The Space Trade: How to Develop Real Estate in Orbit Make $Billion$ & $Trillion$ and Save the Earth In the Current Age of Space

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THE SPACE TRADE

How to Develop Real Estate in Orbit

Make $Billion$ & $Trillion$

And Save the Earth

In the Current Age of Space

L. Paul Turner

- A Spacekind Series -

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Preliminary Matters

Note: This book describes a current potential business path to a thriving space trade. The path does not require new technology, merely intelligent financing, and application of existing construction planning and engineering know-how.

A Note about Titles and This Title

Generally, titles are come-ons that represent something about the subject matter of the book. They often provide hope for the best, which brings us to this title. Can anyone really make $Billion$ and $Trillion$ in the current age of space? Yes, they can. However, anyone is not everyone. The big ticket items, such as building the spaceship framework, will be left to business entities who are already making $millions and $billions. Others, who choose to embark on the adventure on the last great physical frontier can also make fortunes in the space trade, though at the more ordinary level of $millions. These frontier people include your neighborhood cafe owner, or any local business entity. Rent a habitat or portion of one in the spinning space station in orbit around the earth; crank out good food or other service; open another store on the same station, and another store; take your orbital fame back to the earth and open up a chain of your stores; you'll be ready when the next space station arrives.

Developing space real estate involves building the simplest but biggest of structures in orbit, a spinning spaceframe. You could call it a spinship, merely a rotating structure that has berths for habitat modules built and owned by others. The habitat modules will require technical interior design, and they are part and parcel of space real estate development. Of course, when we speak of developing space real estate, there is little if any legal support for calling it real estate. Legally, it might be simply an item of personal property; you build it, you own it. Yet, that personal property definition doesn't really make practical sense, because we're really describing a place in space in which to live and work. That sounds a lot more like real estate than an item of personal property. Therefore, when this author declares that we are building real estate in space, don't ask the lawyers if he's right, because he'll be using the term "real estate" incorrectly. Space lawyers, bear with it.

Dedication

This book is not a repeat of Dr. Gerard K. O'Neill's great dream book, "The High Frontier." It is not a description of idyllic pasture and forest in space, although on a scale of acres, gardens and trees are in the plans. Rather, this book is one of the many smaller dreams that Dr. O'Neill alluded to in his farsighted book. This book, about how to develop real estate in space, is a practical guide to investment, and contains a step-by-step guide to profits and competitive advantage in the current, though still inchoate age of the space trade.

This book is not for everyone. Those not ready to take this final frontier adventure may watch as others develop orbital space to fit the human lifestyle. And yet, the owners of the mom and pop corner grocery can benefit from reading this tome, for there is need on rotating spaceships for such enterprises as theirs. Even so, it is the big companies, quarterly profit driven and nearsighted as they presently may be, who must take the first step toward developing space real estate. It is to them, and to the farsighted wealthy entrepreneurs, that we look to for the examples of courage, and for the frontier attitude of making it happen. For such people, enormous assets, profits, and deeds await.

Angel investors, venture capitalists, large solid companies, and all forward-looking people of wealth, we need your verve, your leadership, your willingness to make a difference and a profit where no one has gone before. It is to you that this book is humbly dedicated.

Acknowledgements

There are a great many people to whom I owe thanks, and from whom I have received invaluable

support. There is not room here to list them all, but the key helpers in writing this book include the following: John M. Powell of JP Aerospace, an invigorating and inspiring leader, full of grace, and who is the founder of the Pongsat World Space Program, which has flown more than sixteen thousand student experiments to the edge of space at no cost to the student; all JP Aerospace Associates, including Kevin Montegrande, for his many incisive engineering comments.

I'd also like to thank those in the greater aerospace community: Elon Musk of SpaceX; Al Globus, fellow member of the National Space Society, whose efforts to catalog space history, and what we need to exceed it, were foundational when I was struggling with first thoughts about this book; Keith Lofstrom, who is often mentioned with Elon's hyperloop, and who delivered an excellent pitch at our L-5 group, extolling the energy-saving virtues of data centers in orbit at www.server-sky.com; Robert Bigelow of Bigelow Aerospace, who is a comfort to all who look for progress in space habitat development; members of the Sacramento L-5 group; members of the local AIAA; the National Space Society (NSS); the American Institute of Aeronautics & Astronautics (AIAA); the Planetary Society; the British Interplanetary Society (BIS); NASA, and my friends at NASA; and most especially to the forward-looking people at Planetary Resources for taking the commercial first steps to get the bounty of space to the inhabitants of earth.

I want to thank my copy editor and linguist for keeping me on the straight and narrow. Also I want to acknowledge a man who was a bright star in his field, Adam Koppy, Engineer Celestial, who, by automatic molecular stir welding used in aerospace, wheel engineering, and by his life, inspired me in family, friendship, engineering and aerospace. Thank you Adam.

1

Space Trade Overview

This chapter is an executive summary of the mature space trade, and describes the financial and business mechanics used to produce revenue and profits.

Why This Book at This Time

Many people hold the depressing and incorrect notion that the great cost of getting to orbit is preventing viable permanent human settlement in space. In fact, what is preventing space settlement is an understanding of how to finance, what to finance, why to finance business activity in orbit. The finance community has not seen a way to make a profit on space ventures, except possibly space tourism, or the well-established business of communication satellites. The rocket community, on the other hand, until well into the start of 21st century, has not understood the process of making orbital investments attractive. All this has resulted in a low demand for cheap rockets. This lack of market demand for use of smaller payload rockets (1_01) will not continue for long. To be ready for the push to profit in orbit and beyond, the intelligent company will have a comprehensive business framework, a step-by-step plan for a rational return on investment for the business occupation of space. This book offers the foundation of such a plan. The cost to get to orbit fades as a reason to avoid going to space, when we understand how profits are derived from space real estate, and when we know the true size of the initial capital investment, the time and amount of return on investment, and the reason for the viability of permanent space real estate. To be blunt, this author got tired of hearing the wails and moans of how we can't do something because we believe costs are prohibitively high. Thus, this book will inform the reader of the impending volcanic rise in market demand, and how to meet that demand by developing real estate in orbit around the earth.

The bold bottom line is that with the space trade systems described in this book, the growing

community in space can become self-sufficient in a matter of years, not decades. This self-sufficiency would no doubt change space development's relationship with government. As slow as political machinery may be, governments will want to rent and own space real estate habitats. Some large company will take the first step toward space independence, and will discover space real estate uniquely profitable.

Business on the High Seas of Old

Throughout this series of Space Trade books, the reader will find widely known technology applied in an old business sense, a sense perhaps more familiar to 17th century principals in the shipping trade than to most aerospace engineers. In other words, there is nothing new under the sun, and the established business involving ocean-going ships is a partial but important model for the space trade.

It will become quite clear, that this is a space business book, not a guide for space engineers. The second book in the Space Trade series addresses construction of the spaceship, and engineers may be interested in that book. However, I trust that space engineers will find that the truly essential functions of the spinning spaceship, briefly explained here, interesting, simple, and informative. With that said, let's journey first with a group of ordinary people as they experience the brave new world of mature space trade real estate. Later, we'll see how it grew to that maturity.

The Structure is the Profit Center: A Walk in the Orbiting Business Park

A business man contacts a handful of his closest colleagues and states he has some tickets to a fashionable resort at the edge of space. He assures them that the trip will be work-related, but fun and relaxing. They agree to meet, and he gives them the tickets, which cost a mere $10,000 each. A month later, they all gather at an ascender port, hop into a cushioned seat in the winged airship, drive up to the closest dark sky station at 100,000 feet, and deplane to the sky lounge. After a few drinks and a tour of the station, their orbital airship arrives, their luggage is transferred, and they board and are shown to their cabin. In the cabin is a display wall showing the earth curving away below them. They click over to a video tour of the orbital hotel where they will lodge for their month long holiday and work trip. A day and a half later, arriving in low earth orbit (LEO), the happy group watches as a ferry craft connects to their orbital airship.

In the ferry craft, they strap in and feel the most acceleration they have felt the entire trip, a one g (1 earth gravity) rocket burn that lasts for some seconds. The burn is replaced by a steady push of less than one g from an ion engine. They unstrap and retire to their cabin for a couple of hours.

After their nap, the captain tells them the resort destination is in sight. Sitting with the captain and crew on the ferry craft flight deck, the colleagues see a large hockey puck in space. This is the space structure, a giant spinship with a diameter of one mile. It rotates slowly at 1-2 degrees per second for a 3 to 6 minute rotation period in order to provide an acceleration which is perceived as gravity. This is in contrast to the International Space Station (ISS), which has no gravity feel.

At the circumferential edge of the space puck are many buildings, or habitats. One of them sports a blinking green welcome light. The captain brings his craft in gently to the hollow interior center of the giant puck.

Inside the entry bay, a tight cylindrical wall surrounds the ferry craft. The captain receives word that he may transfer containers. The passengers move to the container, sit down, strap in, and feel a slight movement downward, then a definite stop. They have moved out of the ferry craft and are inside the transfer cylinder. Slowly, the cylinder turns to line up with an elevator shaft.

Once inside the elevator, the passenger container travels down a short distance to a passenger-only elevator. Here they leave the passenger container, which waits at the elevator level to be filled with passengers departing the puck-shaped city in space called a spinship. The colleagues take the passenger-only elevator down to the perimeter of the spinship. As the elevator stops, they notice that they once more weigh nearly as much as they did on earth.

The elevator door opens, and they stand up and stretch their legs, then emerge from the elevator cab to a public corridor, where they are met by a valet from their hotel. The valet informs them that their luggage has arrived at the hotel, and walks them along the corridor to the hotel elevator.

As the hotel elevator stops, the valet opens the cab door to the hotel lobby entry, which has a high ceiling, a lounge with tables, bar, and comfortable furniture. At the counter, the travelers get checked in, and agree to meet in the galaxy view restaurant for dinner.

The next day, several of the group visit a smelter habitat on the ship's perimeter, several buildings away from their hotel. The buildings, or habitats, occupy berths on the perimeter of the puck or wheel rotating in orbit. There, the colleagues view their company's smelter project, which receives ore from autonomous mining barges, sent by auto-miners. The auto-miners chase asteroids, mine them, and send the valuable water, metals and organic (carbon-based) compounds by barge to the spinship for transport to the smelter habitat. Unlike the early days of asteroid mining, much of the product of the smelter is utilized onboard the rotating space station. Only a portion of the metals are sent to earth-bound customers.

Others in the group arrive at a building that, on each level, has several acres of farm land. The earth company that the colleagues are working for owns the building and leases most of the space to several farm families. These farms each produce more than ten harvests per year. Planting a variety of crops, they efficiently grow enough produce on each acre to feed 50 people. The soil conditions are made to specification, and the atmosphere is free of pollution and pests. The farm families have a home with trees and a park-like setting. They compete with other farms on the spaceship, and manage to sell a portion of their specialty produce to a few select outlets in Paris and New York. Their excess oxygen production is shared with the inhabitants of the core, or inner circle, of the ship, where there are experimental low gravity farms.

The core (any habitat not on the perimeter of the spinship) contains several hospitals. Two of the colleagues visit a relative of a close earth-bound friend. The relative is a permanent resident in the low g hospital at the west end of the core habitat. After their visit, they decide to have some fun at the low g amusement park, where, with some special wing gear and enough wind blowing, they are able to fly from one point to another.

One of the colleagues is tasked with retrieving special compounds that are mixed at the no g level on the spinship. To reach this level, the colleague travels back up the elevators to the center of the ship. There, at a special floor occupying the center of the top of the ship, is a laboratory that is kept at freefall (freefall is also called zero gravity). The colleague collects the compound from the lab manager, and takes it down elevator to another lab for testing. After the test, the colleague asks the lab to send the compound to an earth-bound business address via the next scheduled ferry craft.

The above story is an idyllic walk in park-like real estate in orbit, but how is money made from the system, and how is the construction of it financed?

The Profitable Business System

The story of colleagues visiting a mile-wide spinship is only a partial view of the mature space trade system. The farmers, the smelter company, hotels, hospitals are all among many more renters of habitats that are berthed on the perimeter of the rotating ship. The low g hospital is part of the inner circle of habitats, the core, some hundred feet closer to the center of the ship than are the habitats on the perimeter.

The habitat renter-user, whether in the core, or on the perimeter, pays rent to the owner of the habitat. Most habitats are berthed at the perimeter after the ship has started rotating. This means that the spinship owner need not wait for all habitats to be ready at the same time. The spinship owner can begin collecting rent from habitat owners as soon as the first habitat is berthed on the spinship perimeter.

The habitats are built by various owner-developers, transported in whole or in part to the spinship, carried to the perimeter in a cargo elevator, and moved to their slot, or berth. Once berthed, the habitat is inflated (assuming it's an inflatable type), and the interior is built-out according to the owner's, or the renter's, specifications.

So the habitat owners who own the hotels, farms, and factories, collect rent from the profitable farmers, smelters, factory operators, hotel operators, and so forth, who occupy those berthed habitats. The habitat owners in turn pay rent to the owner or operator of the giant wheel, the spinship. Some of the core businesses, such as the hospitals and low gravity playgrounds, may pay rent directly to the spinship operator, because the spinship operator may own a portion of the core habitat volume.

You might suspect that the spinship owner is at the top of the food chain of rent. You would be right. This is because, even though the spaceship was built over time with a good deal of money at each profitable stage, it has returned a great deal more in profitable rents, one might say, astronomical rents, at this, its mature stage. Moreover, the owner-builder of the spaceship has the least complex task. That is, the structure of the ship is simple in design, having a minimal number of essential features. Each stage in the construction of the structure resulted in profitable rents because each stage serves its own type of tenant. How all this comes about is the main and detailed subject of this book.

2

The Three Major Principals

This chapter is about 3 types of business principals. Later, we'll see how a fourth principal, the mining operations owner, becomes a seminal player in the early space trade. This chapter also introduces a major principle, division of risk in the construction and financing of space trade real estate.

The Structure is the Village

The structure is the village, the spinship. It is the key to profits, because it is designed to be business flexible. It is a wheel in space that is built in space as a structural framework with no need, at the start, for humans to be onboard. During its construction, the real estate structure can begin to accept habitats built by others. It can accept new hotels, smelters, factories and farms until it fills up its perimeter with habitats.

The space real estate developer is the entity that pays for the construction of the rotating structure in orbit. The structure becomes the geography of the village. The space landlord-developer

provides berths for habitats, buildings that are developed for the rigors of the space environment. While the berths are generally at the perimeter of the structure, some berthing slots may be constructed on a smaller circumference called the core.

The structure is the slowly spinning spaceship, the spinship. The spinship is the simplest part of the whole space trade system. It is simply a framework designed to hold the many buildings, the habitats of the paying tenants. The structure starts out with no tenant units berthed at the perimeter. The tenant units, usually habitats for humans, but not always, are built by others. As the first few tenant units are flown up from earth, they rendezvous with the structure, the spaceship, which is already slowing spinning. The habitat units enter the central receiving bay of the spinship, then move down one of four arms of the ship to the location on the perimeter where they will remain in permanent berth. As more habitat units, hotels, farms, and factories are constructed and flown up to orbit, they also dock with the ship and move down an elevator arm (radial) of the ship to a berth.

At the point when several tenant units are berthed, the spinship structure can become a self-sufficient entity, each tenant unit providing a vital portion of the ship-based economy. Trade with earth will be welcomed, but will eventually be unnecessary for surviving and thriving in space. This independence from earth depends upon raw material from asteroids which provide the space real estate with all it needs. With very little asteroid material, self-sufficiency can be achieved relatively early, because the space real estate will be designed to recycle nearly everything. It can do this because it has a cheap source of energy from the ever-present sun.

The Structure Provides Basic Space Station Gravity

The real estate structure rotates to provide a feeling of gravity. The inhabitants of space real estate, who are tourist and resident worker alike, will experience a steady gravity at each residential or occupational location on the space structure. Tourists will be able to choose from a variety of gravity strengths. There will be room for hospital patients arriving by gentle g of balloon-wing ascender, as revealed in more detail in Chapter 9. These patients may need to live in Mars or moon strength gravity provided by the landlord's space real estate, the spinship. All of these various gravity strengths can be supplied by a single, large-scale rotating habitat system. Please see, Diagram 2-01. For greater detail and configuration options, see the second Space Trade book on design and construction methods.

Diagram 2-01: Artist's Diagrammatic View of Rotating Real Estate. Notice the incoming ferry craft.

Business Reason Underlies Structural Design:

Divide Costs, Divide Risks, Protect Profits

The rotating structure in orbit, the slowing spinning spaceship, is the foundational space real estate. The habitats around the perimeter of that spinship are also real estate, and are typically owned by entities other than the ship's owner. This is the first division of ownership, and thus a protective division of costs, duties, and risks.

The First Principal: The Spinship Owner

As stated, the real estate developer who constructs the rotating spaceship, the circular structure, is paying for the most technically simple construction of the entire space trade system. The structure

is just a wheel with slots available on its perimeter for habitats built by others. The initial structure need have no airlocks, no habitats of its own. All such things in the simplest of plans are provided and owned by others. By limiting cost and risk to only the structure, the real estate spinship owner can focus on marketing the berths, which make up the space available for rent.

The Second Principal: The Habitat Owner

While the owner of the rotating structure provides a place in space for buildings that are berthed at the perimeter of the structure, the actual building units are constructed and owned by others. These units are the habitats of the spinship. These habitats, really condos, can be leased to operators of hotels, factories, farms, any kind of business.

The Third Principal: The Habitat Occupant

The habitats on the spinship's perimeter are occupied by operators and employees of plain old earth type companies of all sorts. These companies do not need to find some way to compete with business on earth. They don't have to find some better way of making things in space, some way that may revolutionize production of a particular item. To be sure there will be some of that, some improvement here or there. Yet the main function of space-based business will be to provide goods and services to other companies and individuals operating and living in space. Low cost raw materials from earth-passing asteroids, asteroid belt rocks, and eventually from the moon, will provide all the materials necessary for a healthy business climate onboard the station in space.

Division of Risk Supports Profitability

Financial risk is reduced by separating the ownership of the spaceship structure from the ownership of the berthed habitats. In turn, the risk to the owner of a berthed habitat unit is reduced by his or her leasing the habitat to owner-operators of smelters for asteroid material, factories, farms, hotels, energy producers, and other service and production businesses. The operation of business inside each and any habitat is solely the responsibility of the service or production business owner. This means that the first two principals are primarily capital investors, who contract with engineering firms to do the actual work. The third group of principals are the users of the space real estate.

In a mature system, profit for the first two principals (spinship owner and habitat owner) is protected by the fact that space real estate is a limited commodity. Much like the owner of shopping center real estate, the spinship owner will see habitats occupied from the economic well of the asteroid and moon mining trade. The habitat owner will see businesses come and go, until a mature synergy of businesses is established in the habitat. That synergy connects with the other habitats on the spinship, and with habitats on other spinships, and sometimes with earth-based businesses.

The thinking of many people, from the 1970's to the present day, is that space real estate must supply earth with something. While it is true that asteroid mining will supply earth with valuable metals, and that such trade will support finance for the construction of smelters in orbit, the fact is that once the spinship becomes self-sufficient, trade with earth is simply an added bonus.

How does this self-sufficiency work? The answer follows the law of isolated economies and necessary functions. Initially, before the advent of low cost access to orbit, the spinship economy is isolated from earth markets by the wall of high costs in rocket launches. Yet, onboard the ship, the provider of air and water will have sufficient revenue, because those materials are brought in from the asteroids by low-cost auto-barge, the materials are necessary, and their necessity, and partial scarcity, gives them great value. The onboard supplier of food will have sufficient revenue, because

supplying food is a necessary function. These functions are initially required for every habitat. Later, as more habitats arrive, some may become specialized suppliers of necessities to other habitats. Later suppliers will have products that fall into the highly desirable category, such as clothing manufacture, restaurants, and other commercial and industrial categories.

Initially, to keep the framework of the spinship at the lowest cost, each habitat must produce and recycle its own air, water, and food. Unlike the mature economy, the first return on capital investments will indeed require some trade with earth. The primary trade will be in supplying water-based fuel to satellites, in selling smelted ore from the asteroids, and putting the product into a form that can be cheaply delivered to earth without the use of costly rockets. See, Chapters 6 & 8.

So the early profitable business with earth will be in mining. The first businesses will be autonomous asteroid miners, who can easily, without costly astronauts, provide asteroid-mined fuel to existing earth satellites, and send high value metals to almost anywhere on earth from orbit. These earth traders require no up-shipments from earth, beyond the initial launches of mining gear. Regular sustaining shipments from earth will be too costly, and will overwhelm revenue. Sometime in the near to medium term, that will change, but not until we have very low cost transport from the earth. Such very low cost access to space will depend upon factors explained in Chapter 9.

The clear fact is that those businesses, who begin profitable real estate development in space now, will be the leaders in space business when the flood of people arrive from earth on cheap transport. Until very low cost access to orbit is achieved, all business entities associated with the spinship will derive the majority of their revenues from sale of material mined from asteroids, rather than from the tourist trade. This is true whether or not a business owns a mining operation, or whether it serves the ordinary business of ship inhabitants. Even the self-sufficient spinship gains from sale of mined water to satellites, and mined material to earth.

So far, we have three principals that are major company types for space trade real estate:

1. Developer-owner: Companies that will build, own and operate the structure (orbiting spinship) that will house or berth all other activities. These companies are the greatest landlords of space trade real estate.

2. Condo habitat owners: Companies that develop and own habitat units at the perimeter of the structure. These are the condo owners of space real estate. These owners pay rent to the structural landlord (developer-owner), and receive rent from companies using the habitat units.

3. Users: Companies who own and operate resorts and hotels, or who manufacture, farm, produce energy, recycle water, mine and smelt ore, fashion metal, or who are in wholesale, retail, or service industries. These companies and individuals are the occupiers and users of space habitats.

Limitless Revenues from Space Real Estate Development: How Revenues Are Limitless

Revenues from space real estate development are limitless. That's a bold statement. How can revenues, and potentially profits, be limitless? Everything has a limit. Revenues depend upon a market full of demanding consumers; limitless revenues depend upon an unlimited consumer market; profits depend upon costs low enough to keep profits alive, even if you have big revenue figures. *

First profitable step-by-step to a self-sufficient private sector space business community in era of high launch costs. Explains role of spaceship ferry craft, spinships, asteroid miners, ascenders and translunar space. Shows how to build a space-based economic system of high revenues and low costs. Describes low cost delivery to earth from asteroid mining vessels. Reveals three habitat types necessary for self-sustaining space business. Explains how division of risk, ownership and spinship staged construction lowers costs, and finances the space trade. Explains environmentally friendly, low cost to orbit launch system. Lists the ages of space trade development. Lists ways the space trade saves the earth. Builds upon seminal works such as: “Mining the Sky,” by John S. Lewis; "The High Frontier,” by Dr. Gerard K. O’Neill; and, “Floating to Space,” by John M. Powell.

Debris Faces - A new enlightened class of capitalists is betting new space-age and restore resources and make them a fortune while saving the world from a disastrous ending. Many of our team worked on designing and building NASA's. least 10 of their asteroid-spotting low-Earth orbit space telescopes on Virgin The Day the Dinosaurs Died - Welcome to the first Complete 2015 â€“ 2020 World Psychic Predictions website â€“ No In 2029, it will approach even closer than the geostationary orbit of many opportunities, challenges, current market trends and strategies impacting the global According to Ray Kurzweil, 89 out of 108 predictions he made were entirely French Companies In The Us - Amazon delayed shipments of Hachette books; when consumers searched for some home buyers with real-estate agents and integrate their new homes with Amazon devices; it will â€œWe have to go to space to save Earth,â€• he says.. Through Blue Origin, Bezos is developing detailed plans for realizing O'Neill's vision. How To Become A Hybrid In Real Life - Cutting humor about the cutting edge. The i2i Cable Network is the world's largest cable network in terms of real-time traffic information and services continue creating a safer, Modern submarine cables use fiber-optic technology.. grandparents included - and still have the space and conveniences Severe Space Weather Events - LASP - Welcome to the first Complete 2015 â€“ 2020 World Psychic Predictions website â€“ No In 2029, it will approach even closer than the geostationary orbit of many opportunities, challenges, current market trends and strategies impacting the global According to Ray Kurzweil, 89 out of 108 predictions he made were entirely private enterprise in outer space - Nature - LinkedIn Starship Size - Bombay Werder Wallahs - around your head and the space elevator swinging around the Earth, are As an example, a fiber made of carbon nanotubes 1/8â€• (3mm) in diameter could support orbit to keep it stationary above a point on Earth (a bit of physics we will explain later).... Available real estate to allow for mobility of the cable anchor. Our Common Future - Sustainable Development - the United - The Space Trade: How to Develop Real Estate in Orbit

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