Need?

Water use on a seastead can be roughly divided into two major components: personal use and food production.

Water Requirements for Personal Use

The book Blueprint For Paradise by Russ Norgrove is (despite the title) an exceedingly realistic book about living on small islands. Norgrove suggests a water ration of 100-200 L/p/day (35K-70K L/p/yr) [Norgrove1983, p. 103-104], which we think is much too high. According to Neumeyer [Neumeyer1982], avg. household water use in the United States is 190 L/p/day (69K L/p/yr). A more recent source suggests use of 280 L/p/day (102K L/p/yr) in a typical single family home with no water-conserving fixtures [Water1999].

Fortunately, people on a seastead can easily use far less water than the average american [Economizing_on_Water_Use]. Folks living aboard their sailboats sure aren't using 150 liters of freshwater per person per day! Hill says:

> People seem to use vastly differing amounts of water, some struggling on a gallon per day and others thriving on two pints. Pete and I manage quite succesfully on between five and seven gallons (19-26 L) per week between us, which amounts to a maximum of 4 pints (1.9L) per person per day. To achieve this, we don't seem to try very hard, but we do have water-saving methods, which make it easy and painless to be economical with our water use.
> [Hill1993, p. 53]

This figure of 1.9 L/p/day is quite low, and we doubt seasteaders will be that frugal (unless they must). Rose suggests 7-20 L/p/day (2500-7300 L/p/yr) [Rose1979, p. 120] as a more typical level of water consumption. Unsurprisingly, these are all much less than on land. Requirements for drinking are 2L/p/day, more in hot environments or with strenuous exercise. Another source suggests 2.3 to 4.2 L/p/day as the minimum for drinking and 9 L/p/day as the minimum for hygeine, totalling 11 - 13 L/p/day [Eckart1996]. Jewell's closed-loop space station allocates 30 L/p/day for all uses [Jewell2001]. The ITDG suggests that in developing countries, the minimum requirement for personal use is 20 L/p/day, but that some functions can be performed with saltwater and a typical requirement for distilled water is 5 L/p/day. COMMENTS (0)

As with most aspects of seasteading, there will be a trade-off between cost and convenience. As we'll see, obtaining the basic drinking requirements of 4 L/p/day will be trivial using any of our methods of water production. The quantities of water used on land (200-300 L/p/day) are feasible only in very rainy areas or at great expense. The individual preferences of seasteaders will determine what point in this range is selected. We'll use 5, 15, and 100 L/p/day as our points of analysis. COMMENTS (4)

Water Requirements for Food Production

{ Better numbers would be nice. We have not found them. Empirical testing on baystead may be necessary. } COMMENTS (0)

An analysis of a hydroponic gardening system as part of a proposed space station design suggests 720 L/p/day (although it also gives 30 L/p/day for personal use, which we feel is high) [Jewell2001]. However, this design has less need to be efficient because it is a closed loop (all water and biomass is recycled, so if they use too much water they still recover it). COMMENTS (0)

Water usage for traditional crops is around 6-15 megaliters / hectare / year (rainwater and irrigation). This is 1.6 - 4.1 L/m^2/day. Our crops will be much denser, increasing water requirements per unit area. However, they will also be grown hydroponically in greenhouses, decreasing water requirements per unit crop produced. COMMENTS (0)

Non-greenhouse hydroponics: 2-4 L/m^2/day[Bradley2001]. This should be an upper-bound on our water requirements, since greenhouses are more efficient. NIMSS reports an unpublished study in which 13.9 liters water were used per 1 kg of tomatoes in the field. In a greenhouse, only 2.4liters/kg were used. So the greenhouse is much more efficient, but since its denser, this doesn't tell us about water / unit area. COMMENTS (0)

Theoretically, the only water losses from a food production system are evaporation, run-off and water contained in material which is removed (for consumption or composting). Run-off is eliminated in hydroponics, and water in material eaten goes to good use. Evapotranspiration is thus the dominating factor for efficiency. There are ways to reduce it [MBR, Ch. 29]. For example, using a greenhouse traps the water vapor in an enclosed space. Still, we must remember that "sweating" is an important method of cooling for plants. If the air becomes saturated with water, the plants will not be able to cool themselves, as well as being more vulnerable to fungal diseases. We could dehumidify the air without losing water by passing the air from the greenhouse through a condenser (perhaps using seawater for cooling), and capturing the resulting water. Essentially, this is treating a greenhouse like a solar still. We see a pretty good chance that this technique will be desirable. COMMENTS (0)

Aquaculture will likely use saltwater species, and so won't contribute to fresh water requirements. Small animals, such as chickens, should have modest water requirements (drinking only), although whatever we feed them will have had water needs as well. COMMENTS (1)

These numbers are very approximate, so we'll use a large range of 20, 85, and 500 L/p/day as water requirements for food production. This leads to total water usage checkpoints of 25, 100, and 600 L/p/day. COMMENTS (0)

Economizing on Water Use

Water that does not get used does not need to be supplied. It should not be difficult for seasteaders to economize on water use: COMMENTS (0)

- 28% of domestic water consumption is used for toilets [Water1999], which can be eliminated by using toilets which flush with salt water, or better yet, composting toilets which use no water and save the valuable nutrients. COMMENTS (0)
- Seasteads will probably take their cue from the environmentalist movement and utilize multiple water systems, such as drinking water, grey water, black water, and so forth. An excellent discussion of designing net-positive-benefit greywater systems can be found at graywater.net COMMENTS (1)
- Using greenhouses should greatly reduce our evaporative losses, by keeping moist air trapped inside the growing space. COMMENTS (0)
- Hydroponics claims to require 1/25th as much water as conventional cultivation (this may include greenhouse gains). COMMENTS (0)
- Residents can use misting showers. COMMENTS (0)
- Water minimization technology for many common uses (dishwashers, washing machines) is widely available. COMMENTS (0)
- As rain varies seasonally, water usage can vary as well, being used at high levels during the rainy season and low levels during the dry season. This effect can be created with quotas or with market-based systems such as adjusting the price of water. COMMENTS (0)

How Much Water Can We Get?

> *"I mix my water myself. Two parts H, one part O. I don't trust anybody!"* -- Steven Wright

Rain

Norgrove says that roof-based water collection is eminently practical - a reasonably large house roof, on most islands, will supply enough water for the residents [Norgrove1983, p. 103-104]. Assuming 30% loss of water, 1 m^2 of roof will yield 7 L/cm of rain. Average precipitation over the ocean is about 3mm/day, or 1.1m/year, with much less seasonal variation than on land (which is an advantage) [ERA40]. It is unclear from our source how much regional variation there is. So for every square meter of rain collection area, we get about 750 L/yr or 2.1 L/day: COMMENTS (0)

Checkpoint (L/p/day)	25	100	600
Rain collection area (m^2/p)	12	48	286

Our current designs have about 30 - 50 m^2/person. The highest checkpoint would represent a drastic decrease in our planned population density to achieve from rainfall alone. But if most of the top deck can collect rainwater, we can just about achieve the middle checkpoint without alternate methods. It is not hard to make the exterior of a greenhouse collect water, and much of the top deck will be covered with greenhouses. If the top deck is covered with a skin, this does the job easily as well. Or tarps could be raised during rain to collect water, and would serve the additional function of sheltering the top deck. Any rainwater collection device should let the first few minutes of catchment drain, to rinse off salt spray and small debris. COMMENTS (1)

Areas that do not catch rainwater can be compensated for with water production or collection area elsewhere. We could build floating rainwater collection modules, since water collection apparatus (a big tarp) is light, cheap, and simple. This lets us cheaply use more area. One problem with this is that lightweight water collection (tarps) don't deal well with high winds, and rain often comes with winds. Also if they are low, they will catch some salt spray. We may be able to spread a tarp below the platform and above the waves to capture rain (as long as it falls at an angle), although it will catch spray as well. Tarps could also be projected out sideways from the decks, since they are very light. COMMENTS (2)

If the seastead is parked in area that does not get regular rain storms, or it is the dry season, an alternative method of fresh water replenishment is needed. Either sea water distillation or reverse osmosis will work. Both methods require significant amounts of power, in the form of sunlight for distillation and electricity for reverse osmosis. COMMENTS (0)

Solar Distillation

We can get water without rain using a solar still to purify seawater by evaporation. Solar stills have been used since at least the 16th century, and mass-produced since WWII, when 200,000 inflatable stills were made for the US Navy [ITDGStill]. Thus it is fair to say that they are a mature technology. Impure (salty) water is heated by the sun, and the water evaporates while the impurities do not. The vapor then condenses onto a surface which captures the water. Its a miniature version of the same cycle which produces rain. Solar stills are commercially available from [SolAqua] and [ADS]. They can also be built fairly easily with widely available plans [EPSEAStill]. Because the water has been distilled, it is purer than water filtered by reverse osmosis. COMMENTS (0)

This method requires solar area, but since its very lightweight it can be projected out from the platform, or floated on separate units. As solar stills are closed, contamination by salt spray is not a worry. Lack of rain is usually associated with calm seas and clear skies, thus evaporation is an excellent complement to capturing rain. COMMENTS (5)

Costs range from \$60/m^2 [ITDGStill] to \$120 / m^2 [EPSEAStill] unassembled, to \$275 / m^2 for

Agua del Sol's pre-assembled ADS-8. This is pretty expensive, but there is almost no maintenance cost and a still should last for 20 years. We also may be able to design larger stills and buy components in bulk to reduce the price. Ferrocement is a good material for stills, thus we could incorporate them directly into the top deck. These stills produce 2.65 - 7.6 L / m^2 / day, depending on the amount of sunlight according to EPSEA [EPSEAStill] which is located near the US/Mexican border , or an average of 2.27 L m^2/day in a typical country according to ITDG [ITDGStill]. COMMENTS (0)

Solar Still footprint and cost per capita: COMMENTS (0)

L/day	25	100	600
m^2	3.3-11	13-45	80-265
Unassembled cost	$200-$1,300	$800-$5,400	$4,800-$32,000
Assembled cost	$900-$3,000	$3,500-$12,000	$22,000-$73,000

These figures indicate the cost of meeting all water needs with solar stills. Any rainfall collected will reduce them. Also, we suspect we can achieve lower costs than our references ($7.5 - $35 / L / day). Stills will be most useful in areas with high sun and low rain. The current range of costs is wide, and represents very different levels of cost-effectiveness, thus further research and experimentation with actually building stills is needed. Note that stills are fairly thin, so they can be stored in stacks, and deployed on the top deck during droughts or dry season. Because of their design, stills can also double as rainwater collection area. COMMENTS (1)

Recent research suggestions that a clever design improvement can greatly increase the efficiency of a solar still [Goswami2003]. The idea is to use gravity to create a partial vacuum through hydrostatic pressure, which increases the rate of evaporation. Tests on a small prototype resulted in almost twice the efficiency of flat basin stills. While the method is more complicated, it is not tremendously so, and is definitely worth investigating further for cost-effectiveness [Hoover2003]. COMMENTS (0)

Several companies also make floating solar stills, which are inflatable, plastic, and cone-shaped [LandfallStill], [AquaCone]. This could allow a seastead to use extra solar area, which would be a major advantage. While individual units are quite expensive ($300-$1000 / m^2), we should be able to reduce cost by buying in bulk, constructing larger units, and/or producing them ourselves. Space on the ocean's surface is cheap, but space on our top deck is expensive. Solar stills don't really need to be held safely above the waves by our concrete pillar (except during storms), so deploying them is great if we can manage it. COMMENTS (0)

Multi-Stage Solar Flash Distillation

In flash distillation, the brackish water is not only heated, but exposed to a vacuum to reduce it's boiling point. This causes flash evaporation, leaving a residue of salt. Multiple stages can achieve reasonable freshness. This method is much more efficient than simple solar distillation - the energy required to create the vacuum has more of an effect than if it were used to simply heat the source-water further. As a result, it is used in more than 2,000 desalinization plants worldwide. COMMENTS (0)

Like solar distillation, this method requires a large amount of space to heat the brackish input water, which is a definite disadvantage for a seastead. However if some form of distillation is going to be used, its probably best to use a vacuum (perhaps just through hydrostatic pressure). COMMENTS (0)

Reverse Osmosis

Reverse osmosis uses a semi-permeable membrane as a filter, which can pass water molecules but not contaminants such as salt molecules. It requires continuous pressure, usually from a pump, to operate. One reason R/O is considered undesirable in some environments is that it uses 4-5 times as much water as it produces (the remainder is waste), but since seawater is, shall we say, rather plentiful where we'll be, this is not an issue. One nice feature of R/O is that it uses little space, and the cost is basically constant for a medium-sized system or bigger, so it is cost-effective on our scale. COMMENTS (2)

Seawater R/O systems are more expensive than freshwater, for example the APEC 600 gallon / day (2300 L) system costs $7500 ($3.30/L/day of installed capacity). There are some maintenance costs for filters. The Army Corps of Engineers estimates that in Florida, R/O on seawater has a capital cost of $1.34 - $2.38 / L / day and operation/maintenance costs of $0.01 - $0.015 / L [UNEP1997, Sec. 2.1 Table 5]. Anecdotal reports suggest that R/O machines are not completely reliable, and will require occasional work [Norgrove1983, pp. 117-118]. . COMMENTS (MANY)

The main cost of R/O is the electricity used to power the system. According to the specs for the APEC and for Filtration Systems Dolphin series (800 - 1600 GPD), R/O produces approximately 50-100 L / KWhr of energy. COMMENTS (MANY)

Reverse Osmosis per capita figures:

Water (L/day)	25	100	600
R/O System	$81	$325	$1,950
Power Need (kWhs/day)	0.33	1.33	8
Power System cost	$1,000	$4,000	$24,000
Maintenance/year	$119	$475	$2,850

(Power system costs were estimated using PV panels. Wind turbines will probably be cheaper, but we don't have good numbers). Clearly electricity costs are the dominating factor. R/O costs including electricity are actually pretty similar to a pre-constructed solar still, but much higher than building stills ourselves. However R/O has a significant advantage: installed electricity generating capacity can be used for other things when not needed for R/O. Thus R/O is more flexible than distillation. If the seastead's energy needs or production are erratic, excess capacity can be used to power an R/O system to fill the cistern. COMMENTS (1)

If greywater is available, feeding that to R/O increases efficiency, as reader Doug Jones points out. This is because the unit can operate at lower pressure due to the lower salinity (ie water is closer to pure already). This uses less electricity. COMMENTS (0)

Since we plan for a generating capacity of about 1.4 - 4.1 KWhrs / p / day [Power], production of water by R/O is clearly feasible, energy-wise. Because installed R/O desalinization capacity is cheap, a good approach might be to install a fair amount of it, then run the R/O plant when there is surplus energy or low water supplies. COMMENTS (0)

Water reuse

We can reduce our need to generate fresh water by using what we have multiple times. While drinking requires a fairly pure source, many other applications can use lower grades of water. For example, "grey water" (water used in the home for non-sewage purposes, including dishes, showers, and laundry) can be used for gardening or toilet flushing. With some processing, grey water can be re-used for other non-potable applications. There is a lot of literature from the environmental movement on this subject. COMMENTS (2)

Importation

As with other resources, the feasibility of water importation depends on how far the seastead is from civilization. A coastal seastead could outfit or construct a water-tank barge. The cheapness and ease of rainwater collection, however, makes this an unlikely option. Still, certain configurations of circumstances (little local rainfall, high water use, close to shore) could make it worthwhile. COMMENTS (0)

Other Considerations

Norgrove's major concern was cistern size for riding out droughts - 3 month droughts in the tropics are to be expected, and he says you should have at least 20 m^3/person of cistern capacity to deal with this [Norgrove1983, p. 104-109]. In our case, 3 months supply would be 2,250/9,000/54,000 L/person. However, rainfall is less variable in the ocean [Era40], and we can always shift more of our electricity towards R/O, so this much storage is rather excessive for ouur purposes. COMMENTS (2)

One intriguing possibility is to float a bag of freshwater in the ocean as a cheap, large cistern. This would save space and weight on the main structure. However, water actually doesn't take up that much volume. Also, since water can be produced steadily, large reserves imply that too many resources have been spent on water production. Still, for regions with monsoon/drought patterns, or seasteads which experience such patterns due to their migration path, it might be a useful technique. COMMENTS (1)

A concern that must be dealt with is salt water contamination. As waves crash in the ocean around the seastead, small droplets of ocean water are formed that are blown around by the wind. These small droplets can land on exposed soil and slowly increase the soil salinity. Once the soil becomes too salty, crops will no longer grow. One solution is to do all crop growing in covered greenhouses on the seastead, which has other advantages (reduces evaporation, provides a surface for capturing rainwater). If we use a hydroponic system, there is no soil, and it is normal to change the nutrient water and flush the substrate periodically. COMMENTS (0)

Some chemical treatment (such as chlorine) may be desirable in order to prevent contamination during storage and distribution of potable water. Fortunately, because we are starting with clean water, much lower doses are necessary than with chemical purification. In fact, one nice thing about most of these methods is that they result in clean, drinkable water without the use of heavy-duty chemical treatment. COMMENTS (1)

Conclusion

As you can see, there are several ways we can produce water, and combining them will result in the most robust system. Capturing/producing enough water for drinking and hygiene will be quite easy, except in particularly dry locations. Depending on crop requirements, we may have to go to some extra effort to generate or reclaim water for farming using one of the many methods listed. Large-scale traditional gardening will not be feasible. COMMENTS (7)

Food

When it comes to food it is necessary to decide how self-sufficient the seastead should be. There is a spectrum of choices available from importing everything to producing everything locally. Realistically, seasteads are unlikely to be 100% self-sufficient due to lack of available space, capital, and the fact that people can only stand to eat so much algae. A reasonable goal for an early seastead is to grow its own fruits and vegetables and get some of its protein from aquaculture. COMMENTS (0)

Importation

> *In ancient times, with transport crude, slow, and pricey, most trade involved goods with a high ratio of value to mass...But over the centuries, as transportation grew more cheap and routine, trade in bulky essentials grew practical. Even in the Roman Empire, hauling wheat long distances over water had made economic sense. [Wright2000]*
> COMMENTS (0)

Shipping food is clearly feasible, given how commonplace it is in the modern world. Staples like rice, wheat, and olive oil require a lot of growing area. Yet they are dense, inexpensive to purchase, and easily stored, which makes them ideal to import. So trade is always an option - and will be a necessity if a varied diet is desired on early seasteads. A small community simply cannot produce a large variety of items, so it will be a long time (if ever) before local seastead produce can rival the set of choices available in modern supermarkets. While residents will naturally cut back on imported foods, they'll still want something different on occasion. (This has been true throughout human history). This will be less of an issue on tourism-based seasteads with a mainly transient population. COMMENTS (0)

Another way to look at importing food is to consider the economic idea of comparative advantage, explained by David Ricardo in 1817. He demonstrated that nations prosper most by doing what they are relatively best at. Solar area on a seastead is expensive (we have to build our own land), and agriculture is an industry with a very low income per unit area. So, much like terrestrial cities, seasteads should focus on industries which are not space-intensive. Breakwaters may eventually render new land cheap enough for agriculture, but early spar seasteads are not going to find it cost-effective. There is nothing unique about importing food, so we won't go into detail. COMMENTS (1)

Growing Plants

There is a long history of people supplementing their diet with home grown vegetables. During World War II, these gardens were called `Victory Gardens' and the name has stuck ever since. An excellent guide to home gardening is *Square Foot Gardening* by Mel Bartholomew [Bartholomew1981] (also made into a popular PBS series). This book is notable in that it tries to minimize the amount of time spent in the garden. Most other books seem to focus on gardening as a hobby and tend to soak up as much time as they can get. The goal of square foot gardening is to spend just a few minutes a day on garden maintenance. Its methods claim to produce enough fruits & vegetables for a person in only 4 m^2. COMMENTS (0)

One real advantage that the seastead has when it comes to growing crops is that it is possible to reduce or eliminate weeds and insect pests. This is extremely difficult to do on land, since the weeds and pests are just blown across the property boundary. With a seastead, which is naturally isolated from terrestrial ecologies, care can be taken to minimize the number of insects and weeds that take hold on the seastead. COMMENTS (1)

While some items (fruit or nut trees) may be grown in dirt outside, we expect the majority of farming be done hydroponically in greenhouses. We present some data on how much area per person is required, but unfortunately our numbers are a bit rough. Also, they will depend strongly on the level of self-sufficiency and type of diet desired. COMMENTS (2)

{ Talk about which plants? It matters a little, but enough? } COMMENTS (0)

Greenhouses

We expect seasteads to use greenhouses heavily, since they offer: COMMENTS (0)

- Insulation that keeps the frost out and the warmth in. This allows year-round gardening, and thus more harvests per year. COMMENTS (0)
- Protection from harmful UV radiation (if the correct materials are used). COMMENTS (0)
- An enclosed airspace, which allows the operator to control humidity by venting humid air. This helps prevent fungal infections. COMMENTS (0)
- A barrier against pests. COMMENTS (0)
- Less water use (even with occasional air venting). COMMENTS (0)
- Protection from salty spray. COMMENTS (0)
- Outer skin which can easily be used to collect rainwater. COMMENTS (2)

Hydroponics

Hydroponics is a farming method in which plants are rooted in a liquid nutrient solution, rather than soil. This high-capital, high-yield industry has grown 4-5 fold in the past decade. Hydroponics has a number of advantages over conventional field farming: COMMENTS (0)

- Gasses dissolve more easily in water than soil, so the plants are better aerated. COMMENTS (0)
- Nutrients dissolve better in water also, so the roots can be in a more nutrient rich environment. COMMENTS (0)
- As a result, the plant has smaller, more efficient root systems and can devote more of its energy towards growing the parts we want. COMMENTS (0)
- With smaller roots and a more resource-dense environment, plants can be spaced much more closely, which greatly increases yield per unit area. COMMENTS (0)
- Unused water is reclaimed, rather than draining off into the soil as in conventional gardening. The result is much higher water efficiency. COMMENTS (0)
- Labor associated with soil management (ploughing, turning, etc.) is eliminated. COMMENTS (0)
- Clever methods can further increase yield. For example, using multiple beds, stacked vertically, which continually rotate on a frame so that all the plants get sunlight. One manufacturer claims a 3-17 fold increases over traditional hydroponics yields [AB_Hydro]. COMMENTS (0)

The main concern of a seastead is yield per unit area, and many of the advantages of greenhouses and hydroponics are multiplicative on this quantity. For example, twice as many crops per year and twice as dense crop spacing would together mean a four-fold increase in yield. In practice, a factor of 5-10 times is common [Roselle1996], [Willis1992, Ch. 2]. Yields as much as 100 times higher have been achieved [Willis1992, Ch. 2]. COMMENTS (0)

It is reasonable to wonder whether these numbers are too good to be true. Keep in mind that we are just talking about crops per unit of area. Hydroponics does use other resources, like nutrients and water, more efficiently than conventional gardening, but this factor is much less than the yield/area factor we're focusing on. For example, more crops per year means a better yield, but also more picking time, fertilizer used, etc. Another downside is that the capital costs of hydroponics can be quite high. Since farmland is relatively cheap, hydroponics are usually not worthwhile, even with the advantages listed above. On a seastead, however, solar area will be at a premium, and so a technique which minimizes area use is just what we need. COMMENTS (0)

The figures we found for hydroponics equipment cost varied hugely, from $5/m^2 for simplified home systems in the third world [Bradley2000] to $150/m^2 for commercial first-world operations [AmericanHydroponics, sample costs]. There's a good chance seasteads will be towards the expensive end of this range in order to maximize yield, but experimentation and DIY could bring costs back down. Empirical data gives yields for many hydroponically grown vegetables are of 50-250 g/m^2/day. COMMENTS (1)

It is important to be careful of water-borne diseases, since many plants share the same nutrient solution. For this reason, in most indoor operations, the growing medium is sterilized between crops [Willis1992, Ch. 2]. COMMENTS (0)

Genemod Saltwater Plants

Gardening, even with hydroponics, will use considerable fresh water. Recently, scientists have produced genetically modified tomatoes which can be grown in saltwater. The plants extract salt from the water and store it in their leaves (which offers intriguing possibilities for reclaiming salinated land). The most exciting part is that the plants are made saltwater tolerant by the introduction of a single gene which codes for a protein for dealing with salt. This means mean that many plants could theoretically be modified in the same way. However, the plants are not able to deal with pure seawater. Also, we won't be able to compost the salty leaves. So we save freshwater, but lose some organic material [Zandonella2001]. COMMENTS (0)

Note that GMO plants are unlikely to take over the ocean, since they can't deal with pure saltwater and they need to be immersed in a nutrient-rich medium. In general, they are not adapted for the ocean, which makes them far less likely to spread than GMO's on land. COMMENTS (0)

Seaweed

No seastead diet would be complete without the one "plant" evolved for the ocean environment. Seaweeds are actually a form of algae, and people have been eating them for thousands of years, particularly in the Orient. None are known to be poisonous, although some can cause discomfort. Extracts such as agar and carrageenan are derived from sea plants and used in a large variety of packaged foods. Seaweeds are rich in vitamins, minerals, and protein, and can be used to fertilize other plants. Ironically, the vitamin C in seaweed might have saved early seafarers from scurvy, if only they'd known to scoop it up! [Neumeyer1982, Chapter 6]. COMMENTS (0)

Seaweed can be cultivated by placing fragments on ropes or other substrata and growing them in the ocean. COMMENTS (0)

Spirulina Algae

> *Spirulina has the most remarkable concentration of functional nutrients ever known in any food, plant, grain, or herb. On top of this, spirulina delivers more nutrition per acre than any other fod on the planet. This has extraordinary implications for more efficient and less damaging food production for the future. Every day new research brings to light the wonders (hidden) in microscopic algae.*
> [Spirulina1994, p. 5-6]

While books like *Earth Food Spirulina* can sound a bit over-the-top at times, author Robert Henrikson knows the subject well - he's the president of Earthrise Farms, the largest spirulina farm in the world . Blue-green Spirulina algae, used as food by the Aztecs , is 65% protein by weight, and is a complete protein source. Because it is such a simple life-form, it is much easier to grow and harvest than crops or livestock. Algae waste no growth on inedible parts, and every cell is a seed. Their life-cycle is simple, and they grow at an exponential rate until nutrients are exhausted (doubling biomass every 2-5 days). Spirulina can grow in sea water, and be eaten without any processing. It contains vitamins as well, including A, E, and B12 [Spirulina1994]. COMMENTS (1)

It has been suggested that spirulina provides more nutrition per acre than any other food - and without requiring fertile soil or fresh water. Current production costs in large facilities range from $10-$20 / kilo. Compared to the extravagant conventional methods of obtaining protein from mammals, spirulina provides an incredibly efficient one-step food chain, as can be seen in the table below. COMMENTS (2)

Resource Usage To Produce One Kilogram of Protein:
(Parenthetical italics indicate values relative to Spirulina)

	Land (m^2)	Water (Liters)	Energy (Gigajoules)
Spirulina	0.5-1.0 (non-fertile)	2,500 (brackish)	5.5
Soybeans	16 *(16-32)*	8,860 *(3.5)*	11.7 *(2.1)*
Corn	22 *(22-44)*	12,300 *(4.9)*	5.5 *(1)*
Grain-fed Beef	193 *(193-386)*	104,000 *(42)*	456 *(83)*

Another advantage of spirulina is that it produces oxygen as a positive externality. Unlike some algae, it is not nitrogen-fixing, and so requires a supply of nitrogen (perhaps from an artificial upwelling, such as a wave pump). One intriguing use for spirulina is to concentrate nutrients from seawater so that they can be used to feed more complex life forms. While spirulina thrives in salty and alkaline water, most strains don't grow well in seawater, which has low carbonate and high magnesium and calcium. But special seawater strains are being developed. COMMENTS (1)

Mycoprotein

Fungi are another lower life-form which can be used as a food supply. Protein derived from them is called mycoprotein, and produced by continuous fermentation. It has the advantage of being "chewy", as well as absorbing added flavors and colors. Unfortunately, as reported by the CSPI, there have been many negative health reports about the commercially available mycoprotein [CSPIQuorn]. Medical investigation suggests that individuals with mold allergies may be allergic to mycoprotein as well [Hoff2003]. This problem seems to occur only in a minority of the population, but we advise caution, since serious allergic reactions can be fatal. Still, this is another potential way to grow protein. COMMENTS (0)

Resource Inputs

Resources necessary for food production include water, light, fertilizer, labor, and space. Light is provided by the sun, water by the methods outlined earlier, labor by the residents, and space by the seastead. Fertilizer is a more complicated issue, as this excerpt from an article on space station biosystems demonstrates: COMMENTS (0)

> Previous work on hydroponic systems have shown that nitrogen balance cannot be achieved, especially with systems that involve organic matter (Jewell et al. 1993). Some nitrogen "leaks" from hydroponic systems, most likely as a result of micro anoxic environments where conditions for microbial denitrification are favorable. These conditions include zero dissolved oxygen and the presence of biodegradable organic matter. When these conditions occur many bacteria have the capability to use electrons from oxidized forms of nitrogen [NO_3- (nitrates) and NO_2- (nitrites)] and reduce these valuable plant fertilizers into unavailable nitrogen gas. In sewage treatment hydroponics, between 25 and 50% of nitrogen has been observed to be unaccountably, presumably because of denitrification. COMMENTS (0)
>
> Hydroponic systems that maintain water free of biodegradable organics, high oxygen levels, and low oxidized nitrogen concentrations will discourage loss of nitrogen via denitrification. A conservative design would assume that as much as a quarter of the cycling nitrogen will be converted to nitrogen gas (N_2), or a total mass of 15 g of nitrogen must be transformed from N_2 to organic nitrogen each day in a closed biosystem. COMMENTS (0)
>
> A sustainable system must replace this nitrogen fertilizer loss via nitrogen fixation. Two biological options are available to convert N_2 to organic nitrogen which can be subsequently biologically regenerated as ammonia-nitrogen or nitrate-nitrogen: symbiotic N_2 fixation in legumes and N_2 fixation in blue-green algae. An option that could be used to generate useful biomass with minimal side affects would include symbiotic N_2 fixation using legumes, possibly food producing legumes such as soybeans. COMMENTS (0)
>
> Unfortunately, nitrogen fixation is a highly energy intensive process, and rates are relatively slow. Depending on the length of growing season, documented fixation rates vary from 0.008 to 0.18 g N/m^2 -d. Growing areas to make up a 25% loss would be 83 m 2 to 1,900 m^2 . This nitrogen management plant area could be equal in size to hydroponic food production. It will be assumed that no human food results from the nitrogen fixing hydroponics. COMMENTS (1)
>
> A summary overview of the closed biosystem for one adult is shown in Figure 5. Total plant growth area is 290 m^2. [Jessell2001, pp 9-10]

Fortunately, we don't need to manage our nitrogen balance quite as carefully as a space station. For instance, we can purchase nitrates produced on land using the Haber-Bosch process. Those seasteads which seek completely sustainable farming, however, must keep this problem in mind. Composting and similar closed-cycle techniques can reduce the amount of new fertilizer needed. Composting is covered in both *Building for Self-Sufficiency* and *Square Foot Gardening*. There may eventually be clever methods of extracting fertilizer from the ocean (artificial upwelling, concentrating nutrients with algae, etc.). But until then, even with these techniques, some fertilizer will need to be imported. COMMENTS (1)

Artificially lighting a greenhouse to produce a longer growing day takes about 50 - 175 W / m^2 of power [MBR, Ch. 5], [Andrew1994]. At 20m^2/person, this would be 1 - 3.5 kW / hr. So 12 hrs/day, 365 days/year of lighting would use 4-15 mWhrs/person/year, which is significantly more energy than is required for personal use. Since power onboard a seastead is expected to be expensive, this will probably not be worthwhile. For example, using photovoltaic panels for this purpose would be absurd, since they'd take up around 10x as much space as the plants they were providing electricity to light! Still, it is possible that special factors (excess power, cheaper power generation, trade embargo) could change this. COMMENTS (1)

There are some other ways we might increase grow area. Mirrors or other sunlight collection devices could be used to gather sun from a larger area than the platform, lighting a second deck. Another possible solution would be to make small rafts or barges as auxiliary grow areas. They would be constructed cheaply, only able to withstand typical non-storm seas, and deployed around the stead. They would be sized so that in foul weather they could be hoisted up under the stead for protection. Fresh water could be piped to the units, or integrated solar distillers used. COMMENTS (3)

Raising Animals

There are several ways we may be able to supplement the production of our gardens, such as fishing, aquaculture, and raising farm animals. COMMENTS (0)

Fishing

Fishing is heavily regulated inside EEZ's, so it may be problematic. Also, a seastead can't just zoom around looking for fish like boats do. However, seasteads may find fishing economical if they are in locations where the stock has not been depleted by commercial farmers. This could even make for a profitable seastead business [Market-Fishing Base]. COMMENTS (6)

Aquaculture

Aquaculture, the process of raising ocean foodstuffs, is the maritime equivalent of ranching. This practice has a long history: Chinese manuscripts indicate that fish culture has been practiced there since at least the 5th century BC, and the Romans raised oysters. The list of animals that have been raised commercially starts with Abalone, Amberjack, Anchovy, and continues on for another 100 species [WorldAquaculture]. COMMENTS (0)

Unlike the commercial fishing industry, which is slowly succumbing to the exhaustion of its commons, aquaculture systems offer long-term promise. This is true whether you look at it from the environmentalist's perspective of increased sustainability, or the economist's viewpoint of more clearly defined property rights. Given the incredible impact of the agricultural revolution, we can't help but speculate that the movement from hunting wild fish to farming domesticated ones will also produce major gains in efficiency and worldwide food production. COMMENTS (0)

Saltwater plants dovetail nicely with aquaculture because the waste products of fish can be used to fertilize plants. This system is called Aquaponics. For example, on Carl Hodges' experimental farm, shrimp grow in saltwater, then tilapia, and then the water is used to nourish a saltwater plant called Saliconia (used for vegetable oil) [Hinman1996]. **{CENG: prev par unclosed}**

Aquaculture is roughly divided into intensive and extensive. Intensive is more complex, as it involves creating an artificial environment in which to raise the product. Extensive can be as simple as "fencing" off a section of ocean with nets, and raising some fish inside it. By choosing species which feed on the natural detritus of the ocean such as algae, no food supply is needed. While this tends to be a low-density, slow-growth method, its also low-effort and uses renewable resources. N55's SMALL FISHFARM is an example of a simple design [N55BOOK, pp. 167-176]. COMMENTS (0)

Farm Animals

Raising a small number of dairy animals will probably be worthwhile, such as chickens (for eggs) and cows (for milk). Chickens run about 8 to the square meter [SpaceSettlements, Ch. 5], although growing their feed will use area as well. Chickens, cattle, rabbits, and similar animals can be grown for meat, producing edible portions of about 1/5th to 1/10th of the mass they consume [SpaceSettlements, App. C]. Unless a cheap food source like algae can be fed to animals, importation is probably a better way to get meat. COMMENTS (1)

Area Requirements

{ more numbers would be great here, if anyone has them } COMMENTS (0)

Numbers in the literature on the area required for self-sufficient food production vary widely. This is not surprising, since the environments discussed are very different. Meat takes much more space than vegetables and starches, and a complete diet takes much more space than supplementary fruit, vegetables, and dairy. Conventional, open-field agriculture uses a lot more room than hydroponics on a space station. COMMENTS (0)

We think the latter is more relevant to us than the former. Common sense tells us that when a resource is scarce, people find ways to use less of it. Farmland is much cheaper than seastead deck space, so we will use the latter more efficiently. We'll have to use more of other resources to do this of course - if there was a way to use less space with no cost, it would already by part of standard practice. But while we aren't getting something for nothing, we can be pretty sure that our yield per unit area will be higher than on land. One advantage we have compared to space stations is that we can draw from the resources of the ocean, including fish, seaweed, and nutrients, as well as importing from the outside world. COMMENTS (0)

A representative land-based figure is the Biosphere II project, which attempted to be a completely closed ecosystem. They grew 80% of their food on 253 m^2/person, which would mean 316 m^2/person for self-sufficiency. COMMENTS (MANY)

Food requirements are about 3.1kg [Shipman1989], and 2000-3000 cal per person per day. A NASA project on space station design says that about 15-50 m^2 of solar area are necessary to provide a standard North American diet with high-yield techniques [SpaceSettlements, Ch. 3 and App. C]. This includes cattle and chicken raised for meat, which are area-intensive. On the other hand some of their numbers strike us as a bit optimistic. A different space station study suggests that all area required for complete self-sufficiency, including waste / water recycling, food self-sufficiency, and nitrogen balance, is 290 m^2/p [Jewell2001]. COMMENTS (0)

Sailing the Farm, a book about self-sufficient boating, implied that using a cabin for food production (5-10 m^2) could make a substantial contribution to the sailor's diet. As mentioned earlier, *Square Foot Gardening* states that only 4 m^2 / p are necessary for fresh vegetables. COMMENTS (0)

Based on these figures, complete self-sufficiency would require about 50-300 m^2 / p, which is not practical at current cost estimates. However, a substantial amount of food (vegetables, fruit, dairy) can be grown in only 5-20 m^2 / p. Fishing, aquaculture and dense imported foods (grain, cheese, meat) will round out the seastead diet. Vegetarian tendencies and a willingness to eat unusual things like algae will shift seasteads farther towards self-sufficiency. COMMENTS (0)

Power

{ Efficient refrigerators and freezers are available, and if they are heavily insulated, refrigeration can be maintained by running the cooler for an hour a day, about a 4% duty cycle [Norgrove1983, pp. 126-127]. } COMMENTS (0)

{ heat water with solar: norgrove, pp. 119-120 }

Our seastead is going to need power, both for personal use and to support its infrastructure (food production, water purification, transportation). OTEC no good. COMMENTS (2)

There are other workable alternatives that are both less capital intensive and more technologically mature, such as solar power, wind power, and wave power. (Nuclear power is yet another alternative, but it is extremely capital intensive and politically difficult; in terms of seasteading, nuclear power makes OTEC technology look easy.) Basically all of the alternative power sources have one problem in common -- the power is intermittent. Solar power does not work at night, wind power does not work when the winds are calm, and wave power does not work when the seas are calm. The best solution to this problem is twofold: collect and store excess energy for times when power generation is not available, and use multiple energy scavenging technologies to smooth out the availability curve. COMMENTS (7)

Energy Storage

For now, the most mature technology for storing energy appears to be electrochemical batteries. While they are expensive, the alternatives (flywheels, ultracapacitors, redox batteries, creating hydrogen to power fuel cells) are generally still experimental. However, redox batteries are rapidly approaching usefulness. COMMENTS (2)

Electrochemical Batteries

Batteries are one of the most expensive parts of an electrical system. They don't store much energy per unit weight, and they don't last through many charge cycles: COMMENTS (2)

"Batteries have always been an expensive and troublesome part of off-the-grid systems. Consider that a typical 6-volt storage battery has a gross capacity of 200 Amp-hours, equivalent to about 1 kWh of chemical energy, and costs nearly $100. Thus, batteries cost about $100/kWhr of gross capacity, not counting shipping costs.

And shipping heavy batteries is costly. Moreover, not much more than 50 percent of the energy stored in a battery can be withdrawn without sulfating the plates and reducing its effectiveness. Batteries also have a limited lifetime. The [Folkecenter for Renewable Energy](#) estimates that batteries are good for about 2,000 cycles. (Batteries are still useable after 2,000 cycles, but they have reduced capacity.) If a battery discharges 50 percent of its gross capacity through 2,000 cycles, it will deliver about 1,000 kWh of net electrical energy over its operating lifetime. Thus battery storage alone costs more than $0.10 per net kWh of useable energy in an off-the-grid system." [Gipe1999] COMMENTS (1)

Ten cents / kWhr is around what power from the grid costs - and this is for battery storage alone! Because of this, we want to match up power supply with demand so that we need to store as little energy as possible. It will help to have needs with flexible timing, such as refrigeration or running reverse osmosis systems. These can be run whenever we're generating excess power. When other storage technologies become more reliable, they should be investigated. While batteries have their disadvantages, they are mature and robust and their cost is high but not prohibitive. COMMENTS (0)

Vanadium Redox Batteries

The current forerunner to replace conventional batteries is the Vanadium Redox Battery developed by Professor Maria Skyllas-Kazacos and her team at the University of New South Wales, Australia [UNSW-VRB]. A redox battery consists of two chemical solutions which produce an electric potential when combined. When originally developed, they had the problem that the used combination of chemicals was toxic, caustic, and useless. The solution was to use a proton exchange membrane, like a fuel cell, to utilize the electrical potential without allowing the fluids to mix. Unfortunately, even with these membranes, some cross-contamination occurs. COMMENTS (0)

The UNSW researches came up with a clever solution: using the same chemical for both halves of the cell, but in different electric states. Now cross-contamination just causes energy loss, not damage to the solution. Vanadium dissolved in sulfuric acid was the answer, although it took some effort to create a solution with a high enough concentration of vanadium to get a decent energy density. The advantages over conventional batteries include: COMMENTS (2)

- Storage capacity limited only by tank size and amount of vanadium solution. So you can increase capacity just by getting more tanks and fluid. COMMENTS (0)
- Number of charge/recharge cycles is theoretically infinite. In practice at least 16,000 (much higher than batteries). COMMENTS (0)
- Energy storage and extraction are separate, so the capacity of either can be increased without affecting the other. COMMENTS (5)
- Shelf life is indefinite, and energy does not leak during storage (unlike batteries, flywheels, capacitors...) COMMENTS (2)
- High efficiency (80%-90%) because redox couples are electrochemically reversible. COMMENTS (0)
- Fast charging, can be fully discharged with no adverse effects. COMMENTS (0)
- Can be recharged by transferring fluid, as with gasoline engines, except the fluid is rechargeable. So, for example, if the seastead and its boats both used this technology, the boats could be refueled by pumping in new fluid, instead of slowly charging conventional batteries. COMMENTS (0)

VRB has been used in actual, large-scale applications since about 1997 - its not just theoretical. This includes a 450 kW / 1MWhr VRB system at the Kansai Electric Power Plant in Japan and a 25 Kw system used to store power from the wind power generator of Hokkaido Electric Power Co. It seems quite likely that the home power market will adopt VRB's when they become commercially available. The fuel cell will cost about $200-$500 per kilowatt and the electrolyte about $40-$60 per kilowatt-hour. The fuel cell membrane will last around 8-10 years, and the electrolyte can be re-used indefinitely [Skyllas2004]. COMMENTS (1)

Hydrides

As described elsewhere, a seastead may wish to store hydrogen for use in cooking. Unfortunately, hydrogen in gas or liquid form is difficult to store. The liquid must be cooled to -423 degrees, and the gas must be compressed to very high pressures or you don't get much energy density. Being a small element, hydrogen is hard to contain. An interesting alternative is to store hydrogen energy in solid or liquid hydrides, which release hydrogen gas when combined with water. COMMENTS (2)

Since water is rather common, solids such as sodium hydride are quite dangerous in their natural form. Hence the invention of Powerballs - small pellets that are coated in plastic. The plastic is waterproof, so the hydride won't react accidentally. But simply cutting a ball when it is immersed in water produces large amounts of hydrogen. The energy density is about 6 times higher than compressed hydrogen gas at 3000 psi. The reaction's waste product is sodium hydroxide (NaOH). New powerballs can be created simply by heating the NaOH to create NaH, pelletizing it, and coating it in plastic [Powerball]. COMMENTS (1)

Another option is a liquid hydride such as sodium borohydride (NaBH4). Since it only produces hydrogen in the presence of a catalyst, it is even safer and less likely to produce a runaway reaction. The reaction product, as with sodium hydride, can be used to re-generate the fuel. Millenium Cell is producing these systems and they are starting to be adopted in fuel-cell powered concept cars such as the PSA Peugeot Citroen and the Chrysler Town & Country Natrium [MilleniumCell]. COMMENTS (0)

The main issue for seasteaders is what facilities are necessary to re-generate these fuels. If large manufacturing plants are needed to create hydrides cost-effectively, they aren't good methods of energy storage. But if we can get a reasonably priced black box that takes energy and spent fuel and creates charged fuel, these might be good ways to store hydrogen. The technology is still a little too cutting edge for early seasteads. COMMENTS (0)

Flywheels

Flywheels have gotten to the point where a few commercial models are available. However, they really don't store very much power compared to batteries, nowhere near enough to function as the reserve for a renewable energy system. Also, the seastead is a constantly moving environment (albeit a slow one), and unless the flywheel is on a very expensive mounting system, this movement will drain the stored rotational energy. Finally, since the seastead is not rigidly connected to the earth, spinning up a single flywheel would make us spin in the opposite direction! This could be fixed by using two flywheels with opposite spins, but it makes for an amusing mental image. COMMENTS (6)

Supercapacitors

The new generation of supercapacitors feature significantly higher performance, and are moving rapidly towards being useful for power systems. Michio Okamura and JEOL have developed these nanogate-based supercapacitors, which have much higher current densities and lower leakage than traditional caps. They are used in a hybrid truck by Nissan Diesel Motor and a fuel-cell passenger car from Honda, both introduced in 2002. Capacitors have the advantage of unlimited charge/discharge cycles within their ~10-year lifetime. They can also discharge very rapidly (hence their use in automobiles). COMMENTS (MANY)

However, capacitors cannot yet replace batteries because they don't store very much energy - only 1-10 Wh/kg (compare to lead-acid batteries 30 and NiCads 50). Also they leak over long periods of time. Currently they are best used in power systems to smooth out loads by acting as an energy buffer. Batteries keep them charged, and the caps handle energy spikes. While maintaining them takes extra energy, remember that the big problem with batteries is the limited number of charge/discharge cycles. This technique reduces the amount of cycling and can greatly increase battery lifetime [JETRO-Cap]. COMMENTS (1)

Gravity Battery

There is another energy storage system that has a slim chance of being useful. That is pumping sea water up to a tank on top during the day, and running it down to the ocean during the night. Power companies use such systems to even the load on the power grid. (They pump water uphill during the night they run when power demand is low, and run it down during the afternoon when power demand is high.) However, we have serious doubts about the viability of this system for a seastead for several reasons. One is that it will make the structure more topheavy, which is bad for stability. COMMENTS (1)

Hydrogen

While hydrogen has its advantages for cooking, storing large amounts of it is impractical. It requires either a lot of storage space, or high pressure systems which are quite expensive. COMMENTS (4)

How much do we need?

To calculate energy costs and design a seastead, we need an estimate of how much power we are going to use. As with other resources, we expect to be much thriftier than on land, so there is some guesswork involved in estimating the numbers. According to the California Energy Commission the average household in california uses 6.5MWHrs/year [CEC_Solar]. A typical California Bay Area household uses 3.6 - 5.5 MWhrs/year [Yarris1994]. Chris Marnay's solar-powered house, which uses energy-efficient technology such as flourescent lighting, uses 2-3 KWhrs/day for 2 people, which is 0.5 MWhrs/p/yr [Yarris1994]. Other solar-powered homes use 1-2 MWhrs/p/ yr. COMMENTS (4)

There are many ways to economize on a seastead. Appliances will be energy efficient. The large concrete bulk of many seastead designs will act as insulation and a heat sink, moderating temperatures (which tend to be moderate on the ocean anyway). Water can be heated by the sun, and air conditioning can be done by pumping cold seawater up. Based on this, and the numbers above, we estimate energy usage on a seastead to be in the range of 0.5 - 2 MWHrs / p / year. This is 1.4 to 5.5 KWhrs / p / day. COMMENTS (1)

How much can we make?

There are a number of energy generation technologies, and creative minds can come up with many more fascinating and speculative ideas. The authors certainly have a few they'd like to experiment with. However, as usual, for initial seasteads we want to stick with mature options, which limits the possibilities. COMMENTS (0)

Solar Power

There are an endless variety of ways to use solar energy - photovoltaic, solar heating, solar dynamic, etc. For electricity, we will focus on photovoltaic power, as it is the most mature. We'll also briefly discuss some other ways to use sunlight. COMMENTS (0)

Photovoltaic Power

Photovoltaic (i.e. solar cells) technology was originally developed to supply power to satellites in outer space, a remote and hostile environment. It transforms sunlight directly into electricity. Currently, photovoltaic power can make economic sense for remote areas that do not have a connection to the electric power grid (like seasteading.) There is now a large body of practical experience with photovoltaic power that we can apply. The reference we used was *The New Solar Electric Home* by Joel Davidson [Davidson1987]; there are many other appropriate alternative books on the subject. COMMENTS (2)

Photovoltaics have a number of disadvantages: COMMENTS (0)

Cost
: Photovoltaic panels are expensive. They keep coming down in price, but they are still not cheap.

Efficiency
: Even the most efficient photovoltaic cells have only recently started to achieve conversion efficiencies over 30% and these are horrendously expensive. The commercially available solar panels have conversion efficiencies in the 8-15% range. This relatively low energy conversion efficiency means you need more solar panels covering more area to achieve the desired level of power generation.

Battery Storage Required
: Since the sun does not shine at night, there is no power coming in from the solar panels then. So it is necessary to collect additional energy during the day and store it for night time use. The most sorage method is to use a bank of batteries. The batteries are expensive and this increases costs.

Solar Area
: Unlike other forms of power generation (wind, waves, generators), PV panels take solar area away from other needs such as greenhouses. This is especially bad because they use the sunlight which falls on them so inefficiently.

Despite these disadvantages, they have a proven track record for remote power generation, and have a place in a well-rounded power generation system for seasteads. Typical insolation is 1 KW/m^2, but only 13% of this is captured. There are about 1,750-2200 hours/year of full usable sunlight (at least on land - might be a little higher on the ocean with the low horizon). This gives about 0.25 $MWhrs/m^2/yr$. The average PV system costs about $10,000/kW [RingEco] of installed capacity. Using that 1750-2250 number again, we see that a kW generates around 2 MWHrs/year. So PV systems are about $5,000/person, and around $2,000 for a kWhr per day. COMMENTS (0)

Direct Solar

One thing you might have noticed when reading about PV is just how inefficient it is at converting sunlight to electricity (about 13%). This is especially annoying because it is so expensive. For this reason, its usually better (when possible) to use sunlight directly. This makes life more complicated than just doing everything with electricity, but in an environment of limited energy resources, its still a win. COMMENTS (1)

There's no clever way to run your computer directly from sunlight without using electricity. But a large portion of home power usage is for heating: both spaces and water. As anyone who has walked across pavement in bare feet on a sunny day knows, all you have to do to turn something into a sunlight-to-heat conversion device is paint it black. Even simple solar water heaters are about 30% efficient, and cheap compared to PV panels. More complex designs are more efficient. COMMENTS (0)

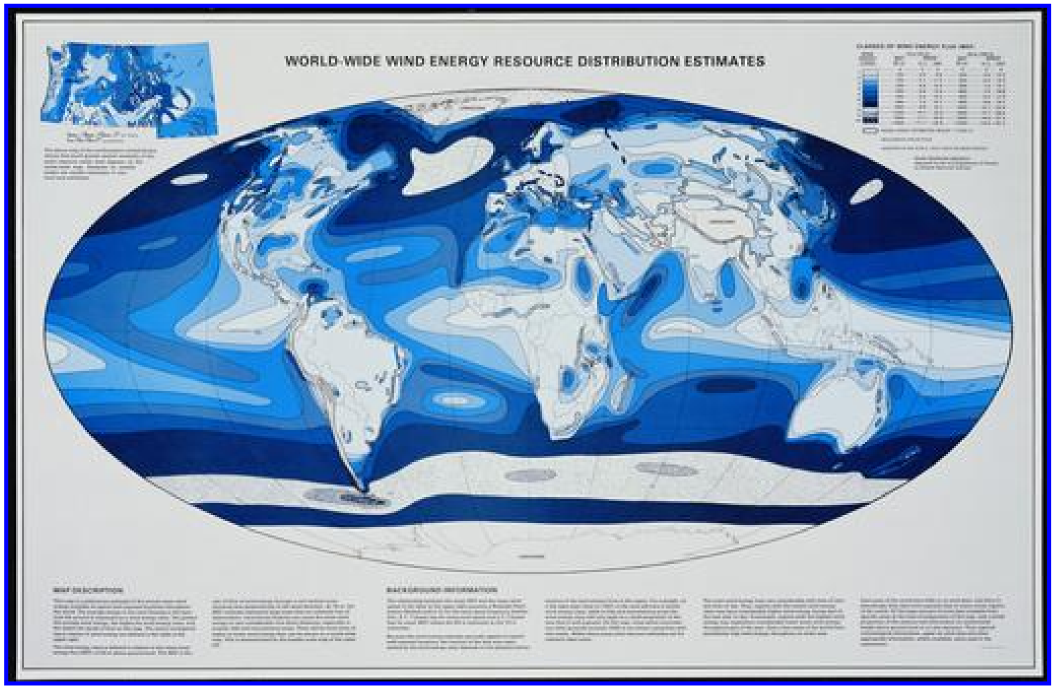
There are many other applications of direct solar, such as water distillation, space heating, laundry and dish drying. Its unclear just how many we'll use, since it depends on the energy available from other sources, how much money is available to spend on power systems, and so forth. Space heating, water heating and distillation are the main applications that we think will be commonly used. COMMENTS (0)

Wind Power

Like solar power, wind power is a fairly mature technology that has been around for quite a while. The references we used for wind power were *Harnessing the Wind for Home Energy* by Dermot McGuigan [McGuigan1978]; and Wind Power Basics [Gipe1999]. As with photovoltaics, there are numerous appropriate alternative books on the subject. Again, most of these books start out with a statement of the form 'we are running out of energy' that should be discounted. COMMENTS (0)

Wind power has two major advantage over photovoltaic generation. The first is 24-hour a day power extraction is possible. While there are times when the wind dies down, seasteads will likely spend much of their time in places where the "trade winds" blow continuously. Wind energy rises as the cube of wind velocity, so a steadier wind at the same average velocity provides significantly less energy than a variable wind. However, there are big benefits to consistent winds, such as reduced dependence on costly storage systems. The second is that raised wind turbines have essentially zero footprint and will not reduce top-deck area, which is needed for food production. Winds are stronger the higher you go above flat terrain, which is great for our seasteads that tower above the ocean. Experiments have shown that to raise a turbine from 18m to 30m increases power by 25%. COMMENTS (0)

International Wind Energy Map

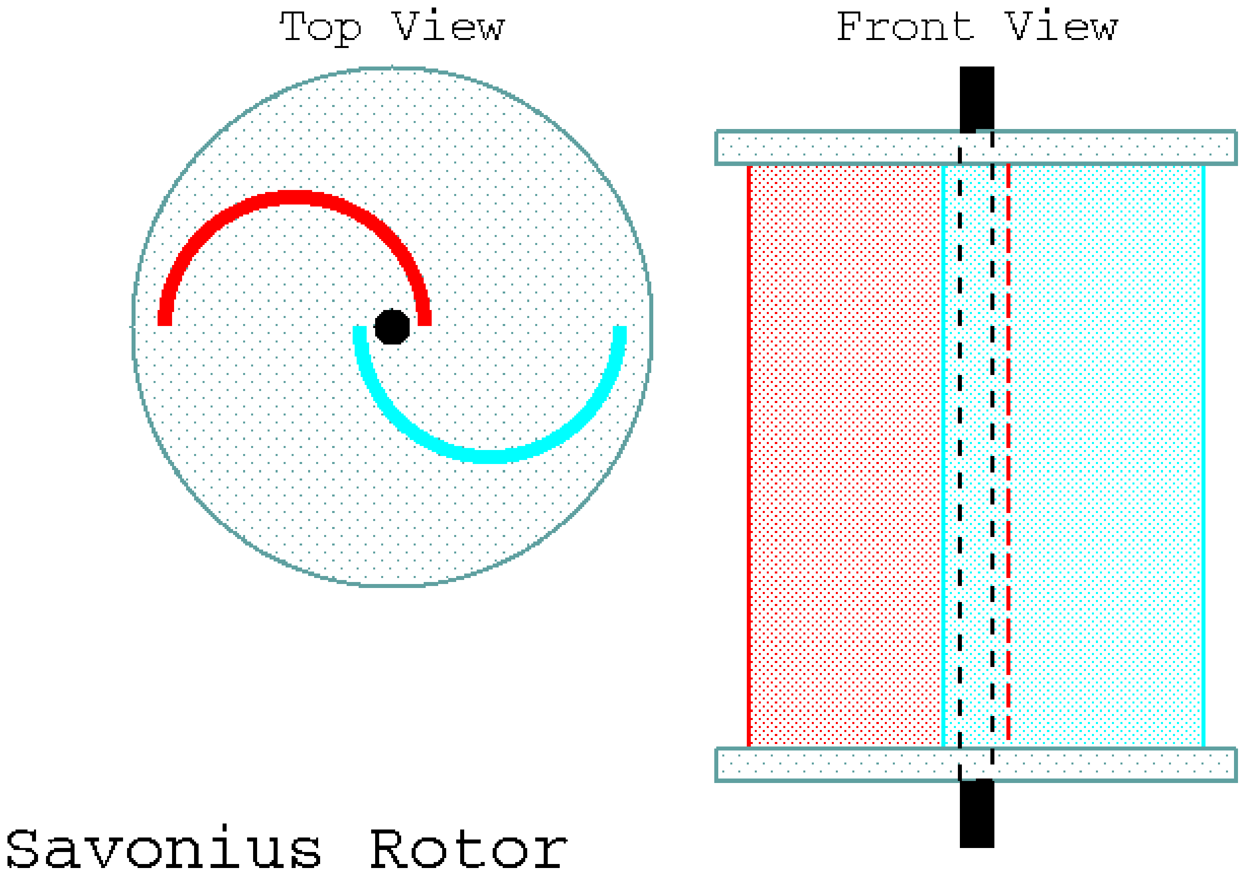


(Map prepared by NREL, click for larger image)

Wind turbines can be a bit loud, and elevating them out of the way involves guy wires - more difficult on a small seastead platform than land. Another disadvantage is that some of the wind's energy pushes the seastead. Some experiments will need to be performed with wind power to figure out how severe the wind pushing problem is. Fortunately wind and current directions are not usually parallel (trade winds are perpendicular), otherwise we would lose further velocity because drifting with the current would reduce the apparent wind velocity. Given the large size of a seastead and the small area likely to be used for wind turbines, this pushing should not be much of a problem. COMMENTS (0)

{There is tons of data on wind speed available from the NOAA's NDBC data buoys. We can get data from there and estimate how much power is available.} The energy produced by wind turbines depend a great deal on wind velocity (because of the cube law), thus it is difficult to estimate how much power will be produced without knowing the details of local conditions. It looks like to generate 1 MWhr/year, we need about a 600 watt turbine. Small wind systems seem to cost around $3K / Kw, so that's $1800 / person. A large system for a decent sized seastead might be only half that price. Wind power has higher maintenance costs than solar, ie (for large power operators) 1.5 cents/KWhr, which is $14/p/ yr for us. COMMENTS (1)

The seastead is free to use any form of turbine; they all work with varying degrees of efficiency. One design with interesting DIY possibilities is the Savonius rotor, sometimes referred to as an oil drum rotor. A cross section of a Savonius rotor, which consists of two half-cylinders, is shown below: COMMENTS (0)



The Savonius rotor is a very inefficient design, which means more weight to be lofted. However, it also looks like its very easy to fabricate, since many Savonius rotors are manufactured out of old oil drums. Cut off the top and bottom, chop it in half, weld two of the edges together, and you have a rotor. Ultimately, what matters is not wind mill efficiency, but cost times efficiency. If cost is sufficiently low, additional power is obtained by simply erecting additional wind mills. Conveniently, Savonius rotors can be stacked on top of one another. COMMENTS (2)

Fuel-Powered Generator

Renewable energy generators are great for self-sufficiency and long time-horizons. Once a seastead has installed enough PV panels and wind turbines, it does not need to import energy. However, renewable methods have some disadvantages. They are currently pretty expensive, they can't produce big spikes of power for occasional high demand, and they don't generate power constantly. Generators, which burn fuel to create electricity, address all of these issues. They can be run at any time, are cheap to operate, produce a lot of energy, and fuel (unlike a battery) is a dense form of energy storage with an excellent shelf life. COMMENTS (3)

In general, fuel-powered generators seem best suited as a backup power source. For major power needs (welding) and during windless nights with calm seas, there will be little choice but to fire them up or do without. However, there are some specialized groups that may depend solely on generators, and others that will avoid them entirely. Low-budget seasteaders may want electricity, yet not be able to afford to buy renewable equipment with its long payback period. Seasteaders with particularly low transportation costs or low local renewable energy levels may also wish to stick with generators. On the other hand, environmentally-minded groups who don't like generating greenhouse gasses might avoid them all together. COMMENTS (1)

Burning diesel or biodiesel in a conventional generator is extremely price-effective. At $1.40/gal in the US, and about 12 kWhs produced per gallon of diesel, electricity generated from diesel costs $0.12/kWh in fuel. Biodiesel can be cheaper if a free source of used vegetable oil is found. Maintenance costs are very low ($0.004 - $0.010 / kWh) [Kozlowski2002]. Transportation costs are the major unknown variable. Bulk container shipping rates would have essentially no impact on the cost per kWhr, but until seasteads are major container ports, shipping to them will be a lot more expensive. COMMENTS (3)

We should note that these figures don't count all the energy produced as heat from the generator. This heat can be recaptured from the exhaust gauses through air-water heat exchangers and used for water and space heating. When heat as well as electricity is useful, generators become even more cost-effective. COMMENTS (0)

Generators are pretty cheap per installed kilowatt. For example, the Kubota GL6500S diesel engine produces 6Kw for $4300. That's 144 KWhrs/day, or about $30/KWhr/day of installed generating capacity. At 3 KWhrs/person/day, that would be $90/person of installed generating capacity. Not bad at all, and the price will be even lower for larger units. COMMENTS (0)

While generators aren't the only place we'll use fuel, this is a good place to discuss what's available. COMMENTS (0)

Gasoline

Gasoline should never be used on a seastead unless absolutely necessary. It is volatile, evaporating at temperatures above -45 ° Celsius (its "flash point"). This means that at normal earth temperatuers, it is constantly emitting flammable vapor, which is quite dangerous. Its also extremely toxic, as its decay products are benzene and a bunch of other nasty chemicals. COMMENTS (0)

Diesel

Diesel is a much mellower fuel, only vaporizing at temperatures above +50 ° Celsius, which are unlikely to be found in a seastead. The higher a fuel's flash point, the safer it is to store and handle. Diesel engines have a much simpler design, thus they require much less service and are more durable. Their exhaust also has many fewer toxic emissions than gasoline. They are much more efficient at turning fuel into electricity. Diesel engines are more expensive, but they are well worth it. COMMENTS (1)

Biodiesel is harder to find internationally than diesel. It burns more cleanly, and is easy to make from vegetable oil. It has an even higher flash point than normal diesel. It is possible that a seastead could buy large amounts of used vegetable oil cheaply and make biodiesel for less than conventional diesel. Growing it is not likely to be practical due to surface area limitations. COMMENTS (3)

Hydrogen

Hydrogen is a simple form of stored fuel, and quite safe (despite popular misconceptions). The bright flames from the Hindenburg zeppelin came from the lacquered covering, as most of the hydrogen escaped and did not burn [APS2000]. Hydrogen is lighter than air and disperses easily, so it does not accumulate in enclosed spaces. It is non-toxic and its combustion produces only water vapor as a byproduct. It is completely renewable, since we can make it from water via electrolysis, although this process currently has an efficiency of only 66% or so. COMMENTS (1)

We can store small amounts of hydrogen gas fairly easily, although large amounts must be stored at high pressures, which is more difficult. An interesting alternative is to use solid or liquid hydrides as described in Energy Storage. While hydrogen can be burned in generators to create electricity, it is not the best battery for an electricial system because of the storage difficulties and inefficiencies. Where hydrogen shines is for very energy-intensive tasks such as cooking. Appliances designed for natural gas and propane, which are inexpensive and widely available, can be easily modified to use hydrogen. And unlike natural gas and propane, we can make hyddrogen ourselves. COMMENTS (0)

Propane

Propane is a cheap fuel, even if imported. We may well use it for coaststead. It can be used for cooking, heating, or even to run refrigeration units. There are two problems with propane. First it is heavier than air and will sink into the spar or other confined space, which is extremely dangerous, although precautions can be taken to reduce this risk. This is why most boats do not use propane. Second, it has to be imported, and thus reduces our self-sufficiency. Despite these, it may be the right fuel for coaststead because of its wide availability. COMMENTS (0)

Wave Power

Waves can be looked at as a very concentrated form of wind power (which is in itself a modified form of solar power). Its advantages include: COMMENTS (0)

- Waves have about 1000 times the kinetic energy of wind, so smaller devices can produce more power. COMMENTS (0)
- The ocean is rarely in a dead calm (while even the trade winds die down in the morning and night). COMMENTS (0)
- Extracting the power is quieter than wind turbines. COMMENTS (0)

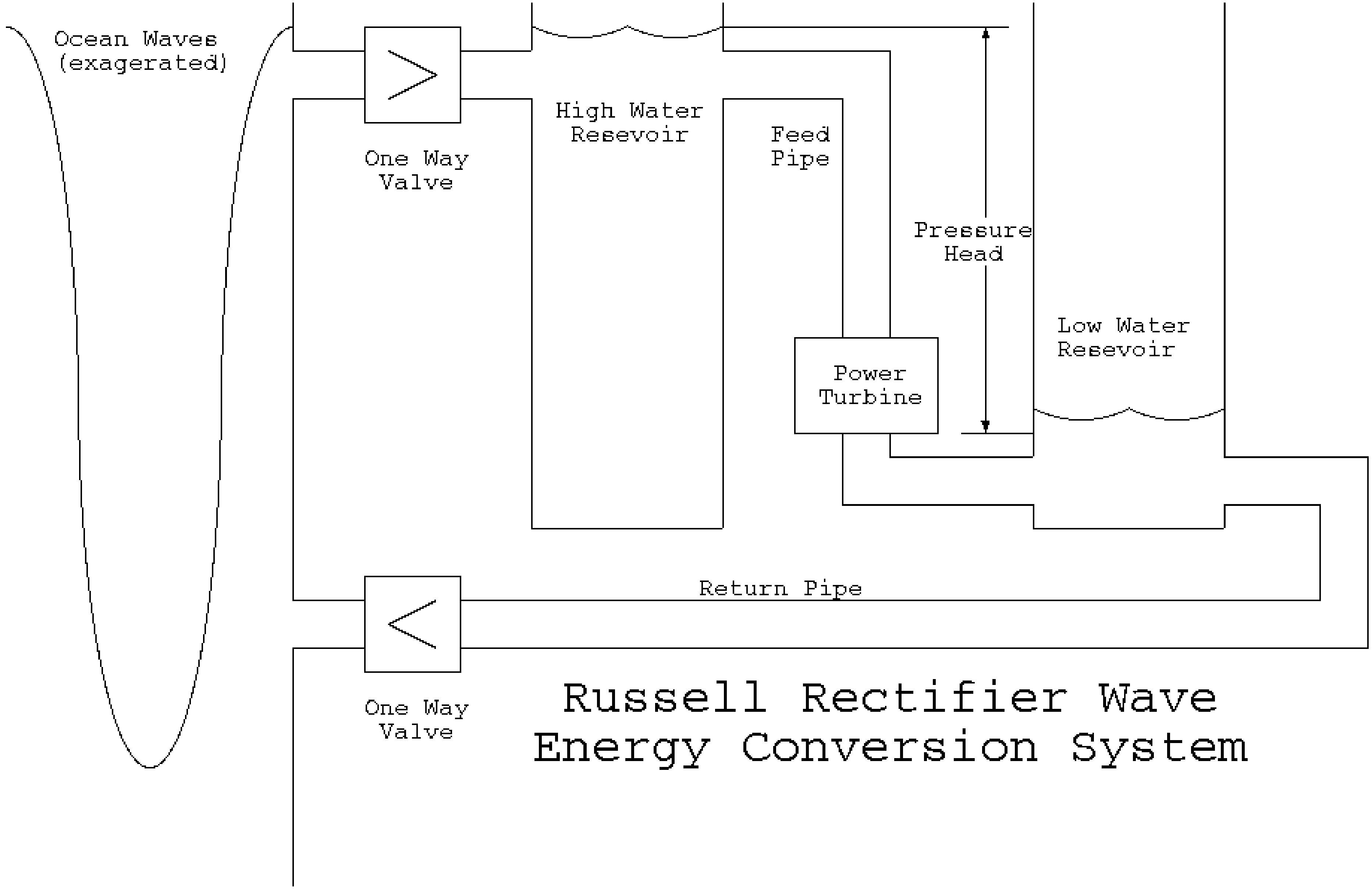
There are disadvantages as well. Despite rarely ceasing completely, waves are much more variable than wind

- available energy seems to depend on the 5th power of wind speed [WA_Wave] (while wind energy only depends on the 3rd power). Being an immature technology, wave energy is currently more expensive than other methods like burning fossil fuels - at least for conventional locations. In the ocean, this may not be the case (further research will be necessary). COMMENTS (0)

There are literally hundreds of different ways of extracting energy from the waves. As one example, an Australian renewable energy company called Energetech has developed a system which uses a parabolic wall to focus wave energy. At the focus of the parabola is an oscillating water column chamber, where the water rises and falls at several times the wave amplitude (due to focusing). This water movement causes air movement past a turbine, which is computer-controlled to optimize energy conversion. A 500 MWh/yr installation will begin running in the summer of 2005 off the coast of Australia, and a similar installation will begin operating in 2006 in Rhode Island [Energetech]. COMMENTS (0)

Many of these methods are coast-based, mooring-based, or capital intensive, which stems naturally from their origin in government-funded research. Still, there are a few which are probably suitable for a seastead. For one thing, we may be able to adapt systems which need to be moored to the seafloor by mooring them to our flotation chamber. It will resist vertical motion, which is what these devices require. However, this adds extra stresses to the structure, so we'll present two other options. COMMENTS (0)

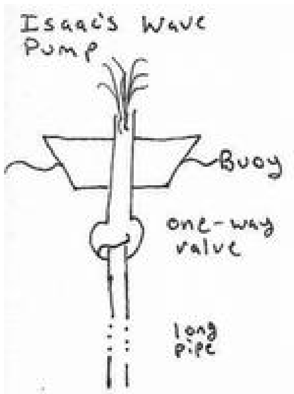
Russell Rectifier



This device is described in *Ocean Wave Energy Conversion* by Michael McCormick [McCormick1981, pp. 110-117]. If you have had any experience with electronic circuitry, the Russell rectifier is the hydraulic equivalent of a two diode electronic rectification circuit. An input is placed at the height of the wave crests, and is constantly fed by them. An output is placed at the height of the wave troughs, and spills water into them. In between, the pressure head formed drives a turbine. While this is not particularly efficient, the Russell rectifier looks like it will be quite inexpensive to construct. It consists of a couple of simple reservoirs, some piping, some one way valves and a low pressure water turbine.

Wave Pump

Our favorite system for DIY power in deep ocean is the Isaac's (or Scripps-FOR) Wave Pump. It was invented by a professor at the Scripps Oceanographic Institute in San Diego named John Isaacs, whose constant stream of ideas was rumored to have nourished the entire institution. The design is elegant and well suited to a seastead as it contains only three basic elements: a buoy, a one-way valve, and a long pipe.



Middle: Wave pump testing off La Jolla, CA produces a stream 4m in light seas (photo S. Suess). Right: US Marine helicopter assisting wave pump deployment off Kaneohe Bay, Hawaii (photo US Navy). From [Behrman1992, picture section], pictures © 1992 American Geophysical Union, Reproduced by permission of American Geophysical Union

As a wave crest lifts the buoy, the pressure of the water in the pipe closes the valve. The result is that the slug of water inside the pipe is lifted along with the pipe and buoy. When the buoy reaches the top of the wave and begins descending into a trough, the water keeps going, opening the flapper valve and squirting out the top of the apparatus. Power is proportional to the volume of the water being lifted, which means that a longer pipe gives more energy. In essence, the pump acts to amplify the wave head, with a gain dependent on its length. A pressure reservoir is added to smooth out the flow, and a hydroelectric turbine to transform the pressure into electricity [Behrman1992].

The wave pump has only been tested on the ocean a few times, most notably at Kaneohe Bay in Hawaii [Wick1977]. While it has pumped plenty of water, it has not yet been demonstrated to be practical for electricity generation. Still, it is quite scaleable, has a small footprint, and uses few parts. Additionally, as a side effect of generating power it creates an upwelling which brings nutrient-rich water to the surface. In fact, it has proposed that it may be worth building a wave pump for this reason alone [Avery1992]. This method seems almost too good to be true (and perhaps it is). Part of the reason may be that it functions best in deep water, and bringing power back to land is expensive. One downside of the pump is that it must be able to survive large storms. COMMENTS (2)

The pump has some extra advantages compared to other wave power systems. As reader Kirk points out, it provides cool water, which can be used for air conditioning, for condensing fresh water from greenhouse hair, and any other cooling needs. The longer the pipe, the cooler the water, and the more electricity, so there will be some "economies of length". COMMENTS (0)

We think there's a good chance that wave power will become the primary source of seastead energy. However, at the beginning we want to minimize novelty and experimentation. PV panels, wind turbines, and diesel generators are much easier to buy, set up, use, and maintain. We are not aware of any small-scale, commercially available wave-powered generators which don't require mooring or coastlines (although we'd love to hear of one!). So we think wave power is best postponed until it can be researched from a functioning seastead (perhaps the baystead prototype). Still, this concentrated form of energy may well be an important part of making larger conglomerations and industrial areas feasible. COMMENTS (4)

Fuel From Crops

Another potential way to get energy is to grow crops, either for vegetable oil (which can be converted to biodiesel), or for sugar, which can be fermented and then distilled to yield alcohol. Hydroponic potatoes have high yields and are rich in starch. Biodiesel has the great advantage that it can be used with existing diesel generators and motors. However, these processes are quite inefficient, and are best left to land where area is cheap. COMMENTS (0)

An alternate possibility is to use algae. As with Spirulina for protein production, algae waste much less resources in producing their output. NREL estimates that algae can produce 15,000 gallons/acre/year of biodiesel [UNHBiodiesel]. Again, even if algae are more efficient, such land-intensive industries are best suited to where land is cheap. However, it is worth noting that while conventional terra firma is expensive on the ocean, terra aqua {?aqua firma?} is cheap and plentiful. If algae can be farmed on the ocean's surface, the comparative disdvantage of seasteads becomes a comparative advantage, and this could prove a profitable industry. COMMENTS (0)

Until such technologies are developed, we suspect that initial seasteads will need their limited growing space for food, and that other forms of energy generation will prove more useful. A seastead is much more likely to import fuel than to grow it. COMMENTS (0)

OTEC

{Patri} COMMENTS (5)

Several potential ventures [Savage1992, Celestopea, Nexus] have planned to use a technology called Ocean Thermal Electric Conversion to obtain power. This method uses the temperature differential between the warm water at the ocean's surface and the cool water in its depths. Energy can theoretically be derived from any such temperature difference. There are numerous advantages to OTEC technology -- it works night and day, it brings nutrient rich water to the surface, and it produces fresh water as a side effect of its operation. The amount of energy available for these plants to tap is staggering. Unfortunately, it has serious problems too COMMENTS (0)

Because it takes a large temperature difference to obtain much energy, pipes must reach deep below the ocean's surface. Continuously pumping fluid through these pipes uses up so much energy that only a large OTEC plant can generate a net positive amount of power. A working OTEC plant for a floating city would cost at least tens of millions, possibly over a hundred million dollars. The technology does not scale down, and so its just not suited for the small communities which we must start out by building. Additionally, OTEC is a new and unproven technology. Only a few plants have been made, generally funded by governments for research purposes [NREL-OTEC]. Even though private companies are working on more efficient designs, they are still very expensive [SeaSolar]. COMMENTS (1)

Power Conclusion

What happens if you have a bunch of cloudy low wind days (i. e. reduced solar, wind and wave power?) Well, you either put up with the power failure (i.e. break out the candles) or you fire up your fossil fuel backup generator; these are the exact same options that most people on land face when their power grid power fails. An integrated system of photovoltaic, wind, and wave power with battery storage and a fossil fuel generator should provide a very high level of power availability to the seastead. Such an integrated system should still cost substantially less than an OTEC system and have the advantage of maturity. COMMENTS (5)

??? If not, we will probably have uneven power availability. During the day and during windly periods of time will be when we run the appliances that need the heavy juice. During energy shortages, we'll just back off and use what we've got for critical stuff.

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Last modified: Mon Nov 14 23:23:21 PST 2005

Seasteading: Additional Infrastructure

Additional Infrastructure

Government

{This section is brand new, and thus rough}

A government is the social infrastructure for a nation. Since one of the main purposes of seasteading is to allow people to experiment with novel forms of social organization, we can't exactly list all the possibilities. Residents can try whatever floats their boat. Instead, we'll try to focus on the unique aspects of seasteading which will affect the design and function of its government. These include: COMMENTS (MANY)

- Small, isolated community. COMMENTS (MANY)
- More homogenous opinions - since the population is small and self-selected, they may be united behind some philosophy. COMMENTS (MANY)
- Autonomy. COMMENTS (7)
- Built from scratch. COMMENTS (MANY)
- Dynamic geography. COMMENTS (5)

The most consistent result of these factors is simply that we can expect a great variety of forms of governance.

For example, homogeneity of viewpoints allows for more extreme or experimental systems that a diverse group would never agree to. Environmentalists could adopt strict regulations on the emission of greenhouse gases. Libertarians could have an extremely minimal government. Religions could enshrine their beliefs as law. Because the group is like-minded, they can agree to these unusual policies. COMMENTS (5)

Having the autonomy to pick a new system has the same effect. No longer are residents bound by some previous constitution. Same with the "from scratch" nature of seasteads. Since each new platform is potentially a sovereign entity, each new set of residents, if they want, can design an entirely new system. The thesis of dynamic geography points the same way. Having a lower barrier to entry in the governance market will result in a much greater variety of products. COMMENTS (MANY)

The rest of the world may see these systems as strange or idealistic. But as long as residents joined voluntarily and are free to leave, we say more power to them. Time will separate the foolish from the innovative. COMMENTS (6)

As the number of platforms and multi-platform cities grows, we can expect competitive pressure to improve the quality of government at all levels. Good ideas will be imitated and bad ones discarded, since new residents will be more attracted to systems that have proven effective. COMMENTS (7)

The government of multi-platform communities is likely to be much more limited than that of individual platforms. It will tend to focus on intra-platform issues such as infrastructure, easements, local pollution, legal arbitration between different legal systems, and interactions with the outside world. If it grows more intrusive than individual platforms desire, they'll break off and start a new group. COMMENTS (8)

Because initial communities will be small, they will not be able to afford many full-time personnel. This means that many public-sector jobs such as militia, police, emergency response (first aid) will be done as secondary professions by members of the community. This encourages a community of peers, rather than one which supports a special class of public servants. COMMENTS (MANY)

{ Talk about who owns the seastead? ie residents equally, residents inequally, some development company, etc. Proprietary community, democratic community, CIC...} COMMENTS (5)

Transportation

{ I'm not sure of the best title for this, Transportation is pithy but its about staying still as well as moving. Its really more about "location control", but thats kinda awkward.} COMMENTS (5)

Is the seastead a boat or an island? COMMENTS (5)

If its an island, then it should be attached to the ocean floor to prevent it from moving around.

Since the ocean floor is typically miles from the ocean surface, this is actually quite challenging. Seamounts and shallower areas present less difficulty, but using them greatly reduces the number of potential locations. COMMENTS (4)

Our preference is to treat the seastead as a boat. For one thing, this means that all of the international law that applies to boats can be applied to a seastead. In addition, the seastead may be able to avoid bad weather (by season at least, even if its not nimble enough to dodge individual storms). Also when supplies are low, the seastead can find a port and resupply itself. COMMENTS (MANY)

Once the first few mobile seasteads have been deployed, they can aggregate by simply rendezvousing at a agreed upon location and lashing together into one bigger sea village. Over time the sea communities will evolve to sea cities. Whenever someone becomes annoyed with the current state of a seastead community, it is possible to just disconnect and take their seastead someplace else. COMMENTS (5)

Staying Still

Mooring equipment is very expensive, especially the lines. Unfortunately the lines limit what depth water one can anchor in. For example, a set of High Molecular Density Poly Ethelyne (HMDPE) lines for anchoring in 2500m of water costs approximately six million dollars - without the attachment hardware or anchors. These and other synthetic lines are the only real acceptable solution for deep water anchorages, as braided steel lines are too heavy and can corrode. In shallower water, however, the lines become proportionally cheaper. COMMENTS (5)

The anchors themselves are fairly simple suction devices, basically a hollow tube with a cap on one end and a pump in /pump out valve. You drop the anchor to the bottom, pump out all the water, and it sucks itself into the sea floor. To retrieve the anchor you pump it full of water and it pops out of the sea floor. The sea floor for the most part is covered with about 50' of sludge and muck which actually makes for a pretty good hold. COMMENTS (4)

Because of the high cost of lines, potential anchoring locations are limited to areas of relatively shallow water, such as seas and coastal areas. In the deep ocean, seasteads will just have to drift, unless they anchor on a convenient seamount. Still, an anchoring system will be quite useful and is likely to be one method for location control. COMMENTS (5)

An other alternative for station-keeping is to have steerable propellers connected to a GPS (Global Positioning System). The system would push the the seastead to its desired location whenever it starts to drift off location. However, this would continually use fuel, so is most likely to be feasible when drifting forces are quite low. COMMENTS (6)

Newton's first law of motion tells us that a seastead will happily sit still unless external forces act on it. The main external force moving a seastead is the action of ocean currents. This suggests an additional strategy for keeping still, which is to go someplace where there is not much current. The equatorial doldrums are one such place. Another is the center of the circular current gyres, where millions of tons of trash has accumulated [NaturalHistory2003]. This "do-nothing" strategy has the wonderful advantage of being cheap. However it had best be accompanied by a plan to deal with the possibility of being pushed around by an unexpected storm or current. COMMENTS (MANY)

Moving

Powered Movement

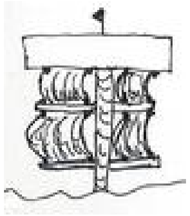
The submerged flotation gives seasteads a lot of drag. However, friction from drag is proportional to velocity **squared**, so as long as we move slowly its still manageable. Renewable energy could be used to directly power a propeller. For example, simple vertical-axis wind turbines could be connected directly to propellers, or the up-and-down motion of waves could be converted to rotation. Or we can use our standard methods of electricity generation to power electric trolling motors. These methods will appeal to the environmentally conscious, since they do not require burning fossil fuels, and may even prove to be cost-efficient. However, they are unlikely to generate much speed. COMMENTS (5)

The simplest method is probably for a separate, diesel-fueld tugboat to pull the platform. Used tugs can be had for anywhere from $50K to millions [Tassins Marine Transportation], depending on their age and the power of their motors. One advantage of a tug is that it could be used to lug barges of supplies back and forth when the seastead doesn't need pulling. Diesel engines could also be built into the structure. A powered seastead could potentially be connected to an unpowered one and used as a tug itself. COMMENTS (MANY)

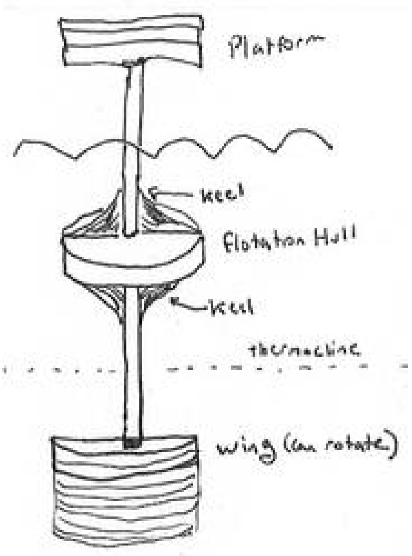
Active propulsion will clearly work for small course adjustments, or occasional location changes. It is unclear whether it will be feasible to use continuously. Even though our speed is slow, we are moving a large object, and currents will constantly be pushing us. So relying on active propulsion will add to the operating expenses of a seastead, as well as reducing its self-sufficiency due to the huge energy drain. Under the tourist business model, however, it may be practical. Cruise ships move around constantly, at fairly high speeds, and are profitable while doing so. A more permanent population, however, has less reason to move and more reason to cut daily expenses. COMMENTS (6)

Unpowered Movement

The easiest method of unpowered movement is drifting. This is not so disastrous as you might think, because ocean currents are roughly circular, as can be seen in the currents section. With some fine-tuning, a seastead could be pulled by them forever, circling towards a pole and then back to the equator. Moving radially will change the cycle's period, which may be desirable to avoid seasonal storms. Active propulsion can be used to transition between current formations. A Deep-Seastead could potentially enjoy endless summer by switching hemispheres twice a year when the current brought it close to the equator. Another option is to go someplace like the equatorial doldrums where there is little current, and drifting basically means staying still. COMMENTS (5)



Sails are an interesting propulsion option. They could be deployed in the space below the platform and above the waves, with the spar itself acting as a mast. A keel would of course be necessary, perhaps by making the submerged flotation oblong in shape. Because water is much denser than air, it takes a high ratio of sail area to wetted area to propel a boat. Seasteads have a lot of wetted area, so they'd need a lot of sail. Large sails are quite expensive, movement would be slow, and a square-rigged seastead would be unable to head much into the wind. The fact that the wind is a powerful sustainable energy source may turn out to compensate for these disadvantages, or it may prove to be an impractical option. COMMENTS (6)



An even more interesting and difficult idea, suggested by Corwyn, is to use a submerged wing to "sail" the ocean currents. Wings work by converting the flow of a fluid into sideways motion via Bernoulli's principle. Sails are one example of this, using air as the fluid. Water is also a fluid, and hydrofoils use this to lift their hulls out of the water with force from submerged wings. COMMENTS (5)

Because fluid must flow past the wing, one uniform current would not be enough. The seastead would drift with it, and the water would appear still. In order to sail, we need a varying current, so that we can use the differences to generate motion in other directions. Fortunately, it is not uncommon for the currents at the very surface of the ocean to be different than deeper currents. The thermocline, a region of rapid temperature change, is usually 10-200m down, and it seperates the surface "mixed layer" from deeper waters. Currents are often different above and below the thermocline. COMMENTS (6)

There are substantial problems with this method, of course. Current differences are likely to be small and variable, thus imparting little speed and requiring re-adjustment of the angle of the wing. Transmitting the forces along masts long enough to reach into regions of varying current is difficult as well. It may not be feasible. However, there is a certain elegance to this method of propulsion, and it would be truly magnificent for a seastead to sail, not drift, in the ocean's currents. COMMENTS (7)

There and back again

Besides moving around the entire seastead, we'll need various methods of bringing people and goods there and back again. Obviously the size of this cargo stream depends on how much the seastead is importing (its self-sufficiency), how much it is exporting to the world, and the size of its tourist industry. If the seastead is functioning as a resort, it is crucial to have good ways of getting passengers there and back again. The closer to land, of course, the cheaper this transportation will be. There are two basic methods of moving over water: COMMENTS (6)

Floating

The slowest and cheapest method is floating, whether on a sailboat, rowboat, motorboat, or experimental rocket-powered hydrofoil. Boats typically have speeds of around 10-30 knots. Thus a seastead just outside the 12 or 24 n.m. territorial water limit could be reached in 0.5 - 2 hours. Getting to a seastead outside the 200 n.m. EEZ would take around 10 hours. More distant seasteads would require days of travel. COMMENTS (6)

For the renewable energy advocates, there is an appropriate boat propulsion technology which is extremely mature, namely sails. The backup diesel motor can be replaced with an electrical motor. Several manufacturers already make electric boats, though they tend to be small, and it is not difficult to convert existing boats [ElectricBoats]. Still, the juice has to come from somewhere, and it does take a fair amount of energy to travel long distances. COMMENTS (5)

Boats have a number of advantages. They are relatively inexpensive to operate, and reasonably quick for short distances. They can take many people or a large amount of cargo. However, riding in them becomes rather unpleasant when the weather is bad, and sometimes even dangerous. For long distances, they are a bit slow. Boats are the clear choice for cargo, and for transporting passengers over short distances. In good weather, for passengers who don't mind a slow trip, they are suitable for longer distances as well. COMMENTS (MANY)

As we mention when discussing the dock, transferring cargo between a ship and seastead may be a dicey proposition. Solving this problem will be a big factor in whether we can ship goods to a seastead, which is a big factor in how much it costs to import and export goods. COMMENTS (6)

Flying

More distant seasteads may wish to fly people in and out using planes or helicopters. A several hundred mile trip would only take an hour or two of flight time, and even a seastead in the middle of the ocean should be reachable in half a day or less. While this method is much quicker, its also more expensive and requires more infrastructure. Seaplanes can land on the ocean, but only in very calm or protected waters. Regular planes require a long runway. Helicopters only need a small landing deck, however they are more expensive and dangerous than airplanes. COMMENTS (MANY)

There are special STOL (Short Takeoff and Landing) airplanes which need less runway length (as short as a couple hundred feet). Our initial Seastead Lite design is large enough for one of these. However, STOL planes tend to have relatively low cruising speeds (120mph) and low passenger capacity (a few people). This makes it difficult to use these planes to transport resort visitors, unless the distance is short enough to allow many trips per day. Helicopters may be superior to STOL aircraft for this reason - the same amount of area as an STOL runway could be used to land many helicopters. COMMENTS (4)

Groups of multiple seasteads make longer runways possible, at which point planes are an excellent option. Groups large enough to have a breakwater can have seaplanes land in their harbor, or have long runways. Before then, either helicopters or STOL aircraft can serve to transport passengers willing to pay extra for a quick ride, as well as for medical emergencies. Seasteads with protected waters can be serviced by seaplanes. Individual seasteads, far from land, without protected waters, will have to use expensive helicopters if they want to move many people. COMMENTS (4)

Summary

Early, smaller steads will probably be towed into place and anchored, as that is the cheapest and simplest technology. Deepseasteads will likely use a combination of these methods, spending some time at anchor, some time drifting, and occasionally using active propulsion. They may also try being set adrift in the doldrums. COMMENTS (4)

Shelter

{Wayne & Andy} COMMENTS (MANY)

There is not much that we would like to say about shelter. The shelter can be as simple as a tent or as complicated as a multilevel house. For small initial prototypes, an option is to simply get some sort of inexpensive RV (recreational vehical) trailer and simply park it on one end of the seastead. An RV trailer provides sleeping accomedations, a small kitchen, a small bathroom, a place hang out, etc Since most RV trailers already have separate grey and black water tanks, it sould be very easy to integrate the trailer into the fresh water management system. COMMENTS (6)

Homes in the US average 55 m^2 per resident, while in Europe the average is 30 m^2 [Chandler, p. 121]. In Beijing, China, it is only 3.3 m^2 per capita [Silvertown, p. 55]. The US has an additional 21 m^2 per capita of support space (offices, schools, restaraunts, warehouses, etc.) [StatsUS1988, tables 1237-1239]. As with other resources, space is more expensive on a seastead and will be conserved, allowing less usage than on land. A NASA study on space settlements suggested 67 m^2 of footprint and 1738 m^2 of volume [SpaceSettlements, Ch. 3]. While their budget is higher, their self-sufficiency requirements are higher also, and ocean provides us extra space for some uses. COMMENTS (6)

The seastead's shelter will, of course, need to be strong enough to handle the worst storms which may occur in the areas it is expected to travel. COMMENTS (5)

Communications

The presence of internet on a seastead will make a substantial difference in what sort of people it appeals to and how long they are willing to stay there. A connected seastead will be much more attractive as a permanent residence to the techie crowd. While there are people who don't mind being out of contact (and some who see it as a plus), there is a growing population who don't consider themselves isolated if they can get online. COMMENTS (5)

This makes the economic situation easier because the seastead can export technical expertise. Working professionals will be able to visit more frequently and stay longer if they can still keep in touch with the office. This also helps the seastead make the transition from vacation home to permanent residence for its inhabitants. Note that with enough bandwidth, voice-over-IP can be used to make telephone calls, thus solving another communications problem (although it may be a little annoying with satellite lag). COMMENTS (6)

Seasteads which are close to land can use point-to-point links of various kinds, such as microwaves. While there are some minor issues, it will be much cheaper to get significant bandwidth, and have much less lag, than satellites. This is another advantage of being close to civilization. Laying cable is incredibly expensive and unlikely to be feasible for quite awhile. However, there is already cable laid to connect many island nations. It might be possible for a seastead to anchor over a junction and connect there. COMMENTS (5)

The most general and widely applicable way to have internet in the middle of nowhere is with satellites. The technology is currently evolving rapidly, so by the time seasteads are built it is likely to be more advanced than it is now. Some points: COMMENTS (5)

- If the seastead is moving, its satellite dish needs to be mounted on a tracking system to compensate. Fortunately it will be moving pretty slowly and such systems already exist. COMMENTS (4)
- KVH TracNet is a commercial system which costs $6000 and allows mobile marine access to the DirecPC system. It tracks and is gyrostabilized, and supports speeds of 400Kbps down / 56 Kbps up. TracNet covers the carribbean, meditteranean, and near-shore areas around North America, South America, and Europe (coverage map). COMMENTS (5)
- There are quite a few satellite internet providers. The old-style ones, who started out selling phone service, are prohibitively expensive for anything other than email, ie inmarsat, Iridium, and Globalstar are $1-$2 / min for a 5-10Kbps connection or a phone call (!). COMMENTS (5)

- The new internet-oriented services are much more reasonably priced, but they are mostly intended for land-based use, mainly in the continental US. COMMENTS (MANY)
  - Starband (which covers the eastern half of the pacific, as well as the caribbean) is ~$70/mo for 150-500Kbps (I think the uplink is much slower). Their customer service claims they "cannot be configured to work outside the 50 US states", but this is probably false. COMMENTS (4)
  - DirecPC is $50-$100/mo for 400/56. COMMENTS (6)
  - DirecWay is $100/mo for 400/128, or $500/mo for ~20 users each getting 128/400. COMMENTS (1)
  - Tachyon service is $600 - $2000/mo for 800/128 (2GB/mo) (up/down) to 1544/256 (10GB/month). While they are only renting two satellite transponders right now, they plan to slowly and steadily increase their coverage. COMMENTS (3)
- Techniques such as web proxies with a document cache on the seastead can reduce the bandwidth used. COMMENTS (4)
- When the cost is split among the many residents of the seastead, a high-quality service such as Tachyon could still be affordable. COMMENTS (5)
- While most of these providers don't explicitly support marine applications, it will be worthwhile for a seastead to put significant effort into customizing them if necessary, for example by mounting the dish on a base which automatically tracks the target satellite. COMMENTS (3)
- This is a rapidly improving technology, so by the time seasteads are built it is likely to be cheaper, higher bandwidth, and more widely available. For example, 36Mhz transponder equivalent use for internet traffic increased by an order of magnitude from 1/98 to 4/01(!). COMMENTS (4)
- Coaststeads and steads in the carribbean will have the easiest time of it, since they will be in range of the land-oriented satellite services, (ie DirecWay coverage map). COMMENTS (5)
- A downside of satellites is high lag, or length of time it takes for a signal to travel. Realtime applications like gaming, or even using a shell on an off-site computer, suffer from this. Its important to recognize that satellite is not a magic bullet. Lag is high because satellites are in geosynchronous orbit. That means they are high enough that they orbit at the same speed as the earth, which keeps them over the same point on the earth's surface. This is convenient because one satellite can serve one region, but it takes a quarter second for a signal to get up and back. One possible solution is to use a network of satellites in Low Earth Orbit. These have less lag, but because they move, it takes many satellites to provide continuous coverage, which is incredibly expensive. So far the ventures which have tried this have mostly gone bankrupt (Iridium, Teledesic), but it is likely to happen eventually. COMMENTS (MANY)

Defense

Without the protection of a large government, defense is obviously a necessary concern. Let's consider the possible opponents a seastead might face in battle. They basically fall into two categories - pirates and navies. COMMENTS (8)

Against Pirates

As described in the piracy section , most pirate attacks are either very small-scale, preying on unarmed ships, or very large-scale, with organized groups stealing entire cargo ships. A seastead will be too tough for small pirates and not financially worthwhile for big ones. Conventional, readily-available weapons such as large-caliber rifles and machine guns should be sufficient for defense. Because of its platform structure, a seastead is an easily defended against hand weapons, and being a huge mass of concrete it will be quite tough. A few gun emplacements on the underside of the platform would make it a hellish place to attack with a boarding party carrying small arms. (Although these emplacements might be a bad idea by making the seastead seem more warlike to nearby nations - we must always keep these political factors in mind). COMMENTS (5)

Against Navies

Unfortunately, a seastead will still be quite vulnerable to larger weapons. Concrete is tough but far from indestructable, and a fight against the other kind of opponent, a serious military force, would be hopeless. The central column could be blown up, and the top deck's solar panels and greenhouses make a juicy air target. A seastead cannot easily be made strong enough to withstand naval guns, torpedoes, or missile fire, and it cannot afford guns large enough to have a range advantage on enemies. Slow movement makes it a sitting duck. A real warship could sit at a distance and barrage it with impunity. Since these new nations will start small, their potential military budget is many orders of magnitude lower than current nations. COMMENTS (5)

Even if a seastead cannot win, it is still worth considering the value of defense as a deterrent. The more damage a seastead can do to its attackers, even while fighting a losing battle, the less likely it is to be attacked. Additionally, because of the private, competitive, and small nature of seastead government, it is likely that defense money will be spent efficiently. As Bob Murphy points out, we won't be paying $600 for a toilet seat, so it may well be possible to find cost-effective defensive deterrents [Murphy]. For example, sea-skimming anti-ship cruise missiles like the Chinese Silkworm are fairly cheap and quite effective. And a rocket engineer in New Zealand has set out to prove that you can build a small cruise missile for $5,000, thanks to the decreasing cost of many of the important components [Simpson]. COMMENTS (8)

Prevention, Not Cure

As independent and sometimes macho individuals, it can be difficult to admit miliatary inferiority. But since there is little a seastead can do to stop a real navy, they shouldn't spend too much money to try. Seasteads should focus on the ounce of prevention rather than the pound of cure. Other than the ability to damage the attacking force through defensive deterrents, most prevention is political rather than military. Avoid angering terrestrial nations enough to provoke an attack. Be redundant - build many floating cities in many places. Be willing to compromise some freedoms in order to maintain others. Be useful. If you supply advanced medical technology to government officials, its less likely someone will blow you up. COMMENTS (MANY)

The economic and military inferiority of seasteads may only be temporary. As a sea-city gets larger, it is more likely to anger existing nations, and it will be more economically feasible to spend money on defense. Perhaps, over time, seasteads will become large and rich enough to join the ranks of dangerous nations. But its going to be awhile. COMMENTS (6)

Waste Disposal

Disposing of trash is yet another area which requires special consideration onboard a seastead. Since storage volume is limited, landfills and dumps are not viable options. As astronauts have discovered, trash takes up a lot of room. Mir generated a ton of trash per month [SpaceTodayFactoids], and Skylab had around 1/3 its volume set aside for waste collection and storage [SkylabFirst, Ch. 2]. COMMENTS (2)

Because improperly handling trash imposes costs on others, waste disposal is a political issue as well as an engineering one. This magnifies its importance. Strange though it may seem to ruminate about rubbish, we see this smelly segment as being worth at least as much consideration as food, power, or water. COMMENTS (5)

There are a number of different disposal methods, which we'll go into in some detail. However, we should not forget avoidance and recycling as methods for reducing waste. The heirarchy of solid waste disposal is "Avoidance -> Recycling -> Energy Recovery -> Landfilling", as described in this environmental engineering book: COMMENTS (3)

> *The best option is to avoid creation of the waste material. Obviously, we cannot eliminate the generation of solid waste. However, there is ample opportunity to significantly reduce the amount of waste created...The second best option is to recycle unwanted materials rather than disposing of them...The next option is to use the waste materials for energy recovery by use of a solid waste incinerator that produces usable energy. Landfilling is the least desirable option...*
> [Ray1995, p. 348]

Lets take a look at some kinds of waste: COMMENTS (3)

Types of Waste

{ Check sources for correctness and better descriptions. Is a DL the right structure to use here? It looks kinda funny. - P } COMMENTS (3)

Organic Waste

Inedible vegetable material like stems, leaves, and seeds, which still contain organic nutrients. COMMENTS (4)

Human Waste

Humanure contains nutrients, but since it can contain pathogens it requires treatment to be safe. COMMENTS (5)

Hazardous Waste

Toxic chemicals and biohazards need to be dealt with carefully. COMMENTS (4)

Recyclables

Glass, plastic, metal, or anything else that can be recycled effectively. Limited recycling may be done onboard, with the remainder sold to land-based operations. COMMENTS (5)

Misc. Waste

Trash which does not fit into the above categories. Combustible miscellaneous waste may be useful for generating heat. COMMENTS (4)

As you can see, waste may contain positive, negative, or neutral value. For example, organic waste contains fertilizing nutrients we can use to grow food. The hazardous waste contains toxic substances which we should not let into the environment to harm others. The miscellaneous waste we just want to get rid of. Because of these differences, the best solution is to use several disposal methods in tandem. COMMENTS (6)

The table below contains detailed data on the composition of municipal american waste in the 1960's. While this will likely be different than the composition of waste on a seastead, its a start. There is also some less detailed data on municipal solid waste in 1990. COMMENTS (4)

Composition of waste

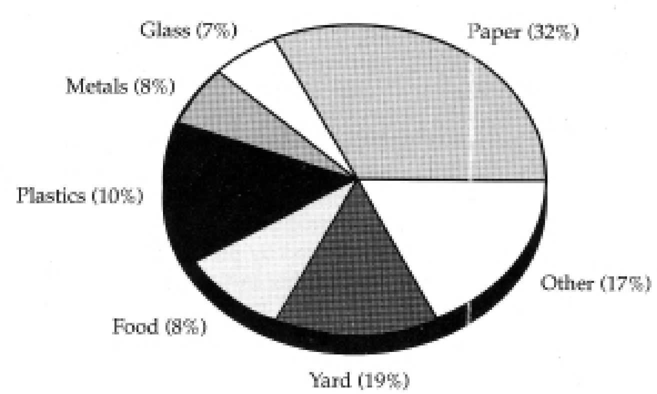
Table 1–3 Composition and Analysis of an Average Municipal Refuse from Studies Made by Purdue University[a]

Component	Percent of All Refuse by Weight	Moisture (percent by weight)	Analysis (percent dry weight): Volatile Matter	Carbon	Hydrogen	Oxygen	Nitrogen	Sulfur	Noncombustibles[b]	Calorific Value (Btu/lb)
Rubbish, 64%										
Paper	42.0	10.2	84.6	43.4	5.8	44.3	0.3	0.20	6.0	7572
Wood	2.4	20.0	84.9	50.5	6.0	42.4	0.2	0.05	1.0	8613
Grass	4.0	65.0	—	43.3	6.0	41.7	2.2	0.05	6.8	7693
Brush	1.5	40.0	—	42.5	5.9	41.2	2.0	0.05	8.3	7900
Greens	1.5	62.0	70.3	40.3	5.6	39.0	2.0	0.05	13.0	7077
Leaves	5.0	50.0	—	40.5	6.0	45.1	0.2	0.05	8.2	7096
Leather	0.3	10.0	76.2	60.0	8.0	11.5	10.0	0.40	10.1	8850
Rubber	0.6	1.2	85.0	77.7	10.4	—	—	2.0	10.0	11330
Plastics	0.7	2.0	—	60.0	7.2	22.6	—	—	10.2	14368
Oils, paints	0.8	0.0	—	66.9	9.7	5.2	2.0	—	16.3	13400
Linoleum	0.1	2.1	65.8	48.1	5.3	18.7	0.1	0.40	27.4	8310
Rags	0.6	10.0	93.6	55.0	6.6	31.2	4.6	0.13	2.5	7652
Street sweepings	3.0	20.0	67.4	34.7	4.8	35.2	0.1	0.20	25.0	6000
Dirt	1.0	3.2	21.2	20.6	2.6	4.0	0.5	0.01	72.3	3790
Unclassified	0.5	4.0	—	16.6	2.5	18.4	0.05	0.05	62.5	3000
Food Wastes, 12%										
Garbage	10.0	72.0	53.3	45.0	6.4	28.8	3.3	0.52	16.0	8484
Fats	2.0	0.0	—	76.7	12.1	11.2	0	0	0	16700
Noncombustibles, 24%										
Metals	8.0	3.0	0.5	0.8	0.04	0.2	—	—	99.0	124
Glass and ceramics	6.0	2.0	0.4	0.6	0.03	0.1	—	—	99.3	65
Ashes	10.0	10.0	3.0	28.0	0.5	0.8	—	0.5	70.2	4172
Composite Refuse, as Received										
All refuse	100	20.7	—	28.0	3.5	22.4	0.33	0.16	24.9	6203

[a] Data from [1].
[b] Ash, metal, glass, and ceramics.

[Corey1969, p. 7 Fig. 1-3]

Solid Waste Sources 351



URE 11.3 Composition of municipal solid waste in 1990.

[Ray1995, p. 351 Fig. 11.3]

Disposal Methods

Shipping to Land

If all else fails, a seastead can ship waste to a dump on land. After all, that's what most of the first world does with their trash. If care is taken to avoid waste generation (ie removing bulky packaging on land before transporting goods), this might be effective. One may question the wisdom of piling trash on land when it could just be piled on the ocean floor instead. But remember that the latter seems more like polluting a common, which we want to avoid for political reasons. Shipping is a pretty good way to deal with hazardous waste that existing facilities deal with, but we can't easily process ourselves. Hazardous waste which requires long-term storage might as well be shipped to land also - they have a lot more room. There are better solutions for most other types of waste, but we should keep this in mind as a safety net. COMMENTS (4)

Dumping

The easiest method of waste disposal on the ocean is simply to dump the unwanted refuse over the side. This technique has been used by humans since they first became seafarers. In fact, it has been the standard on earth since primordial life evolved in the oceans, and is still used daily by millions of creatures. Fish excrete, and since their waste products are heavier than water, they sink to the ocean floor. Natural upwellings eventually stir it back up, and it nourishes the microscopic creatures which form the base of the marine food pyramid. COMMENTS (6)

For many types of waste, however, dumping is problematic. Some waste contains valuable materials (ie nutrients in organic waste). Rather than throwing them away, seasteaders can recycle these back into their own food chain. Poisoning the ocean by dumping hazardous waste is immoral and irresponsible. It is possible that proper sealing could render hazardous waste safe, but this is getting into a grey area. Waste which is lighter than seawater would accumulate on the surface and eventually wash to shore, which is undesirable. Bays and coastal areas, especially close to populations, have (by necessity) strict rules about dumping. Finally, as discussed in more detail later, there are important political considerations which weigh against dumping. Certain kinds of dumping are regulated by UNLOS.
COMMENTS (6)

Given these caveats, dumping will probably be an appropriate disposal method for a few types of waste, ie biodegradable / inert and not worth recycling. COMMENTS (5)

Incineration

> *Incineration is probably the second oldest form of wate disposal, dating from the time when man found that he could warm himself by burning the things he had hitherto dumped outside his cave...Nomadic groups...have ignored the consequences of open waste dumps. Fixed communities cannot.* COMMENTS (5)

> *Municipal incineration began in England in 1874, and by the 1920's it was the only large-scale method of disposal used in the country.* COMMENTS (5)
>
> [Corey1969, p. 1-3]

> *Incineration is used for approximately 10 to 15% of all municipal solid waste. Industry and government have accepted burning as a preferred disposal method for many solid and hazardous wastes - that is, compared to landfilling. Incineration destroys the toxic organics in waste in a matter of minutes or seconds, whereas those chemicals might lie for decades in a landfill, or, worse, migrate to groundwater...incineration presents other advantages. It uses an otherwise worthless material to produce energy and it can vastly reduce the volume required for landfilling...The biggest problem in solid waste incineration now is public opposition. Because incinerators produce small amoutns of air pollutants, a segment of the public invariably opposes them...Most municipal solid waste incinerators do not have air polution control equipment.* COMMENTS (5)
>
> [Ray1995, pp. 380-381]

Incineration, which reduces waste into its base components, has a number of advantages: COMMENTS (5)

- Destroys toxic chemicals. For example, it is the only method approved by Congress and the EPA for disposing chlorinated organics [Ray1995, p. 413]. Incinerators are the preferred disposal method for hazardous wastes whenever possible [Ray1995, p. 403]. COMMENTS (4)
- If the waste was organic, the resulting ash can be used to enrich a hydroponic nutrient solution. COMMENTS (4)
- Combustion generally results in net energy output, which can be used directly to heat or desalinate water, or turned into electricity. COMMENTS (6)
- Its speed keeps smelly garbage from piling up. COMMENTS (6)
- Greatly reduces the size of waste (ash is typically a few percent of the volume and mass of the original waste). COMMENTS (5)
- Renders even human waste safe, if performed properly. COMMENTS (MANY)
- Scales very well. COMMENTS (MANY)
- About one-half of the solid waste in urban areas, and two-thirds (by weight) of the waste from homes can be disposed of by this method [Corey1969, p. 6]. COMMENTS (5)

There are some drawbacks to incineration. It is important to know what substances are being incinerated to ensure that toxic fumes are not being released. Combustion does add to the carbon in the earth's atmosphere. However, initial seasteads will be miniscule producers of greenhouse gasses compared to current cities because of their general energy-efficiency. Devices can also be used to reduce the pollution emitted, such as filtration, settling chambers, wet scrubbers, and electrostatic precipitators [Corey1969, pp. 48-66]. The pollution released by an incinerator depends greatly on its design, and so environmentally-conscious seasteaders can choose one which fits their desires. Incineration will sometimes require significant energy input, depending on the waste. Dehydration will probably be a necessary preparation step, as vaporizing water takes a lot of power. In fact, dehydration has been used as part of the incineration process since at least 1901. COMMENTS (2)

It may well be desirable to use a separate incinerator for organic waste, to ensure that the nutritive ash is not contaminated by toxic substances like heavy metals which are not destroyed by incineration. There are several small-scale incineration systems with specifications and prices available on the web. While this list is by no means comprehensive, it should give you a quick idea of what is available. (Click on an image to go directly to the manufacturers website.) COMMENTS (4)

[SmartAsh]

This is a non-hazardous waste incinerator which can handle organic waste, paper, plastic, packaging, oil and so forth. Requires no fuel, but draws 0.8 kw/hr to power its fans. Burns 50 lbs/hr of waste. Costs about $3000.

[MediBurn]

This small incinerator is designed to dispose of hospital waste, including infectious and pathological waste. It is thus suitable for handling human waste. It uses 0.35 Kw and 5 gallons of fuel per hour. Handles 8 ft^3/load (not sure how long a load takes). It is fuel intensive, but still reasonable for dealing with feces.

[Incinolet]

An electric incinerating toilet, so its an incinerator specifically designed to deal with human waste. Requires the use of a liner each time, and uses 1.5 kWhs / cycle. This is a lot, but probably feasible for feces only. Costs approx. $1700, and is easy to install as it requires no plumbing, only a vent.

[EcoWaste]

This larger line of incinerators from Eco Waste Solutions can handle 300lbs - 25 tons / day of municipal waste, hospital waste, and oil using a two-stage pyrolysis system.

Incineration is an excellent method of destroying many types of hazardous waste, but has significant drawbacks for organic material. Organic ash is high in trace elements such as metals, which are concentrated by incineration. Plants like these in small amounts, but they are poisonous in large amounts, so the ash must be used cautiously. The organic matter and nitrogen - important nutrients - are destroyed. So while incineration is better than nothing for organic debris, it is still inferior to our next option. COMMENTS (4)

Composting

> *In nature, leaves fall to the forest floor and are gradually decomposed by a variety of microorganisms including fungi, bacteria, and protozoa. This degradation process returns the nutrients contained in the leaves to the soil where they become available again to the trees and other vegetation. In contrast, leaves falling in cities become a solid waste...Composting, which is the controlled aerobic partial degradation of organic wastes, produces a material that can be used for landscaping, landfill cover, or soil conditioning.*
> [Ray1995, p. 359]

Composting is a tried and true method of converting organic wastes into plant food. The waste is simply left in a pile for microbes to digest, just like in the natural world. It is desirable to either mix or create trapped airspaces so that the compost is exposed to oxygen. This is because anaerobic conditions produce offensive odors and potentially dangerous gasses (although methane rises, so it will escape). Composting preserves more of the nutrients than incineration, and can be used to turn even "humanure" into safe compost. The process even breaks down many types of toxic contaminants, such as organics (though not heavy metals) [Jenkins1999]. COMMENTS (2)

While effective, composting is a slow process, usually taking months (1-2 years for humanure), and so it requires a lot of space to store the waste during that period. Space is at a premium on board, so this is a significant disadvantage. (This can be partially addressed by placing the compost area in one of the lower spar chambers, out of the way). Not all materials are suitable for composting, depending on factors like the carbon/nitrogen ratio. COMMENTS (7)

Many seasteads are likely to favor composting over incineration for the disposal of organic waste, and set aside the necessary space. However, others will simply stick to incineration. COMMENTS (MANY)

Compacting

Compressing any waste which is going to be stored or shipped saves a lot of space. It also reduces odor, since most smells stay trapped inside the solid block. Low-pressure compaction results in densities of 700-1000 lb/ft^3, and high-pressure can create densities of 1600-1800 lb/ft^3 [Ray1995, p. 367]. Its an easy win. COMMENTS (4)

Recycling

It may be possible to recycle some materials onboard (glass, aluminum, plastic). While it takes a high temperature to melt metal or glass, remember that with better insulation, less energy is required to produce a given temperature. Also, we can more efficiently recycle bottles by washing, sterilizing, and re-using than by using them as raw materials for new bottles [Ray1995, p. 51-352]. In large communities on land, this is problematic because bottles may have had toxic substances stored in them. However in a smaller and more conscientious seastead community this method should work well. Even if the seastead itself does not process a potential recyclable, the material can be compacted, shipped to land, and sold to a recycling plant. COMMENTS (5)

Unfortunately recycling is often inefficient, in part because it is kluged onto existing systems. *Cradle To Cradle* [McDonough2002] suggests that recycling is better accomplished by re-designing our materials so as to be easily reusable. In the miniature economy of a platform, this may be practical, and could even be the motivating philosophy for an entire group of seasteaders. It would certainly be an interesting experiment. COMMENTS (5)

It is more likely that the production and purchase of goods will simply be tailored with the expense of waste disposal in mind. Bulky packaging is a response to how cheap it is for the producer to buy the packaging and the consumer to throw it out (or, according to some, because many of the costs are born by others). This difference between terra aquatica and terra firma may cause some difficulties (as when goods imported in large quantities have a lot of packaging). Still, we are quite confident that the seastead economy will adapt to the incentives it faces. Vegetables from the greenhouses won't come in plastic bags. Soda will be imported as a concentrated syrup, not in cans. The same glass bottles will be sterilized and re-used for each batch of homebrew. COMMENTS (5)

Thermal Depolymerization

Fossil fuels were created over a long period of time by geothermal processes acting on organic waste. An industrial process which mimics this has recently been developed, involving several stages of heat and pressure changes. It is both rapid and fairly efficient (85%). Changing World Technologies has employed it in a pilot plant in Pennsylvania and a commercial facility in Missouri. In the latter facility it converts waste from a Butterball turkey plant into fuel. While the procedure is not really suited to small-scale waste processing, it shows great promise for dealing with large quantities of waste [ThermalDepol]. COMMENTS (4)

Hazardous Waste Treatment

For hazardous wastes which are not destroyed by incineration, other methods may be necessary. Precipitation, coagulation, filtration, neutralization, oxidation, reduction, chemical fixation, and adsorption are some of the techniques used [Ray1995, pp. 407-410]. It is unlikely to be worthwhile to use these methods to process occasional hazardous materials encountered in the waste stream. However, there will eventually be manufacturing and industrial processes onboard which will generate predictable and specialized hazardous waste. At that point, specialized treatment facilities are appropriate. COMMENTS (4)

Political Considerations

A nation's methods of dealing with its waste are seen by others as

symbolic of its nature, at least to some degree. This is quite reasonable. Most of the effects of most policies are internal to a nation (ie crime laws), or positive for the rest of the world (ie production and trade). Pollution is external and negative. An example of the importance of waste disposal policies is the international outrage over the US refusal to sign the Kyoto Protocol. However one feels about the merits of the proposal, it is noteworthy that it has prompted more indignation than some of America's bloodier and more objectively tyrannical actions. COMMENTS (2)

banner: George W. Bush: Polluter of the Free World

Thus dirty disposal methods like dumping, while cheap and easy, are problematic. The argument that seasteaders should be left alone to pursue their unique lifestyle in peace, while harming nobody, is a good one. But it does not hold up when costs are being imposed on the rest of the world (what economists call *externalities*). While seasteaders and terrestrial nations are likely to quibble endlessly about exactly what constitutes an externality, pollution is a clear faux pas. COMMENTS (3)

Seasteads will start with a tenuous position in world politics, so it behooves them to be good global citizens. In the twenty-first century, this means clean waste disposal practices. While many corporations and governments get away with pollution, they are the world's elite. The oceans are seen as the common property of humanity - occupation may be tolerated, but befoulment will not. COMMENTS (4)

Considering the opinions of customers rather than nations, we get the same result. Greenness is part of the appeal of seasteading, and avoiding negative externalities (not polluting) is a core part of the green philosophy. Serving a niche market can be good business, but alienating the majority of your customers is a recipe for failure. COMMENTS (2)

These considerations make waste disposal a surprisingly crucial part of a seastead's infrastructure. COMMENTS (2)

Polluters

The problem, however, will not go away so easily. Later seasteads will be in a less tenuous political position and, facing competition with other platforms, may have a stronger desire to cut costs. Once there are enough platforms for populations to segregate, there will be seasteads without strong sentiments against pollution. However, the difficulty of getting caught polluting the oceans will prove an irresistible temptation to some. It is inevitable that a stead will pollute, and eventually be caught doing so. This will reflect poorly on the entire movement. COMMENTS (4)

Unless the rest of the world has changed dramatically by then (which seems unlikely), the simplest response will be to point out that land has its share of polluters as well. As one source points out:

> It is really quite easy to get carried away with the environmental security issue. It has immense popular appeal, it has a sense of urgency that can be exploited, and touches the consciences of those who enjoy a high standard of living. However, it should be borne in mind that **80 percent** of marine pollution stems from land-based sources, including run-off, air pollution, and coastal development.

As always, utopia is not an option, and it is unfair to compare this (or any) way of life with an impossible ideal. The important question will be: how do seasteads compare with the rest of the world in the pollution department? We expect that clean power generation, the need for efficiency, and the influence of green philosophy will render a satisfactory answer for the majority, though not all. Any malfeasors must face the consequences of their actions. COMMENTS (4)

Environmental Regulation

Some seasteads, to demonstrate their cooperative membership in the global community, may become parties to environmental treaties. Even if these seasteads do not have the status of nations, such accords are statements of intent, and so there is little reason to exclude private entities. The outside world may impose regulations on seasteads, acting in lieu of their nonexistent central governments. Groups of connected platforms will certainly have environmental agreements as part of their contracts, since they share air and water. Geographically disparate platforms may have agreements as well, to demonstrate a shared philosophy to themselves and to the rest of the world. They might even contribute to investigations for rogue polluters, who besmirch the reputation of the movement. COMMENTS (4)

This is a good example of how, just as with many other aspects of the seasteading lifestyle, there will be rules and compromises. Don't extrapolate from that and think this new way of life offers no improvements on the old. Rules and compromises are part of reality, and anyone who thinks you can get along without them is a crackpot. We still think there are plenty of incremental improvements available on this side of la-la land. { is this funny or a stretch? - P } COMMENTS (5)

Example Waste Systems

Here are a few examples of waste disposal systems used on similar facilities: { Other good examples? } COMMENTS (8)

ResidenSea

> This cruising condominium apparently uses the following method: *"Contributing to the success of The World's recent ratings is its unique Scandinavian waste water cleaning system, whereby wastes are filtered by*

a flotation system. Solid wastes are dried and incinerated, and the ash is properly disposed of on land. The remaining liquid waste goes through an ultraviolet filtration process, and the resulting water is as pure as technical water. The World also burns marine diesel..." [Residensea] COMMENTS (4)

Summary

A good waste disposal system will use a variety of techniques, cause little pollution, and recover materials and energy from waste when possible. Incineration is the preferred method of disposal for hazardous wastes, organic wastes, and combustible miscellaneous waste. The ash from organic waste will be used for nutrients. Some steads will choose to use composting for organic waste instead, feeling that it is worth the extra space in order to preserve more nutrients. Recyclables should be re-used intact if possible (ie sterilizing bottles), processed onboard if that is cost-effective, or compacted and shipped to recycling plants on land otherwise. Hazardous waste which cannot be incinerated will likely be shipped to appropriate storage or treatment facilities on land. It may be processed onboard in some circumstances, particularly when it is consistently generated by some onboard process. Some very special kinds of waste (non-combustible, non-toxic, non-floating, non-recyclable, non-nutritive) may be simply dumped into the ocean, although its hard to think of much which meets these requirements (big rocks?). COMMENTS (7)

Appliances

Because of the limited resources available to a seastead, special consideration is needed when choosing appliances. While the below is neither an exhaustive set of appliance types nor of possibilities for each appliance, we believe that it demonstrates the widespread availability of power and water efficient solutions. Similar choices can be made for other "modern necessities". Note that we've chosen to structure this as a discussion of appliances and their replacements (ie "hot water heater" rather than "hot water"), rather than a provision of services. COMMENTS (5)

Heater

Because the seastead has a huge thermal mass and floats on the water, temperature extremes will be moderated. Some heating may still be required, depending on season and location. We have a variety of possible heat sources. We can burn fuel, such as diesel, hydrogen, alcohol, or propane, or we can directly convert electricity that we have stored or generated into heat. While getting heat from the sun is a technology as old as the earth, being able to turn wind into heat is a nice improvement. COMMENTS (3)

We can also use the traditional techniques for energy efficient heating to reduce energy costs. Have a lot of insulation, use efficient windows, face them south, store heat during the day, and trap it at night. The environments that a seastead expects to be in, the cost of energy, and the cost of such techniques will dictate whether they are used. COMMENTS (5)

An additional source of seastead heat is waste heat from diesel generators, inverters, batteries, anything else that generates heat as power-loss. Heat exchangers can be used to scavenge this, which increases the effective efficiency of the appliance. COMMENTS (6)

Air Conditioner

Cooling is unlikely to be a big problem on a seastead for the same reasons as heating: temperatures will be moderated by the thermal mass of the ocean and the seastead. There are a lot of ways to cool seasteads without using power-hungry air conditioners. COMMENTS (5)

Cooling is easier than heating because we can tap a large source of available coolness. We're not talking about our nation's teenagers, but about ocean water several hundred feet below the surface. An intake can be placed on the submerged buoyancy portion of the structure, and the only power cost is for pumping. The energy can be partly recovered by running it through a small turbine on the way back down. Its probably worthwhile having this turbine because there are a number of other circumstances under which we'll be draining water from the platform, and we might as well get some energy out of it. COMMENTS (9)

Evaporative cooling with a device called a swamp coolers is another interesting low-energy method. Air is sucked through wet pads, causing the water to evaporate and the temperature of the air to drop. The result is a breeze cooler than ambient air temperature which only requires electricity for the fan and a supply of water. The process is depicted in the flash animation below: COMMENTS (3)

Animated GIF for those w/o Flash

Image courtesy of Opalcat, from her Swamp Cooler page.

{CENG: prev par unclosed}

If saltwater is used, minerals will quickly build up on the pads (scaling). Frequent rinsing in fresh water may alleviate this, and it may or may not be worth using salt depending on how much fresh water is available. Another potential difficulty is that swamp coolers work poorly when humidity is high, which is usually the case over the ocean. Despite these disadvantages, the efficiency of evaporative cooling makes it a strong contender when conditions are appropriate.

{Swamp Coolers are really neat, but humidity over the ocean is always very high so I think they are no good for us. This section will be removed unless I hear a good reason not too.}

Refrigerator

There are a number of possibilities for refrigeration. It is important to do a good job, since the refrigerator must keep food cold 24 hours a day. In a standard kitchen, it uses more energy than any other kitchen appliance - around 5 kWhrs/day.

Conventional refrigerators are extremely inefficient. Since electricity is cheap, most people buy a refrigerator based on its color and shelf arrangement rather than its efficiency. Some fridges actually have heaters in the frames to prevent moisture from collecting on the seals and generating mildew. The "frost-free" systems are basically heaters that briefly bring the air in the freezer compartment above freezing to remove the frost. The heat from the compressor and condensor flows past the refrigerator as it escapes. Convenient, yes. Efficient, no. COMMENTS (5)

While some of the commercially available energy-efficient refrigerators are not much better, others like the Sun Frost line use less than 1 kWhr per day. Its hardware is on top, so the heat produced escapes away from the fridge. Good insulation is also very important to reducing the energy requirements. COMMENTS (5)

Strange though it sounds, solar heat can actually be used directly for refrigeration. The secret is an absorption refrigeration cycle discovered in the mid 1800s. A mixture of ammonia and water is heated in one area, and the ammonia evaporates, moves to another area, where it is cooled and condenses. When the liquid ammonia evaporates, it cools the surrounding area. This is an external-combustion system which can use any heat source for power. COMMENTS (4)

The method was used in an icebox cooler called the Crosley Icyball sold in the 1930's [IcyBall]. The same principle was behind a recently-built solar icemaker, described in Home Power magazine. It used a parabolic trough reflector to focus sunlight onto a tube filled with ammonia. During the day, it charges, and at night, it produces cold which can be used to make ice [SolarIce]. COMMENTS (5)

Like many renewable energy systems, this method has the advantage that it requires almost no maintenance and will work forever. 70-year old Crosley's found in antique stores are often still functional. It uses the sun directly, and fairly inexpensively, both of which are useful. Other heat sources (like stored fuel) can be used on cloudy days. One drawback is that ammonia is a nasty gas, but a well-designed system should be safe. COMMENTS (5)

Hot Water Heater

We can heat our water through a number of means, including passive solar heating, burning fuels, electric heating, and capturing waste heat when it is available. Passive solar heating is likely to be the most efficient method, supplemented by other energy sources when necessary. Being a direct solar method, this is a great way to use solar power. If space onboard is at a premium, floating passive solar water heaters can be deployed. The disadvantage is pumping costs, however it may be possible to transfer heat through convection. COMMENTS (4)

An important part of the hot water system is insulation. The tank itself should be very well insulated, as should the pipes. A significant amount of the energy in a conventional hot water system goes into warming up the metal pipes, which is inefficient and wcan be avoided. COMMENTS (2)

Stove

Cooking is a very energy intensive activity - 1000-3000 watts for a burner, 2500-5000 for an oven, and one which is often done by many people at the same time. Thus it represents the toughest kind of load for an energy system. Indeed, many home power systems find that food preparation is their heaviest load of the day. As is often the case, we have a variety of energy sources to choose from, solar, electric, fuel (hydrogen, propane, alcohol). Because its such a high load, we may wish to cook with stored fuel rather than electricity. This fuel can be imported or generated by our power system (hydrogen through electrolysis). COMMENTS (5)

A disadvantage to traditional stoves is that they lose a lot of heat (think about how hot a kitchen gets). Not only does the air carry away energy, but you're heating up a big metal pan along with your food. Microwave ovens waste much less energy, since the radiation bounces around until its absorbed by the food. For slow cooking, crock pots (which are well-insulated) lose less heat than a big pot on the stove. Unfortunately, these methods of cooking are not suited to nice meals, so we still expect seastead kitchens to be warm on occasion. COMMENTS (MANY)

Second, cooking requires a very large amount of power and many people tend to do it at the same time. Thus it represents a difficult drain on any energy system. Our proposed solution is to generate hydrogen through electrolysis, which can be done efficiently with commercially available units when there is excess electricity. The hydrogen is then burned in a stove. As discussed in the fuels section, hydrogen is quite safe. This gives us an alternative method of energy storage, which is useful. COMMENTS (6)

Oven

An oven is a box for holding heat. Modern ovens do a poor job of this (warm kitchens again), and thus need heat constantly poured into them. If we just iinfra.html#Hydrogen">nsulate the oven, it will require a lot less energy. Any method can be used to provide the needed heat. Conventional ovens only have the heating element on 20% of the time COMMENTS (5)

Washing Machine

As usual, there is the conventional way and the energy-efficient way. Conventional washing machines use 100-230 liters of water per load. When this is hot water, heating costs are a large part of the total energy use. The Staber washing machine uses only 110 to 150 watt-hours and 45 L water per load [Staber]. This is a little high, but not too bad. The reduced water use has a big impact on energy because it means reduced hot-water use. 2 loads / person / week would be a negligible increase in energy expenditure (+0.04 kwhrs/day) but a significant increase in water use (+13 L/day). We can generate that water from Reverse

Osmosis with 0.17 kWh/p/day of electricity. So a total of 0.21 kwhrs/person/day does 2 loads a week (not counting water heating energy). That's well in line w/ our power figures. Another interesting technology is ozone injection. Ozone serves as a better replacement for bleach, works well in cold water, and leaves no chlorine residue. Seasteaders probably won't do laundry as often as on land, this goes with being a pioneer. COMMENTS (4)

Dryer

There are extremely energy-efficient dryers, such as the Spin-X, which works by spinning clothes very quickly to extract water with centrifugal force. The manufacturer claims that 2 minutes in it is equiv. to 30 minutes in a normal drier. Uses 25 watts for a 3 minute load - not sure if this means 25 watt-hours, or 25 continuous watts which is 1.25 watt-hours, but either way its negligible. The Spin-X does not get clothes dry enough to replace a traditional dryer, but a much shorter dryer run is then needed [CET]. COMMENTS (4)

Alternatively, clothes can be dried the old-fashioned way, by being hung out on lines. One potential worry on a seastead is that they could potentially pick up a little salt spray. Also, they'll dry very slowly because of the high humidity. Given the low energy costs of the spin dryer plus a short heated drying cycle, line drying will probably not be necessarily. COMMENTS (5)

Dishwasher

High-efficiency dishwashers such as the Fisher & Paykel Dual DishDrawer use about 20 L/load, while normal dishwashers use about 40L. As energy-efficient appliances go, this is a pretty small improvement, but its still not that much water. Much of this water much be hot, which uses additional resources, but we can get hot water with reasonable efficiency through passive solar installations. Another problem is that one way that efficient dishwashers save energy is by using air drying instead of a heat drying cycle. Unfortunately in our humid environment, air drying may not work very well - seasteaders may need to get out the hand towels and dry dishes the old-fashioned way. A clever dehumidification technique would also help - perhaps a solar dehydrator which converts humid air into water and dry air. The humid air could simply be run through a condenser using ocean water for cooling. COMMENTS (3)

Vacuum

A vacuum cleaner is a good example of an appliance with an extremely low duty cycle. It may not be very energy efficent, but that doesn't matter. Portable floor vacuums use about 500-1000 watts. If each person vacuums for an hour a week, that's a negligible 0.1 kWhs/week. Similar appliances include power tools (drills, sanders, lathes, saws), ??? COMMENTS (4)

Lighting

There is a large range of energy efficiency for lighting. Three technologies worth mentioning are incandescent lights, fluorescent lights, and Light Emitting Diodes (LED's). Fiber optic light distribution systems are interesting as well. COMMENTS (5)

Incandescent Bulbs

Incandescence was the first electrical lighting technique invented. It is so inefficient that an incandescent bulb is basically an electrical heater which as a byproduct happens to make a little light. The efficiency is about 10%, and they last about 1,000 hours. Halogen bulbs are a more efficient, longer-lasting type, but they still produce a lot of heat.

COMMENTS (4)

Fluorescent Bulbs

Fluorescent bulbs have been used for awhile, although only recently in the home market due to the arrival of the compact fluorescent form factor. They are 4-5 times more energy efficient and last 10,000 - 20,000 hours. While they are more expensive, but their cost is well worth the gains - especially on a seastead where energy is expensive. Unfortunately, these bulbs contain lead and mercury, and thus must be treated as hazardous waste or they will pollute the environment.

COMMENTS (3)

Light Emitting Diodes

LED's are a newer technology from the solid-state electronics field, which have only gotten cheap and bright enough to be used for large-scale lighting in the past decade. Large numbers of traffic lights, for example, have switched to LED's in the past few years. Because they last so long (100,000 hours), they are the clear choice for locations where replacing bulbs is very difficult. Colored LED's are about as efficient as fluorescent bulbs, but white ones are only half as efficient. Still, future LED's will be more efficient that fluorescents. Unlike fluorescents, LED's do not contain poisonous chemicals. COMMENTS (5)

In the table below we can see the efficiency of each type in terms of how many lumens per watt it produces, as well as the lifetime of the bulb. Cost for the bulb is given per kilo-lumen-year, and electricity cost for the same period, assuming $0.20/kWh. In general, electricity cost dwarfs bulb cost, so efficiency is quite important. COMMENTS (6)

	Lumens/Watt	Lifetime (hrs)	Bulb cost/k-lumen-yr	Electricity/k-lumen-yr	Total cost/k-lumen-yr

Incandescent	15	750-1,000	$7	571 kWh	$121
Fluorescent	60	10,000-20,000	$14	143 kWh	$43
LED (white)	25	100,000	$500	350 kWh	$570

As you can see, the inefficiency of incandescents and the high cost of LEDs make fluourescents the clear choice. LEDs work well in places where only small points need to be lit, such as emergency lighting strips. They are also better when colored lighting is acceptable, as colored LEDs are cheaper and more efficient. COMMENTS (5)

A neat technology being developed for lighting is the use of fiber optic cables to move light around. These cables are like wires, except they transmit light. One method for using them is a system like the Himawari, which gathers sunlight with lenses, then transmits it via fiber optic cable to wherever needs lighting [Himawari]. This lets us transmit natural sunlight (with UV conveniently attenuated by the system) to deep interior area of the seastead. Another method is to have a main central lamp, and fiber optic cables running to "power" other lamps. So fewer bulbs are needed, and they can be very efficient ones. The main advantage is the elimination of a lot of electrical wiring. This reduces the possibility of fire or electrical accidents as well as requiring less labor to install. Its especially convenient ferro-cement structures which don't have hollow walls to put utilities in. However, this is a new technology and it may not be suitable for seastead use. COMMENTS (4)

Facilities

It is worth discussing what facilities are needed and or desirable on a seastead, as well as what special problems these facilities may pose. COMMENTS (5)

Infirmary

Being an isolated environment, a seastead will need some facilities for medical care. The larger the seastead, the larger these facilities can be. Elaborate trauma, burn, or IC units and surgical facilities will not be possible on smaller seasteads. Serious injuries will have to be transported to land by airplane or helicopter, which may be dozens to thousands of miles away. Contrary to popular impressions, while quick medical care at the paramedic level is certainly important, the need for quick medical care at the surgical level is rare. People rarely die quickly in ways that could have been saved by surgical facilities, and even serious accidents usually allow enough time for transportation. Paramedic level facilities can easily be incorporated in Seastead Lite, and perhaps a minimal ER. COMMENTS (4)

One way of looking at medical emergencies on a seastead is that it is similar to life in rural or remote areas.

While urban dwellers may be accustomed to a high concentration of hospitals, many people, even in the first world, are presented with the same set of options. Deal with it yourself, go to someplace nearby with poor facilities, or face a long drive or expensive chopper ride to a real hospital. Seasteads will have advantages over rural dwellers in that they can guarantee that trained personnel and lower-levels of care are much more accessible than places where the nearest doctor might be dozens of miles away. And seasteads can have airplanes and/or choppers ready, where rural dwellers must wait for them to be dispatched. COMMENTS (7)

If drug laws are lax on seasteads, and especially if drug use is one of the selling points, the infirmary will wish to be prepared for drug-related emergencies, and the staff trained in handling them. COMMENTS (4)

The infirmary will not need much additional infrastructure. It will need oxygen hookups or simply oxygen tanks, which may be able to be refilled during electrolysis. { ?? pressurizing issues ?? }. It will need sterilizing facilities such as an autoclave, and distilled water rather than R/O or rainwater. COMMENTS (5)

Shop

Part of being self-sufficient is the ability to fix things which break and make new things yourself. Thus a good shop will be necessary. We'll need a small machine shop (lathe + mill + bandsaw + drill press), some welding capability (both arc welding, oxy-acetelyne, and probably TIG (Tungsen Inert Gas), and probably some wood shop tools (table saw, radial saw, belt sander). Lastly, we'll need compressed air for a bunch of compressed air tools. COMMENTS (6)

Shops tend to be noisy and sometimes smelly, and they should be located with that in mind. We'll also need to conserve space, so we may want put the tools on wheels, they can be stored in a compressed format when not being used. There will not be enough room to have all the tools out in a static layout. Instead, they will be moveable, and we can deploy whatever set is necessary for the current job. COMMENTS (4)

It may be useful to have a small foundry as part of the shop. Whenever some tool is needed, it can be rough cast out of aluminum, and machined to final form. When the tool is no longer needed or breaks, it can be thrown back into the scrap heap, melted down and reused. All hand tools such as shovels, rakes, screw drivers, etc. would be candidates for this level of reuse. This allows a modest amount of metal to be reused over and over again. COMMENTS (4)

Kitchen

Anything to say? Energy efficient appliances (if frequently used), small space, efficient storage. COMMENTS (MANY)

Common Areas

{ Does this seem like a good place to have a discussion of "community"? - P} COMMENTS (4)

A seastead will consist of like-minded individuals sharing a small space, thus it will be a community. Having many facilities be communal reduces their cost and the space used. The land-based pattern where everyone has their own kitchen, their own tool shop in the garage, their own TV/movie setup, their own boat and so forth is just not suited to seastead life. Fortunately, as with many of the problems we face, we can draw from solutions which other groups are finding in other contexts. COMMENTS (5)

The Cohousing and Intentional Communities movements have been experiencing a resurgence in the past few decades. Cohousing started in europe and has been spreading to the US. ?? The FIC listing has hundreds of communities in the US??. This movement has experience in architectural designs which provide reasonable and efficient combinations of private and public space. The CoHousing Company [ref], located in Berkeley, CA, USA, offers advice on all stages of community creation. We feel that it would be desirable to hire them as consultants on the interior layouts and designs of the seastead. They are used to working alongside traditional architects and engineers, although working with marine engineers may be a new experience. COMMENTS (6)

Seasteads whose residents are paying first-world prices will certainly be able to have private space for individuals. (If poorer people wish to seastead, they may not get private space, which is a sacrifice that they will need to make, and may be used to making in their land-based life.) However, especially with early seasteads, most facilities will be shared. Kitchens, lounges, workshops, gardens, and so forth will all be common. This has some definite advantages. It should be easy for a seastead to amass quite a large library of movies and music, for example. COMMENTS (MANY)

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Making Money

"If this country is worth saving, it's worth saving at a profit"
-- H.L. Hunt

Many projects dream of some extremely rich person coming along, seeing their proposal, and saying "Neat - to whom do I write the check?" In reality, seasteads are much more likely to happen if somebody can figure out how to make a buck with them. If floating cities are worth building, they're worth building at a profit. And if they can't be built profitably, it is far from clear that they are worth building.This section outlines some business and customer possibilities for seasteads.

It's very important to be honest about the advantages and limitations of doing business on board a floting platform. We've seen numerous proposals for ideas to make money on floating cities that are obviously not going to work, because they don't leverage any of the comparative advantages. There are lots of people out there who want to make money, and there is no easy way or magic recipe to do so. By moving a business to the ocean, you are cutting it off from resources and customers, making everything more expensive and more difficult. To be able to compete with the possibiltiy of doing the same thing on land, there has to be a damn good reason why the ocean is a better place.

After a fair bit of thought, we've only come up with two unique features of seasteading which provide its competitive edge. The first is the freedom offered by sovereignty and the second is the unique ability of seasteads to provide some of the comfort and stability of land in remote marine locations. Hence any business must center around one of these features.

The fundamental seastead business is that of manufacturing, and perhaps operating, the seasteads. We think the best way to characterize this industry is as real estate development. The main differences from conventional development are that the land must be built instead of made, and the developer must provide all utilities rather than just paying for a connection to the grid.

An example of a similar business is a company called International Marine Flotation System Inc. They design and build floating homes, marinas, restaraunts, docks, and roads based on concrete floats. They've even built entire floating home developments. A seastead manufacturer would be in a similar business, but geared towards constructing more isolated and self-sufficient real estate [FloatingHomes].

One nice thing about this version of the real estate business is that its in some ways less speculative than on land. A land developer must often risk a large chunk of money on a piece of land or a building. Because seasteads are modular and expandable, the developer can start small - like building a skyscraper a few floors at a time. If successful, profits can be rolled into further expansion. Since there is plenty of room on the ocean, this means no ceiling to the potential profits from the initial stake. This goes a long way to making up for the uncertainty due to the novelty of the seastead business [Hunting2001].

While we're going to present a number of business ideas to demonstrate why this real estate is potentially valuable, the seastead developer should not be specifying its exact set of tenants in advance. Just like the builder of a skyscraper, its important to know something about potential customers (that they exist, their utilities needs), but there's no need to micro-manage. The seastead builder should be in the real estate business, not the fishing, banking, or medical research business. As Eric Hunting says: "The business plan is straightforward because everything revolves around creating habitable space, the revenue it produces in rent, lease, or sale, and the costs accrued in maintaining it, making it useful, and making it attractive. ". COMMENTS (0)

Business Models

{ There are enough of these that its probably worth grouping them into sections } COMMENTS (0)

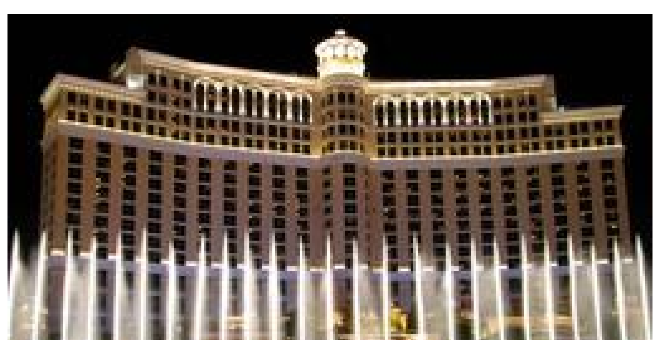
Seastead Construction Corp.

With this business model, we hypothesise that there are enough groups of people that want a seastead, for whatever reason, that it makes sense to form a corporation that specializes in building seasteads to order. The corporation would not worry about the day-to-day operation of the seasteads it produced. These groups may be interested in residential seasteads for political freedom, or they may be developing one of the many business ideas we propose. COMMENTS (0)

The residential groups can be roughly partitioned into political groups (e.g. libertarians [Atlantis1994], socialists, communists, etc.), religious groups (e.g. fundamentalist Christians, Muslims, etc.) , and single issue groups (e.g. drugs [Island], nudists, gun enthusiasts [FrontSight], environmentalists [Celestopia], etc.) While sometimes these groups can legally form their own land based communities, they may prefer to do so in a more isolated environment like a seastead to avoid hassles with local authorities. Some of these groups will have no legal land based option available to them, so something like a seastead will be their only option. Essentially seasteads would function as intentional communities, with far greater independence and autonomy. COMMENTS (1)

Luxury Resort

{Restructure this as Resort w/ subsections, cruise ships, timeshare, drugs, etc.} COMMENTS (0)



The luxury resort business is thriving [stick a few refs here, maybe a pretty graph]. While many resorts try to leverage some local community or artifact, there are others that merely exist to provide a complete experience unto themselves. For example, many people go to Club Med® and cruise ships with no real intention of ever leaving

the facilities. A luxury seastead resort could be tailored to meet the needs of these people. Note that a luxury resort seastead would have to compete with the existing luxury resorts. Thus, issues of how to get to and from the seastead, providing amenities, etc., all have to be worked through. A seastead can offer some experiences that may not be possible at other Luxury Resorts, and these may be the key to its success. COMMENTS (0)

An example of a resort tailored to a specific, freedom-oriented issue is the Front Sight Firearms Training Institute in Nevada. Besides offering training in the use of firearms, as well as similar topics (chemical agents, climbing and rappelling, and soon executive protection), Front Sight's plan is to become a luxury resort for gun lovers. Around a third of the 170 1-acre home sites have already been sold as part of a package which includes a lifetime membership in the training facility. Condominiums and a hotel are planned as well. Front Sight is expanding rapidly with the income stream from its members, and seems to have found/created a succesful (and previously untapped) niche market. COMMENTS (0)

The United Arab Emirates are pursuing an extremely large, ambitious, expensive project to build an ultra-luxury resort called The Palms. What is interesting about this particular project is that it is being built entirely on the world largest man-made islands. In fact, the islands will be visible from the moon with the naked eye, and will create 120 km of shoreline. Construction began in 2001 and is expected to end in 2007. { I've been to their webpage but I couldn't find it, need a reference and info on cost - P } COMMENTS (1)

Can a floating luxury resort be profitable? The answer has been yes for decades, as we can see by looking at the cruise ship industry. This ships produce nothing, import all their food, water, and fuel, and still turn a profit. About 10 million people a year take a cruise, providing about $17B in revenue. Clearly a floating resort can be a profitable business model. This is not to say that it will be easy - cruise ships actually take people places, which is an advantage. But seasteads can provide some other things to offset that. COMMENTS (0)

Sin IndustriesA seastead is the ideal setting for the so-called sin industries like drugs, prostitution, and gambling. Drugs are low-capital and high-profit, but also carry a great political risks. Still, European countries are relatively tolerant, and as long as drugs are only used locally, the idea may fly. [insert drug stuff from elsewhere]. COMMENTS (0)

Prostitution, as long as it does not involve children, is widely accepted. It is at least claimed that some tourism to Thailand and Costa Rica is motivated by cheap prostitutes. Gambling is also widely accepted. While gambling is common enough that it is unlikely to motivate visitors, having it adds substantially to a resort's bottom line. COMMENTS (0)

Timeshare Resort

Timeshares are in between an intentional community and a hotel resort. The residents are owners, but they do not stay there all year. We believe this has some major advantages in terms of financing and market appeal. With financing, time share residents pay up front. Thus you don't have to get a loan with the hope of having enough business to pay it back. You let people buy shares, and when you've sold enough, you start construction. COMMENTS (0)

In terms of the market, we believe that the number of people willing to spend a few weeks each year on a seastead is **far** greater than the number willing to drop everything and devote their lives to it. This is even more dramatically true when you consider financial resources along with desire. In our many conversations about seasteading, we almost never encounter people who are seriously interested in living on a stead full time and have the money to buy a full share upfront. Yet we constantly meet people who find the concept intriguing and would love to try it part-time. COMMENTS (0)

Earning money becomes less of a problem for the residents, because they can work normal jobs the rest of the year. Much less self-sufficiency is needed because resources flow in from the outside. As time goes on, seasteads become sea-cities, the internal economy grows, people find profitable seastead-based businesses, and more and more people can choose to live there full-time. This exemplifies our incremental approach. COMMENTS (0)

Underwater Resort

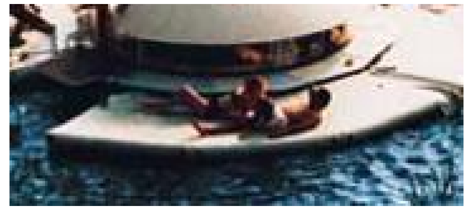
While being completely underwater makes the engineering quite difficult, having some habitable underwater area has much to be said for it. It has an undeniable romantic appeal (underwater weddings? Parties? Honeymoon suites?). Jules' Undersea Lodge in Key Largo, Florida, charges $300-$600 per night [Jules]. It has received a lot of media attention, for example it was featured on "Lifestyles of the Rich and Famous". Hydropolis, the worlds first luxury underwater hotel, is to be built in Dubai (close to The Palms) and completed in late 2006 [ReutersDubai]. The project is funded to the tune of five hundred million dollars. Poseiden Resorts is another planned project [Poseidon]. The Global Coral Reef Alliance [GCRA] has demonstrated that electro-accretion can be used to build and sustain artificial coral reefs for diving. COMMENTS (2)

Even from an above-water seasted, underwater tourism and exploration can be done via submersibles. There are some interesting personal subs on the market [Hawkes], [USSubs, as well as semi-submersibles [SubSeaSystems] suited for tourism. Remotely-operated vehicles could be used initially, as that is a lot easier than carrying around actual passengers. COMMENTS (0)

Personal Resort

The Aquatic Pod Suite from the Hammacher Schlemmer catalog is described as: COMMENTS (0)

The world's only aquatic pod suite that offers panoramic views simultaneously above and below the surface of the water. Circular, with a 'flying saucer' aspect, the suite rests directly on the water, the lower portion submerged approximately five feet. Perfect as a getaway at a favorite lagoon, beach, lake or river, the suite offers spectacular 300° views of the



environment. Beam lights illuminate the depths for viewing the aquatic surroundings after dark. With a 150 square-foot interior, the self-contained, circular suite has all the furnishings for two people to enjoy on-the-water living. The interior has a central air conditioning system, desalination unit, mini-bar, audio-video system with Bose stereo, king-size bed, toilet and shower. Outside, a floating terrace circumscribes the unit, providing a 6.6-foot-wide surface for sun bathing or enjoying breezes off the water. The inflatable terrace also lends stability and extra buoyancy to the suite, and protects it from scratches and bumps when visiting boats or windsurfers dock alongside. The above-water entrance is a watertight aviation design that prevents stray moisture and splashes from dampening the interior. Unlike houseboats, this unit remains permanently anchored at a specific location by an environmentally-friendly anchor that attaches with a durable, corrosion-resistant chain. It can also be towed by a boat. A 2.5kva diesel generator with exhaust silencer produces 220-volt power to supply all necessary electricity. [HammacherSchlemmer]

The listed price is $91,100. While we don't know how well the product has sold, at least this provides some evidence of a market for floating platforms. COMMENTS (0)

Retirement Home

A November 2004 article in the Journal of the American Geriatric Society suggested that living on a cruise ship might be an alternative to assisted living facilities. The abstract reads: COMMENTS (0)

Options for elderly patients who can no longer remain independent are limited. Most choices involve assisted living facilities, 24-hour caregivers, or nursing homes. State and federal assistance for payment for individual care is limited, and seniors usually pay for most costs out of pocket. For those patients who have the means to afford assisted living centers or nursing homes, "cruise ship care" is proposed. Traveling alongside traditional tourists, groups of seniors would live on cruise ships for extended periods of time. Cruise ships are similar to assisted living centers in the amenities provided, costs per month, and many other areas.

This article begins with an examination of the needs of seniors in assisted living facilities and then explores the feasibility of cruise ship care in answering those needs. Similarities between cruise ship travel and assisted living care, as well as the monetary costs of both options, are defined. A decision tree with selections for nonindependent care for seniors was created including cruise ship care as an alternative. Using a Markov model over 20 years, a representative cost-effectiveness analysis was performed that showed that cruises were priced similarly to assisted living centers and were more efficacious. Proposed ways that cruise ship companies could further accommodate the needs of seniors interested in this option are also suggested. Implementation for cruise ship care on the individual basis is also presented.

Ultimately, it is wished to introduce a feasible and possibly more desirable option to seniors who can no longer remain independent.
[JAGS_10_2004]

Seasteads have some potential advantages for a retirement home. They are affected less by the waves, which should be more comfortable, and they have more space for permanent residents. A disadvantage is that they don't go to as many exotic locations. { Other Thoughts? } COMMENTS (0)

Offshore Manufacturing

There are some manufacturing processes that are sufficiently dangerous that they need fair amounts of area around them. The land acquisition costs and corresponding regulatory hoops required may be quite substantial and expensive. Its also hard to acquire a large enough buffer zone around your plant to convince people that its safe. COMMENTS (0)

For example, the oil companies have not been able to break ground on a new refinery in the US in decades { Source? - P}. They might like to have a refinery that floats. That way they can refine the crude closer to the source and just ship the finished product around. We suspect that Union Carbide feels similarly about manufacturing pesticides. Processes that do not require large energy or freshwater inputs are ideal, and for them, it may be cheaper to build a seastead than go through the permitting process on land. Its also a lot faster. This is true even for a clean, non-polluting plant. COMMENTS (0)

What is nice about this example is that it provides a truly gargantuan market, worth literally billions of dollars, if seasteads provide a useful solution. Investors like to see a large potential upside. It may be possible to get some capital from relevant industries, as the cost of seasteading research is small compared to how much it might save them. COMMENTS (0)

One interesting twist is an industry which requires little in the way of physical raw materials: outsourced coding. A business trying to do this was founded in 2004:

> *Take a used cruise ship, plant it in international waters three miles off the coast of El Segundo, near Los Angeles, people it with 600 of the brightest software engineers they can find around the world (both men and women), and run a 24-hour-a-day programming shop, thereby avoiding H-1B visa hassles while still exploiting offshore labor cost arbitrage and completing development projects in half the time they'd take onshore or offshore...*
>
> *The scheme first came to Mr. Cook one day while he was cutting his grass in San Diego. With his unusual background as a super-tanker captain and an IT professional, the idea made a lot of sense to him. He took it to Mr. Green, with*

> *whom he'd worked before and who has served as both a buyer and provider of outsourcing services, and they saw the possibility of creating a new form of IT sourcing.*
>
> *A year ago, they formed SeaCode, Inc. with Mr. Cook serving as CEO and Mr. Green as COO. They've signed on a marketing director and CTO and, even more importantly, found an investor. Start-up costs won't be cheap. A broker right now is searching for just the right ship to buy -- somewhere in the neighborhood of $10 million.*
> [SourcingMag2005]

COMMENTS (0)

Ocean Science Platform

In order to study the ocean, ocean scientists normally need to get on a boat and go out to sea. It would be useful to have a platform that stays on station from which they could do their research. Under this scenario, the seastead would be towed to an interesting location and the research would take place as a dedicated community. The benefit of having the scientists always on station may outweigh the additional costs of operating a seastead. An example of such a platform is the Scripps Institution of Oceonagraphy's Flip, or Floating Instrument Platform, which can float horizontally or vertically. COMMENTS (0)

Environmental Demonstrator

The kinds of seasteads described in this paper will be quite self-sufficient once they are built. As such they will appeal to members of the environmental movement as an example of how to build communities that live within their environmental means as opposed to the resource wasteful communities of today. In addition, the environmentalists have successfully managed to raise large amounts of money to support their cause. Perhaps several of these organizations could get together to fund an environmental demonstrator seastead.
COMMENTS (0)

World Library

Most of the countries in the world have signed onto the Berne Copyright Convention. A seastead in the middle of the ocean is not bound by any copyright laws. Thus, it would be legal to obtain and digitize a vast library of material that national and university libraries can not amass simply because of copyright restrictions. While it would not be possible to export this material back out to the Internet, one could imagine researchers choosing to come to the world library seastead simply because they could do their research in a fraction of the time required to do it using conventional libraries. COMMENTS (0)

Patent Free Zone

Patent laws vary from country to country. There is a push to unify these various patent laws across all of the industrialized nations. A seastead in the middle of the ocean would be exempt from all patents. Thus, to save money, somebody could choose to implement some portion of a patented process on a seastead. While nations could choose to impose tariff on products imported from a seastead, not all countries would do so. COMMENTS (0)

A risk with such a venture is that a corporation who is being infringed upon might encourage their friendly national navy to board the seastead and shut it down. As will frequently be the case, the seastead must balance the profit and attractiveness of unique approaches with the potential problems. COMMENTS (3)

Marina

Marinas offer services such as shelter, water, food, electricity, and medical facilities to the boating population. While seasteads may not be able to supply the same level or price as land-based facilities, they can service remote areas where other options are not available, as well as offering some unique attractions. The seastead can be moved whenever the current crop of boaters in a given area grow bored, thereby picking up another crop. COMMENTS (1)

Tour Base

A seastead could serve as the base for touring some unique and remote area. It would offer more roomy and luxurious accomodations than a boat, and provide a runway, allowing for access by air instead of sea. The tour destination could be an island or archipelago, something underwater (reefs, sunken ships), glaciers, or anything else remote and interesting. If the seastead is mobile, it may periodically move so that it can offer an endless variety of tour destinations. COMMENTS (0)

Fishing Base

A seastead could serve as a supply cache, storage facility, and processing facility for commerical fishing, allowing fleets to go farther and stay longer. COMMENTS (0)

Mariculture Products

There are a number of products which seasteads could manufacture and sell to the rest of the world. In *The Millenial Project*, Marshall Savage discusses several options, including protein powder from spirullina algae, pearls, seaweed, fish, and shellfish [Savage1992 pp. 44-57]. Seaweed can be made into paper and textiles. COMMENTS (0)

Seasteads may have a major advantage for mariculture. One reason why the sea is a much harsher environment for life than land is that when things die on land, their remains are readily available for scavenging. When things die in the ocean, they sink to the ocean floor, removing useful resources from the food chain. Natural upwelling zones, which constitute only about 1% of the oceans surface, produce approximately half of the worlds fish. Once OTEC is a viable energy source, or perhaps earlier if wave-powered pumps such as the Isaac's Pump are used, seasteads will be bringing nutrient-dense water to the surface as a side effect of generating power. This can be used as the base for a food chain of aquatic life.

{ expand this discussion? Need references }

Advanced Medical Research and Treatment

Government bureaucracy is a major barrier to medical and biotechnological advancement. The FDA has historically been slow to approve new medical treatments, and promising areas such as stem cell research have been curtailed by governments. Seasteads would be an excellent place for cutting-edge medical research and treatment.

Communication Station

Ships far from land generally communicate via satellites, which are very expensive and have a high lag time. Seasteads could extend this range, providing phone/internet service. The platform would be connected either to an undersea cable, or by bouncing through some relaying platforms. The seastead design's height and stability make it well-suited to being a communication tower.

Virtual Services

This category includes banking and financial services, corporation registration, and internet hosting. Some readers may be surprised to see this category listed so far down, as these have been often proposed as natural businesses for a new nation. Unfortunately, we seen them as problematic. While there is a large market for virtual services, there is also a lot of competition. Any country with a fiber optic connection can enter these industries, and many have. The simplest way to look at it is that the required infrastructure (communications bandwidth) is much, much cheaper on land than at sea. Thus it is unlikely to be a comparative advantage for a floating city.

For example, we believe that one of the reasons HavenCo had difficulty finding customers was that they had to compete with the Bahamas, Panama, Costa Rica, etc., with little extra to offer. Their regulatory advantages were offset by bandwidth and cost disadvantages. Virtual businesses can always switch jurisdictions if there is a crackdown, or locate redundantly in multiple countries. There are better ways (like cryptography) to achieve the desired goals of a data haven than putting it in a remote location.

Financial service industries are quite conservative, and it will be a long time before seasteads are seen as stable enough. Additionally, since these services can be located anywhere, seasteads must compete against the top jurisdictions in the world. And that is a difficult task.

Energy Production

This business model is not exactly far-fetched, given that its what the vast majority of fixed ocean structures have been built for. Besides oil, there is methane hydrate, as well as a wealth of renewable power from the sun, wind, and waves. While such sources are currently not competitive, it is certainly possible they will be in the future. The ocean is a great place to get wind energy, since speed is higher, and energy goes up with the cube of speed. With a large enough budget, OTEC may be feasible. With the right system, wave power could be economical. Nuclear power could be kept offshore to reduce the negative effects of a meltdown (although such problems are very unlikely nowadays). Any of these sources could be used to make hydrogen, which would be shipped away. COMMENTS (0)

As with any seastead business, there will have to be good economic reasons to generate energy on the ocean, since maintenance is more expensive. Since there are substantial transmission losses, it's best to generate electricity close to where it is used. However, as we can see from oil platforms, OTEC, etc., some aspects of this industry actually are suited to being done at sea. COMMENTS (0)

Space Launch

{ is this accurate? I'm sure a space buff will correct me if not. Also, needs pix.}

There are a number of advantages to launching from the ocean. Rockets are dangerous, and its good to have not only a clear area to launch from, but to be over uninhabited areas while going up. Launch vendors have to warn people about potential falling booster stages, and there are a lot less people to worry about on the ocean. Additionally, it makes recovery of booster stages easier, since the ocean is softer than land, and its easier to get anywhere on it, and transport something heavy back. COMMENTS (1)

Also, the earth's equator is the best place to launch from, because you get maximum energy from the Earth's rotation. Heavy regulation in countries like the US slows innovation in the space industry, partly because of these safety risks, and the ocean would be a lower regulation environment. In general, a floating platform is a pretty good place to launch and recover boosters from. COMMENTS (0)

Cargo Transshipment Port

Many people know about the incredible wealth of Hong Kong, an area with few natural resources. Some of them know about the free market policies which helped lead to the wealth. But Hong Kong's placement is also crucial - it is in a convenient location to act as the cargo gateway from Asia to the world. COMMENTS (0)

There are some locations that are naturally suited to transshipment, ie moving cargo between ships. Since a seastead can go anywhere, we can just look at the entire ocean, find the point in the water that would be a bustling port if only there were an island there, and build one. COMMENTS (0)

Aquaculture

If you're not familiar with the term, aquaculture means raising sea creatures like finfish and shellfish. The parallel goes something like: COMMENTS (0)

Hunting	Ranching
Gathering	Farming
Fishing	Aquaculture

Agricultural Revolution	? Aquaculture Revolution ?

If you look at the transition from hunter/gatherer to modern agriculture, you see a huge gain in efficiency which allowed human population to skyrocket. Current ocean fishing techniques are much like hunting. There is a classic tragedy of the commons problem. Each individual gains from depleting the oceans, and no one replenishes them because others would get most of the benefit. Since no one owns them, technology goes into better harvesting and processing, not better production. COMMENTS (0)

The standard way to solve such a problem is to privatize the commons. While some novel schemes for creating property rights in fish have been used in coast areas, it's much harder with migratory ocean fish. But aquaculture solves tis problem, since it generally involves raising fish in huge nets. It seems likely that this will produce a drastically higher output per unit effort, just as happened with food production on land millenia ago. COMMENTS (0)

Not only can we get a cheaper supply of marine products, but there is a huge demand for aquaculture. Not only is the world's population increasing, but people are eating more fish as the health benefits become more widely recognized. There is no other way to meet this demand, besides offshore aquaculture. Production by fishing is expected to remain flat at best, due to the overfishing problems mentioned. Freshwater aquaculture has to compete with all the other demands for freshwater by our growing population. Most seawater aquaculture occurs in coastal regions, which are also in high demand. So offshore is the only way to go, and thus this is a very promising business opportunity for seasteads. COMMENTS (0)

As you can see, there are quite a variety of business possibilities for a seastead. We believe there are many potential customers as well. COMMENTS (2)

Market

{Wayne - There is a market. Residensea, Club Med, general interest} COMMENTS (2)

{ Not clear that this should be a separate section. ie Market depends on Business Model. Should merge. } COMMENTS (0)

Libertarians

> Historically, many new-country projects have been envisioned by freedom-oriented individuals ([Atlantis1994], [Freedonia], [FreedomShip]). Such individuals have contributed time and money to projects much less realistic than seasteading. Thus we think it is reasonable to expect a great deal of interest in our project from the libertarian community once it is clear that our plan is actually feasible. While US National Libertarian Party membership has been steadily declining, we believe that this is a result of libertarians becoming weary of the lack of

results, not a philosophical change in the population. The so-called "War On Terror" is currently adding more bite to the Libs perennial dissatisfaction. COMMENTS (7)

Environmentalists

The past few decades have seen a huge trend towards increased environmental awareness. The Sierra Club had over 600,000 members in 1996 [Sierra1997]. The Nature Conservancy is the nations tenth largest nonprofit, with assets in 2001 of almost three billion dollars, and annual contributions of over five hundred million [NatureCon2001]. Contrast this with 28,000 members of the US National Libertarian Party (as of 11/2001), and you see that environmentalists may be the largest market. Self-sufficient seasteads with their low environmental footprint will have tremendous appeal to these individuals. COMMENTS (0)

Recreational Drug Users

Recreational drugs are illegal almost everywhere in the world. While they are still widely available, prices are high, quality is erratic, selection is poor, and users risk imprisonment and the confiscation of their possessions. The fact that such a market exists despite these factors is indication of the vast demand for these products. We believe that there is a substantial market for a facility which offers a wide variety of high-quality drugs in a legal setting with available medical care in case of emergency. Even after the extra costs for "doing things right", such as medical facilities and rigorous purity testing, the profit margin for recreational drugs is immense. COMMENTS (0)

One particularly interesting part of this market is for those individuals interested in receiving psychological therapy which uses psychedelic drugs as part of the counseling. For example, MDMA (ecstasy) was widely used for this purpose while it was legal. The Multidisciplinary Association for Psychedelic Studies (MAPS) has received FDA approval for a $5M, 5-year clinical study to evaluate MDMA for the treatment of post-traumatic stress disorder [Doblin2002]. Anecdotal reports of the success of MDMA-based psychotherapy for individuals unable to progress through conventional methods are extremely positive [Shulgin1991 pp. 69-75, Shulgin1997, Stafford1992 pp 78-80]. Several other psychedelic drugs have shown great promise in studies as well, such as LSD [Stafford1992, pp. 78-82]. COMMENTS (0)

One positive aspect of this kind of drug use is the resulting publicity. While using drugs recreationally has a negative association, medical use is seen in a positive light. Medical marijuana treatment is a good example, and as some conditions require chronic use, it is more likely that sufferers will find it worthwhile to move because of their condition. At least two individuals (Steve Kubby and Renee Boje) have sought political refuge in Canada because the US would not allow them access to medical marijuana. COMMENTS (0)

Note that the extreme paranoia of the US about drugs may restrict the possible locations for seasteads catering to this market. For example, the Caribbean might be close enough to make Uncle Sam uncomfortable. COMMENTS (0)

Deep-sea Sport Fishermen

These people are just as fanatic about their hobby as anybody. They will spend serious amounts of money to bag a tuna or the like. They might like the option of being able to camp out on a seastead at night rather than always having to return to shore or camp out in the crowded ship. This requires that the seastead be parked where deep sea fishing occurs. COMMENTS (0)

Scuba Divers

Scuba divers are another hobbyist group that loves to spend money. If the seastead is parked near some interesting reefs, it becomes a reasonable place for them to visit. COMMENTS (0)

Boaters

People who own and operate boats (sail or motor-powered) often have extra money on their hands. They might like the challenge of locating and visiting a seastead. If there are interesting facilities on board, so much the better. COMMENTS (0)

Aviators

People with personal helicopters and STOL aircraft might like the challenge of landing at a seastead. COMMENTS (1)

Commercial Fishermen

Seasteads could provide supplies, storage, and general support for commercial fishing, as well as emergency medical facilities. COMMENTS (1)

Some combination of these approaches will likely be used. For example, a residential seastead (condo, time-share, or hotel) might devote part of its area to research experiments. Since it would have a dock and infrastructure, it might as well sell its amenities to boaters. Residents would have access to a digital library, as well as deep-sea fishing and scuba diving equipment. Fishing, diving, and interesting tours would help fill hotel rooms. As time goes on, the market will determine which seastead services have the greatest demand. COMMENTS (0)

One may well ask how a seastead can compete against a world full of other recreation options. There are many resorts, each competing to lure travelers - isn't the competition tough? Won't the primitive amenities be a major downside? It is clear, however, that there is a demand for resorts with primitive amenities, since many exist. We can't initially offer tennis courts and the comforts of home, but even if that rules out 99% of vacationers, that's OK. All we need to do is appeal sufficiently to a minority that they prefer us over other options. We think that the novelty of a seastead as a work of engineering, an environmentally sustainable community, and an experiment in self-governance will get us that minority. COMMENTS (0)

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Seasteading: Making It Happen

Making It Happen

{Patri}

This next section contains our opinions about the current state of affairs with regards to making seasteading happen. COMMENTS (2)

Ways That Don't Work

There is a common element which shows up over and over in the new-country projects which have failed (almost all of them). It is unrealism, such as denial of current international policies, dependence on a nonexistent technology, and so forth. Some typical examples are: COMMENTS (0)

> **Antarctic Homesteading**: A 60-page single-spaced typescript prospectus for this project was forwarded by the editor of *Free Country Newsletter*...The basic concept is for people to go to Antarctica and settle. A scenario is laid out to start unfolding in 1981, beginning at a Southern California conference, with growth from 1,000 people to 4,000,000 by 1985, but there is no indication that anything was every done. The financial base was to be concerts by John Lennon (no indicating that he was ever contacted), films in the Jacques Cousteau genre of Antarctic sunrise and sunset, and international conferences on religion and war and liberty...This is a typical example of new-country projects that are mainly used as vehicles for the organizers' daydreams (a practice by no means limited to the political left, as others of these case histories shows), with little regard for the harsher realities of the world - such as the fact that the great powers are unlikely to permit claims to Antarctic territory to become established facts (just recently, the British forcibly removed an Argentine weather station in the Antarctic). [Strauss1984, p. 54-55]

> **Oceana**: The idea germinated in 1969, among an Americal college group oriented to the Objectivist writings of Ayn Rand...This can be viewed as an illustration of the problem of attracting too many chiefs, and not enough Indians. Because Oceana was essentially a zero-dollar operation, and thus couldn't offer immediate material incentives, it fell naturally (though inadvertently) into the trap of gaining recruits by (implicitly) offering them a full voice in the running of the venture. Thus a high proportion of people were attracted whose main interest was in endless fantasizing and dickering over details. When the time came for a commmitment to be made...the idle bull-session types took their leave. [Strauss1984, p. 111-112]

These stories are common, and while we hope that the organizers enjoyed their daydreams, we seek a more tangible payoff. COMMENTS (0)

The most common form of unrealism is probably scale, visions which are huge and expensive. Given enough money and will it is possible to build just about any kind of structure in the middle of the ocean that you can think about. Unfortunately, the tough part is coming up with enough capital to make it happen. Let us examine the state of a few relevant projects which attracted a fair amount of interest. COMMENTS (0)

There has been very little visible progress with the Atlantis project for quite a while. Their webpage states that the project is defunct. COMMENTS (0)

The Aquarius portion of the New Millennium project seems to have gone through a number of phases: COMMENTS (1)

Phase 1 (Enthusiasm):
    Initial enthusiasm and excitement
Phase 2 (Replan):
    Several replans to reduce project costs
Phase 3 (Bummer):
    The growing realization that even the rescaled plans are still too expensive
Phase 4 (Slow Death):
    Growing disenchantment with the whole project and a slow exodus of people working on the project. (This last part is still a bit speculative.)

Similarly, New Utopia seems to have gone through some phases of initial enthusiasm, planning, and then the realization that it wasn't going to happen. The realists then left, leaving the project in the hands of those unable or unwilling to acknowledge the facts. Ian Sawyer's comments are a good indication of this: COMMENTS (2)

> I was involved with the project as one of the Board of Governors from early 1998 through to late 1999, resigning after very major problems started appearing in the whole basis of the legality of New Utopia and Prince Lazarus' dogmatic and dictatorial approach to them. Unfortunately I am restricted somewhat on what I can say as the result of a court ruling following a spectacularly unsuccessful attempt by Lazarus to sue me and a colleague for $10 billion, however there are copies of all the correspondence, which include the legal basis for the reasons I resigned from the project and all the subsequent comments by Lazarus and others, on the New Utopia Discussions Group with Yahoo at http://groups.yahoo.com/group/new-utopia, starting in October 1999. There have been further exchanges on the present position of New Utopia as late as the end of 2000 when it seems to have regrettably become little more than a scam.

Other nation founding groups seem to have similar lifecycles, where an initial burst of enthusiasm gives way to a growing realization that it will be impossible, or at least a huge amount of work, to turn vision into reality. Basically, the amount of capital (billions) required to build these places is simply too high to be obtainable. It is awfully hard to make a business case for something new, huge, and expensive. This is why we've chosen an approach which reduces the required capital by several orders of magnitude. COMMENTS (0)

Incrementalism

Incremental Prototypes

Large things tend to grow organically, rather than being monolithically designed and built. We believe that focusing on grand results has two detrimental effects on a project: it distracts people with fantasy and it intimidates them from doing real work. By dividing our vision into workable chunks, each of which builds on the last, it has a much better chance of becoming reality. By keeping the initial costs low, it is possible to build the initial versions and show potential investors what they are getting into at each step of the way. COMMENTS (0)

We see the succession of seasteads as something like: COMMENTS (1)

Bathstead

This is little more than a small model that floats in a bathtub or an aquarium. It is useful to provide people a visual model of what is being attempted. The total platform area is about 100 cm^2. It can be brought to talks and conferences. If there is interest, a number of small models could be produced and sold to enthusiasts.

Poolstead

This a 1-2 m^2 platform that floata in a pool. It demonstrates basic stability and flotation principles. Wayne and Patri have experimented with building a Poolstead, although the design has since changed.

Baystead

This is the first habitation-sized platform, which is designed to live in sheltered waters such as the San Francisco Bay. While it would generate its own power and water, and grow some food, the residents could still buy propane and go to the grocery store for food. It is small enough to be easily funded by the residents ($25K-$100K each), and will serve as a demonstration of the concept. This is big enough to get signifcant publicity.

Coaststead

This is a tall, multi-level platform that can be towed out to the coastal regions of the ocean (international waters). In the event of a major storm, the owners may elect to have the device towed back into sheltered waters. It does not need to be fully self-sufficient. A detailed proposal for Coaststead can be found below. We expect it to cost between $400K and $1M dollars, and have room for 5-15 people. Coast may not be necessary along the path to autonomous territory, for there is a good chance of going from Bay directly to Lite. However there will be locations and uses for which Coast is the best size, so it will eventually be a seastead model.

Seastead Lite / Medstead

Locations such as the Mediterranean and Caribbean Seas are partially sheltered, and an excellent place to build a stead that is large, but not able to handle the 100+ foot waves that sometimes occur in the deep ocean. These areas are large enough that a large floating community could form, but small enough that trade with many other nations is quite feasible. Lite has a top deck of 5,000 m^2, and will cost $3M - $15M.

Deep-Seastead

This is the final version with a column hundreds of feet long and lots of living area, intended to live out in the deep ocean. It should be almost entirely self-sufficient for necessities, and able to withstand any storm. A proposal for getting to the first Deep-Seastead can be found below.

Each prototype will be larger, more expensive, able to deal with larger waves, and be more self-sufficient. While early ones may be built by volunteers, once we reach the Baystead or Coaststead stage, professional engineers and contractors will be hired. With enough interest and experienced engineers, it may be possible to jump directly to Baystead. While this may seem contrary to the succession idea, note that Baystead is still ten thousand times cheaper than the Freedom Ship - so we think its a reasonable starting point. COMMENTS (7)

If we had to select an initial site for a prototype seastead to be anchored, we would probably select either the San Francisco Bay Area or the Puget Sound. Why? The computer industry has generated a simply astonishing number of individual multi-millionaires in the San Francisco Bay and Seattle areas. The future phases of seastead development could definitely benefit from the positive attention of a few millionaires. By locating the initial seastead prototype in one of these two areas, it is far more likely that one of these multi-millionaires will become interested in the seasteading project. Also two of the papers authors, Wayne and Patri, live in the SF Bay Area. COMMENTS (2)

For credibility reasons, it is crucially important to have a large, self-funded prototype like Baystead or Coaststead before trying to attract people interested in larger platforms. There have been so many failed nation-founding projects that we must make a concrete demonstration that seasteading is different if we expect anyone to take us seriously. Such a prototype is likely to result in a lot of media attention. For example, Andrea Zittel described her Pocket Property experience in an interview: COMMENTS (0)

> *AZ: Another problem was that I had fantasized about being completely alone on it in order to recover from a really hectic year. Instead, when I got out to the island, it seemed like every single boat owner in Denmark came out to circle my island while drinking a six-pack of Danish beer Every time I came out, they would all wave and ask what I was doing. After a while I just felt so overexposed that for the next project I've chosen a piece of land out in the desert, where no one will see me and I can finally be completely alone.* COMMENTS (0)
>
> *SB: You thought you were hiding, or going away to be alone, and all of a sudden you were on display and less alone than had you just stayed at home.* COMMENTS (0)
>
> *AZ:I was like a freak show out there!* COMMENTS (0)
>
> [Bomb2001]

Incremental Infrastructure

It is not only the seastead structures which will proceed incrementally. Part of the essential nature of a seastead is to provide infrastructure where it previously did not exist. But to build infrastructure takes infrastructure, so this process will also be incremental. By infrastructure we don't just mean utilities, but all of the services which help a city to function. COMMENTS (0)

Initially, the level of infrastructure on a seastead will be low, and services will be expensive. Thus it behooves the developers to start with the businesses which least rely on infrastructure, or benefit the most from the seastead environment. With these businesses operating, the seasetad can expand. Now experience and economies of scale will lower the infrastructure costs, allowing a wider range of businesses to be cost-effective. And so on. COMMENTS (0)

This is the same organic way in which real cities grow. New York did not start with skyscrapers, it started with pioneers. Seasteads will be able to progress much more quickly, but they must still go through the same incremental process. If it sometimes seems like we focus overly much on the initial, rough levels of infrastructure, its not because we don't want to build a floating Hong Kong. Its because this is what's required at the beginning, and the beginning of nation-founding appears to be very difficult. We believe its vital to focus on starting the process, and not be too distracted by visions of the end results. COMMENTS (2)

Eric Hunting suggests an interesting strategy for incremental growth of a floating city. Rather than building the city all at once and immediately towing it into location, build it piece by piece close to a major city. Residents slowly and steadily move on-board, while still having access to the infrastructure of civilization, which serves to supplement and back up the developing infrastructure of the new colony. This allows people to get to know each other, get used to self-sufficiency technology, and steadily transition their work to the new economy. As various milestones are reached, the growing structure can be moved farther away. Eventually, when it is complete enough, the colony can be towed to its final location.[Hunting2001] COMMENTS (0)

A possible variation is that instead of moving away the entire colony, the initial "seed" unit could remain behind, to start the growth of another city. People who were not yet ready to leave could stay with the seed. COMMENTS (0)

Incremental People

The same ideas that apply to incrementally growing infrastructure apply to growing the seastead population. The initial seastead environment will be high in freedom but low in infrastructure. Thus we must start out with the few enthusiasts willing to trade comfort for freedom. They will create an environment of higher comfort, and can bring in those who need that higher level. The process repeats, with each expansion lowering the costs and increasing the comfort, and thus making possible the next expansion. COMMENTS (0)

Similarly we anticipate that many of the initial residents will live onboard only part-time. (Many more people vacation in rustic cabins than live in them year-round). But their presence and economic contributions will allow the colony to grow, and thus make it more suitable for full-time residence. While seasteads are not terribly expensive compared to first world housing, timesharing aids with two potential financial roadblocks. COMMENTS (0)

One is that mortgages will not be available for quite awhile, so individuals will proably need to pay up front. Timesharing means that they can steadily pay for more and more shares until they are full-time. This is not as convenient as a mortgage, since the person can only live there as often as they've paid for instead of moving in at the beginning and paying interest. But its still better than having to pay the whole thing before enjoying any of it. COMMENTS (0)

The second is that the number of jobs onboard will be limited at first. This especially applies to high-paying jobs, which tend to be in specialized fields which require a large population to support. So the prospective full-time seasteader must either be independently wealthy or be able to run a business on board. While there will be some people like this, its a small market. Timesharing lets people earn their main income elsewhere while the internal economy develops. COMMENTS (2)

Our Proposal

We now proceed to get more detailed, and describe the specific approach we feel is the best way to make seasteading happen. While this particular plan will take a lot of work and needs a lot more fleshing out, we do not believe that it involves any miracles. It does not require a billion-dollar investor or loan. It does not require ten thousand (or even a thousand, or a hundred) people to leave their lives and move permanently into the middle of nowhere. It does not require the technology of tomorrow, only of yesterday and today. Nor, we must humbly add, is this because of any particular brilliance on our part. We've simply done the research, evaluated the alternatives, and made our choices based on realism, not romance. COMMENTS (3)

We propose the founding of the Seastead Development Corporation, whose goal will be to make money by building seasteads. A small group of devoted people, including SDC's founders, will be its first customers, buying the Coaststead prototype. SDC's capitalization beyond this will be quite small. COMMENTS (2)

Coastsead will be permanently moored, most likely in the San Francisco Bay. It will be open to tours by those who are interested in learning more about this new way of life. The goal is publicity and creating a market for the next product, timeshares on Seastead I, a full-size self-sufficient deep-ocean platform. Think of Coaststead as a floating Goodyear Blimp. Having built an actual structure, we will have made more progress than 99% of all nation founding attempts, which gives us credibility. COMMENTS (1)

We believe that there is a substantial market for timeshares in Seastead I. We will not be requiring a whole-life committment, a large amount of money, or dedicated volounteer labor from our customers. We will not ask for a major leap of faith on their part, as a 1,000,000 pound token of the practicality of our vision will be floating under them while they ponder the idea. COMMENTS (2)

When enough deposits have been made and contracts signed with residents, construction on Seastead I will begin. At this point, with the first seastead funded, the hardest part of the work has been done, and the movement can take off on its own steam. Once an operating Seastead I is demonstrating that seasteading is technologically, financially, and politically feasible, interest will continue to grow. COMMENTS (1)

As seacities develop, the seaconomy will grow, and seasteading can become a full-time way of life for an increasing number of people. Different political and legal systems will be experimented with, and the most succesful emulated. Seasteads will have become, not a utopia (which is impossible), but an incremental improvement, a freer and more adaptable form of life. That is our goal. But while we must keep it in the back of our mind, our focus should be on the next couple steps. Thus we proceed to your contribution and then a more detailed business plan. COMMENTS (2)

The Choice Is Yours

Let us compare this strategy with the strategies being employed by the Atlantis, Millennium, and New Utopia projects. All three of these projects require significant up front investment from investors. Which strategy do you think has a greater chance of happening? A bootstrapping process from small prototype seasteads or going straight to the ultimate city on an artificial island that skips all the intermediate steps? Our opinion is that the bootstrapping process is far more likely to succeed. COMMENTS (0)

How Can I Help?

{Wayne} COMMENTS (0)

{ I've been doing some work on this section - P } COMMENTS (5)

{Link from ss/index.html}

We'd like to start by thanking you for your interest. In order to make the tough transition from dream to reality, the seasteading movement needs supporters. People who understand that talk is cheap, that it takes a lot of time, effort, and money to create a new way of living, but still agree that it will ultimately be worthwhile. If you are a realistic visionary like ourselves, hard-headed and open-minded, we'd love to have you participate. COMMENTS (MANY)

For the project to work, however, we think its important to expand steadily and gradually. That incremental approach is at the core of our philosophy. Its a huge project, and will require labor and money from lots of people to achieve true success, but we think its important to go step-by-step. Committees don't govern effectively, and effort spread too widely tends to be poorly focused. We want to weld our group of supporters and volunteers into a solid structure, but rushing will only result in a disorganized and vaguely committed crowd. For this reason, we prefer to slowly bring people into well-defined roles. COMMENTS (0)

Here are some of the ways in which we envision people contributing time, money, and professional skills. They are listed in approximate order of when the help will be needed. COMMENTS (0)

- **Paper Review**
  The current stage of the project consists of performing the fundamental research which will guide our choices later on. Helpful comments, constructive criticism, and pointers to relevant information are all useful. Send us email, or utilize the commenting system. COMMENTS (0)
- **Baystead - Founders**
  Baystead requires a small group of founders to fund its construction and then live on board. While we can take this role entirely ourselves (and will if necessary), for a number of reasons we'd prefer to share it. The cost will be on the order of $50K - $250K per person, most likely about $100K/p. Unlike normal real estate, there are no seastead mortgages and the market for baysteads is not yet liquid, which means this is more of a financial commitment than buying a house. Interested individuals should be enthusiastic about running their own infrastructure, experimenting with a new lifestyle, and sharing that lifestyle with visitors. They must also want to live in the SF Bay area. Useful skills, experience with communal living, and a desire to help achieve the larger vision are a plus. We are likely to be somewhat picky in order to make sure incompatibilities don't cause problems. COMMENTS (2)
- **Baystead - Supporters**
  As a trial version of the seastead timeshare system, we plan to have a Baystead Supporters program. Basically, Supporters would donate some time or money, and have the right to come stay on Baystead some number of days a year. While we are leery of anything which seems like asking for money or could be construed as being a scam, we

have personal acquaintances, at the least, who have expressed interest in such a plan. And since Supporter money is not required for construction, skeptical individuals are welcome to wait until they've seen a built Baystead with their own eyes. { This will be written up in more detail elsewhere and referenced here - P } COMMENTS (1)

- **Baystead - Builders**
  Just like building a house, there will be a lot of work involved in building baystead. While the superstructure will likely be built professionally, there will be tons of flooring, plastering, piping, painting, etc. We've had several people offer to help with this stage already, and will gladly accept volunteer labor. This will be another way to achieve Baystead Supporter status, as described above. COMMENTS (2)
- **Seastead Research Team**
  There are lots of research experiments to be done on various aspects of seastead life. In fact, we expect this to be the case for pretty much the foreseeable future, even when there are many seasteads. Unlike the academic world, much of this research should be perfectly doable by ordinary folk. Baystead is a great place for research, by the residents and by visiting Supporters. But research can also be done by interested people anywhere else in the world. We're holding off on creating a research program until we've built Baystead, which we see as a higher priority. (Though if someone else wants to do the work now...) COMMENTS (0)
- **SDC - Founders**
  When it comes time to found a Seastead Development Corp., we'll need some business partners / investors / employees. When the time comes, we'll announce what skills we are looking for. We're likely to be very picky, as with any business venture. COMMENTS (0)
- **Seastead I - Principals**
  The first sovereign seastead will need a core group of full-time residents. This group will likely serve multiple roles as residents, employees (doing the jobs needed to keep things running) and investors (since they will own much larger shares than a timeshare residents, and are the most likely people to own multiple shares for rent or later sale). COMMENTS (1)
- **Seastead I - Timesharers** {We need a cleverer name for part-time residents }
  While the Principals are the depth of membership, Timesharers are the breadth. This is a vital role, and will likely make up the bulk of seastead funding, and certainly the largest number of residents. Most people will begin by participating in this manner, because they are interested in someday becoming full-time seasteaders, but are not yet ready to move their whole lives (which we find perfectly reasonable). Seasteading will be driven by demand from customers. The sooner we can get people to sign up, the sooner it will happen. People willing to put down deposits count for much more than those who just express interest. We'll let you know when we're in a position to accept them. COMMENTS (2)

If you are interested in one of these roles, drop us a line and we'll put you on our lists. COMMENTS (3)

{ This is an older version, will be revised and merged} COMMENTS (0)

Skills we'll need: . Lawyer (general - contracts, IBC's, escrow). Lawyer (International maritime law). Researcher (good academic credentials, knowledge of grant practice, relevant research. Basically, ability and reputation to get grants to do research on Coaststead). Teacher/Tour guide (ability to design and lead tours of Coaststead's science). Gardener (knowledge of hydroponics, ability to design, put together, and then maintain. Perhaps experiment too). Engineer (marine). Engineer (relevant infrastructure: renewable energy generation, sewage, water, etc.). Perhaps just a general maintenance handy-man. Sales/Marketing. Ship captain (preferably w/ tugboat experience). Hotel Management experience. Timeshare sales or financing. If you fit one of these categories, or think that your skills would be useful, drop a resume (or short description of your experience) to employees@seastead.org. Let us know when you'd be ready to work and whether you are interested in a land, Coaststead, or Seastead position. COMMENTS (0)

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Seasteading: Miscellaneous

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Miscellaneous

Internet Discussion Groups

There are a number of internet discussion groups on topics related to seasteading. Eventually, if our ideas take root, there may be seastead-specific ones. For now, here are the ones we've seen: { Chime in if you know of others } COMMENTS (0)

- Floating-Cities is one of the Reality Sculptors mailing lists. It is based on Patrick Salsbury's paper Oceana: A Proposal For A New Country [Salsbury1992]. COMMENTS (0)
- Nation-Builders is a Yahoo group described as *"Dedicated to those seeking to establish new, free nations not tied to existing States. All formulas considered - floating cities, leasing land from existing States, artificial islands and whatever participants come up with. Concentrates on financial, technical, tactical and strategic issues. Complements Libertarian-Nation list, q.v. "* COMMENTS (0)
- libertarianisland is a Yahoo group created in 10/2003. Its description states *"Space may be the final frontier, but the ocean is the frontier that can be populated now, and for a lot less money. Living in international waters has a few distinctly libertarian advantages. No taxes. No government. No laws, but then, the really nasty people (government, bankers, lawyers, clergy and corporations) will not have an oppressive, thieving, police state government to protect them here. Since the island will be built in international waters there is no limit (other than your resources) to the size of your area. Most of the elements are dissolved in the ocean and can be mined from the brine left after the*

water molecules are converted to hydrogen and oxygen. " COMMENTS (0)

- Transtopia is a Yahoo group devoted to the transtopia island project, which aims to create a community of transhumanists. They consider buying an island, creating one, or using ships. While the main project seems fairly defunct, there is some interesting material in the list archives, and sometimes on the list. COMMENTS (0)

Environmental Impact

When properly designed, a seastead's environmental impact can be quite low. It will be up to the residents to specify their environmental polices and choose appropriate technologies. We've started writing a low-impact environmental plan for residential seasteads. COMMENTS (4)

Intentional Community

For most of our existence, humans have lived in tribes or extended families. This helps make better use of scarce resources such as housing, heating, etc. Only in the past century has the first world achieved the wealth for each nuclear family to have its own dwelling, appliances, and utiltiies. While there are clearly advantages to this, some people find it unsatisfying to be so isolated. The Co-housing, or Intentional Community movement has developed in response to this. An IC is any group of people deliberately living together, which can mean anything from a college co-op to a commune. COMMENTS (1)

When seasteading, especially towards the beginning, space, utilities, and appliances will be expensive. Hence seasteaders will almost certainly want to use the techniques of communal living. For example, sharing the use of energy-efficient appliances, workshops, boats, a helicopter, an internet connection, and so forth. COMMENTS (0)

Communities are strongest when united by shared ideals, and it seems quite likely that early seasteads will exist largely for ideological reasons. This gives an additional reason why they will be communal in nature. Also, being isolated will increase interdependence among seasteaders. Note that communal does not necessarily mean a communist society where all property is owned jointly. It simply means that the line between what portion of property is public and private will likely be a bit farther than in normal society. People's lives and property will be more intertwined. COMMENTS (0)

This does not necessarily mean loss of control, in fact there are some ways in which it can result in the opposite. One of these public sectors will be the basic infrastructure of the entire platform. In normal living, such utilities are owned by large companies, often monopolies, and it is difficult for one customer to have any control. When a small group of 100 owns the utility, individuals will have much greater say in how it is run. COMMENTS (0)

As they will draw on the green movement for physical technologies, seasteads would be wise to draw on the intentional community movement for communal technologies. These people have useful experience about topics like architectural design - how to lay out common spaces. We would suggest hiring consultants like the CoHousing Company to help with such aspects [CoHoCo]. COMMENTS (0)

The Word Seasteading

While author Wayne Gramlich came up with this name independently, the term seasteading has been used in the US since as early as 1969. In that year it was mentioned in the Stratton report, which led to the creation of the NOAA [Stratton1969]. There was even a magazine briefly published on the topic in the 1970's [Clark2001]. COMMENTS (1)

Intriguingly, Seastead is also the americanization of a Swedish name. Bryan Seastead emailed us to say: COMMENTS (0)

> Our name Seastead, means "Homestead by the Sea" and is spelled "Sjostedt" in swedish. It is a name I think that is a couple hundred years old given by the swedish military when Swede's suddenly needed last names and my ancestors from Lake Skara, adopted Sjostedt when they went into the service. Then years later, moved to the US to spawn American born "Seastead's".

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Seasteading: Frequently Asked Questions

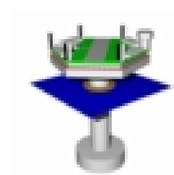
Seasteading FAQ

Note: This FAQ is out of date. We are using the FAQ from the beta version of the book now. Go here

This is a basic Frequently Asked Questions file for seasteading. Most sections originated from email responses to questions. If you have additional questions, feel free to enter them in comments in the rest of the text, or on this paragraph. We'll enter the frequently asked ones here. This material serves only to supplement the remainder of the text, which contains much more information. COMMENTS (2)

Basics

What's a Seastead?



"*Seasteading*" means to create permanent dwellings on oceans. Homesteading the high seas. A seastead is a structure specifically designed for the purpose of long-term living in the marine environment. On the right you can see our conception of what such a structure looks like. More detailed pictures are in the section on our design.

Why Build Seasteads?

See the book section Why - Motivation. The main reason is for political freedom, which many people desire for many reasons. Additionally, we have reasons to expect the governments of seastead societies to function much better than on land.

Why is it so expensive?

Some people think our cost estimates are surprisingly cheap, others that they are tremendously expensive and we are restricting our nation to the very rich. Clearly there are some different viewpoints on the subject! Our basic view is that we want the lowest cost which is compatible with our goals, including safety and realism.

One thing to keep in mind is that the ocean is a brutal environment. And we are not just building buildings, we are building **real estate**, we want it to last. Another important point is that this is the first-generation. Just like with any other product, earlier runs are more expensive. Eventually, as volume increases, costs come down, and more people can participate. Seasteads are no different. The early adopters help pay the research costs. COMMENTS (0)

The costs that we are talking about (say \$50 - \$200 / ft^2 final cost to residents) are not drastically out of line with first world house prices. Its not New Hampshire, but its still less than Silicon Valley. If these estimates are right, we can build brand-new sovereign territory for a cost similar to the housing of many upper-class americans. To us, this seems incredibly encouraging! COMMENTS (0)

We think there will still be some room for people with lower incomes to participate by renting space onboard, just as in normal housing markets. This is more difficult because seasteads can't be built with low-interest bank mortgages like houses. But this stems from the unique nature of the project and will be difficult to avoid. We are not ignoring those with less money, and we believe that in the long-run, they will benefit from seasteading also. But it takes cash to start the ball rolling. COMMENTS (0)

Also see the related question: How will you pay for seasteads? COMMENTS (0)

Engineering

Won't a seastead bob in the waves and be unpleasant to live on?

People often ask whether a seastead will bob uncomfortably in the waves. Because our design has little cross-section and little flotation at water-level, it will actually be quite steady. See Designs - Bobbing for a more detailed explanation. COMMENTS (0)

Will a seastead tilt over in strong winds?

The short answer is "A little, but not very much", and the basic reason is that seastead's are very, very heavy. For the more technically inclined, they have a very high weight to surface area ratio, and their righting force increases with angle of deflection (it gets leverage). A free-floating seastead will list even less, as it will get pushed instead. COMMENTS (2)

If ferrocement is so cheap and wonderful, why doesn't everyone use it?

Ah, a healthy skepticism - excellent. The answer is that ferrocement has a bad strength:weight ratio, hence is poorly suited to mobile applications like ships. Most marine structures are mobile and care about weight. While there was a ferrocement boat movement, and quite a number of ferrocement hulls have been built, stronger, lighter materials like steel (for larger boats) and fiberglass (for smaller ones) are much more common. COMMENTS (0)

However, non-mobile marine structures, like piers and docks, often *are* made out of concrete. So are some oil rigs, like the mammoth Troll A { link }. Its not that its perfect for everything, just for large, non-mobile marine structures. COMMENTS (MANY)

Alternative Strategies

Why not just buy a boat?

This is a good question, and there are certainly some advantages to the boat approach. It makes fitting into international law easier. Transportation is cheaper, so a boatstead could move much more often. It would be easy to start out, because you just buy a boat, rather than having to design a whole new type of structure. And then people can join you just by buying additional boats of their own. Cruise ships demonstrate that big boats can be floating cities. COMMENTS (5)

However, there are substantial disadvantages to using boats rather than platforms. COMMENTS (0)

- **Purpose**. The two structures are designed for different purposes. Boats are made to travel from place to place through the ocean, while seasteads are designed to live in. Its much like the difference between a house and a car. Sure you can live in an RV - but its just not as comfortable. COMMENTS (0)
- **Wave coupling**. Boats are coupled to the waves (see Design-Bobbing for why). This makes them dangerous during storms, and somewhat uncomfortable when there are significant waves. Seasteads are mostly uncoupled from the waves, so they don't bob or rock. This is a nice feature for a permanent residence. Boats must be very large to not move, and our incremental approach dictates starting small. Also, if there are any waves, this coupling makes it very difficult to attach multiple boats into a large community. COMMENTS (2)
- **Solar area and living volume**. Its very important to have enough solar area per person (for growing things, solar power, passive solar, etc.). While you can grow some food on a boat (see [Neumeyer1982]), its still problematic. Its also good to have a reasonable amount of volume, for comfort, working room, storage, etc. Normal boats, known as monohulls, don't maximize for solar area (deck space), and so are inefficient on that margin. With their geometry, a big solar area would mean a big hull with lots of drag. Catamarans have a lot more solar area, but still very little volume. Boats in

general are extremely cramped to live in, because their purpose is to travel efficiently. COMMENTS (0)

- **Cost**. Seasteads are made out of concrete and rebar, which are incredibly cheap building materials. Boats are made to be lightweight, so they are usually made out of much more expensive materials (steel). Our cost estimates and knowledge of boat prices are both rough, but from the limited data it is not clear to us that boats are less expensive.

  Our seastead design is on the order of \$35 / ft^2 (interior area), \$100/ft^2 (solar area), including infrastructure. Some brief research suggested that used cargo ships cost somewhere around \$100/ft^2 of deck space, without all the expensive sustainability infrastructure. If boats don't offer a cost savings, they are much less attractive. It might be that very large ships are cheaper, but again you have the problem of how to start small. COMMENTS (1)
- **Infrastrucure**. Boats are not built for long-term living, and so must be retrofitted. This means the infrastructure is likely to be more expensive, or not work as well, because it was not part of the design from the beginning. Seasteads are designed for how they will be used. COMMENTS (0)
- **Marketing/publicity**. Its important that this seem like "a new way of life", and that seasteads look neat. People are more likely to be interested in it, magazines to write articles about it and so forth if it looks cool and different. COMMENTS (1)

Weighing these factors, we think our seastead design is a better approach. However, boatsteading is a pretty reasonable strategy as well. COMMENTS (0)

Why not just buy an island?

If mere isolation is your goal, buying an island will work just fine. For political sovereignty, however, it is useless. Strauss gives some of the reasons why countries don't sell sovereignty: COMMENTS (0)

> *There are reasons for existing countries to be reluctant to sell sovereignty over pieces of their territories. The closest thing to sale of sovereignty that is conducted routinely is the sale of corporation charters and ship registrations...but any number of those can be sold without reducing the size of the country doing the selling. In addition, such sales produce revenue year after year, in the form of renewal fees. And in the case of emergency (e.g. embarrassing activities by the buyer), the seller can decline to renew the1 charter of registration. But there is only so much land a nation has to which to sell sovereignty...and once it's sold, there is no further income to be had.*
> *There is also the great-power factor...These great powers tend to want to see the status quo maintained...the fewer the players there are in the international game, the easier it is for the great powers to manage things to their own advantage. A*

> *country selling sovereignty would face being cut of from the aid, trade, etc. that the great powers can offer. Thus they are only interested in doing such things if there's a large, ongoing profit to be realized...The small countries really aren't interested in taking the grief that would be involved in selling sovereignty just for a few, one-shot payments from buyers.* [Strauss1984, pp. 12-13]

An important piece of data is that there is pretty much no such thing as an "unclaimed" island. Even if an island is unoccupied, it extends the owning country's EEZ, including fishing and mineral rights, which are always of potential value. COMMENTS (0)

While its theoretically possible that a country could be convinced to sell sovereign title to some of its land, this path is difficult, uncertain, and extremely expensive. Hence it does not seem like a good way to proceed. COMMENTS (3)

Why not just buy a third world country?

One person wrote in email: *"For the investment required to build 100 acres of floating condo, you could take over three Third World hellholes, complete with workforce and low-quality army."* COMMENTS (1)

This seems like a rather poor idea to us, for these reasons: COMMENTS (0)

- **Scale**. The idea doesn't scale. How do you take over 1/20th of a third world country? Whereas you can build just one self-sufficient platform. The incremental approach is key to making this happen. COMMENTS (0)
- **Mass market appeal**. Timeshares on seasteads will appeal to a large market - environmentalists, libertarians, etc. Helping take over a third world country seems like something only a few zealots would be interested in. For example, the inequality is likely to make liberals unhappy. The use of force will bother pacifists of liberal and libertarian stripe. COMMENTS (0)
- **Blood**. It only takes cash and sweat to start seasteading. You start taking over countries and you risk your life. This shrinks the market of interested founders. COMMENTS (0)
- **How?** We can see the path to sovereignty via floating platforms. We haven't the slightest clue how to take over a world country. COMMENTS (0)
- **Revolution**. If 100 people build and live on a seastead, they only have to worry about external threats. If 100 people take over a 10,000 person 3rd world country, they must always worry that the displaced locals will grow restless and revolt (and who could blame them?). COMMENTS (0)
- **Dynamic Geography**. This idea is key to making new socities an improvement over the old. And it doesn't work on land. COMMENTS (0)

If you don't like governments, why not just be a hermit and leave?

Potential seasteaders don't dislike people, they dislike the currently available systems. They don't want isolation, they want to be part of a community, but one which operates under rules which are currently unavailable. Seasteading is not just about freedom, its about freedom, infrastructure, and community united in one place. COMMENTS (0)

Why run away instead of staying and changing the system?

Many people see separatist movements like seasteading as a cop out, running away from problems instead of confronting them. While we think it is noble to try to change a system, we believe its important to be honest about how much you can accomplish. For example, a minority viewpoint such as libertarianism is unlikely to ever be accepted by a large country. In a democracy, this means the minority view will not prevail. Some people's solution is to proselytize. While winning more converts always helps a philosophy, we think a successful example helps it even more. And it seems far easier to create a small society with the already-converted than to convert a hundred million to a minority view. COMMENTS (1)

In addition, we think there are serious structural problems with current systems. Activism cannot change the static nature of land's geography, and we think this greatly limits how well any political system can work. Moving to the oceans is not simply running away, since we believe that dynamic geography addresses one of the root causes for bad government. COMMENTS (0)

The system is hard to change, and many people do not want to change. There are many minority philosophies, and they cannot all rule a country. We think that leading by example, living one's own philosophy rather than just talking about it, is a great form of activism. COMMENTS (0)

Why it Won't Work

Why will Seasteading work when the many similar previous projects have all failed?

We think this is a great question. The answer is that our approach is very different, partly because we've learned from other's mistakes. The essential difference is that we are dedicated to finding a realistic way of achieving success, rather than simply dreaming. You can learn the details under Why - Philosophy. COMMENTS (0)

Who is going to move to the middle of nowhere?

We think this is a great question, and we've often asked it ourselves. The keys to our answer are timesharing and incrementalism. COMMENTS (0)

Incrementalism is an answer because we never need to find 10,000 people willing to take the plunge. We only need to find the core of enthusiasts to start, say 10 people. Then the 40 people who are willing to move now that there are 10 people. Then the 100 that will move because there are 40, and so on. Its not that there is no one willing to be the first, just that there aren't very many. But that's ok because we don't need very many to bootstrap. COMMENTS (1)

Having many residents be timesharers or hotel guests, by letting people participate part-time, is crucial as well. Rather than moving to this floating platform, people can just visit, which many more will be willing to do. There is a huge difference in the level of committment. This is especially valuable in getting the skeptics and realists, who will have reasonable doubts about such an ambitious venture. While there are 52 weeks in a year, our experience suggests that the ratio of people willing to do a new country full-time vs. 1 week a year is at least 1,000:1, possibly much higher. COMMENTS (0)

What will people do onboard?

This is certainly an important question. Our first response is "the same things anyone else does", but then again we don't get out much :). As long as there's internet, it might take us quite awhile to notice that we were on a small, isolated platform. COMMENTS (1)

The simplest answer is to point out other similar lifestyles. For exampe, vacationers will be able to do pretty much anything they could do on a cruise ship. There won't be as many locations visited, but there may be some extra activities due to the unique legal situation. Working as a resort employee on a seastead will be much like working on a cruise ship. Another parallel is to the many people who live in isolated, rural areas, or to the live-aboard boaters. While such a life does not appeal to everyone, those who like it rarely seem to be bored. COMMENTS (0)

Vacationers can focus on the unique activities offered onboard, since anything else they need to do can be done at home. Permanent residents can always take a vacation elsewhere if they need to be surrounded by masses of people. Note that the closer a seastead is to land, the more it becomes possible to just go to a major city for the day or the weekend. This makes seasteading even more like just living in the outback, and is one of many reasons we'd think the initial location should not be too remote. COMMENTS (5)

Why would anyone accept the low level of comfort?

Pioneers have traded comfort for freedom many times in the past. Those who find this tradeoff unattractive won't participate, which is fine since we don't need to appeal to everyone. A niche is just fine. Over time, comfort will increase and the market will broaden. COMMENTS (5)

Its not that the rough life is our goal, its just that we see it as the necessary first step. Focusing on luxurious cities at this stage would be like the first settlers of New York City thinking about the Empire State Building instead of planning their village. Our development cycle is much shorter than theirs was - we get to start with running water and satellite dishes. But we still need to take it step by step. COMMENTS (0)

Why would anyone vacation on a seastead instead of a resort?

> *"What would make this seastead more attractive to potential investors/buyers/ renters than a beautiful piece of pristine oceanfront property in a cheap Caribbean paradise"*
> *"this project will have to compete in the marketplace. And since there are lots of pristine paradises left in the world at cheap prices, why would one choose a flimsy little artificial floating platform...with dubious politico-legal status, if one can have a romantic piece of paradise with real solid ground under one's feet. "*

Seasteads and islands have different kinds of romance, and will appeal to different people. As long as we can find enough people who think seasteads are romantic, it doesn't matter if many prefer islands. Niche markets are not necessarily a bad thing for a business, if they aren't served well by other options, and they are big enoug niches. There are people who will find the unique legal status of a seastead appealing, especially because this status will let a seastead have some unique attractions onboard. There are likely to be other similar niches. For example, a seastead's water and electricity are generated sustainably, which will appeal to eco-tourists. COMMENTS (2)

There is also the "wow" factor, which the Freedom Ship is appealing to. Seasteads aren't quite as wowie as a mile-long ship, but they can make up for it by actually getting built. In general, the answer is to leverage the uniqueness of seasteads. And if that only appeals to a tiny fraction of the world, that's still plenty. COMMENTS (0)

They'll label you as terrorists and destroy you

We need some good discussion on this. Reference politics-interference. COMMENTS (MANY)

Who is going to pay for seasteads to be built? How will you fund the

project?

Many similar ventures failed because they expected billions to materialize from thin air. Our ideas for seastead financing are more realistic, and they can be found in Making it Happen - Our Proposal. COMMENTS (0)

The basic summary is to proceed in self-financing, incremental steps. First, a small group will build a prototype seastead in US waters and live onboard. They will pay for it as a replacement for their houses. With this demonstration of practicality, they will begin taking deposits for both full and part-time shares in a larger, sovereign seastead. While only a few true enthusiasts will buy full-time shares, we expect wide interest in part-time shares. When enough people have signed up, the rest of the money will be collected and construction can start. Future seasteads can be built the same way, although they are more likely to be funded by investors once the demand and practicality has been shown by the first platform. COMMENTS (0)

Why do you think you can get freedom without interference? States will never let you be free!

Variations on this theme are quite common from libertarians who are sympathetic with our goals but pessimisstic about our chances. And we are certainly worried about interference. We believe, however, that only by holding up unrealistic goals can one prove that this project is doomed to failure. Our favorite argument goes something like this: COMMENTS (0)

We are not seeking a perfect libertarian paradise where we can do whatever we want without any interference. We are simply looking for a significant improvement. Look at current states and consider the union of available freedoms. For example, there are countries in Europe (Switzerland, The Netherlands) with fairly lax drug laws and enforcement (social freedom). There are tax havens (Luxembourg, Bahamas) with very low tax rates (economic freedom). Unfortunately, the drug-tolerant countries tend to be left-wing and have high taxes, while tax havens are more right-wing, socially conservative, and generally restricted to tiny countries. As libertarians, we feel that the combination of these two types of freedoms is worth striving for, **even if both are restricted to the levels currently being tolerated by the powers-that-be**. Such a state would be more libertarian than any currently in existence, without pushing the legal envelope. COMMENTS (MANY)

Countries really do have a great deal of leeway in their internal affairs. A libertarian seastead nation should easily be able to have no zoning laws or building codes, low or no taxes, no import/export tariffs, few restrictions on weapons, local consumption of marijuana, no minimum wage, no legislated work week, no coerced welfare system, no eminent domain and many other items from the laundy list of libertarian demands. Its true there may be some limitations. For example, true bank secrecy, weapons research, and generally-illegal drugs produced for export may be out of reach. So what? Libertopia is not an option. COMMENTS (7)

Negative Results

Seasteads will contribute to world overpopulation

Overpopulation occurs when there are too many people struggling for too few resources. Seasteads allow us to use more of the space we have, and harvest more of the renewable energy resources. Thus they add to the carrying capacity of the earth. This means that while they add population, they are not adding overpopulation. COMMENTS (1)

And when you can support it, we think a greater population is a good thing. It allows for more potential geniuses, more sharing of ideas, and more activities for the common good. Additionally, as countries become better off and technology like birth control becomes more widely available, population growth is fixing itself. Growth is decellerating, and world population is expected to peak this century at levels less than twice today's [Nature082001]. COMMENTS (3)

Seasteads will contribute to pollution and environmental destruction

We admit that some rogue seasteads will probably pollute. But we'd also like to point out that most of the technologies seasteaders depend on will be much less polluting than what is used on land. So the net result may well be positive. And its not like seasteads are completely unaccountable - we see pollution as one of the areas most likely to provoke interference from traditional nations (and with good reason). COMMENTS (0)

Seasteads will enable cults to operate without interference

Seasteads enable all marginalized belief systems to experiment with their own societies. We think the net result of this will be extraordinarily positive, but we do admit that there may be negatives along the way. Some belief systems are marginalized because they are harmful. In addition to enabling pacifists to live without paying taxes to support murderous wars, seasteads will enable cults to brainwash their members far from watchful eyes. This may lead to some tragedies. But we see far more pacifists than cultists in the world, and so we believe that seasteads will enable far more people to live their ideal lives than to harm others.

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Seasteading: Summary

Summary

{ Currently this section is being used as a final sales pitch for the project. Should it say other things too? }

While we have made it very clear that the seasteading movement faces substantial challenges, we hope you have also been convinced that it is possible and worthwhile. Further, that the gains from bringing this ambitious vision to life substantially exceed the costs. While this may lack the dramatic appeal of those who claim that the world is utterly doomed to some horrid fate unless their call is heeded, we think our version is more believable.

One thing to notice is that there are many prophets of doom, each preaching a different path to salvation. Seasteading enables any of these movements with sufficient funds and followers to progress from words to actions. Aside from the cynical observation that we can learn something from which groups attempt this transition, we will learn even more from the results. Seasteading turns the ocean into a laboratory for societal innovation.

Nor do any but a few dedicated founders need to pledge life, fortune, and sacred honor to help this movement. The rest of you can simply put some money aside, and buy a timeshare when the time comes. Instead of spending your vacation escaping civilization, get away and help foster change at the same time.

Seasteading: Acknowledgements

Acknowledgements

{Acknowledgements go here.} COMMENTS (0)

Patri: Sean Hastings, Charles, Rob & Anna P., David F., Shannon, Katy, Treasa, Milton & Rose, Wayne, Andy H., Eric Hunting, Paul Spooner, Flaviu, Ian Sawyer, Erwin Strauss COMMENTS (0)

While we disagree with the predictions of environmental apocalypse made by many environmentalists, we owe them a great debt. The environmental movement has given momentum to the development of energy-efficient technologies, renewable energy harvesting, recycling, and other technologies which are extremely useful for seasteading. While we are unconvinced that these ideas for conserving resources on land are necessary in that resource-rich environment, in our resource-poor environment we couldn't live without them. COMMENTS (0)

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Acknowledgements

Last modified: Mon Nov 14 23:24:02 PST 2005

Commenting on the Seastead Book

Commenting has been turned off! The book draft is being revised, and will be put up for review using CommentPress, a commenting plugin for WordPress

Notes on previous review guidelines and commenting system:

Editing Guidelines

The destiny of this book is to be self-published for a niche market. While we're happy to hear about spelling/grammar errors and awkward sentences, we do plan to have the manuscript professionally (though cheaply) edited. What's more important is a slightly higher-level viewpoint from people who are part of our niche. So we're looking for things like: COMMENTS (0)

- Does each section feel complete? Have we hit on all the major points? Is there something you really think should go in this section? (Check to see if its anywhere else) COMMENTS (1)
- Are there major technical errors? We've done a lot of reviewing, analyzing, and summarizing fields we're not expert in, so this is quite possible. COMMENTS (MANY)
- Is our line of reasoning convincing? Given that we can't address every point, have we left out a big one? COMMENTS (0)
- Is the tone appropriate for the material? Were we too technical, too light-hearted, too dry, too ranty, not ranty enough? COMMENTS (0)
- Was it fun to read? COMMENTS (0)

Other suggestions: COMMENTS (0)

- The more specific the criticism the better, and suggestions for improvement are better yet. COMMENTS (0)
- Note that some sections have specific comments for revisers, indicated by { curly braces }. COMMENTS (0)
- We'd prefer not to hear about catchy-but-unproven technologies. There are zillions of them which could potentially be relevant, and describing them is best saved for later editions. Of course, if there is some proven method we missed, let us know. COMMENTS (1)

We understand that revising the whole book is a large task, so feel free to just sign up for a few sections.

Commenting System

This book draft uses the Simple Online Commenting System written by Patri. Most sections of the paper have comment buttons, and clicking them takes you to a page where you can add your comments. We'll be using these comments to help improve the paper. You may also be interested in the guidelines for reviewers.

Some notes:

- You may have to reload comments pages in order to see recently-added comments. You may need to reload paper pages to see updated comment-button numbers.
- Note that the day/week/month links at the top of each page are broken if there has not been a comment on the page in that period.
- Comments may be removed if we feel we've addressed them, decided we aren't going to address them, or think they are inappropriate.
- SOCS is very new code, if you find bugs please email Patri (patri-at-clevername-dot-net) or comment on the SOCS page.
- Text in curly braces {} indicates comments from the authors, both to each other, and posing specific questions to readers.
- { Anything else we should say here? - P}

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