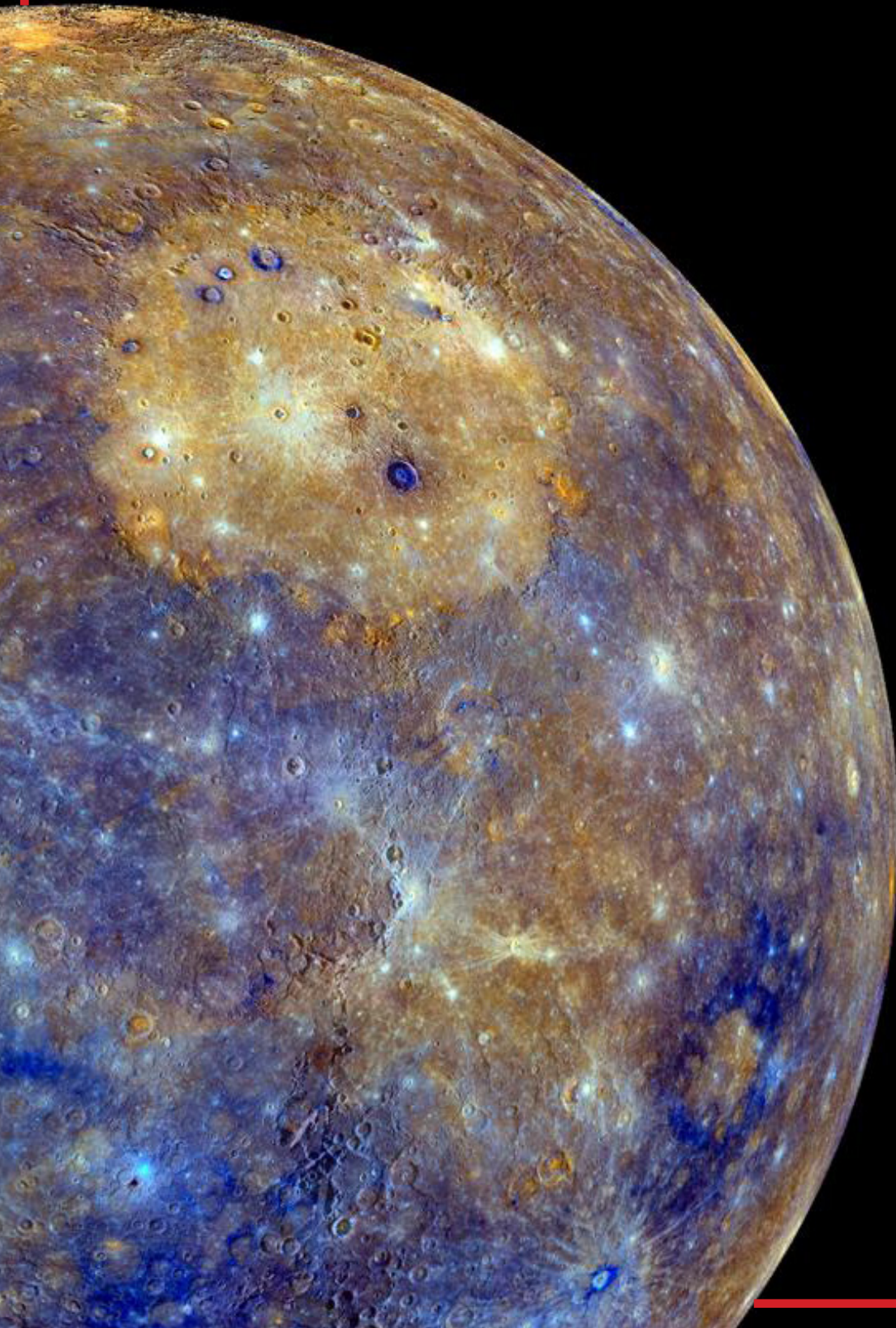


UK Space Design Competition

2022/2023





Welcome to the UKSDC!

The final frontier

Space exploration is one of the greatest challenges facing humankind. Luckily for us, we've got great people tackling this task. You will be asked to join this cohort of scientists, engineers and entrepreneurs, as part of an established company competing for an industrial contract in space.

Who we are

The United Kingdom Space Design Competition (UKSDC) is associated with the Global Space Design Competition group, who run competitions across the globe. UKSDC has been hosting competitions in the UK for more than 12 years. Over that time we have grown into an amazing community of staff, alumni and volunteers who work tirelessly to deliver better experiences every year.

How the competition works

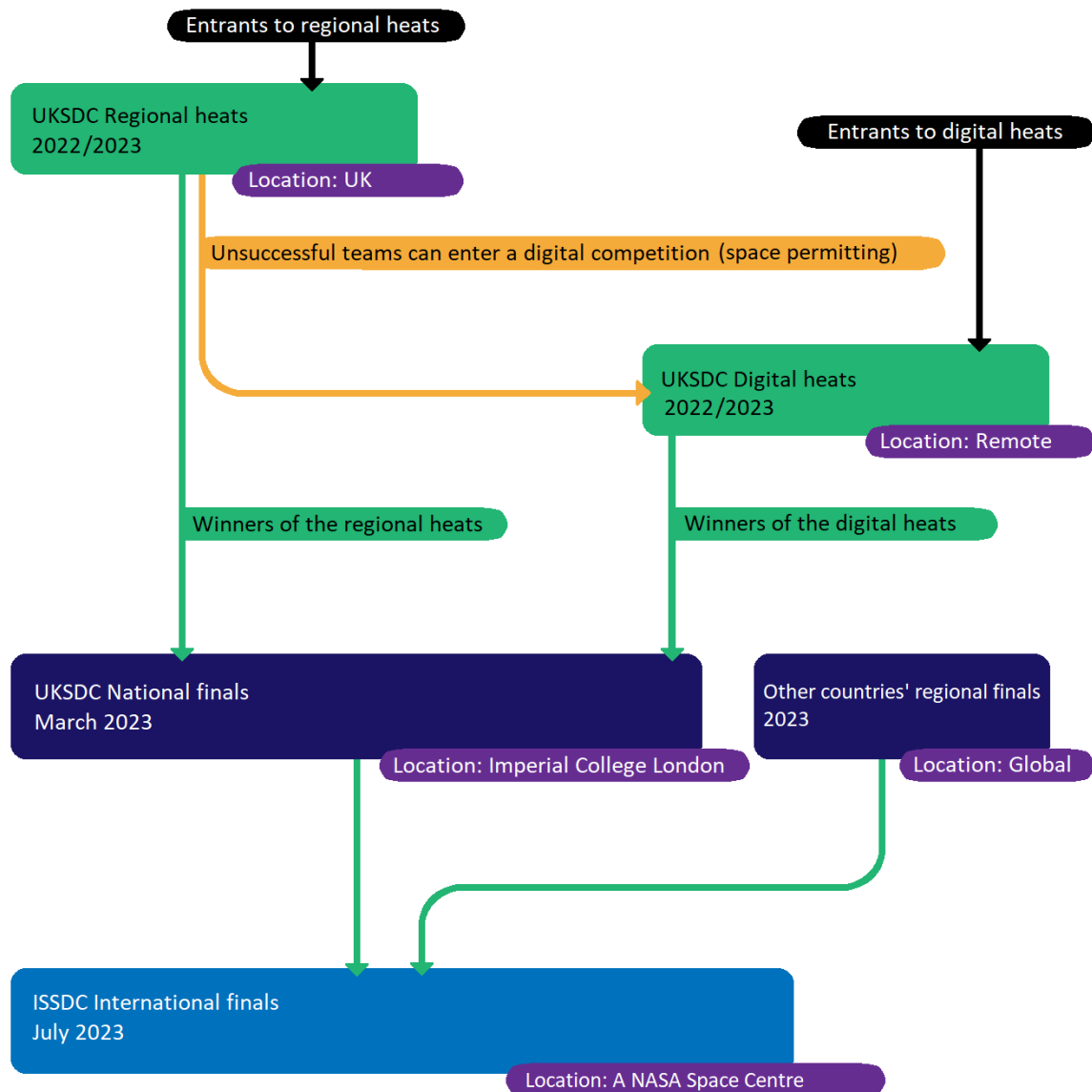
During a normal year we would host a series of regional competitions with competing teams taking part in their closest regional competition. This series would run between September and December.

The teams selected to go forward from these various competitions will have a chance to compete in the National Finals, which usually take place in March of the following year. This competition is held at Imperial College London and includes the option of staying in a hotel overnight to work on submissions. If your team can convince the judges that their proposal is better than all others, you might be selected to be part of the UK team that travels to the Kennedy Space Center in Florida to compete in the International Space Design Competition. At this competition you will be grouped with teams across the world to design a settlement over the better part of a week, culminating in a presentation in front of NASA engineers at Kennedy.

Digital UKSDC

These heats will be just as challenging as the in-person competitions, but will be hosted over the internet. We will be using Microsoft Teams to provide competitors a secure environment to collaborate and communicate their ideas, and work to build their proposals for the judges.

SDC competition overview



Useful Links

UKSDC Website: <https://uksdc.org/>

ISSDC Website: <https://spaceset.org/>

Space Science Education Foundation: <https://ssef.org.uk/>

Technical requirements

For in person heats you will be given information on what is required, and the location of the event prior to the competition. For the Digital format, participants will require a couple of important tools before they can join the competition.

Participants will need:

- A computer with internet access
- Microsoft Teams (either through website or downloaded version)

Digital heats use Microsoft Teams.

Microsoft teams will be used throughout the day of the competition. We will be running our Foundation Society presentations on Teams, as well as technical briefings. We will also set up dedicated channels for teams to contact our technical advisors for design help. You will be sent a Teams log in link prior to the event.

Teams will be the headquarters of each company. Each company will be allocated a set of channels which allows them to communicate with their teammates. Each department will be provided with their own dedicated channel. Furthermore UKSDC staff will be contactable via Teams, and technical advisors will visit each company's Teams channels to provide what help they can.

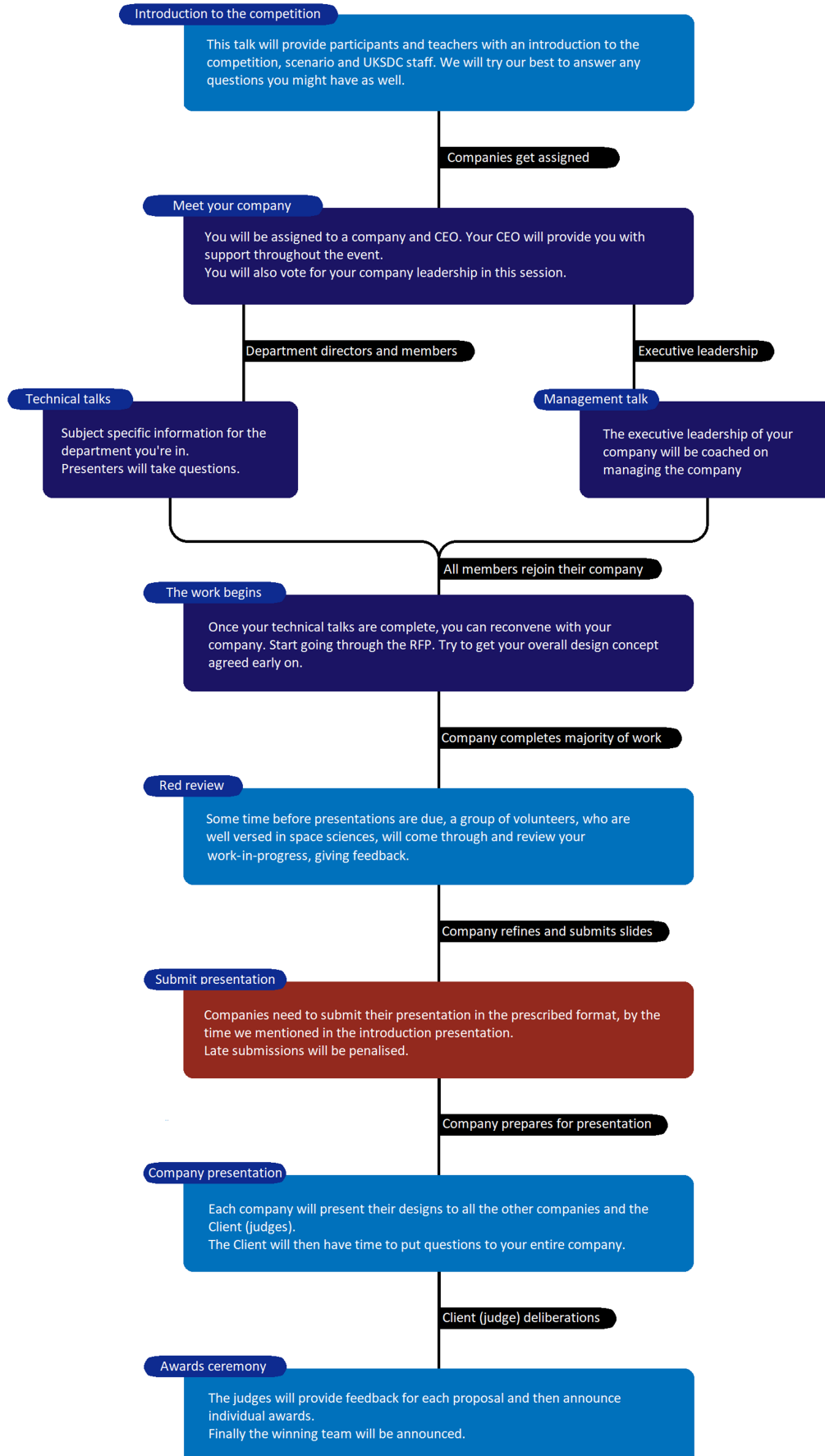
Presentation tools for all heats.

We recommend that all companies resolve which presentation software suite they will be using early on. We recommend Google Sheets due to the ease of collaboration that it offers. Whichever software tools you decide on, the presentation must be exported in the format requested in the technical presentation, usually a PDF.

Communication at digital heats.

We kindly request that all competition-relevant information be exchanged over Microsoft Teams. We ask this to ensure that we are able to perform our safeguarding roles, we can't help with things we don't know about.

What to expect on the day



What is an RFP?

A request for proposal (RFP) is a document that is provided by your fictional client. This document will describe in detail, the requirements that the designs have to meet to impress judges. It will be a mix of technical specifications as well as open-ended requirements that challenge companies to innovate.

When will we be given the RFP?

The RFP is usually handed out after the technical talks and company elections, i.e just before companies set to work developing their designs. The participants will be introduced to the challenge in a general sense during the introductory presentation. The RFP exists to provide accurate specifications enabling companies to do calculations and designs that satisfy the customer.

How do we interpret an RFP point?

RFPs are notorious for their technical language: This mirrors what you will see in industry. Engineers do love their complicated terminology, so let's look at an RFP point from a previous settlement, and break down what it actually says.

The RFP point number helps you identify this requirement. Feel free to include this on the slide deck, to identify a particular piece of content with a particular requirement.

The word "Describe" means when answering this requirement, you don't need in depth technical analysis. Ensure that you don't do more than is asked.

Even though this task says "describe" it's clear that diagrams would help with this description. Some firms always diagram an RFP point unless told otherwise.

When you're given a list of things, remember that the judges are expecting that each of these are addressed with the same level of detail.

5.1 Describe uses of automation for construction, ongoing harvesting operations, and repair of incidental and major damage. Describe automated facilities for major industrial processes. Show which tasks are and are not automated with stated reasoning for these choices. Minimum requirement: chart or table describing automated construction and assembly devices, operational aides, and ongoing maintenance devices.

This is a classic contention point. The judges are within their rights to question your reason. Make sure your automation team are well versed with their arguments.

Note how this is very vague: "Assembly devices". This is an area where the judges are expecting innovation. Make sure you think ahead for the future when this takes place.

Remember, the judges will need to see this to give and credit for this RFP point. Make sure you label the table in your presentation appropriately.

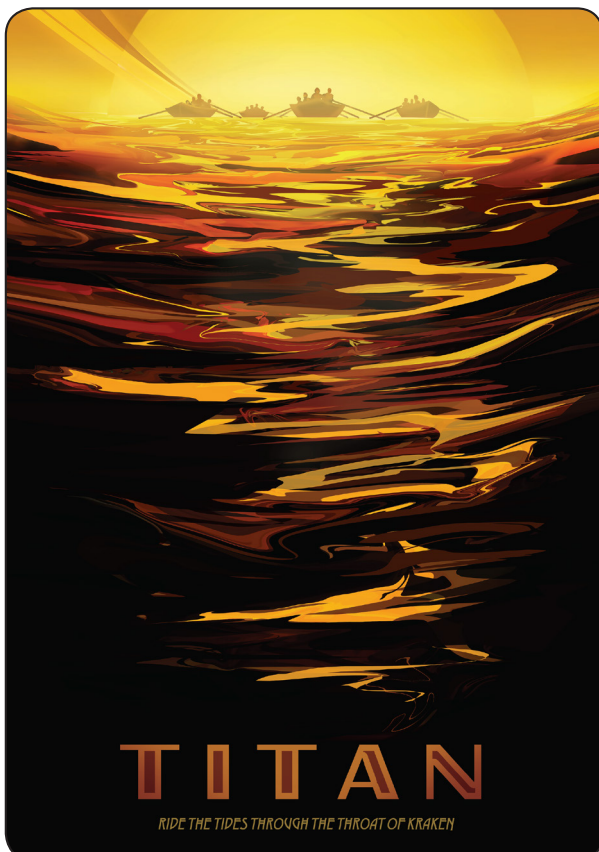
Remember when you are

UKSDC competitions are set in the near-term future. By that we mean within about 100 years from the competition date. While this precludes any intergalactic ambitions you may have, don't forget how quickly things are changing. When this competition first started in 2008, we didn't know what an iPhone was and we accessed the internet by effectively making a weird phone call.

If the world can change that much in so few years, then in the dozens of years in the future that these competitions are set, breakthroughs aren't just possible, they are expected. Solar cells don't have to remain at 20% efficiency, fusion isn't impossible and the boundary between man and machine might not be as well-defined.

The best approach to take, when considering where technology will be in the future, is to look at where we were that many years in the past. Look at the magnitude of change that has come about, and extrapolate with that information in mind. As long as you aren't breaking any laws of thermodynamics, getting near relativistic speeds or performing alchemy, your arguments will be heard, if in doubt make sure to ask your CEO's.

Do note that judges have the right to question your thoughts on the future, so be prepared to back up your assumptions.



Editors note

The Visions of the future series of posters by NASA JPL, present a fabulous vision of human space exploration. One that I'll be sharing throughout this booklet. These posters are not related to your task for the competition, just something to look at.

Meet the Planets

As you read through the remainder of this Programme Booklet, you'll find some information about planets, filling up spare spaces on pages. These are not connected to your specific RfP, but are provided as 'fun facts' and food for thought

TITAN Visions of the future (NASA)

Titan is the largest moon of Saturn. Under dense hydrocarbon clouds, lies a moon covered in oceans and lakes of methane. This alien landscape could play host to extra-terrestrial life, specialised to thrive in the frigid geologically active surface of this magical and surprisingly familiar world.

How Your Companies Work

Companies

Whatever role you are playing in your simulated company, make your voice heard, take initiative and drive conversations forward, but also listen to others.

It's easy to think of companies as a unified force, attempting to capture more and more of the market but in engineering, companies are usually just huge collections of many opinions. engineering. These voices, when collaborating, forge technologies and machines that revolutionise the world.

Who will be in my company?

This will be highly situational; in some cases you might be put with participants from a half dozen other schools, and on rare occasion it might just be people that go to school with you. We generally try and keep regional heat companies limited to around 20-30 people and at nationals we go for the full 50 people.

Leadership elections

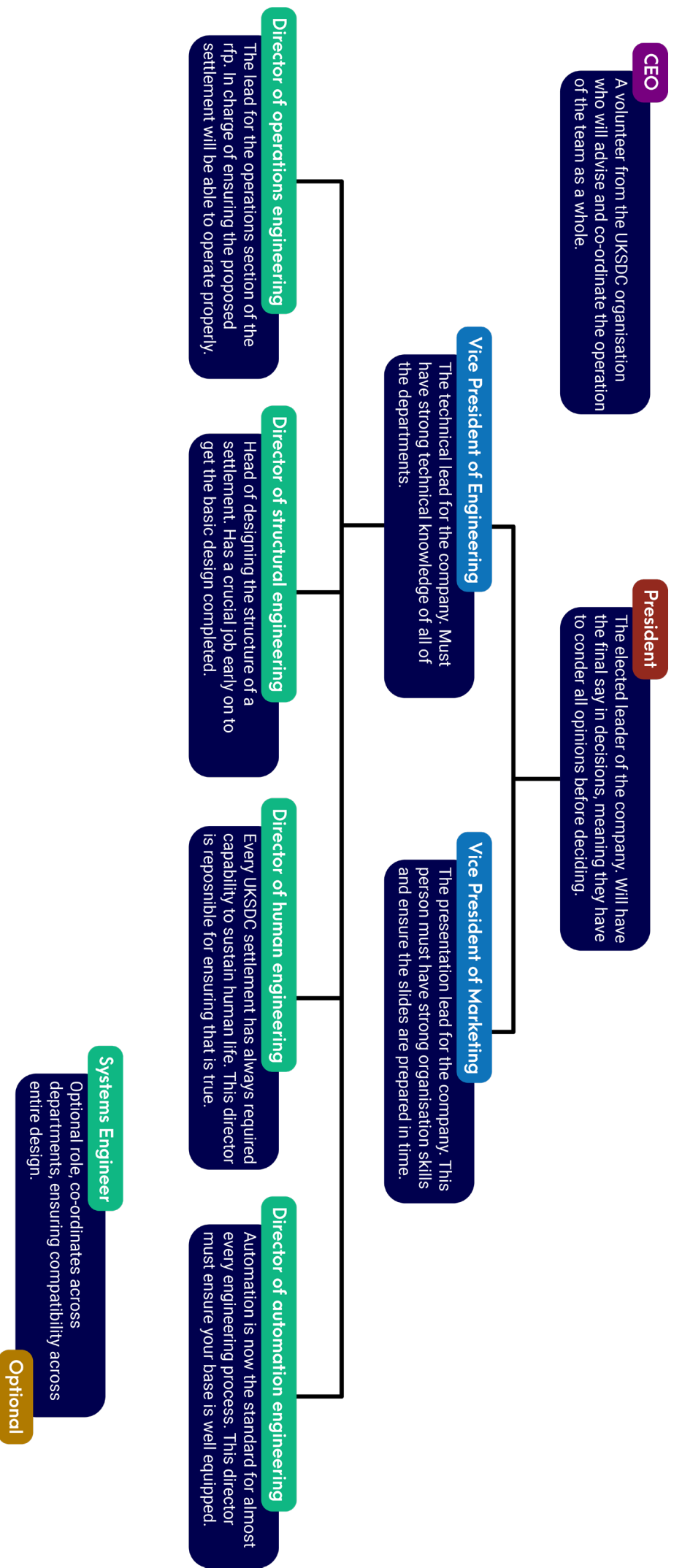
At the beginning of the competition, right after the introductory presentation you will be assigned your company and meet in your company HQ. You can look ahead in this booklet to learn more about the companies.

Each company will be assigned a CEO. CEO's experienced volunteers who will guide your team throughout the competition. This CEO will be there in an advisory capacity and won't directly be contributing to the proposal. Use them as your engineering consultants.

The CEO's will hold elections for a variety of leadership roles (please see the chart on the next page). Each position is normally hotly contested, so each candidate will be asked to give a short speech outlining their suitability for that post. The CEO's will conduct a vote, and the winner will take up the elected position. You are welcome to campaign for more than one position if you don't get your first choice.

When voting, the temptation is just to vote for your friends, but remember that to win you need as strong a leadership team as possible. It's not unheard of for a single departmental head to effectively drive innovations that win the competition. So each elected position is crucial to your teams efforts. Vote wisely.

Organisation chart



Structural Engineering

The structural team will define the settlement design that all other departments rely on. This team will create drawings and external views of the settlement.

Join this department if you enjoy working with mechanical systems, material science, physics and problem solving.

Key Skills

- Mathematics
- Materials knowledge
- Drawing or CAD
- Creative thinking

Key responsibilities

- Design the overall structure of the settlement
- Provide other departments with dimensions for designs
- Select the core materials required to build settlement
- Assist other teams with locating and fitting their parts

Strategy

At the beginning of any space design competition, the structural engineering division have the crucial task of laying out a basic design. Many companies have had their entire proposals derailed by a structural team who didn't lay out their vision clearly or flexibly enough.

This department must be the golden source of knowledge on the physics of the settlement (e.g. artificial gravity, available volume etc.). Furthermore, ensure that a subteam of this department is working on materials early on. Knowing early, what material you're making your base from, assists in defining the construction process come crunch time.

Operations Engineering

The Operations Engineering group have the daunting task of working out how the base will function on a day-to-day basis.

Join this department if you enjoy managing multi-faceted workflows and co-ordinating the operation of multiple systems with some optimisation.

Key Skills

- Logistics
- Practical thinking
- Time management
- Strategising

Key responsibilities

- Define the systems in place to ensure comfortable life for residents
- Ensure emergency procedures in place for evacuation
- Ensure the settlement is able to achieve it's purpose

Strategy

Operations Engineering has got its own section in the RFP, however members of this department will often find themselves working to facilitate other departments' RFP points. This department will see the most benefit from a Systems Engineer role.

If you're working in this department, make sure you account for all the latest changes across all other departments. Operations has to integrate the design as a whole, making sure that everyone's hard work meshes into an operable settlement.



Human Engineering

The most important part of any settlement, is the people on it. Their safety comes before any stated commercial goals.

The Human Engineering group has to ensure that each and every person who will live on this base is in a comfortable environment.

Key Skills

- Biology
- Design
- Maths
- Psychology

Key responsibilities

- Ensure that all life support systems are robust
- Design systems and procedures for emergencies
- Provide for the social needs of inhabitants
- Ensure that the health of inhabitants is maintained

Strategy

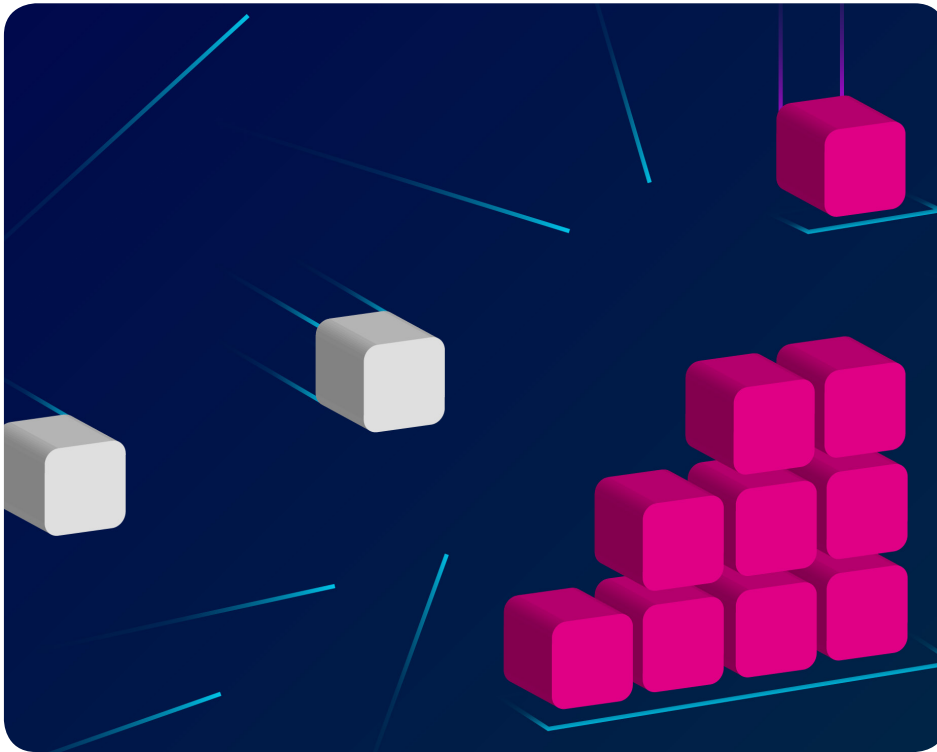
The Human Engineering team will likely start working on their sections in parallel with Structural Engineering. This can cause conflicts later on when human requirements are not possible due to the structure designed; for example Human might require 24 million cubic feet of air, which might not fit in the structure designed.

It is therefore imperative that the Human group communicate with other departments to ensure that their requirements aren't impeded by work others are doing. This is especially important with respect to life support. Furthermore, the Human engineering slides will be the most visual of your presentations, make sure it's delivery sells the design

Automation Engineering

In a world dominated by technology and automation, the role of this department cannot be overstated.

Join the automation group to work on applying computers and robotics to enable capabilities and accelerate processes for your space settlement.



Key Skills

- Computer science
- Mathematics
- Engineering
- Physics

Key responsibilities

- Must design and describe the robotic systems on base
- Define and explain the computing architecture for the base
- Innovate to create a communications architecture
- Provide contingencies for emergency situations

Strategy

The Automation department will play a huge role in any successful proposal. The speed, efficiency and accuracy that computers provide are essential to space exploration. Automation engineers must work with other departments to ensure that their needs are met by the automation department's designs.

Automation should also take a practical approach to designing the computer architecture of the settlement, ensuring no single point of failure and defending against cyber-attacks. They will strongly liaise with Operations on this point.

Impactful Presentations

What we expect from a presentation

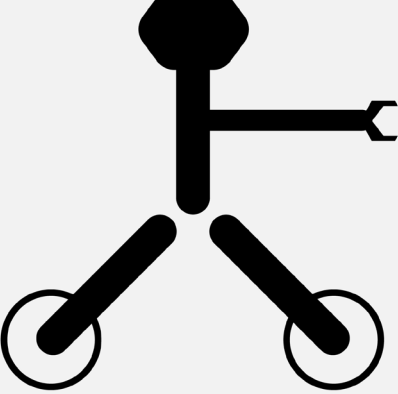
It's a common misconception at UKSDC that we judge a proposal solely on the technical achievement of the companies. As in industry, persuasively-explained presentations are equally as important as your designs.

We expect you to faithfully represent your company's values, through professional presentations and like to see practised speeches by the presenters. Remember, while this is a technical competition, we are going to be hiring a company for a (potentially) multi-trillion dollar enterprise. Therefore, we are looking for a business to partner with, as well as a strong technical group.

Breakdown of a bad presentation slide

Manufacturing Robots

For every digram, include dimensions. We have no idea of the size of this robot, or the feasibility of its operation.



You could include an RFP point, if this slide addresses one. Also although obvious here, mentioning the department will help a lot too.

The "Hati" robot will drive to the Oblivion lorries. The robot will then transport the delivered components back to the main base.

How large are these components?, which part of the base are they being transported to?

We will build 400 of these Hati robots. Each will cost \$3,000,000. It will be able to carry 400 kg.

Even though this might answer the RFP point, it seems these numbers are plucked from thin air. Give us details.

This robot will use powerful AI to automatically assemble the components into required products.

Try and avoid vague statements like this. Especially if not mandated by the RFP. We don't want to pay for extra AI we might not need

Whenever possible, give us a close up of some of these appendages. We might want to know how the hands or motors work.

References?, include footnotes or bibliography at end

Include the slide number. Otherwise, it becomes difficult for judges to work out which slides they have questions on.

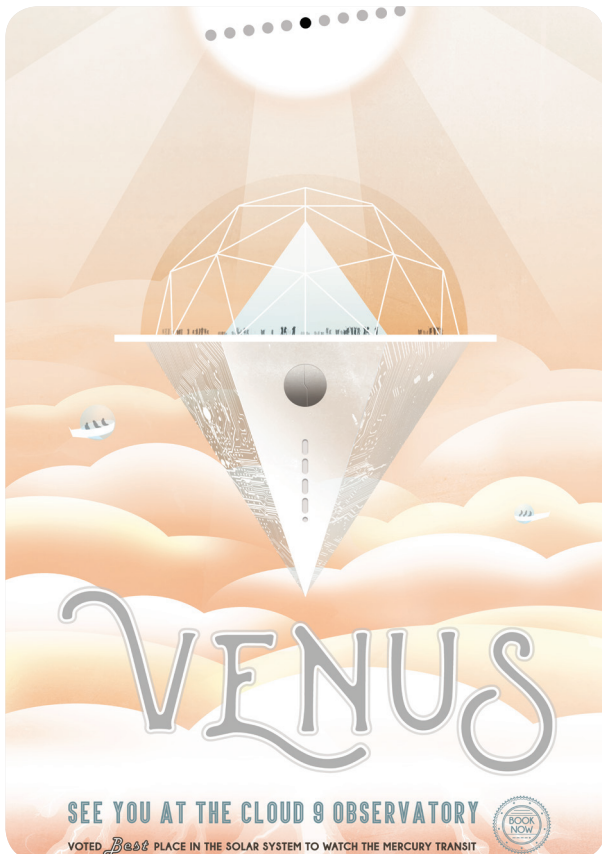
Remember the vision

One of the most common mistakes made by companies is forgetting what they are pitching to the clients. These are megaprojects, requiring the co-operation of many many thousands of individuals to make possible. The Foundation Society is willing to invest huge sums of money based on the quality of your design.

To convince us, you need to ensure that your presentation is engaging and of high quality. We don't want too many flashy animations, but we'd appreciate a couple of impressive visual artefacts. Furthermore, a plain white slide with some vaguely formatted text is not as helpful as one with at least a basic template, however ensure that aesthetics does not distract from content.

What can you do to impress us?

Firstly, colour is a huge part of visual presentation. The Vice President of Marketing has plenty of time early in the competition before slides start rolling in, to start working on the PowerPoint. They must ensure to pick a colour scheme and unified set of fonts for the presentation. After that, make sure to proof-read: Not just for spelling errors but for more fundamental errors as well, like the price being orders of magnitude less than you meant it to be.



Venus Visions of the future (NASA)

Venus, in many ways, is Earth's twin. Similar in size, and within the goldilocks zone of the sun, you might imagine she'd be a haven for life. However with clouds of sulphuric acid and surface temperatures and pressures high enough to melt steel, Venus is as dangerous as she is beautiful.

Welcome to our Solar System

The world of UKSDC is populated by a human race who've taken their first steps into the solar system. The inner planets are rich with settlements, some of which are run by the Foundation Society. Have a look at the map on the next page to view many of the Foundation Society settlements, each labelled with the year they became active.

We strongly encourage you to make use of existing infrastructure and settlements to aid in your construction and logistics operations. These established settlements have various capabilities outlined later in the document.

Rocket science

On the next few pages you'll be presented with the launch vehicles you will have access to for launch operations. Included on the map on the next page are the delta-v requirements to complete each transfer orbit. Make sure you pay attention to each launch vehicle's Delta-V capability; make sure any journeys you ask of them are within their capability.



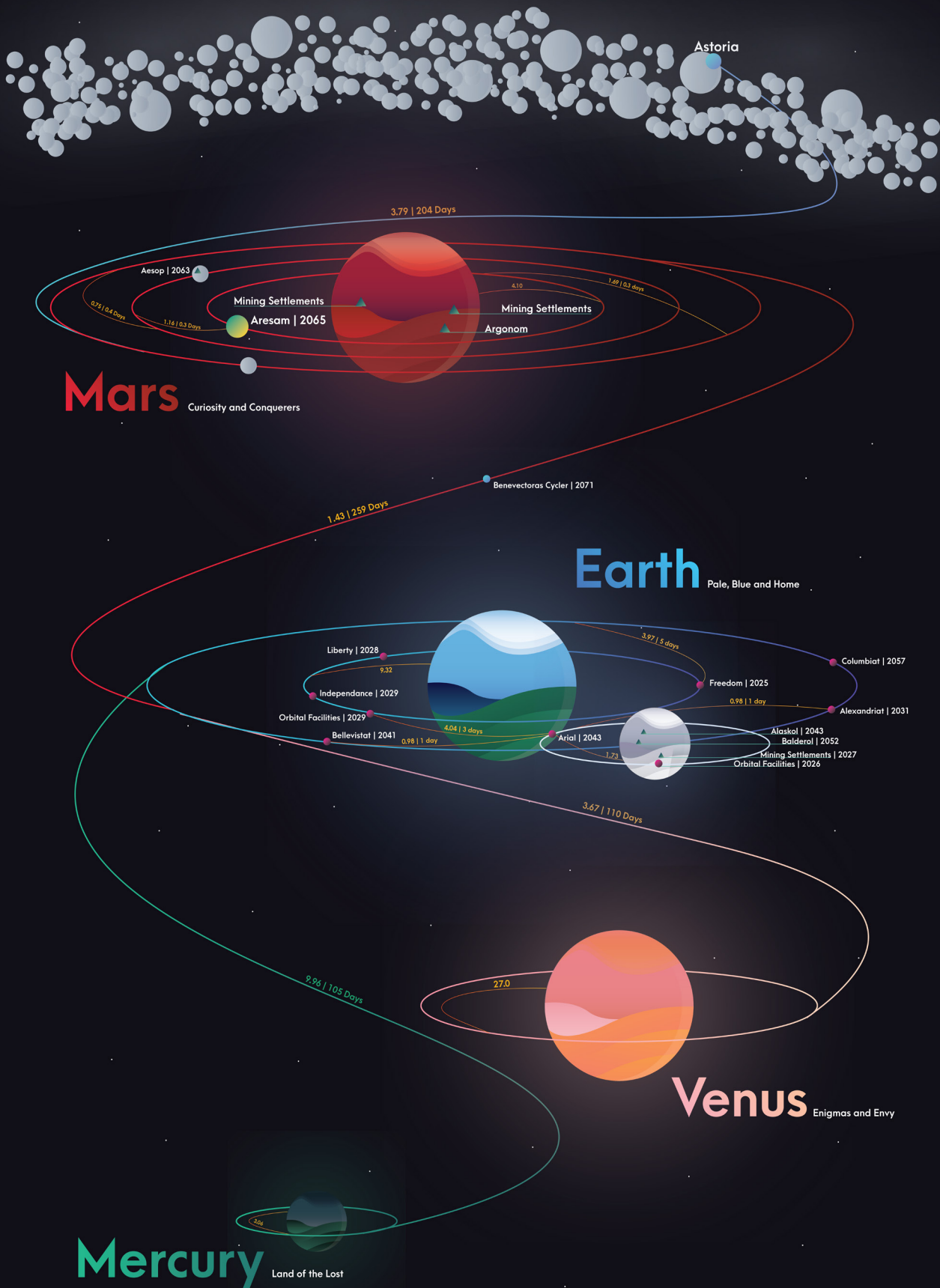
Jupiter Visions of the future (NASA)

Jupiter, the largest planet in our solar system. Diverting hurtling comets, this giant ball of gas shields the inner planets. The giant red spot holds a storm that was first observed over 300 years ago, a gargantuan hurricane that is larger than Earth itself.

Space Settlements

UKSDC Universe as of March 2020

Here Be Dragons...



Delta V (km/s) | Travel Time

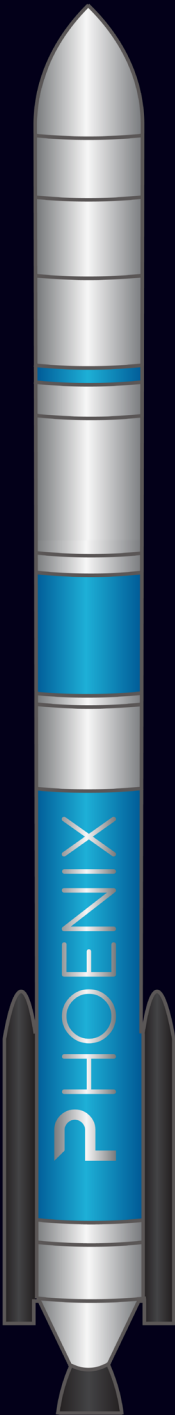
ASTRIUM LAUNCHWORKS

PHOENIX

The Phoenix launch vehicle is a wonder in the commercial launch world. By any measure, it is the heaviest lift launch vehicle available for Aresam operations. It has a total Delta-V of 36 km/s . To achieve this it uses a 3 stage approach, and has launch costs topping \$500 mn. It has advanced guidance systems allowing for optimal burn to the Aresam site. This allows the full 70 Metric tonnes K4 payload stage to be delivered to Aresam.

Any Phoenix launches from Earth must comply with the Green Earth Launch Alliance (GELA) accords. The Phoenix carries a type rating of C104, meaning the minimum wait time between consecutive Phoenix launches (from Earth) is 104 days, unless an emergency arises. From Earth Phoenix can be launched in a C30 configuration if fuel is sourced from carbon-neutral sources, this is available from Astrium for a 30% surcharge on the launch costs.

Argonom Operations:
Astrum launch works have a functional launchcomplex at the Argonom settlement on the martian surface. However due to the limited manufacturing capabilities and expensive mining resources the cost of a Phoenix launch from Argonom is \$1.1 bn. Phoenix can deliver a modified K8 payload to Aresam due to surplus thrust capabilities for the Martian gravity, hence payload to Aresam is 210 metric tonnes.



GRUMBO AEROSPACE

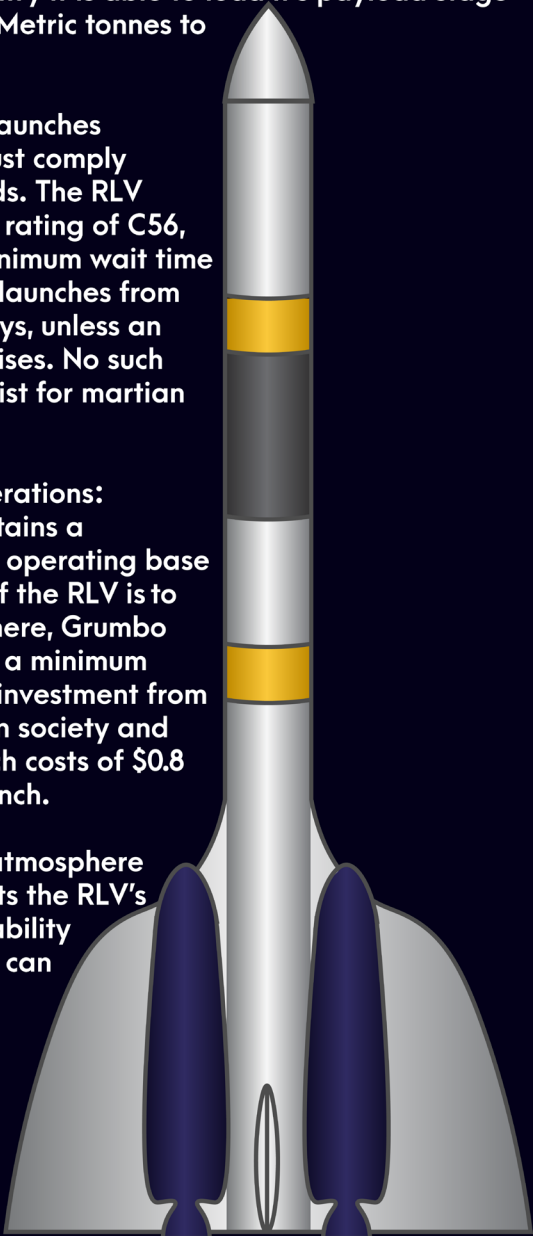
RLV

The RLV launch vehicle is unique in its extreme resusability as well as deep customisation options. It's winged lower stage allows for fuel expensive missions with aerodynamically assisted re-entry. It has a total Delta-V of 12 km/s, but due to its glide assisted re-entry it is able to load it's payload stage with up to 25 Metric tonnes to Aresam.

Any Phoenix launches from Earth must comply (GELA) accords. The RLV carries a type rating of C56, meaning a minimum wait time between RLV launches from Earth is 56 days, unless an emergency arises. No such restrictions exist for martian launches.

Argonom Operations:
Grumbo maintains a small forward operating base on Argonom, if the RLV is to launch from there, Grumbo would require a minimum \$100 billion investment from the foundation society and ongoing launch costs of \$0.8 billion per launch.

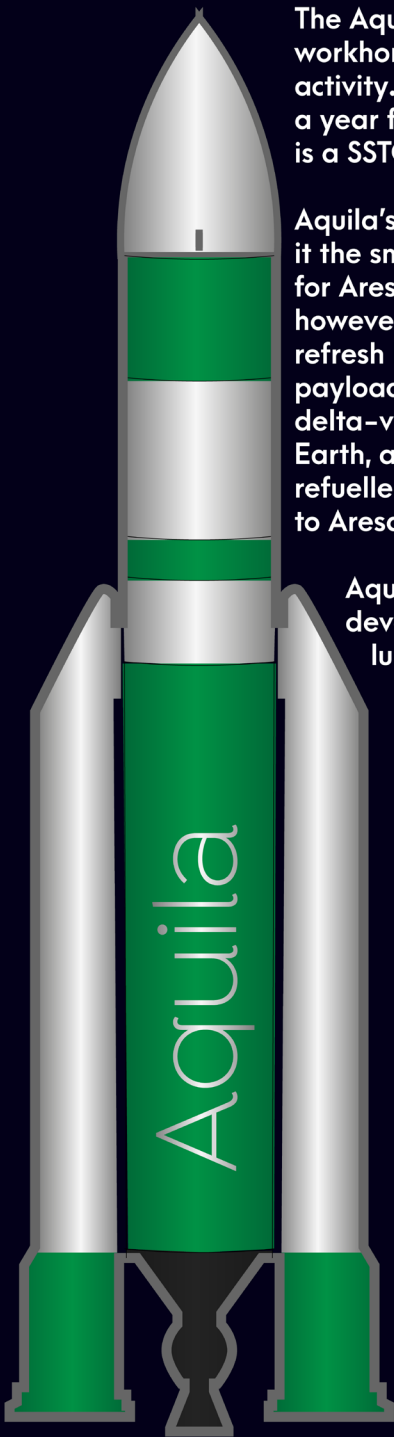
The reduced atmosphere on Mars affects the RLV's aerobraking ability and therefore can only carry 20 Metric tonnes to Aresam.



Launch site	Cost	Delta-V	Payload to Aresam
Earth Kennedy LC-56	\$350 mn	36 km/s	70 Mt
Mars Argonom LPS4	\$0.8 bn	36 km/s	210 Mt

Launch site	Cost	Delta-V	Payload to Aresam
Earth Vandenberg LC-4	\$0.3 bn	12 km/s	25 Mt
Mars Argonom LPS4	\$0.6 bn	12 km/s	20 Mt

Aquila



The Aquila launch vehicle is the workhorse of commercial space activity. Launched over 400 times a year from Earth. Each vehicle is a SSTO reusable launcher.

Aquila's small payload makes it the smallest vehicle selected for Aresam launch operations, however a recent hardware refresh has given it a 4 Mt payload stage with enough delta-v to reach Arial from Earth, and then must be refuelled to be sent on it's way to Aresam.

Aquila was initially developed for the lucarative lunar mining market. So while it cannot operate from Argonom, it is highly integrated with Alaskol's launch complex. Therefore it's able to launch from Luna for less than \$300 million per launch.

Thanks to Valiant's regenerative programs the Aquila has a C0 GELA rating, allowing consecutive Aquila launched from Earth.

Gryphus



The Gryphus launch platform was invented out of necessity by Valiant. After levels of space junk around Earth caused most companies to switch to wider orbits, the Aquila and Valiant by extension were on shaky ground.

The Gryphus is formed from two Aquila hulls, but thanks to ingenious distribution of equipment within the hulls, the payload stage(s) can carry up to 10 Mt, a huge improvement and something which brings Gryphus in direct competition with the RLV.

The Gryphus is exclusively available for Lunar launches, from Alaskol with enough delta-v to reach Aresam.

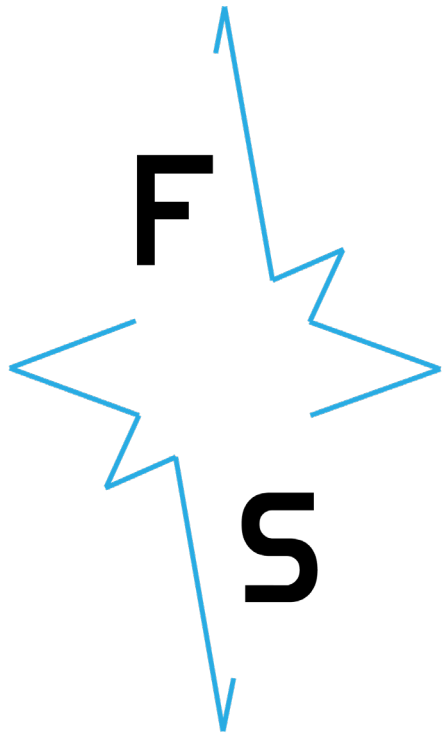
Thanks to it's simplicity in construction from used Aquila hulls, the Gryphus only costs \$700 million from Alaskol.

Valiant offers an interesting proposition and will construct up to 40% of the 200 Mt hull out of any metal with melting point above 400 degrees celcius.

Payload insurance is available on both vehicles free of charge.

Launch site	Cost	Delta-V	Payload to Aresam
Earth Kennedy LC-12/13	\$100 ml	10 km/s	4 Mt
Luna Alaskol P3/4/5	\$300 ml	10 km/s	4 Mt

Launch site	Cost	Delta-V	Payload to Aresam
Luna Alaskol P1/2/6	\$500 ml	12 km/s	10 Mt



FOUNDATION SOCIETY

Foundation Society

The Foundation Society is a multi-planetary organisation, set up for the betterment of humankind. This massive industry titan funds major space settlements which span the entire system.

They are also a huge investor in humanitarian operations, ensuring development equality for all the settled worlds.

Dr. Kistanto Danta

The current president of the Foundation Society is Dr Kistanto Danta. An Indonesian born doctor of physics, he pioneered the effort to prevent isolationist space colonies, earning him a Nobel Peace Prize.

President of the Foundation Society

Lobbying Efforts

The Foundation Society was initially founded as a commercial enterprise between several large multi-national firms. These firms recognised that the laws, regarding ownership in space at the time, precluded any incentive for commercial exploration. Without the ability to own a particular resource, no entity (national or commercial) could financially justify funding further exploration initiatives.

The Foundation Society worked with the United Nations to implement a strict set of property rights which apply to objects that are above the Karman line. A subsequent set of treaties organised rights to claim parts of the Lunar surface. The basis of these laws was the idea that, if an entity had a base capable of supporting human life on an astronomical body, any land within a 30 kilometer radius would legally belong to the entity.

This simple change in the laws on property rights in space triggered the greatest industrial effort ever undertaken by humankind. In 2025, just five years after the treaty was signed, nationals from over 45 countries had set foot on the moon. The first humans to set foot on Mars were carried there on partially commercially-funded vehicles.

The Orion Initiative

In 2030, the Foundation Society undertook the Orion initiative. This initiative required the Society to pour all of its resources into founding, in equal parts, scientific and industrial settlements in the solar system.

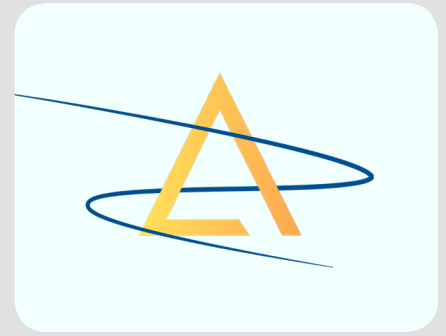
The Orion initiative, propelled by the thrills of humanity's rush to space, created some of the most recognisable and significant settlements in the solar system.

Alexandriat

Aptly named the 'Jewel in Earth's Crown'. Alexandriat was the first major settlement sponsored by the Foundation Society. Constructed by Earhart Advanced Industries, Alexandriat orbits earth at it's L4 point.

She was built as a gateway to the solar system, but her modularity has meant that Alexandriat has become a business hub for the inner planets. Most financial institutions servicing the exploration sector have an office on Alexandriat, as well as almost every major engineering firm.

Alexandriat hosts four renowned universities, each with exceptional astronaut schools, she also plays host to advanced physics research facilities, as one of the few stations large enough for a fusion reactor.



Key services

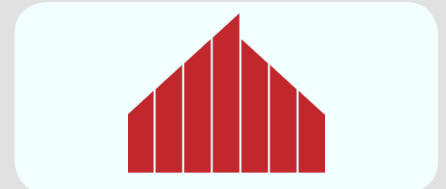
Refuelling
Shipyards
Fusion energy expertise
Financial and technical hub

Argonom

Argonom is Mars' second city. Oriented almost exclusively as an industrial hub, Argonom has strong launch capabilities, along with advanced manufacturing capabilities. Argonom is effectively the forge of the inner planets.

Argonom is essential to the operation of Olympia, Mars' capital. Providing not just industrial, but also low cost access to space powers the martian shipping industry.

Argonom is likely the only settlement for now that can support outer planet operations.



Key services

Manufacturing
Access to Mars
Super Heavy Launches

Columbiat

Key services
Manufacturing
Education
Residential Amenities
Fusion energy

Bellevistat

Key services
Business hub
Mass Driver
Cargo Handling
Refinery

Alaskol

Key services
Commercial services
Legal services
Entertainment industry
Tourism

Aresam

Key services
Freight handling
On Orbit construction
Access to Argonom
Mars emergency response

Astoria

Key services
Asteroid Mining
High velocity Mass Driver
Manufacturing
Access to outer planets

Benevectoras

Key services
Earth Mars Freight
Shirtsleeves transport to Mars
Mass Driver
Astronaut School



EARHART ADVANCED INDUSTRIES

Key Specialisms

- Nano-bot based onsite fabrication.
- Soft magnetic Titanium alloy
- Ownership of Valiant Launch Corporation, providing 20% reduction in launch costs
- Highly experienced with Foundation Society Projects

Founded as Earhart Noonan by the pioneering aviator Amelia Earhart in 1934, three years before her disappearance over the Pacific. The company initially specialised in airfield planning and construction, and saw huge demand during the Second World War. Thanks to this success the company was awarded contracts by the US Atomic Energy Commission to build nuclear reactors for the rapidly modernising american population.

In 1961 as the Apollo program was starting to select contractors EAI created a subdivision to tackle the challenges of the upstart space industry, naming it EAI Celestial. This wing of the firm used their hard won expertise and experience to win contracts with NASA to construct launchpads and facilities at the Cape Canaveral Space Centre.

Ever since, EAI Celestial has hired NASA engineers to strengthen their spacecraft design and construction capabilities, which won them contracts for modules of the ISS in the mid 1980's. In 2014 EAI Celestial started a material research skunkworks which led to the development of advanced nano-bot forging techniques. Their proprietary nano-bots have revolutionised additive manufacturing, with novel applications developed by thousands of users.

In 2024, EAI made a huge leap in material research, they developed a titanium alloy that had incredible tensile properties and is also a soft magnetic material. This combination of properties allowed EAI to build the famous Ha Long Floating City. The entire settlement, nestled amongst the towering islands of the Vietnamese peninsula, magnetically floats 30 meters above sea level and has become a hub for technological progress and research activities.



EAI Celestial have played a role in every single Foundation Society project since 2030. Their strong relationship with the Foundation Society is solidified in the annual tranquillity ball held at Tranquillity base on Luna. This star-studded event is the crown jewel of the fundraising drive that EAI has been undertaking to uplift the most impoverished communities on earth.

EAI pride themselves on their vertical integration and attempt to develop as much as they can in-house. This technique is particularly suitable for the scale of the projects that EAI work on. EAI’s vertical integration structure allows them to manage the complex and interlinked workflows that accompany megaprojects. EAI Celestial’s combination of strong management, advanced fabrication and material research capabilities have won them the primary contracts in the past for the Foundation Society’s flagship settlements like Bellevistat and Columbiat.

Their most recent contract award was for the Benevectoras Earth-Mars cycler which has further reinforced their reputation for excellence at the largest scales.

Earhart’s traditional weak point in launch vehicle procurement and operation was addressed in 2029 when Earhart acquired Valiant, a leading launch provider whose Aquila launch vehicle has formed the backbone of EAI Celestial’s operation since 2029. With Valiant’s help EAI have placed themselves firmly at the forefront of human space exploration.

EAI have often been called the “Old Guard” amongst space enigneering companies. EAI is quite defintely the oldest company competing for Foundation Society contracts, but instead of forming baggage, EAI’s illustrious heritage gives it’s engineers and innovators legitimacy to design the newest and most advanced settlements that humankind has ever attempted.

Cost table

Item	Exclusivity	Unit	Cost per Unit (\$)
Nano-bot onsite fabrication	Exclusive to EAI	KG of metal required to be sculpted	5000
Soft-Magnetic Titanium Alloy	Can be contracted out, EAI gets 70% discount	KG	20000
Valiant Launches	Can be contracted out, EAI get 20% discount	See page 18	
Assembly on Alexandriat	Exclusive to EAI	KG of assembled mass	200
EAI Celestial Consultancy	EAI can be subcontracted for construction	% of total project contract value	50

KEPLER AUTOMATION

SPECIALISMS

- Advanced automation and artificial intelligence
- Satellite Communications and navigations Suite
- Spacecraft habitation module Design
- Cutting edge security against AI led attacks

AWYRNET-7

AWYRNET-7 IS ONE OF KEPLER AUTOMATION'S HIGHEST PROFILE PROJECTS, PROVIDING TIPLE LOCK SECURITY FOR THE EUROPEAN UNION

Kepler Automation GmbH is a European multinational space contractor. Formed in 2020 as a joint venture between Südlandwerke AG of Germany and Marcel Systèmes SA of France, Kepler Automation boasts the former's extensive experience of systems integration on major defence and aerospace projects, coupled with the latter's expertise in uninhabited space platforms and autonomous systems.

The pioneering discoveries of 17th-century German astronomer Johannes Kepler inspired the company's name, along with its mission statement: "To equip humanity with an advanced space fleet built upon our engineering excellence, opening pathways to new reaches of the Solar System". During the 2010s, Europe found itself in an increasingly competitive space sector, with significant pressure from American, Chinese and Indian rivals. This prompted European governments to push for more collaboration between engineering companies in order to protect and grow the continent's domestic space industry. Südlandwerke and Marcel Systèmes answered this call with the 2020 merger of their respective space divisions to form Kepler Automation, a joint venture company. The company's independence and sole focus on space engineering allowed it to become rapidly competitive . By 2024, Kepler Automation had already established itself as the go-to satellite partner of choice for European governments, being selected as prime contractor for AWYRNET-7, europe's satellite defense grid. At any one time 3 awyrnet satellites will be over mainland europe and intercept any threats.

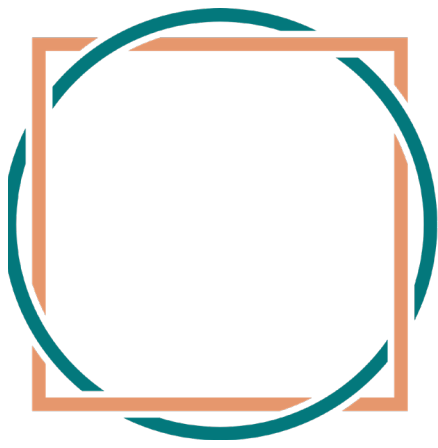


During this period, Kepler Automation also began its involvement in orbital space settlements as a subcontractor for Alexandriat. Through its parent companies, Kepler Automation called upon a wealth of experience from adjacent sectors. Marcel Systèmes' successful automation of the Paris bus network gave Kepler Automation the knowledge and skills it needed as a subcontractor responsible for designing Alexandriat's autonomous internal transportation. Habitable space modules for the station were also designed by Kepler Automation, led by seasoned engineers seconded into the company from Südlandwerke; experience gained from designing pressurised structures for submarines and vast on-board living spaces for aircraft carriers proved readily transferable to the space sector. Thereafter, Kepler Automation was in prime position to take its skillset into space.

Kepler Automation differentiates itself from the competition with its dedicated expertise in robotics and autonomous systems. Its advanced Star Dream habitation management system coordinates and automates the full breadth of habitation systems on board numerous existing space settlements. Star Dream possesses an advanced artificial intelligence and a vast knowledge of human linguistics, such that crew are able to deliver instructions and manage the settlement through conversational verbal commands.

In-orbit construction and repair work is automated by the company's mass-produced fleet of Daio-3D drones; these penguin-sized robots take care of smaller tasks normally performed by human hands, such as fine electrical wiring, installation of components, and small-to-medium repairs. Their built-in additive manufacturing functions are able to print using a wide range of feeder materials. While a single drone is better suited for small tasks, a large swarm of Daio-3D drones scales up to meet major construction challenges. Drones communicate with each other using multi-channel short-wave radio, forming a mobile ad hoc network (MANET) that allows for significant redundancy and decentralisation, while support for SATCOM reachback enables remote command and control (C2). Drones determine their own position using inertial navigation, coupled with support for a range of position, navigation and timing (PNT) sources; this information is shared throughout the MANET to provide shared situational awareness.

ITEM	EXCLUSIVITY	UNIT	COST PER UNIT (OUTSIDERS)
STARDREAM - HABITATION CONTROL	EXCLUSIVE TO KEPLER	SINGLE UNIT	\$40,000,000
DAIO-3D DRONE	CAN BE CONTRACTED OUT - KEPLER GETS 50% DISCOUNT	SINGLE DRONE	\$8,000,000
INFINIUM SUPERCOMPUTER - EXASCALE COMPUTER	EXCLUSIVE TO KEPLER	SINGLE UNIT	\$5,000,000,000
HABITABLE EXTERNAL MODULES	EXCLUSIVE TO KEPLER	M3 OF PRESSURISED SPACE	\$50,000



DaVinci

MECCANICA

Specialisms

- Repurposing previously used parts for different areas of settlement
- Solaris advanced satellite power delivery
- Space debris collection and repurposing
- Arno—modular phone
- Vertical integration consultation
- Satellite renting services

DaVinci Meccanica was founded in 2001 following Dennis Tito's landmark trip on the Soyuz TM-32 spacecraft when he became the first ever tourist in space. The company was formed as a side project by several Roscosmos engineers, with the idea of expanding their company internationally and the aim of "humanising" ecologically responsible space exploration – promoting the concept of sustainable space travel to members of the public beyond the elite astro community. The company was named after Leonardo da Vinci, the famous painter, musician, scientist and inventor. DaVinci was the first true Renaissance Being - his detailed research across a vast range of subjects established the interconnectivity of art, science, medicine and philosophy and laid the foundation for all modern scientific development.

Despite the company's current focus on space exploration, its first significant success came from the development of clean energy sources to power the production of solar fuels from super abundant natural resources. In 2009 they launched Solaris - an array of mid Earth orbiting solar "harvesters" that beamed power back to earth via microwave links. DaVinci Meccanica initially provided energy for Earth based industries but subsequently developed the technology to distribute discrete energy packets to orbital and colonial settlements - including the Foundation Society's projects Alaskol, Balderol, Alexandriat and more.

Green Horizon

Following the 2014 People's Climate March, DaVinci Meccanica adopted its now famous Green Horizon mission statement. This required all of its future developments to be carbon positive, ensuring that each product contributed to repairing the environment rather than simply avoiding further damage. This led to the development of innovative recycling techniques and the repurposing of waste products into valuable new resources. In 2024, following the damage of the ISS in a collision with a piece of space junk, the company began their mission to collect and store all space debris with the aim of "securing space" and - as a sideline - recycling much of the material to the emerging space colonies. The huge financial return generated by being able to insure all future launches and settlements were safe from damage caused by space debris allowed the company to expand significantly throughout the late 2030s.

Humble origins

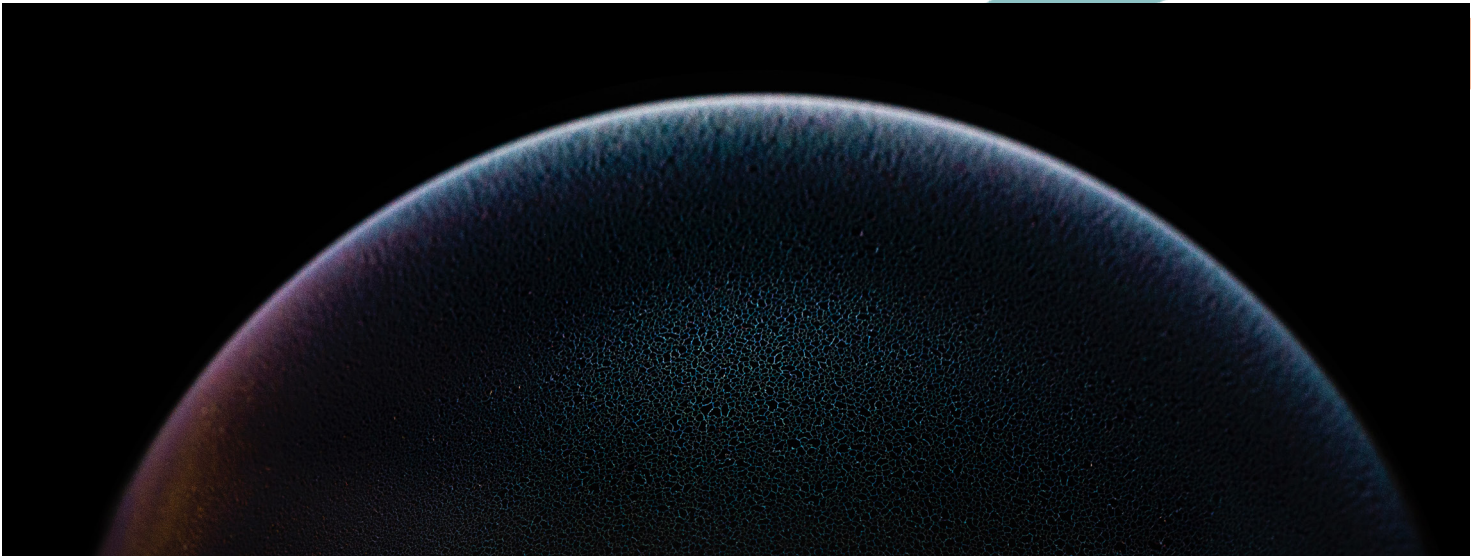
The company saw huge opportunities in the space settlement world through their involvement with the Foundation Society. In 2043 DaVinci Meccanica won their first contract with the Foundation Society to build Alaskol- known as "The first Big City on Luna". DaVinci Meccanica used this opportunity to finally test out their new product Arno- a modular phone, designed with the aim of reducing E-waste and increasing reusability of components. Arno provided secure communication throughout the settlement, allowing the residents to access any vital information and alerts immediately. The device was later upgraded to integrate with all proposed networks, allowing for an increase in control of all automated devices onboard such as personal appliances as well as allowing authorized personnel to access, modify and halt any task being done by specific machines. The success of Arno onboard Alaskol prompted DaVinci Meccanica to further explore more into the incorporation of modular and repurposed devices within their design plans, with a specific focus on the integration of a variety of wearable devices for the residents onboard their settlements.

Onward

Alaskol Contract

DaVinci is a company which uses innovation as its primary growth tool. In this vein, DaVinci has established itself as the foremost authority on clean energy systems. Sustainability is a particular strong point which DaVinci wishes to explore in the future, especially in the field of preventing isolated environmental collapse, sometimes called a cascade collapse.

Davinci aspires to continue the process of designing the impossible, that Leonardo da Vinci started so many centuries ago.



Item	Exclusivity	Unit	Cost per unit \$ (Outsiders)
Arno - Modular phone	Exclusive to DaVinci	Single unit	7000
Space Junk recycler	Can be contracted out - DaVinci gets 50% discount	Single plant (can process 4000kg a day)	12,000,000
Solaris Array	Exclusive to DaVinci	24 satellite constellation	1,200,000,000
Clean Energy Consultation	Can be contracted out	% of project value	4



Involved in:

- Affordable, reusable launch systems
- Atmospheric production
- Large volume pressurisation
- Nutritional Vegan Food
- Hydrodynamic farming

The parent company started as Outback Vegan, an Australian based vegan consumer goods company founded in 1997, which had the aspiration of providing astronauts with food to demonstrate the advantages of the vegan diet. Eventually the company was merged with a UK food and drinks processing conglomerate. Condor's parent company is the largest vegan food provider in the world, and intent on saving the Earth from climate change, moved into the space settlement business. Outback Vegan created the subsidiary Condor in 2037 to be exclusively focused on space exploration and settlement creation. They were initially successful with selling rocket fuel by using the processes and facilities of the existing food and drinks factories.

Condor was founded to move the company into the launch vehicle business with resounding effect. The company now has a reputation for producing high quality, affordable launch systems. Recently they have used the processing and manufacturing expertise to begin to research into zero gravity mining processing.

A newcomer into the megaproject industry, Condor has a substantial budget from their food and drink business that has recently shaken the industry. The space settlement business is now number one business priority, with the food and drinks a stable income. Condor remains true to their sustainable and pro-vegan stance, however they are increasingly known for offering proposals praised with 'thinking outside the box' solutions.

Current established products include the versatile reusable launch system, Multi Fuel Rocket (MFR) which can transport a 15Mt payload at a cost of \$70mil to Aresam from Earth. Condor purchased an equity lease in 2044 of the purpose built sea platform and spaceport complex which dominates the island state of Nauru. The location 60km from the equator further aids the increase in launch efficiency. The launch system combines solid and 'green' non-toxic liquid fuels in different stages with programmed burns to improve the efficiency and decrease costs of launches. Following the success of reusable rockets in the 2020's and 2030's, Condor broke into the market slightly later but the MFR with improvements in efficiency, safety and reliability, surpassed the industry leaders.



The major break for Condor came with the subcontracts for the launch of Columbiat 2057 and Aesop 2069 settlements. With the increased investments, cash flow and reputation Condor have recently extended the processing patents to be used to create earth-replicated atmospheric conditions in space settlements. Condor hold a strong position in the algae production market, using genetic modification techniques on a number of different strains of algae and the algae now photosynthesises at a greater rate. 1.5m² of this plant mixture is enough to support a 95th percentile human's breathing chemistry indefinitely.

Using advanced research in pressurisation, Condor now own established airlock subcontractor Lossless Airlocks. Additionally, Condor have a unique partnership with Extreme Survival Technologies (EST) involving sharing the Condor pressurisation patents in exchange for EST supply chain and intellectual property rights, with an available discount of 30% for the use of the products.

A key consideration and publicity push of the company is the food and drink, which is regularly shown through Condor proposals to include all vegan food and drink for astronauts, using patented processes to make high protein, vitamin and mineral rich food. Some food products provide Vitamin B12, Zinc and Iron sources to give consumers fully balanced diets. There is still research in providing calcium in the food however.

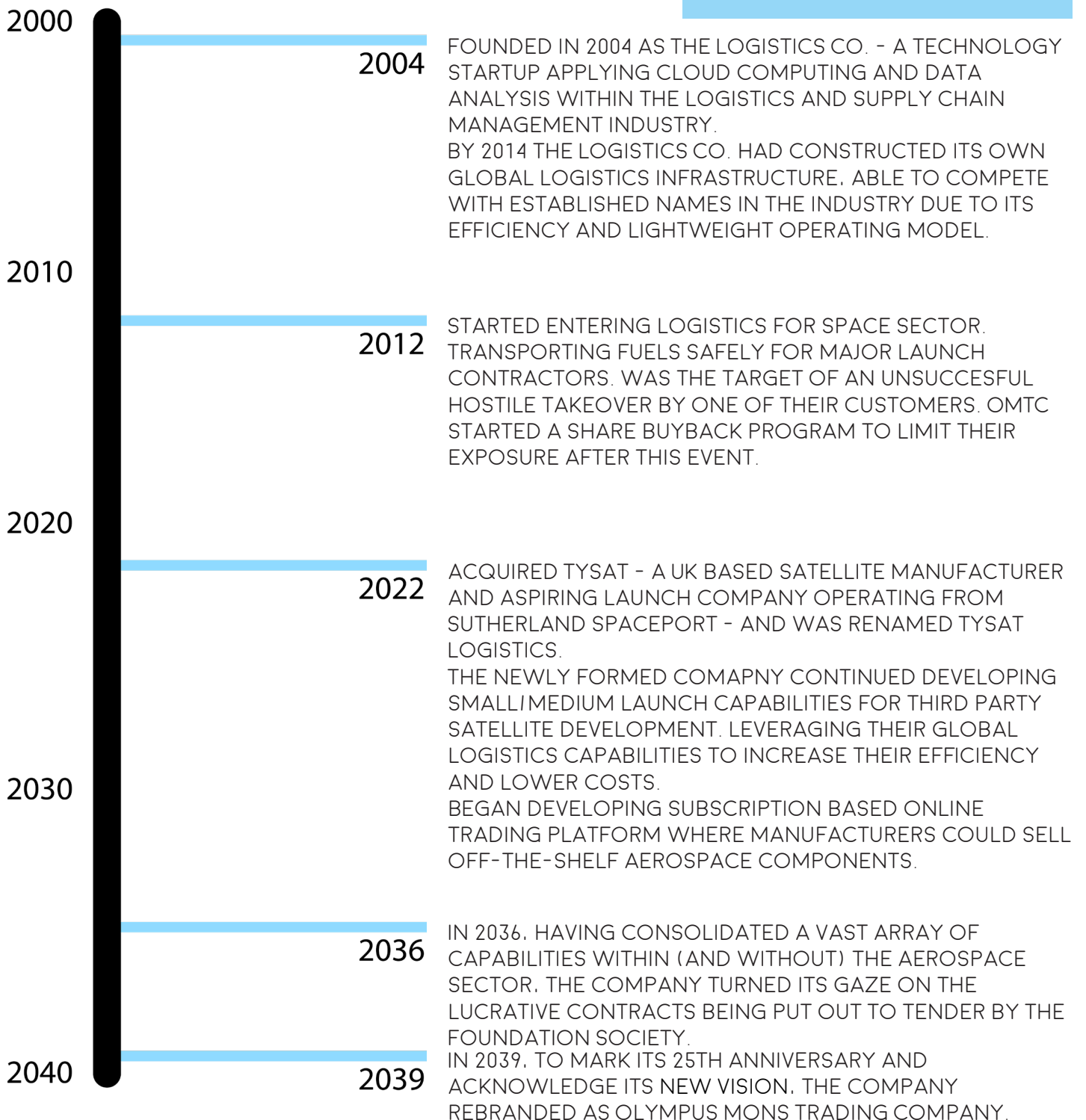
Item	Exclusivity	Unit	Cost per Unit (\$) (If applicable to outsiders)
Multi Fuel Rocket (MFR) Launch	Exclusive to Condor	single earth launch	70,000,000
Zero-g Mining processing	Can be contracted out, Condor gets 40% discount	KG of ore to be refined	12000
Extreme Survival Technologies products	Can be contracted out, Condor gets 30% discount	See page 47	
Vegan Food provision for Space settlements	Can be contracted out, Condor gets 50% discount	KG of food	200



SPECIALISMS

- DEPLOYMENT OF SATELLITE CONSTELLATION
- FREIGHT TRANSIT THROUGHOUT THE SOLAR SYSTEM
- ADVANCED CASSSC HANDLING FOR DELICATE CARGO
- MASS DRIVER BASED CARGO DELIVERY EXPERTISE

HISTORY



SATELLITE CONSTELLATIONS

OMTC IS A LEADING PROVIDER OF CONSTELLATIONS OF SMALL SATELLITES. INITIALLY DEVELOPED TO PROVIDE COMMUNICATIONS AND NAVIGATION SERVICES TO ANY LOCATION ON EARTH' S SURFACE. THEIR INITIAL CONSTELLATION WAS TASKED WITH IMPROVING SECURITY FOR THEIR GLOBAL LOGISTICS AND FREIGHT TRANSIT INFRASTRUCTURE. SUCCESS LED THEM TO PROVIDE SUCH SERVICES INITIALLY TO GOVERNMENTS. ESTABLISH THEIR OWN TELECOMMUNICATIONS NETWORKS GLOBALLY. AND ESTABLISH THE OLYMPUS FOUNDATION (ORIGINALLY THE TYCARE FOUNDATION) IN PARTNERSHIP WITH OTHER INTERNATIONAL DEVELOPMENT ORGANISATIONS TO PROVIDE AFFORDABLE INTERNET ACCESS TO THE DEVELOPING WORLD.



FREIGHT TRANSIT

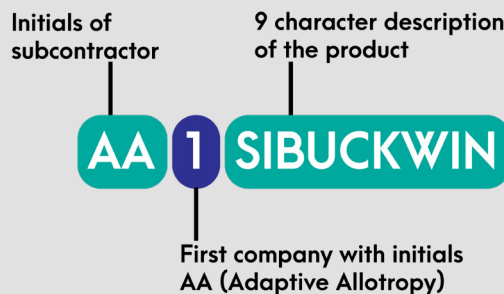
OTMC HAS ESTABLISHED TRANSIT ROUTES IN REGULAR USE THROUGHOUT THE SOLAR SYSTEM. WHICH CAN BE USED BY THE COMPANY TO MORE ECONOMICALLY AND AUTONOMOUSLY MOVE NON-HUMAN PAYLOADS BETWEEN LOCATIONS.

Item	Exclusivity	Unit	Cost per Unit (\$) (If applicable to outsiders)
Satellite Constellation	Exclusive to OMTC	36 Satellite constellation	4,000,000,000
Freight Transit	Can be contracted out, OMTC gets 40% discount	KG of material to be transported/ms delta-v	20
Gravity Assisted Freight Transit 3x slower than usual	Can be contracted out, OMTC gets 50% discount	KG of material to be transported/ms delta-v	15
Contract negotiation consultation	Can be contracted out, OMTC gets for free	% of contract value	3

Subcontractors

How to use subcontractors

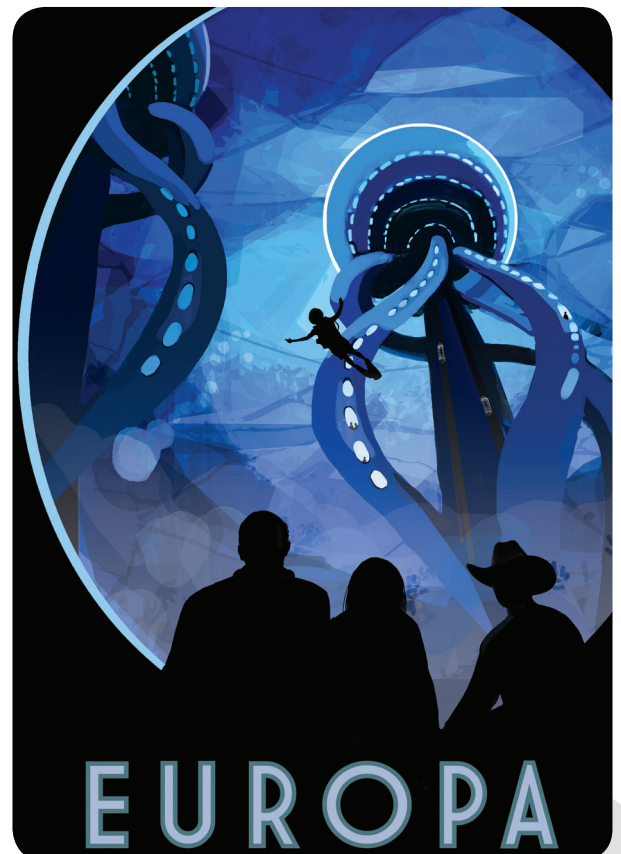
Over the next couple of pages you will be presented with entries of subcontractors. Each subcontractor will provide a description of their services, and conditions for their use but we urge you to look for our most up to date information on the website. Most subcontractors will require designs to be submitted to them (and therefore included in the final presentation) before they can manufacture the designs. Each subcontractor will also provide a price list, and for each service there will be a product identifier e.g. AA1SIBUCKWIN. This product identifier can be broken down:



To ensure that we understand which exact product you are ordering from a subcontractor, please ensure to include the product identifier on the slide, as well as the cost per unit and number of units ordered. This is not required for products offered by any of the prime contractors.

Europa Visions of the future (NASA)

Europa, one of Jupiter's largest moons is an enticing celestial object for human exploration. We have confirmed the existence of a subterranean ocean, and with the water plumes erupting from her surface, she is an ideal candidate for finding alien life.



Adaptive Allotropy

Supplies windows made from silicon bucky-structures materials for use on space settlements. Windows can be ordered in any shape. With proper sealing, standard, 12 mm thick windows with rectangular side length or diameter no greater than 0.91 m can retain up to a 1.01 bar pressure difference across them. The allowable safe span doubles if the thickness of the window is doubled, while the allowable pressure difference squares with the increase in thickness (e.g. doubling the thickness allows for four times the pressure difference). This is quantified with the equation $\sigma_{\max} = (\Delta P L^2) / (2 t^2)$ where ΔP is the pressure difference in Pa, L is the span in m, t is the thickness in m, and σ_{\max} is the maximum allowable tensile stress in the material, 290.1 MPa. If never exposed to direct sunlight, windows provide adequate radiation and thermal insulation, they are, however, prone to brittle failure. Prices listed below do not include shipping costs from Bellevistat.

Item Code	Description	Unit	Cost(\$)/unit
AA1SIBUCKW00	1-10 m ³ of SiBuck Windows	m ³	1000
AA1SIBUCKW10	10-100 m ³ of SiBuck Windows	m ³	900
AA1SIBUCKW25	100-1000 m ³ of SiBuck Windows	m ³	750
AA1SIBUCKW30	1000 - 10,000 m ³ of SiBuck Windows	m ³	700
AA1SIBUCKW35	> 10,000 m ³ of SiBuck Windows	m ³	650

Advanced Materials Group

Are the industry leaders in the supply of specialist plastics, composites, and aerogels. AdMaG produces unformed bulk material to customers or their own specifications. Their own products include a transparent PMMA equivalent (density=1190kgm⁻³) with a working temperature up to 675 K (this can be used in windows by applying the formula from Adaptive Allotropy with a σ_{\max} of 70 MPa), and a space rated carbon-nanotube-mesh reinforced polycarbonate with a maximum temperature of 500 K and a yield strength of 130 MPa (density=1240kgm⁻³). AdMaG sells silica, carbon, and alumina aerogels, produced on-site with specialist equipment. The transport of the equipment and raw stock is included in the price of the material, but a minimum order size of 30 kg is in place. AdMaG processes their plastics, composites, and aerogels at Liberty, a Martian Mining Settlement, and Arial respectively.

Item Code	Description	Unit	Cost(\$)/unit
AM1PMMMAEQV	Transparent PMMA Equiv.	kg	1.60
AM1CARNAPOLC	Carbon-nanotube Polycarbonate	kg	0.85
AM1SICAALAE	Silica/Carbon/Alumina Aerogel	kg	2000
AM1CUSTOMMIX	Custom Material Mix	kg	750

Blown Away

Specialises in making inflatable buildings to customer specifications, to enable quick construction of new communities. Although these structures are not intended for permanent or indefinite use, they provide shelter for residents to start new economic activities, until more durable solutions can be established. They are manufactured at Bellevistat for the customer's collection. The shelters provide no protection against radiation but are 90% thermally insulative.

Item Code	Description	Unit	Cost(\$)/unit
BA1CSINFLBUG	Custom Inflatable Building	m ³	1000

Crucible

A British company which operates an automated manufacturing facility on a ferro-nickel asteroid (6178) 1986 DA. The company produces triangular trusses (usually in a Warren girder) and sheets to customer-specified dimensions, at a rate of 2,500 kg of beam per hour. Some limited assembly of products is permitted in the vicinity of this operation (space rented on the asteroid's surface or within 10 km at a rate of \$500 per day). However, customers are required to organise transportation themselves, with the most common destinations being the orbits of Bellevistat and Aresam, having delta-Vs of 1.20 kms⁻¹ and 1.14kms⁻¹ respectively. Crucible charges \$0.20 per kilogram of formed metal or \$0.10 per kg of metal provided as 5 mm diameter spheres. The metals offered are: iron (steel), nickel, chromium, cobalt, copper, lead, molybdenum, manganese, magnesium, silver, zinc, zirconium, and alloys of any of these metals (surcharge of \$0.10 per kg). Available unformed only at a higher price of \$1.20 per kg are bismuth, calcium, gold, iridium, osmium, palladium, platinum, rhenium, rhodium, ruthenium, tantalum, tungsten. Crucible will pay clients \$0.05 per kg to rid them of slag, consisting of 98% fused silicon dioxide by mass, and 2% trace metal oxides.

Item Code	Description	Unit	Cost(\$)/unit
CR1FORMMETNA	Formed Metal - Non Alloyed	kg	0.2
CR1FORMMETAL	Formed Metal - Alloyed	kg	0.3
CR1UNFOMETNA	Unformed Metal - Non Alloyed	kg	0.1
CR1UNFOMETAL	Unformed Metal - Alloyed	kg	0.2
CR1RAREMETUF	Rare-Earth Metal Unformed	kg	1.2
CR1SLGPURSIT	Slag buy back, 98% SiO ₂	kg	-0.05

Digg

Adapted designs of excavation equipment used on Earth for use in low-g environments. It has created mining equipment, trench diggers, backhoes, dirt-movers, graders, drills and tunnelers and will create new machines on request. Some types of applications require more than one design solution depending on whether local conditions enable bracing the equipment to compensate for lack of gravity. Contracts have call out and services costs in order to place equipment at location and to perform the required task.

Item Code	Description	Unit	Cost(\$)/unit
DG1EXCAVMATR	Excavation of material	m ³	10000

Lightworks

Provides soletta and lunette illumination for lunar and terrestrial surface locations. The huge orbiting structures reflect sunlight during the night. Six lunettas (each 1 km²) enable solar power plants to operate all night. The devices consist of sodium-coated fabric made from lunar materials stretched over lightweight composite structures and are constructed in 4,000 km lunar orbits.

Item Code	Description	Unit	Cost(\$)/unit
LW1LUNETTASG	Lunetta	Single unit	120,000,000

Out of the Woods

Is a small organisation that operates one of only a handful of off-world tree farms. They are based at Balderol and produce their wood as a by product from their main task of CO₂ removal. Their founder repeatedly stresses the virtues of design involving wood, particularly the calming and homely feel it creates. They sell a huge variety of wood from Oak to Purple Heart cut into regular sizes for an average of \$500 per cubic metre. However, their manufacturing capacity is limited to 8 tonnes of exports a year.

Item Code	Description	Unit	Cost(\$)/unit
OW1WOODSINGL	Wood	m ³	500

Progressive Plumbing

Has developed peristaltic sewerage systems that are less prone to jamming, do not require high pressure to operate, and operate in zero-g conditions. The sewers have a power drain of 1W per kg to be moved per second. The waste maxes out at a speed of 1 ms⁻¹ in the 0.5 m diameter pipes. Silicone spheres with the same outer diameter as the pipe are used to provide a surface for the electro-hydraulic bladders to press against to move the waste stream. Provision must be made for these spheres at intersections or terminuses with processing equipment. The spheres must move through a loop or have separate systems in place for moving them back through the system and must be cleaned after 96 hours in operation for hygiene purposes. The peristaltic effect may operate in both directions along the pipe. The probability of a single failure in a system of length x metres is $x \times 0.0001$ and hence multiple failures are distributed Poissonially. The system will be guaranteed for 5 years after the completion of installation. The pipe weighs 1.5 kg per metre while each sphere weighs 11.3 kg and both are produced in Nebraska.

Item Code	Description	Unit	Cost(\$)/unit
CR1FORMMETNA	Peristaltic Sewage System	m	50

Sealant Advancements

Makes paint and coatings from near-Earth asteroid mined materials that provide air-tight surfaces on rock, SuperAdobe and other porous surfaces. Application is done with standard paintbrushes or aerosols and the surface requires 30 Earth days to dry before being capable of retaining air. These are produced at Bellevistat where the company holds a stock of 50,000 litres priced at \$55 per litre. To be effective the paint requires a coating thickness of 0.5 mm and it has a density of 2,000 kg/m³.

Item Code	Description	Unit	Cost(\$)/unit
SA1SEALPAINT	Air tight paint	liter	55

Tubular Technologies

Based on Alexandriat, is the most prolific producer of carbon nanotubes for industrial and scientific uses, for both space and dirtside customers. The company has succeeded in making nanotube cross-linked strings up to 2 km long, although most applications are in the one to ten foot range. Nanotubes add strength to conventional materials; primary customers are manufacturers of construction elements (e.g. for buildings and bridges) and components for machinery, vehicles and tools.

Item Code	Description	Unit	Cost(\$)/unit
TT1NANOTUBES	Nanotube	meter	1

Baena Robotics

Offers purpose-built robots for home and office use only. Currently available functions for robots are cleaning household surfaces, washing dishes, doing laundry, moving furniture and fetching household items for their owners. The company offers to build robots to customer specification, \$10,000 deposit per custom specification. Built on Alexandriat.

Item Code	Description	Unit	Cost(\$)/unit
BR1CUSTROBOT	Custom Design Robot	piece	700

ElectroProtect

Build components for circuitry that can withstand space environments and shielding or protective boxes for components and circuits that cannot be built to withstand local environments. ElectroProtect stock components run at the same price as the unprotected variants while custom hardware runs at approximately twice the price as unprotected equipment. ElectroProtect charges a yearly membership fee of \$400,000 for access to its services and shipping is not included from its Bellevistat manufacturing facility.

Item Code	Description	Unit	Cost(\$)/unit
EP1PROTEPCB	Protected PCBs	Yearly	400000

Fusion Founders

Serendipitously happened upon an apparently ideal combination of conditions and equipment to produce practical fusion power in 2032. Although it can assemble large municipal power plants at customer-specified sites, its most popular product is a self contained unit that can be shipped in a modified version of a C-18 transport aircraft, and installed by local labour with supervision of a company engineer. The unit, weighing 90.8 tonnes, includes a 5.2 metre diameter sphere, its 24.4 metre long turbine 'barn' and support 'shed'. The system is shipped pre assembled and generates a heat output of 30 MW. The plant operates at an efficiency of 70% of the Carnot efficiency. The maximum temperature of the effective hot reservoir is 1,300K. The cost of such a unit excluding heat dissipation systems is \$60,000,000. The reactor must be shut down every 1,200 hours for maintenance of the containment chamber (requires plating replacement every other maintenance period on average) and to refurbish the cermet turbine blades. The reactor containment requires a constant power input of 5 MW while running and 6MW during the 1 hour start-up period. Fusion Founders require a full schematic and report of cooling measures before agreeing to install, for legal liability reasons.

Item Code	Description	Unit	Cost(\$)/unit
FF1POTFUSION	Portable Fusion Plant	Plant	60000000

Nano Solutions

Was established at Alexandriat to commercialise production and marketing of nanobots after techniques were developed to grow them in zero-g and vacuum. The company is constantly innovating new nanobot applications, and accepts challenges to design for custom uses. Programmed nanobots sell by the ounce at roughly 10 times the cost of platinum, when delivered they resemble a fine powder the customer applies as a thin layer to the working surface. Service life is one to five Earth years, depending on operating environment and application. The company reprograms nanobots for new tasks (compatible with their original application) for a modest fee.

Item Code	Description	Unit	Cost(\$)/unit
NS1PROGNANOB	Programmed Nanobots	kg	300000

Personal PCBs

Market themselves as the solar system's finest custom manufacturer for electronics. They operate a small fabrication plant at Bellevistat and manufacture pretty much any electronic device using a large variety of consumer and professional chips based on RISC-V instruction set, and their open source derivatives. Using material gained from asteroid mining, their electronics have prices comparable to custom electronics found on earth. All their electronics have a 4 year warranty (dependant on proof of shielding and good power regulation) and are shock and acceleration resistant.

Item Code	Description	Unit	Cost(\$)/unit
PC1GENCOMPST	General Compute Stack	10 ⁹ Inst/s	0.01
PC1CUSTASICD	Custom ASIC Device	10 ⁹ Inst/s	0.05

ChemSense

Supplies atmospheric and water supply monitoring equipment that reliably and accurately detects chemical concentration changes. These sensors provide a serial data output and list all elements detected and their relative proportions. They provide two variants for their systems: passive and XRF. The passive systems draw 0.5 W per sensor and output data in a constant stream with detection lower bound equivalent to 1,000 ppm and an accuracy of ± 100 ppm for a cost of \$100 per sensor. The XRF system draws 2,000 W during its triggered 10 second run time on a discrete sample of substance. This provides a detection lower bound of 50 ppb with an accuracy of ± 10 ppb, however the sample is irradiated and made hazardous. This system costs \$20,000 per unit and must be triggered to operate when a sample is in place. The XRF system may be used on matter in any form while the passive sensor may only be used on fluid material and has a temperature range of 223-573K. The passive sensor is vulnerable to radiation and amounts in excess of 50,000 Becquerels may cause inaccurate results from sensors.

Item Code	Description	Unit	Cost(\$)/unit
CS1XRFMINSYS	XRF Main System	single	20000
CS1PASSENSOR	Passive Sensor	single	100

Vaporly

Ships nitrogen, oxygen, and clean water from its facilities. Liquid nitrogen and water are shipped in sealed CASSSCs from their production facilities at Alaskol and Argonom. Liquid nitrogen is priced at \$0.15 per litre, liquid oxygen at \$1.5 per litre, while the flagship product, water, is priced \$5 per litre. Stuff of life market their water as; "Never having been touched by human pollution, free from additives and contamination".

Item Code	Description	Unit	Cost(\$)/unit
SL1LIQUIDN2X	Liquid Nitrogen	litre	0.15
SL1LIQUIDO2X	Liquid Oxygen	litre	1.5
SL1LIQUIH2OX	Liquid Water	litre	5

WasteSide

Offers a final disposal service for irreducible waste products out of internal reprocessing systems. This includes dealing with hazardous waste such as spent nuclear fission fuel. Ultimate disposal involves questionable ethical decisions in the name of capitalism; these involve burying waste on areas of moons currently devoid of human habitation, or using reentry conditions to sublime or autoclave certain materials. Toss it To Me charge by the mass of the material to be disposed of, charging \$5,000 per kg, requiring the waste to be delivered to their facilities in lunar orbit. Due to the high demand for their services, they limit the use of their services for a single client to 2,000 kg a year.

Item Code	Description	Unit	Cost(\$)/unit
TM1WASTEDISP	Waste Disposal	kg	5000

Lossless Airlocks

Has developed and sells airlocks and hatches that operate with almost no loss of atmosphere to space on opening. LA offers systems in several designs and sizes. These comprise their cylindrical airlocks, which come in various sizes for different purposes, and their hatches, which provide interfaces between already pressurised volumes. The airlocks available are for a single occupant, up to three occupants, up to ten occupants, and one capable of passing a single CASSSC. The hole for the airlock in a pressurised hull will induces a region where the local stress in the material is three times higher than the unaltered hull. LA produces a specialist component to allow docking with front of a pressurised CASSSC.

Item Code	Description	Unit	Cost(\$)/unit
LA1AIRLOCK15	Ø1.5 m by 2.2 m Airlock	single unit	6000
LA1AIRLOCK30	Ø3 m by 3.2 m Airlock	single unit	20000
LA1AIRLOCK45	Ø4.5 m by 5 m Airlock	single unit	60000
LA1AIRLOCK75	Ø7.5 m by 11.5 m Airlock	single unit	160000

3D Logistics

Is a multinational corporation that leads in additive manufacturing technologies, with their main off-world production facility based out of Alexandriat. The company provides both printed components and complete 3D printing systems for purchase. They are able to produce metal, plastic and ceramic components with an accuracy of 30 microns up to 8 x 4 x 4 metres in sizes with their in-house proprietary systems, while systems on sale are capable of 40 micron accuracy within a volume of 5 x 2.5 x 2.5 metres (\$750,000). Their mobile printer designs can achieve 3,000 micron accuracies laying at 0.5 litres per second in an unlimited volume of simple metals and plastics with a power requirement of 60 kW for \$500,000. The high precision systems consume 50 kW to lay 0.5 litres of material per 20 seconds. This material is laid across the entire surface before laser sintering.

Item Code	Description	Unit	Cost(\$)/unit
3L1MOBILEPRT	Mobile 3D Printer	single unit	500000
3L1STATPRINT	Immobile 3D Printer	single unit	750000
3L1PLASTICPR	In-House Plastic Prints	litre	2
3L1METALPRIN	In-House Metal Prints	litre	8
3L1CERAMICPR	In-House Ceramic Prints	litre	16

Hard Roll

Accepts ores from off world mining operations, refines the metals and produces rolled sheets, extruded beams and custom shaped parts manufactured by cutting or turning processes. Hard Roll is capable of a throughput of 2,000 kg of product per hour, charging \$0.15 per kg of ore given and processed through them. They have processing facilities on Earth, Bellevistat, and Alaskol. They will not pay for shipping of products or stock for customers.

Item Code	Description	Unit	Cost(\$)/unit
HR10REPROCES	Processing of Ore	kg	0.15

Large Print

Buy in and adapt second-hand 3D logistics mobile printing robots to give the capability for 3D printing of large parts on the Lunar environment. Their mobile printer designs can achieve 10,000 micron accuracies in an unlimited volume in superadobe laying material at a rate of 1 litre per second. Each unit costs \$450,000 and is supplied from Alaskol.

Item Code	Description	Unit	Cost(\$)/unit
LP1MOBILEPRT	Mobile 3D Printer	single unit	450000

Aesculapian Ventures

Is a medical organization who manufacture medical supplies and equipment for use in cislunar space. From their home at Liberty they are at the cutting edge of medicine, being able to construct advanced artificial organs for use in humans. Their main business is managing a series of hospitals and hospices in LEO, but they sell 3D printers that can manufacture artificial organs for use in settlements for \$50,000,000 each. They also act as the main manufacturer and supplier for all settlements in cislunar space and beyond for more mundane medical and pharmaceutical supplies.

Item Code	Description	Unit	Cost(\$)/unit
AV1ORGAN3DPR	Organ 3D Printer	single unit	50000000

CRISPR Cod

Sell, despite their name, a large variety of genetically modified fish. Based at Liberty, their fish are genetically modified to be able to survive and thrive in all gravitational environments up to 1g. At a competitive average of \$500 per 1kg of eggs (~3,000 eggs), presuming safe transportation, the fish are guaranteed to provide greater yields of produce with greater resistance to parasites and diseases. In efforts to curb the potency of the release of any genetically modified organisms into the greater environment, each fish has had its reproductivity slightly diminished, meaning that a colony of fish will decrease slightly with each generation requiring a regular top up of eggs.

Item Code	Description	Unit	Cost(\$)/unit
CC1FISHEGGSX	Fish eggs	kg	500

Garden-A-Go-Go

Manufactures potable hydroponic and aeroponic ecosystems at Alexandriat for sustaining long duration spaceship crews. The modules attach to the exterior of a ship, over an airlock that would normally go to vacuum. New inter-orbit spacecraft are designed with appropriate interfaces as standard. Sizes are available for crews of five (\$3,000,000), eight (\$4,000,000), and twelve (\$5,000,000) while special orders are reactively fulfilled (min 1000 person). Use of a Garden-A-Go-Go system requires that two crewmembers be trained to work the farm for one hour per day on average. These deliver grains, vegetables, fruit, meat and eggs. The systems require bi-annual maintenance to replenish water and nutrients, introduce non-inbred animals, and replace plant species that have died off.

Item Code	Description	Unit	Cost(\$)/unit
LA1AIRLOCK15	5 person Hydro/Aero-ponic unit	single unit	3000000
LA1AIRLOCK30	8 person Hydro/Aero-ponic unit	single unit	4000000
LA1AIRLOCK45	12 person Hydro/Aero-ponic unit	single unit	60000
LA1AIRLOCK75	Special order unit (min 1000)	per person	100000

Svalbard Seeds

Have expanded their mission to catalogue and store the genetic information of all plants to providing them also. They are currently based at Argonom and have completed a seed vault not too far away. They sell all seeds and cuttings at cost, at 100 seeds per dollar, with the hope to spread natural plants to all corners of the solar system.

Item Code	Description	Unit	Cost(\$)/unit
SS1GENERSEED	Seeds - Generic	seed	0.01

Synthetic Seeds

Are based in Lunar orbit and have used their extreme remoteness to render any restrictions on genetically modified organisms redundant. As such they manufacture genetically modified plants with efficiencies that are getting close to the theoretical maximum of 11%. Combined with other variables, in ideal scenarios, this leads to a doubling of growth rates, a doubling of yields, a lesser need for resources, and complete immunity to any known parasite or disease. All of this with enhanced reproductivity has meant that on Foundation Society settlements, areas dedicated to farming these seeds require full automation, with separate atmosphere processing and additional measures to ensure that no seeds are released into the greater environment. They are famed for their web portal, offering consumers the ability to customise the taste of the produce grown, along with almost all aspects of each plant's genetics. Prices are on average \$1 per seed, with other offerings such as infertile trees saplings that can mature in as little as 5 years priced at \$100 dollars per sapling.

Item Code	Description	Unit	Cost(\$)/unit
SS2GENERSEED	Seeds - Generic	seed	1
SS2INFERTREE	Infertile Tree Sapling	sapling	100

Custom Cargo Accommodations (CCA)

Produces Cargo Accommodation Standard Space Shipping Containers (CASSSCs), compatible with standard interfaces on all launch vehicles and interorbital spacecraft currently in use. In efforts to standardise and reduce free waste in space, the Foundation Society has stated that, after 2038, all extraterrestrial cargo must be transported in CASSSCs. CASSSCs are 9 metres long with square 4.5 metre cross-sections and weigh 2 metric tonnes each when empty. Generic CASSSCs are aluminium, fully enclosed and vented to permit pressure equalisation, however special CASSSCs can be whatever customers choose within standard size and interface constraints, including pressurised, open framework or made of composite materials. CASSSCs are now offered across cislunar space with distribution facilities at all major Foundation Society settlements.

Item Code	Description	Unit	Cost(\$)/unit
CC2CASSSCHIR	CASSSC Hire	single unit	2000
CC2CASSSCPUR	CASSSC Purchase	single unit	120000

Consegna Veloce

Operates interplanetary charter vehicles for either cargo or passenger transportation. Their crewed spacecraft called Caroliners, named after their late founder Carola Genovese, can carry payloads of up to 220,000 kg in up to 10 CASSSCs or 30 passengers, and can travel to and from almost anywhere in orbit within the inner solar system. They charge either \$15.54 $t^1(ms^{-1})^{-1}$ for cargo or \$1,500 per day of travel for passengers. In order to reduce radiation exposure, and to increase shipment times as well, Caroliners are designed to engage longer burns, reducing the transit times between destinations to around half of a typical Hohmann transfer.

Item Code	Description	Unit	Cost(\$)/unit
CV1CARGOTRAN	Cargo transport	$t^1(ms^{-1})^{-1}$	15.54
CV1PASSENGER	Passenger transport	day	1500

Custom Couriers

Manages a large number of offices in all major settlements and transport hubs from where they track and manage the transfer of cargo for their clients. They have negotiated with the Foundation Society an agreement for the tracking of cargo for settlement construction and operations in cislunar space. Custom Couriers charge \$350 per CASSSC for the tracking of the cargo and managing the transfer between carriers at each stage on its journey.

Item Code	Description	Unit	Cost(\$)/unit
CC3CASSSCMAN	CASSSC Journey Management	per CASSSC	350

Transportation



Dangerous Packages

Is a transportation company that specialises in the controversial movement of hazardous material from one location to another. This includes the nuclear material that is used in nuclear fission power generation. Dangerous Packages emerged as a company as an offshoot from Vulture Aviation, and now acts as an independent firm with regular contracts with almost every major space settlement. Based at Alexandriat, their spacecraft are crewed, and charge \$2,000 a day for the transportation of up to 1,000 kg of hazardous material to anywhere in orbit in the inner solar system. Their company motto is; "If no one else will take it, we will."

Item Code	Description	Unit	Cost(\$)/unit
DP1HAZMATTRA	Transport of Hazardous material	kg	2000

Interorbital Heavy Payload Carriers (IHPC)

(IHPC) is a Danish company that operates a fleet of gargantuan spacecraft which are the largest in current usage. A single IHPC craft can move up to 1800 fully loaded CASSSCs at once to almost anywhere in the inner solar systems through the use of efficient Hohmann transfers. These massive ships offer some of the lowest cargo fees of any transportation company, coming in at 3.95 \$t-1(ms-1)-1. The customer must make the necessary calculations of Delta V and account for the transport mass when booking cargo space on the ship. Their spacecraft, due to their size, cannot dock with settlements and require specialist portside equipment that is only available at certain spaceports (Columbiat, Aresam, and Astoria) or require tugs to collect delivered CASSSCs from free space.

Item Code	Description	Unit	Cost(\$)/unit
IH1CARGOTRAN	Cargo Transportation	t-1(ms-1)-1	3.95

Space Trans

Started as a business plan written for a college class project by an ambitious self-styled entrepreneur who idolised the founder of Federal Express. The company acquired funding to build vehicles in space that can provide regular but unscheduled transportation services between locations in Earth orbit, including space stations, major commercial sites and future settlements. Nowadays they oversee, from their headquarters at Columbiat, over 50% of trans orbit flights each day in cislunar space. Rates average \$3000 per person and \$60 per kg of cargo, per day of travel. Their vehicles may carry up to 75 CASSSCs with no total mass limit. Ships carrying both CASSSCs and passengers reduce the maximum number of CASSSCs by ten and may replace a CASSSC with capacity for two individuals.

Item Code	Description	Unit	Cost(\$)/unit
ST1HUMANTRAN	Human Transport	person/day	3000
ST1CARGOTRAN	Cargo Transport	kg/day	60

Extereme Survival Technologies (EST)

Build spacesuits, and pressurised fabric furniture and impact protection systems (e.g. air-bags and restraints) from its Alaskol facility. Its series of custom inflatable products are not rated for extravehicular use but cost only \$6,000 dollars per m3. EST's most popular products are its spacesuits however, with the most popular model being a hard shell suit customised for lunar operations but frequently used for other applications. Efficiencies of line production enable \$40,000 unit costs.

Item Code	Description	Unit	Cost(\$)/unit
ES1INFLATUNI	Inflatable products	m3	6000
ES1HARDSHELL	Hard Shell Space Suit	single suit	40000

Litigation Limiters

Is a law firm that created a niche market which virtually eliminates conflict-of-interest suits for its clients, who usually are companies competing for the same contracts but in need of each others products and/or services, and their customers. From their Colombiat headquarters, the company has negotiated such agreements with all of the world's diversified corporations that have significant product lines applicable to space development. Litigation limiters charge a 2% fee on product of service value.

Item Code	Description	Unit	Cost(\$)/unit
LL2CONFRESOL	Conflict of Interest Litigation	\$ project cost	0.02

Magnetic Propulsion Union (MPU)

Was founded by three professors at Princeton who continued work with mass drivers originally started by Gerard O'Neill. The MPU has spiraled out into a large international project, encompassing many universities and voluntary projects. They exist as a large repository of knowledge and idealism; with constantly improving designs, in terms of launch mass, efficiency or reliability. MPU offer to build mass drivers with a muzzle momentum of up 120,000 kgms-1. The price of such a system is based on the length of the mass driver, costing \$50,000,000 per kilometer, and massing in at 98,000,000 kg per kilometre. The mass driver will impart 6000 kgms-1 per kilometer of length. Shipping is not included. The mass driver transfers energy to projectiles with a 60% efficiency.

Item Code	Description	Unit	Cost(\$)/unit
ST1HUMANTRAN	Mass Driver	kilometer	50000000



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The Space Science Engineering Environmental Foundation (SSE²F) was set up to foster and extend students' interest in space and the environment, and to use the environment as a vehicle for learning about science, technology, engineering and mathematics, the STEM subjects of the National Curriculum, and importantly, leadership, psychology, management, design and business. It does this through the Space and Environment Design Competitions (SDC and EDC) as well as the Eco Meet and Galactic Challenges (GC), all industry simulations. Formulated to give students an insight into the real world of business and industry it addresses the long-standing complaint from employers that students sometimes leave school and college without the general attributes that would make them useful employees. In contrast, the SSE²F's programmes show students how important it is to be able to work in a team, solve problems, work to deadlines, keep within budgets and communicate effectively.

The students bear testament to the success of our programmes in achieving all these goals, and it has been interesting to note that there are several other advantageous personal results. These include increased confidence, awareness of their own strengths, a breadth of understanding of other people, a feeling of capability and responsibility for the consequences of their actions. Above all, there is a sense of enjoyment and achievement. How does all this happen in the space of a few short hours?

The (fictional) Foundation Society, requests a design proposal (RFP) with specific parameters for a design in space or on a planetary body. Students then form companies that they run through their own management and engineering team. Each company is made up of an elected president, vice president of marketing, and heads of engineering in four areas: Operations, Human, Structural and Automation. Professional engineers and scientists assist the students, however, the running of the company and the designs are the student's own work. Companies have a day to come up with a detailed design, in the form of a slide show which they present to a panel of judges who include experts in the field and representatives of the UK Space Agency.

For the SDC finals, usually held in mid-March each year. the students have two days to address the RFP. Selected students presenting winning designs go to a NASA's Space Center for the International Finals.

The Space Design Competitions are organised and funded by the Space Science Engineering and Environmental Foundation (registered charity number 1170548), along with generous support from other sponsors



EARTH

YOUR OASIS IN SPACE

WHERE THE AIR IS FREE and BREATHING IS EASY

Earth Visions of the future (NASA)

Our final stop on this series of posters by NASA looking into the future, is a reminder of our home. Earth, for now, remains the only planet humans have visited. A molten iron core drives geological activity that constantly reshapes the planet's surface, and liquid water oceans provided the staging ground for the emergence of something we haven't found anywhere else in our vast cosmos; life.

Editors note

As engineers who dream of going to space, we know better than anyone, how many luxuries our temperate planet affords us. Earth is the only celestial object we have discovered so far where the air is safe to breathe, the temperature and pressure amenable to our bodies and where we can stand on almost any point on its surface and gaze at a world full of life stretching to the horizon and beyond.

Humans alone have the ability to rescue earth from this period of ecological collapse which we have brought upon ourselves. The Holocene provided us with a garden of Eden, which we used to grow and expand into a spacefaring civilisation, but climate change is a poignant reminder that our planet, which we once thought to be vast and never ending, is in fact a pale blue dot.

Many geological researchers have remarked that the Holocene has ended, and we have been living for some time now, in the Anthropocene. This era could end, as so many have before it, in catastrophe for life on earth. The mass extinctions which we have seen in the past have devastated the Earth's biosphere. Make no mistake, the first casualty of such an event caused by climate change would be the human race. No other species requires so many resources to sustain an individual, and our lavish lifestyles and global culture could be wiped out.

The most important thing for us to do is change, even if in small amounts at first. We have to reduce the resource consumption of all humans, especially those in nations where nature is at its most vulnerable. The natural world can recover alarmingly quickly, but only if given the chance. Deforestation and fossil fuel use has dealt our carbon cycle a double whammy, both producing more CO₂ than the planet can recycle, and removing the most effective tools we have to reduce the levels of this greenhouse gas in our atmosphere.

As students, we will be the generation which has to choose. Whether to hold onto the wasteful and destructive attitude of the past, or reconcile with the natural world, through intelligent reduction in greenhouse gas emissions, along with innovation in the fields of carbon capture and conservation to restore Earth's biodiversity.

Sponsors of UKSDC

Dangoor Education

Dangoor Education provides opportunities across the learning spectrum with sponsorship of Westminster Academy, Open University Massive Open Online Courses, STEM university scholarships, the Dangoor Centre for Medical Education at the Royal Society of Medicine, and the Dangoor Centre for Personalised Medicine at Bar Ilan University. Dangoor Education's sponsorship of the UK & EU Space Design Competitions and Galactic Challenges builds on the fantastic legacy of Sir Naim Dangoor, who supported the Competition for a number of years.



Global Space Design Challenge

Global Space Design Challenge runs a summer camp for students from around the world. It offers varied series of lectures and workshops on STEM subjects, computer sciences, robotics, business, design, university preparation and medical, culminating in a Space Design Competition. It uses its profits to help support the Space Science Engineering & Environmental Foundation.



GLOBAL SPACE DESIGN CHALLENGE

UK Space Agency

The UK Space Agency has been a generous supporter of the UK and EU Space Design Competition and Galactic Challenge since 2013. They are at the heart of the UK efforts to explore and benefit from space.



Garfield Western

For 60 years the Trustees of the Garfield Weston Foundation have supported local charities across the UK. These small to medium organisations are often un-sung champions doing important work to keep our communities connected.



Imperial College London

The SSE²F thanks Imperial college London for allowing us to use their facilities since 2009.



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