

# HIGH TRADER

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By Eric Finley, Phil Eklund, and Ken Burnside  
(Though versions 2.0 and beyond are 99.8% Eric's fault!)

## OVERVIEW

Players take the roles of aerospace agencies, companies, or citizens, involved in the space effort in our near future. Each turn, you'll get a chance to fly one mission. Example missions include a manned exploration of Europa, building an antimatter-drive taxi service, establishing an asteroid mine, or putting a colony on Titan.

The first, and largest, part of each turn is the planning phase. Your mission planning worksheet walks you through the stages of the plan, prompting you for all of the things you need to decide. Your plan can be secret if you want. To keep your plan affordable, you will need to bargain with the other players for various resources. When it's all done, the output of the worksheet will show two things: one, how much money is this all going to cost you, and two, how long will it take. You may also pass, or be forced to pass, if your mission is a lot more complicated than the rest of the players' missions.

Then before we resolve any of those missions, we hand out incomes – both time and money – based on how long it's going to take for us to finish most or all of our missions this turn. We draw global events which affect everyone at the table, sometimes in good ways, sometimes bad. The global events also provide a countdown to the end of the game – it might end in doomsday, or it might end in peace. We can each pay time or money to draw Harbinger cards. Most cards are disasters you can inflict on other players, some are protection from disasters.

In the third and final phase of the turn, we resolve missions. First we reveal all the missions, even ones that had been secret, and get a chance to poke holes in each others' plans. Then we all play cards on each other. Some will be disasters, some will be bluffs; we'll shuffle them so we don't know who played what. One mission at a time, we work out the results of these cards on the mission. They could make it take longer, cost more, or in some cases even fail spectacularly. If the plan survives in usable form, the player pays its costs and executes the mission. Where a mission's achievements are noteworthy – most distant colony from Earth, or most advanced tech researched, for instance – then the player collects a victory point chit corresponding to the achievements. This may involve taking it away from the current record-holder, until he trumps you back again in turn. And, ultimately, we go back to the planning phase of the next turn.

# THE CURRENCIES AND ICONS

Money units, or cash, are one of the two fundamental currencies. They can be exchanged between players at any time, and in any way, they like. One unit of money is an arbitrary, but large, amount of real-world dollars, yuan, stocks, and so forth. Money values are always shown inside a [circle] or [oval] icon.

The other fundamental currency is *time*. One time unit is one month. Every time unit in your possession is one month of your faction's activities which we, the players, haven't yet seen in game. By spending time units, you get caught up toward the game's clock, at the same time as you get stuff done. If you are 'broke' in time terms, it means that you're fully caught up. *For the most part you don't need to worry about this.* Just treat time as a currency, according to its rules, and you'll be okay. Time values are always shown inside the time icon [a box with its sides pinched in to resemble an hourglass]. After we do the details in months, we will do a last-stage conversion to expressing time as dates, to make it easy to compare timelines; this will use a wider-than-normal time icon, with a comma, so that you can fill in dates such as "08, 2015."

The other time icon you'll get used to is [a clock face], for the Turn Length. This is in years, not months; it's how far we're moving the game's timeframe forward each turn. The Turn Length will dictate incomes of time and money chits.

The Turn Length often turns into money as well as time – that's what a consistent income is, after all. We use the clock icon to show this. Many factions have an income shown as **[money: [Turn Length] x N]** where N is a multiplier like 7 or 10. We'll explain about the Turn Length later in detail. In some kinds of verbal bargaining this is the most useful form to express things... so you might ask for "a turn Length times two" for your help building my new mine, or "a times five" as a licensing fee.

There are six second-tier currencies, in the form of resource types. These are never tracked on an ongoing basis, they're just needs which come up during the construction part of your mission and have to be satisfied a couple of steps later in the accounting part. These are:

- ❖ **Macro** (for 'macrofacturing,' large-scale construction), denoted by [a hexagon].
- ❖ **Nano** (for nanocircuits or nanomaterials), in [a trapezoid].
- ❖ **Research**, in [a truncated diamond].
- ❖ **Propellant**, in [a sideways droplet].
- ❖ **Earth Boost**, in [a fat upward-pointing arrow].
- ❖ **Power**, in [a lightbulb-and-time icon].

The Macro cost of something is always equal to its mass; for this reason, occasionally something measured in mass units will use the hexagon symbol even though it doesn't need "macrofacturing." One mass unit is twenty-five tons. A propellant unit is one mass of propellant (generally either H<sub>2</sub> or H<sub>2</sub>O, depending on the drive). One Earth Boost point lifts one mass from Earth's surface into LEO. Nano and Research do *not* denote mass like the others, they weigh nothing or effectively nothing. Research never requires transportation; Nano does require transporting if you're moving it further than LEO, but masses essentially nothing.

In this text-format draft we'll use square brackets exclusively to show that we're rendering something in text which will be iconographic in the final game.

Notations like **[money: 1]** or **[nano: 2]** denote amounts inside of resource icons.

The last resource type is **Power**, meaning beamed power (power on Earth is relatively plentiful, power in space is much harder to come by). Output power is measured in 'channels' – one channel is enough power to run a normal gamescale generator system continuously. The unit of exchange is the 'channel-month', which is enough power to supply a microwave receiver or equivalent for one month, either of operations (for facilities) or travel (for rockets). Each channel is capable of supplying one target at a time; targets which require more than one channel can't just be satisfied with twice as many channel-months from a single channel, they need to be getting them from different sources. You can, and often will, 'lock in' a power channel as a dedicated supply to something which you want to be able to use continuously. A reasonable form of deal for a 'locked' channel from another player would be to exchange it for a share of income, such as **[money: [Turn Length]x2]**.

The other icons you will encounter in the game don't denote currencies, but characteristics and requirements. Rockets will always possess both a specific impulse, abbreviated ISP and shown in [a rightward-pointing arrow], and a thrust, shown in [a box with the upper corners clipped]. Rockets, facilities, and other objects will have requirement icons, including beamed power [the power icon], generators [generator icon TBD], cooling [cooling icon TBD], and neutron flux [neutron flux icon TBD]. If a requirement icon is present, then it must generally be satisfied or the object won't work at all.

The contract icon [hanging folder] gives a quick means to tie purchases to sources; a contract icon lets you clearly show both 'ordinary' transactions and more unusual deals or swaps.

There's also a Rare Isotopes icon, [a gemstone]; this is a resource you can occasionally discover while exploring, and it's just worth cash – twice as much when shipped to Earth as an equivalent resource of some other kind would be.

Finally, most of the Harbinger cards have a 'type' icon on them beside their disaster level. The type icons do not mean anything in their own right – the restriction is simply that each player will face at most one of each type of disaster, per turn.

#### ***What are the units here?***

- ❖ Specific impulse is in kiloseconds.
- ❖ One mass unit is twenty-five metric tons.
- ❖ Burn dots, orbit changes, and delta-vee are tracked in impulses of 2.5 km/s.
- ❖ Thrust is on a log scale; a thrust of ten is about 2000 kN of force, and each point below this is half as much force. During play we actually use 'thrust' to refer to acceleration as well, with a baseline mass of 200 tons as a "plus zero thrust" conversion factor. A planet's gravity well has a minimum thrust value, and your ship's mass generates a bonus or penalty to your thrust. Technically both of these are accelerations, with acceleration ten being about  $10 \text{ m/s}^2$ , and each point below that being half as strong. This distinction is *not* an important one in play. It's all "thrust."
- ❖ The map is compressed with regards to distance – the further a Hohmann transfer goes, the faster it's going throughout most of its trip, but the map is in units of "two months of Hohmann per orbital." Thus it does not convert directly to distances, but rather to travel times.

# INSIDE THIS BOX

Your game should contain:

- ❖ This rulebook
- ❖ Large solar system map
- ❖ A pad of Mission Planning Worksheets
- ❖ 24 half-page faction cards
- ❖ 18 quarter-page resource cards
- ❖ 108 standard-size Harbinger cards
- ❖ 32 standard-size Bluff cards (same cardback as the Harbinger cards)
- ❖ 48 standard-size Global Event cards
- ❖ 12 quarter-page Endgame cards
- ❖ Three Tech Library pages
- ❖ Three Condensed Tech Library sheets
- ❖ Two laminated fuel nomograms
- ❖ One Rocketry Aid page (*Unless we can get all of this onto the map. -E*)
- ❖ N Money chits (green) in various values
- ❖ M Time chits (red) in various values
- ❖ Q Exploration tiles
- ❖ 55 Achievement & consolation tiles, plus some anonymous -1VP tiles
- ❖ Six rocket ship tiles, and P complex and waypoint markers
- ❖ Two six-sided dice

The Appendix describes each of these in detail. As you read through these rules, you will want to do so with the relevant components beside you.

The one exception is the Mission Planning Worksheet. This play aid is not in the Appendix. It forms the core of the game... in a very real sense, the entire rest of this rulebook *is* the detailed discussion of the Worksheet.

Take one out now.

# SETTING UP

Lay the map in the center of the table. Put the Tech Library sheets, the fuel nomograms, the Achievement tiles, and a bank each of Money and Time chits on the table, in common reach. It is probably best to have one player be the 'banker' for money and another one do the same job for time. Give every player a blank Mission Planning Worksheet.

Separate the Harbinger cards from the Bluff cards. Shuffle the Global Event, Bluff, and Harbinger decks. Deal each player one Harbinger card. Put the exploration tiles into a cup or bag so that they can be drawn randomly when needed.

Shuffle the faction cards and deal out three face-up to each player (more in games of two or three players). If a faction with multiple variants (in the basic set this is NASA, ESA, and China) is dealt out twice, the second one is discarded and replaced immediately. Each player then takes the factions he was dealt and selects one to play, one to be discarded from the game, and puts the rest into a pot in the center. After this is done, shuffle the pot in the center, and then draw the listed number of factions to serve as NPCs. Stack the NPCs' faction sheets with the grey boxes showing, but the rest hidden under the map. Discard the rest of the factions in the pot. Put both the factions deck and the discarded factions back into the game box; you'll need them rarely if at all.

Players	Factions Dealt	NPCs
2	5	4
3	4	3
4	3	2
5	3	1
6	3	0

Players take their starting money from the bank. Everyone starts with zero time chits except where otherwise specified.

Players and NPCs whose factions provide a Resource Card draw them next. Factions which specify a type of resource (such as Earth Boost) draw first, drawing and discarding until they get one of the proper type. Others draw immediately afterward, in any order. In the unlikely event the resource deck runs out, reshuffle the discards and continue. Every player with a Resource Card should also receive a Vendor's Log play aid, and transfer the resource equation and reference code letter from the resource card to the log. After doing so, the resource card itself can be set aside, though it should be kept available for checking specific details later.

Play begins in January, of the year ten years from today.

## ***Victory Point Handicaps***

Each faction has a handicap, either positive (a bonus) or negative (a penalty). This number is applied to their total Victory Points throughout the game.

Factions with substantial negative handicaps will have large resources – but they'd better use them! On the flip side, factions with substantial positive handicaps should aim lower – their resources won't sustain the same scale of ambition. Doesn't mean you can't accomplish very cool stuff – you just can't accomplish *everything*.

## ***The Players' Resources***

During the initial setup, if a player draws a resource card they do not want, they may invoke one 'mulligan' per game, at which point they discard this resource, and the other players draw two other resources (or – for type-specified resources – all that remain to be drawn, if less) and vote upon which one the player should receive. The player himself breaks ties.

No Achievement tiles begin in play. If a player's starting resource, faction ability, or any other start condition would normally assure them a tile, then this sets the threshold which must be beaten to gain that Achievement tile. Starting resources may play part in sets of resources (such as number of facilities, etc) which develop later. Special abilities which occur during turn one, such as that for Five Really Smart Guys, Inc., do count for securing Achievements.

All players are assumed to possess, in LEO, all the basic infrastructure for their efforts. Factories to turn shipped minerals into parts; relay stations to bounce or transmit beamed power; life support replenishment; secure storage; onsite assembly capabilities. If it doesn't mass enough to have an Earth Boost cost, then you have access to it (possibly at its listed cost, such as with Nano) in LEO.

## ***Joining In Later***

High Trader is designed to fully support adding players to the game after it begins. It may be challenging to them if they join later than about turn three, but the game's mechanics allow their resource totals to not suffer for their absence. Here's how.

1) Draw *one* new faction card. The player has the choice of this faction, or any of the existing NPC factions. If he chooses the drawn faction, all the NPCs stay, and he is simply added to the game. Draw resource card(s) for the new faction only after he has committed to this choice. If he chooses one of the NPCs, the drawn faction is discarded. In this case, he keeps the NPC's resource card(s); only draw new resources if this doesn't give him all he should have.

2) Add up the total Turn Lengths of all turns which they missed. Give the new player their income (both of time and of money) according to this total. They can only join in on a Planning Phase, so if you're currently doing Clock or Execution phases, include the current turn in the list of ones they've missed, and bring them in at the start of the next turn.

To account for their resources, see the chart for selling resources to Earth; they automatically do so in whatever way would be most advantageous, and adjust their income accordingly. If this invokes the multiple-sources penalty, do so using one fewer source than is present (the sources sold in the game to date, plus the new players'); this is the closest equivalent we can get, to what the other players had the chance to obtain.

These incomes are added to their starting cash and time. They'll be able to manage one heck of a first turn!

# THE SEQUENCE OF PLAY

The full sequence of play for one turn in a game of High Trader looks like this:

## ***Planning Phase***

Each player:

- i. Choose mission destinations and actions
- ii. Plot route on map
- iii. Select items needed
- iv. Calculate fuel costs
- v. Bargain for resources needed
- vi. Calculate final costs and time bid
- vii. Submit plan or pass; last to submit accepts help and time limit

## ***Clock Phase***

- a. Players reveal their bids
  - i. Second-highest bid sets the Turn Length
- b. Draw Global Event cards and resolve them
  - i. Draw the Turn Length in cards
  - ii. Initiate Endgame if a Doomsday Clock roll hits 13+
- c. Advance the game clock
  - i. All players collect the Turn Length times twelve in time chits
  - ii. Players collect their base income (multiplier times Turn Length)
  - iii. Vendor's Logs are tallied for additional income and set aside
- d. Players buy Harbinger Cards
  - i. Cost three money/time/cards each, max hand size is nine

## ***Execution Phase***

- a. Unfinished Business
  - i. Check for pending milestone completion, resolve.
  - ii. Delayed missions pay up and execute
- b. Players reveal, clarify, and error-correct their plans.
- c. Players play disasters.
  - i. Draw as many Bluff cards as desired, up to max hand.
  - ii. Play at least one card on each opponent.
- d. Execute missions – in bid order:
  - i. Reveal and suffer disaster stack
  - ii. Recalculate mission costs
  - iii. Player chooses whether to abort, delay, or continue
  - iv. Figure timeline, check for milestones resolved this turn
- e. Scoring

# THE PLANNING PHASE

The Mission Planning Worksheet has been built to walk you through the steps of this phase. It runs in a logical sequence, and no step can be done out of turn, so pay attention to this part. We'll cover them one at a time here. The Worksheet has two sides. One side is referred to as the "Mission Plan" and shows waypoints and trip legs – the rocketry stuff. The other side is referred to as the "Mission Budget" and shows the manifest and accounting – the space program stuff. You'll start on the Mission Plan side.

When you're done, you'll be putting it down in the center of the table to show everyone that you're ready to proceed. Try not to take the longest with your plan; there are minor penalties for players who are the last to submit or pass.

The first rule, and it's important enough that this is a rule: *Fill in the Worksheet in **pencil**.*

## ***Headers – Name and Years Covered***

The first thing to fill in is the header on both sides of the page. Either the player's name or their faction's name will serve for identification. Each game starts on turn number one. Lastly you'll record the years covered by this turn. On the first turn, the starting year is the year you're playing this game in, plus ten. On future turns, the starting year is the ending year for the previous turn.

You won't be able to fill in the end year yet. That'll be defined based on the resolution of time bids, which is the beginning of the Clock Phase, after the Planning Phase is all done. So don't worry about that right now.

Conceptually, if the turn covers 2025-2028, then when we do the execution phase we'll be interested in all of the events (launches, explorations, facility builds, etc) which took place as early as a January 2025, or as late as a December 2028, and everything in between.

## ***Mission Concept – Destinations and Actions***

Broadly speaking, there are four kinds of missions in the game. Each one is tied to a different set of victory achievements, and some have other benefits as well. A **prep** mission is one which has as its primary result an accumulation of materiel of some kind for later use, such as building a rocket without a payload, or a payload without a rocket. An **exploration** mission will land on the surface of the target body and inspect it – for the purposes of science, or for tourism, or to evaluate it for a colony, or to prospect it for minerals. Regardless of your reasons for being there, you'll get the same data. A **facility** mission will deposit structures or objects on the surface (or in space), either for later use or for immediate assembly into something useful. And a **colony** mission is like a facility mission but specifically will bring and deposit nontrivial numbers of people, to brave the last frontier.

Colony awards are generally worth the most, but can get very expensive indeed. It depends on the individual award, though, and your faction may give more or less weight to some kinds of mission.

The first thing you do on each turn is to decide where you want to go, and what you want to do there. This is the essence of the plan; everything else is just working out *how* you make that happen.



## Destinations

On the Mission Plan side of the worksheet, you'll see dark boxes (example pic here); each one corresponds to a single stop on your route. Some routes will be as simple as one destination, not even a return trip; others might require more than one worksheet to hold all their stops! The rectangle at the top of each stop is simply its name, whether that be "Khufu," "Mars: Valles Marineris," or simply "Waypoint Alpha" with a waypoint chit on the map.

The map is covered in possible destinations. Minor bodies, such as asteroids, comets, and some moons, are considered one *site*. If you want to head for one of these, just name it. Major bodies, such as planets and the biggest moons, have multiple sites listed, one in each corner of their space; low orbit above each of these bodies is also a distinct site, which will often matter if you end up needing a separate lander for the way down. Just be clear about which one you're at, with any given stop. It's quite possible to do a mission which hits more than one site. A multiple-asteroid exploration, for example, or one which uses crawlers to hit more than one site on a moon. That's fine, just list them all, one at a time – that's why there are many waypoint boxes provided. You can even add multiple sheets if your mission is really complex – the record is somewhere around thirty stops, over the course of a seventeen-year survey mission.

Factors to consider about picking a destination are the strength of the gravity, the presence or absence of an atmosphere, the *spectral class* of the site, any special symbols such as Cool or Hazardous, and of course location, location, location.

Cool sites (cool as in nifty, not cool as in cold) are intrinsically more interesting, and are often worth more to explore or colonize. Hazardous makes it subject to certain disasters and catastrophes which normal sites don't have to worry about. The surface gravity sets the minimum thrust you need to land and take off there. The spectral class defines what the body (or site) is made of. This dictates what you're likely to find there in terms of minerals and other random factors.

The six spectral classes are:

	Class	Possible Resources	Other factors
c	Carbonaceous Chondrite	Nano or Macro	
d	Achondrite	Macro, Nano, Propellant	
i	Icy	Nano; guaranteed Propellant	More likely Hazardous
m	Metallic Nickel-iron	Macro, Rare Isotopes	
s	Stony Iron	Macro, Propellant, Rare Isotopes	More likely low-grade
u	Unknown	Any	Most likely to be Cool, Hazardous, etc

Nano finds are in the form of carbon deposits; macro finds are in the form of useful metals such as titanium; propellant finds are usually water, which can be used straight up or electrolyzed to hydrogen as appropriate for the drive. Rare isotopes are simply worth money, twice as much as any other resource type, when shipped and sold on Earth. Any body, except Icy, has a chance of turning out to have no useful minerals at all.

For exploration missions, this is the whole point. For facilities, you probably want to know what's there before you ship a factory out there... but you can take the risk and jump blind if you want. For

colonization, any of the mineral outcomes except for rare isotopes will be valuable to you onsite, but the other factors like Cool and Hazard are probably more important.

One final note on destinations – if you're planning to come home again, then you'll need to list that as part of the mission. Final destination LEO. Gotta bring enough fuel to do that part too...

## Site Actions

Once you know where you're going, you also want to decide what you'll do when you get there. There's a specific list of possible activities which are meaningful in-game; it's also possible that you'll end up using the Rule of Clarity (see Appendix B) to add others. List the actions you're taking at the site beneath it, so that you can see at a glance what you're doing where. (Sometimes, you're doing nothing at that point; that's fine, all site actions are optional. For example, you can use a waypoint to transition from one transfer orbit type to another, or enter orbit and immediately land.)

Some actions can be taken by anything; some only by rockets, others only by crew. All crew actions can also be done by bot teams (see the items list), though generally at a lower net efficiency than if a human is present to guide the process.

The list of site actions is:

- ❖ **Load or Unload (Rocket action)** – It is assumed that you design your rockets around their tasks, so neither loading nor unloading requires crew or bot teams. Offloaded objects include not just facilities and materiel (see the Assemble action shortly)... it's also often useful to unload propellant tanks, for example leaving your return fuel in orbit rather than burning fuel to haul it down and back up again. Or even to 'unload' the long-haul rocket from your lander, leaving it in orbit while the lander goes and takes some actions and then returns to 'load' the long-haul body back again. The net mass *unloaded* at a site goes into a space below the site actions; often you will not be able to fill this in right away because you don't know how much things will end up massing, but that's okay. Just write down that you'll be unloading stuff so that you remember to fill this in later.
- ❖ **Explore (Crew/Bot action)** – Exploring a ground site properly takes time. For crew, this time is half the surface gravity of the body, rounded up. For bot teams under robotic guidance, the time is the full surface gravity of the body. (Cyborg or A.I. Guidance will allow your bot teams to act as efficiently as crew, but can be expensive.) As soon as this action happens during resolution, you'll get to draw an exploration chit based on the site's spectral class. Right now, you can already use the known site gravity to fill in the onsite time required for this, in the onsite time box over on the right.
- ❖ **Assemble (Crew/Bot action)** – Facility objects require onsite assembly after having been packed up for transport. This also includes all of the initial diggings, specific landing-site selection, and acceptance tests for the new facility. Assembly of a facility by crew costs half its total mass, including add-ons (such as generators), in months. Bot teams under robotic guidance take the full mass, in months. On the first pass through this sheet, you'll just leave the onsite times associated with these blank; you don't know these masses yet, until you finalize exactly what you're building and how you're building it. Note that *only* facility items require assembly; tools, colonies and their add-ons do not. If you list an assembly action, the unload action to get the facility off the rocket first is implicit and need not be listed separately (unless doing so helps avoid confusion). Just remember to account for the unloaded mass.
- ❖ **Land or Take Off (Rocket action, or payloads via parachute)** – These steps are usually, but not always, implicit. Once you've been playing the game awhile you'll be able to omit them as understood, except in unusual cases. At first, you'll be best off entering them explicitly. This site action covers several cases:

- Parachute landings – If your body has an atmosphere, you can land your payloads for free, as a site action, without even needing to take your rocket down at all. Neither the surface gravity nor the grav dots matter to this, on gamescale.
- Landings/takeoffs on minor bodies – This site action requires that your net thrust be at least equal to the surface gravity of the site. Simply list your net thrust during the landing or takeoff along with this site action, such as "Land (8)"; the body's surface gravity is listed nearby for comparison. You'll see later how to calculate net thrust. Often this means bringing a lander, in which case only those things loaded into the lander are actually onsite. It costs zero fuel on gamescale (this won't be true of major bodies), and takes zero time. Sometimes your rocket may be strong enough to carry only partial payloads at a time; you can make as many trips as you like, but you cannot break down a game object (such as a Factory) into smaller parts once it's built. You can bring down the generator or other add-ons separately, however.
- Major body landings/takeoffs without fuel costs – Once you've become used to the game, you will find situations where a rocket can navigate the fuel nomogram (see XX) and come out needing zero fuel for landing even on a major body. An example would be an Orion Pulse rocket landing on Luna with a payload of six mass or less; the Orion is efficient enough that it costs well under one fuel to do this. If you know this to be the case, then you can simply enter this landing as a site action as above. Otherwise, enter both low orbit and the surface site as distinct waypoints, so that you can calculate the fuel spent on landing.
- ❖ **Gather regolith (Crew/bot action)** – Certain rockets (the mass driver and annihilation drive) can use anything as propellant. For them, refuelling is simply a site action. One crew unit of any size, or one bot team, can gather one mass of propellant per month's onsite time. (For once, being smarter doesn't really help speed things up here.) An extraction mine can gather at ten times this rate.
- ❖ **Initiate Shipping (Rocket action)** – Once you've got a mine set up and ready for extraction, you usually need to ship the resources to a fabrication site (LEO or an appropriate facility) for them to be useful. The moment you do the Initiate Shipping action, the shipping process and the shipping rocket hide behind an abstraction wall, and are 'turned into' a resource equation at the destination. More on this on page XX.
- ❖ **Advanced Modalities** – Listed in Appendix B, you'll see a number of things which can be included in missions once you've mastered the basic game. Many of these have specific site actions via which they can be activated. We won't list them here; by the time you're ready to use them you'll be comfortable with site actions in general.

The following things are **not** site actions; you cannot simply jot them down inside of a single stop on your trip.

- ❖ Major body landings or takeoffs with nontrivial fuel costs. For these landings, you will use two waypoints, one in low orbit around the body, and one on the ground proper. This gives you a trip arrow in between the two, which you'll use to enter the fuel expenditures of this step. Note that these still take zero time on gamescale.
- ❖ Ballistic hops. On a major body, you don't have to go all the way up to orbit and land again, to go from one site to another. Instead you do a partial orbit and land again. The math on this works out very neatly; the total cost of any ballistic hop is the same as the cost of a landing or takeoff, and that takes you right from on the ground at one site, to on the ground at another site on the same body. On your sheet, since each of those sites will be a distinct waypoint anyway, you'll automatically have a trip arrow in between them which you'll use to work out this cost. Time required is of course still zero – it's on the order of hours, not months.

Rockets and away teams aren't tied together at the hip. It's perfectly possible to plan to drop, say, a bot team for exploration, and then have the ship move on before the exploration will be finished. To denote this on your plan, put the onsite time in parentheses at this stop. Then, when it comes time to work out the dates of things, you'll use the onsite time in the calculation of milestone completion (like when the exploration data comes in) but the rocket's departure date will ignore this, and simply be the same as its arrival date.

## Route Plan

Having listed our stops, it's time to fill in the arrows that take us from one to the next. Here's where you push everything else out of the way for a bit and head to the map.

The map is divided up into spaces, also called *orbitals*. Most orbitals are empty, some contain a body (asteroid, comet, moon or planet). Most orbitals have light borders, but some have a dark border with a dot on it; this is a *burn dot* equivalent to 2.5kps of velocity change.

The map also shows, by colour gradations, a series of *photon flux zones*. This indicates the intensity of the sun's light at this point, which is important for things like photovoltaic power and solar sails. The borders of photon flux zones are where you find most (but not all) of the burn dots on the map.

To plot out a possible route to the destination you've selected, take one of the rocket chits and move it on the map according to the following rules:

### **1) A rocket – or anything else – faces either the side or the corner of an orbital.**

If it's facing a side, it's in a *transfer orbit*... it will necessarily proceed through the border and into the next orbital. If it's facing a corner, it's in a *stable orbit*, either around the sun or around the body itself. It won't leave the space until you go into a transfer orbit again.

### **2) A path counts both the *distance* (in orbitals) and the *energy* (in dots) needed to travel it.**

Track the two totals independently – often it's easiest to count the orbitals, write that down, and then come back and count the dots. Distance includes the destination orbital but not the starting one. In some cases you might opt for a longer path because the energy cost is lower, or vice-versa. Crossing a border with a dot on it counts as one dot toward the trip's total.

### **3) To rotate your facing adds a burn dot to the trip.**

This includes rotations which take you from one transfer orbit to a different one (facing a different side of the orbital), and also rotations which take you from a transfer orbit to a stable orbit or vice versa. These are course correction burns, orbital insertion burns, and so forth.

### **4) When you take off, you're in a stable orbit. When you land, you land from a stable orbit.**

On takeoff you're facing a corner of the orbital containing the body you just left. You will need a burn to rotate to face a side of the orbital before you can go anywhere; this is always your first burn dot of the trip. Similarly, in order to land on a body – if you don't want to plow into the ground at 2.5 km/s, anyway – you need to make a burn to a stable orbit above the site you want, and then land.

### **4) When you enter a four-sided orbital, you face the far side. When you enter a triangular one, you get to pick one of the two other sides; you don't face the far corner.**

Transfer orbits (that is, movement on the map) carry you along until you actively choose to burn to stabilize yourself. So you *have to* keep going until you do that. In a triangular orbital, you can pick – you face one of the two sides which isn't the one you came in by, and it's entirely up to you. There are a couple of hexagonal orbitals at the gas giants – like four-sided ones, you face the opposite side when you enter, and can facing change to any side or corner.

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There are also certain features on the map which might affect your route plan.

**Major Bodies** are those bodies which have multiple surface sites and a surface gravity higher than seven. Major bodies will also have dots (called grav dots) shown beside their name; the number of dots is their *slingshot value*. The number of dots is given to you as free orbitals and/or dots, your choice, or even a combination of the two, as soon as your plotted course enters their orbital. Use them up immediately, then resume counting from where you end up. There are a couple of restrictions: you can't use these dots to stabilize your orbit here or anywhere else, and you can't slingshot off the body you most recently visited or launched from.

Bodies that massive will also involve spending fuel to get on or off of them, in addition to simply requiring a certain minimum thrust. This is what you've heard referred to as their *escape velocity*. The number of dots shows you approximately how many burn dots this is, although for most bodies High Trader's fuel nomogram shows exact values for their escape velocity. Landings or takeoffs from such bodies are treated as trip legs in their own right, from (Body: Low Orbit) to (Body: Site) or vice-versa.

Note that grav dots are *not* the same thing as surface gravity. The surface gravity is a measure of thrust, of acceleration; it's how much strength your rockets need to have, and it also indirectly defines the size of the body for things like exploration actions. It's a number, listed next to the spectral class. Grav dots are a measure of energy – energy either provided from a slingshot maneuver, or used up to land or take off. No grav dots simply means that the energy benefits and costs lie beneath the scale of the game.

**Bodies surrounded by a white halo** have an atmosphere – not a breathable one, except for Earth, but substantial enough to be usable. This has two valuable effects. First, you can use the atmosphere to *aerobrake* as you arrive at the body. This lets you make the facing change into a stable orbit here for free, without having to make a burn. It is, however, slightly risky; there is a disaster card which targets aerobraking specifically. The second useful effect of having an atmosphere is that you can use it to parachute items down to the surface; doing it this way eliminates both the thrust requirement and the delta-vee cost, but only on the way down.

In particular, changing from facing one corner to another, for example when dropping multiple bot teams on a planet, is not a special case. It's a trip leg, distance zero (therefore time zero, as you'll see in a sec), one dot. And the aerobraking rule is written such that yes, you can "aerobrake" – or, more precisely in this case, use atmospheric flight, or parasails instead of parachutes for the cargo, or several other analogous plans – to pay for that one dot, if it's got an atmosphere.

**Orbitals filled with squiggly lines** are heavy with radiation. This has no game-significant effect on unmanned flights, but manned missions have to be more careful. The Solar Flare disaster and Solar Storm event cards are more dangerous to manned missions which pass through one of these areas. Of course, until later in the game there's not much you can do about passing through the Van Allen belts around Earth... but be aware that using a spiral transfer (see below) to move crew through a rad zone will increase this risk.

Finally, right at the border of the map there's an orbital which contains the stats for a further voyage outside of our solar system, **to Alpha Centauri**. It is pretty unlikely that your game of High Trader will go long enough, at a high enough tech level, to permit actually making the trip to Alpha Centauri. Certainly the travel time at the game's tech level is so high that the only way you'll actually *arrive* is in those endings (the majority of them) which end with "Play out all missions currently in flight." But the stats are provided here because about half of the players of a game of High Trader ask at some point what this would cost. Certainly the payoff is very high – look at not only the 'Interstellar journey' ones but also the relevant 'Coolest' and 'Most distant' achievements for your mission type. The distance and energy listed here are worked out starting from this orbital, so your route has to travel here first,

and then add the listed costs on top of that. Note – Ad Astra maintains an honour roll of players who have ever managed to build an Alpha Centauri colony in a competitive game of High Trader. As of printing, after a few years of playtesting, that honour roll is empty. If you make it, take note of the founding date of that colony, and let us know!

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Once you've worked out the *distance* (in orbitals) and the *dots* required, the next step is to pick what kind of transfer you're doing. Each one has a minimum thrust rating, a time, and an energy cost, calculated from the distance and dots. The most energy-efficient one is the *Hohmann Transfer*, a classic in rocketry, but it's also pretty slow, often not feasible for manned voyages with life support restrictions. The *Spiral Transfer* is even slower, and actually slightly more expensive in fuel, but is sometimes the only option for very low-thrust rockets. *Elliptic* (but steeper than Hohmann, which is technically also an elliptic orbit) and *Hyperbolic Transfers* are faster and more expensive, and the *Brachistochrone Transfer* is perhaps the most famous – and expensive – one of all: turn on your engines, all the way to the midpoint, then flip around and turn them back on again all the way to the end. In game terms their costs are given on the Rocketry Aid sheet, and duplicated here: Ninety-five percent of the time you'll use a Hohmann Transfer; the Hohmann's characteristics are shown in grey on the planning sheet.

The delta-vee to be filled in will always be equal to the number of dots, plus some multiple of the distance in orbitals. For the Hohmann transfer, this added  $\Delta V$  cost is zero. For other types it won't be. Round fractional delta-vees and months normally... 1.5 rounds up, 1.4 rounds down.

Trajectory Type	Time (months)	Added Delta-Vee	Min. Thrust
Spiral Transfer	Distance x4	Distance x 1/10	0
Hohmann Transfer	Distance x2	None	1
Elliptic	Distance	Distance x 1/2	1
Hyperbolic	Distance x 1/2	Distance x 3	2
Low-Gee Brach	Distance x 1/3	Distance x 5	1
High-Gee Brach	Distance x 1/4	Distance x 10	3

In the leg arrow on your worksheet, if you're using a Hohmann transfer with no aerobraking maneuver, that's the default; there's a checkbox for aerobraking, and another for non-Hohmann transfer types (supply name and minimum thrust), on the right-hand side of the arrow. There's also a box to be checked if this arrow represents a major-body landing, takeoff or ballistic hop... more explicitly, if it's a major body landing or takeoff with nontrivial fuel, as discussed on page 12. In any case the minimum thrust for all landings and takeoffs, major-body or not, is simply the surface gravity of the body. In landings and takeoffs you won't fill in the time (it's zero) or the delta-vee (for major bodies it's the exact escape velocity of the body, and is listed on the tool you'll use; for minor bodies it's effectively zero).

Fill in the final time and energy cost for the step in the leg arrow under "Months" and " $\Delta V$ " respectively. If your mission involves coming home again, repeat this process for the return trip. This won't necessarily be the same because of details like slingshots and aerobraking, and also because you might choose a different orbit type – maybe you're sending your rocket home unmanned, slowly, for much later use. Or, if you're making many stops, fill in the legs between them, one at a time. With practice, this will be very quick indeed.

# ***Rocket Manifest***

Time to flip the sheet over, to the Mission Budget side, and talk to the engineers about this plan.

The next thing that you need to work out is what objects you'll need to build in order to complete your mission. This will generally include both a rocket (unless you're reusing one or doing some kind of onsite construction mission), and a payload (unless the rocket *is* the mission).

## **The Objects**

The items you can build are shown on the Tech Library pages. The libraries with all the pictures [ed: not yet available] are designed to be easy to use; later, the more compact one with everything on one page [ed: ditto] will be of use to advanced players. There is also a more detailed listing in the third chapter of this book [ed: which we currently use as the tech library in play].

Every item has three kinds of costs listed, as well as its requirements (if any) and any special rules associated with it.

The three costs are Macro (the hexagon), Nano (the trapezoid), and Research (the truncated diamond). Macro and Nano costs must be paid anytime an item is built; Research costs have to be paid only the first time. The possible requirements include Cooling X, Beamed Power, Generator, and occasionally the presence of some other item (like a factory) in the same complex. All requirements must be satisfied for the item to work.

Guidance is not formally a requirement, even though in many ways it's treated as one – every rocket and every operational facility does need it. Guidance is provided automatically by any nonfrozen crew (hab or colony), and can also be provided by the Cyborg or A.I. Guidance add-ons. If it is not being provided through one of these methods, then the rocket or factory is under Robotic Guidance, which has certain disadvantages. One, it's subject to certain disasters which don't affect more sophisticated guidance. Two, you can't play defensive cards on behalf of something which is currently under nothing but Robotic Guidance; it can't anticipate, troubleshoot or do damage control. However, because you can always default to robots, guidance is not technically a "requirement" as it's understood by other rules.

Rockets will also list their ISP and their Thrust rating. These are very important, but we'll talk about them in a bit.

## **What You'll Need To Build**

What you'll want to do is to think about what kinds of items you will need for your mission. If you're doing an **exploration**, then you'll need either a hab (or colony), or a bot team object to do it by remote control. You may also need a lander if your rocket's Thrust isn't high enough to land on the body. For most minor bodies a simple chemical rocket will do the job cheaply.

If you're doing a **facility** mission then obviously you'll need the facility you want, plus a rocket strong enough to get it there. Both may have their own requirements. You'll also need either a crew or a bot team if you want the mission to include the setup of your facility once you're there. And you are quite likely to need a lander, since the mass of your facility will further reduce the effective thrust (acceleration) of your rocket.



If you're bringing a **colony** then you need the most stuff. The colony itself – they come in small, medium, and large – includes the people, their life support system, living quarters, minimal radiation shielding, and so forth. This gives your colonists everything they need to survive while in transit, and for a while on the surface of your destination. Luckily, unless you're packing them in coldsleep, your colonists will be chosen for their ability to (among other things) fly the rocket, so your guidance needs will be taken care of.

However, at the far end, if you really want them to be set up to stay indefinitely, you'll also need some colony infrastructure appropriate to your colony size. That, in turn, will have requirements (such as a Factory). You do *not* have to bring the infrastructure on the same trip you bring the people! In fact, most Mars missions discussed in the real world involve sending the infrastructure first, by slow efficient methods, and then sending the colonists in a fast rocket afterwards. In HT, this would typically be done over two turns, first a facility mission to bring the infrastructure, then a colony mission to bring the people.

Choosing a rocket is in every case an art. This is where the real skill in the game comes in. Every approach has its advantages and its disadvantages. Many factions and resource cards have starting technology knowledge; this is one good place to start. Try that out and see if it works for you. Another approach is this rule of thumb: work out your payload, then grab the nomogram (on which more later) and pick a rocket whose Thrust, even while carrying itself and the rest of your payload, is at least two. That's another good place to start. In general, if the mission has a high  $\Delta V$  cost, you will want a higher ISP; if your payload mass is very large, you may need to be concerned about having enough Thrust to move it; if your rocket is a whole lot more ambitious than the other players', then you may end up not getting to actually collect victory points for quite a while. Remember that *first X* is always valuable – possibly more so than the economic payoff of something more ambitious.

## Costing It Out

So, based on your mission specifics, first write down the major components like the rocket, the colony, etc., along with their prices. Then on the smaller spaces below those, write any modifiers and add-ons you choose to add, in order to satisfy requirements like Cooling or Generator. Write the Macro and Nano costs for each into the spaces provided.

If this is the first time you've built this specific item or modifier, put down its Research cost as well. Don't do this if you've built this item before. There's also room at the bottom for technologies you're just paying the Research cost on, but not building yet, and also for listing things you already own and don't have to build this time around (but might have to boost).

Sum these costs at the bottom of the Manifest box on the worksheet. The total mass, which is usually just equal to the total Macro cost, has a special name in rocketry... it's known as the Dry Mass. Occasionally we may also refer to the total mass of just the rocket plus its modifiers plus other permanent parts (like the hab if they'll be staying with the rocket instead of being treated as payload). We call that the Hull Mass. Both of these terms are used just for clarity; you don't need them right now.

## Cross-Referencing

You'll note that each line of the manifest has a hanging folder icon, labeled "XRef" for cross-reference. Usually, this will be blank, meaning that no special explanation is necessary; building this item is part

of the normal mission, and thus it counts toward your resource needs at the bottom of the manifest just like everything else. But sometimes you'll make a special deal which changes these numbers.

The most common case here is if you're able to buy, or trade, a tech from another player who already knows it at the start of the turn. In that case, that deal becomes one of your Contracts, listed over on the right, and that contract in turn has a cross-reference number (a roman numeral) which you fill in on the item's line so that it's easy to link the two at a glance. In exchange, you can list the item's research cost as zero (you no longer need to research it yourself) instead of its normal full value.

Similarly, if you buy a finished rocket or payload from another player, it will have no construction costs to you, so you'll leave those blank, but you'll want to be able to reference the deal so that you can easily see why those are blank. Note that deals in finished products are harder to wrap your head around in this system, so try to use the standard methods (you specify the rocket as an output in your own turn, and then buy the resource points needed to build it) unless you have a good reason to do otherwise.

### **Just Research It (or Build, or whatever)**

Yes, you can do just part of an object on your turn, just the research part, or just the boost part, or whatever. The only limitation is that you have to do all of that thing – you can't do "Half the research on AI Guidance" in a turn. But you could do the research component, without actually building one (yet). Or you could build something on Earth, and not boost it (yet). This is usually used in combination with a Prep mission. For example, if you expect Boost to get much cheaper next turn, it might make sense to research and build some products, and then hold them on Earth until next turn's mission. No problem.

The easiest way to mark that you're *not* boosting a thing is to give it a negative "boost cost" equal to its mass. The standard build lines don't have a boost spot (to help avoid confusion in general), but if you look at the "Prebuilt" lines down at the bottom you'll see where it would go. Just sketch in a boost icon for your own use on the item's build line. Obviously this only makes sense if you're using a Macro resource with an Earth Boost cost in the first place.

### **Losing Their Identity**

Once you've generated those subtotals, the resource costs of individual items within the manifest is basically lost – at least when it comes to budgeting for of your mission. The manifest's subtotals will transfer over to the Accounting section; the information about which items made up those subtotals will not.

What this means is that as you move forward, you're going to be concerned about how to make the entire mission happen. You no longer need to worry about where you're building any one piece of the puzzle. It can be tempting to try and work that out... but as we'll discuss later, this is a twofold mistake; one, it's generally impossible to know just when (or how) during the mission construction any specific component of it may have been built, and two, even if it were possible, it would be way more work.

## ***Propellant and the Mass Line***

Now that you know the masses of things, there's one more item on the cost sheet that you need to figure out. If you think gasoline is expensive... try boosting hydrogen into low orbit for \$4 a gallon. To get the propellant cost we'll flip back to the Mission Plan side, and work backward along a line of cumulative masses, called the Mass Line.

In rocketry the name for the mass of a rocket including its propellant is the Wet Mass; we use this even when the propellant is something other than water, like liquid or solid chemicals (Chemical Rocket), hydrogen (most rockets in this game), or even rocks (the Mass Driver or Annihilation Drive can run on *anything*). Note that for the rocketry purist this is distinct from *fuel*... fuel is the energy source, propellant is the stuff you fling out the back to make you go. They're not always the same thing; for instance, the Annihilation Drive uses a tiny amount of matter/antimatter as its fuel, but the mass of this fuel is so small that it is far, far below game scale. You will never, in this game, be concerned with fuel in the technical sense, so it's fine (unless you're playing with people who will be annoyed by imprecision) to call Propellant "fuel" during play. These rules will, for brevity, use the two interchangeably. The purists can cope.

Wet mass is, of course, what we care about. It tells us how much propellant we're loading, and it tells us how massive we are, which in turn tells us if our rocket's even strong enough to move that much mass. Both are important, and both come directly from working out the wet mass.

All trips are broken down into a sequence of **legs**. Each of those arrows from one site to another is a trip leg. We'll do them one at a time.

We work out the wet mass of the rocket, leg by leg, **last leg first**. We do this because the one thing we know for sure is that when we get to our very last stop, our mass had better be the dry mass of what we brought with us; we didn't leave any tons behind by accident! That's our starting point for the mass line. So total up the mass of everything that's being brought to that endpoint, for instance the rocket and hab you're bringing back to Earth, but not the factory you'll have dropped off by then, and write that in the Arrival Mass box for that last stop. If the last step involves an unload step you might want to list the rocket's hull mass in the "Departure Mass" box, and the offloaded mass normally, to get the mass you arrive with. As long as it's clear, it's good.

Now we look at the leg that got us here. What we want to know now is how much we had to weigh, including propellant, at the *start* of this last leg of the trip. That's the grey hexagon labeled 'Depart' under the previous stop – or, once we work our way all the way back to leg #1, the 'Initial Wet' mass at the very start of the trip. The only thing that changes between the left hand side of a leg and the right hand side is burning fuel! Dropping stuff off, picking stuff up, or anything of that sort is always handled within a stop, not along a leg..

The equation that tells us what our initial mass had to be is called the rocket equation. It's not complicated, but it involves exponentials (or logarithms). To let you do this during play without a calculator, we've designed what's called a *nomogram*. A nomogram is kind of like a graph, except that it's a graph of several things at once. You read a nomogram by following lines on it, lines based on stuff you know, and eventually by following lines and spotting where they cross, the nomogram brings you to the answer you need. It's tricky at first, so do this together, but once you get used to it, it's really quick. On your mass line, there's a picture of it – a little rectangle with sets of curved lines inside, directly under the  $\Delta V$  on your leg arrow – to remind you that that's the tool you use at this point on the mass line..

Right after this section, we'll give the step-by-step procedure for using the fuel nomogram. It looks long only because we're trying to be painfully clear; follow it meticulously the first time, and you'll rapidly grasp exactly how it works. It can also be worked in other directions, once you get good at it – for example, *how much mass can a single D-T Fusion open cycle carry, on an elliptic transfer?* Save that for once you're used to doing it the default way, to answer the default question: *I know how much I want to carry, and how far I'm carrying it, and what I'm using to do so... so what does my wet mass have to be when I start?*

**The nomogram will give you both your starting mass, in the 'Departure' hexagon, and also your net thrust, in the grey thrust icon beside it.** Here's an example of what filling out the route details using the nomogram looks like:

Vince's lander and hab come to a total mass of five. He's landing on Luna to explore. To get up to Lunar orbit with a mass of five (end mass, in the white box on the left), he uses the nomogram to work out that he has to leave Luna with a mass of seven. His net thrust is eight at this mass. These go in the grey 'start' spaces on the right. On the ground his mass doesn't change. His final mass on the landing is the same (he has to bring that takeoff fuel down here with him), namely seven, so that goes in the white box on the left on the next line. He works the nomogram again and finds that he has to mass ten at the start of the descent, so he puts this in the grey hexagon on the right. His net thrust is seven at this higher mass.

In between legs you'll always have a chance to load and unload cargo. Both are extremely common, both in between takeoff & landing legs, obviously, but also in orbit, between trip and landing, or takeoff and trip. Examples include actually assembling a facility to leave in place (*unloading* the facility's mass from your lander), or rendezvousing back with a main rocket you left in orbit (*loading* the main rocket and its return fuel tanks). Just remember that you're working backward, trying to get the end mass of the previous leg ("How much did I mass before doing this loading and unloading?"), working from the start mass of the one that came after ("How much did I mass just as I turned on the engines to go?").

When Vince arrives at Luna, he's leaving in orbit an arcjet engine massing 3 along with 4 mass of return fuel. In the example above, he worked out that his lander must mass 10 at the beginning of the descent. So below the line for his takeoff from Luna, he puts an unload of 7 mass, as he leaves the arcjet behind him for now. This means that his end mass for the next row, his trip to get here, is going to be 17.

The most important thing to remember is to keep track of what each line means! A trip leg from Earth to Mars takes a line; a takeoff from asteroid Khufu takes a line. With practice, you'll be able to ignore some of the unimportant lines, where no fuel gets spent and the thrust is guaranteed to be sufficient, but for now you need to check both.

Speaking of thrust, remember to fill in the white Minimum Thrust box for each leg. For takeoff legs, the Thrust requirement is the listed surface gravity of the body. For landing legs this is the same, unless we're able to use parachutes to eliminate this requirement. For trips on the map, the minimum Thrust is set by the transfer orbit we chose... for example, the Hohmann Transfer requires a Thrust of one.

Compare your actual thrust, on the right, to the minimum thrust, in the middle. It needs to at least equal the minimum for the plan to work as currently written. If it does, great. If it doesn't, don't despair! Yes, you are going to have to rework some of the plan. But you have several ways to do this.

- ❖ **Use a lander.** If the answer to your thrust check was that your main rocket didn't have enough thrust to land or take off from where you wanted to go, that's quite common. There's nothing saying you have to use the same rocket for landing as you did to get here. A lander is a second rocket, often just a small Chemical Rocket, carried as payload in the first one until it's needed. You can part your big rocket in orbit, or even bring it down to the surface with you, using the high thrust put out by a lander. Its low ISP doesn't matter if it's not going very far!
- ❖ **Build a bigger rocket.** Each point of Thrust implies a doubling of the real-world force; the corollary to this is that if you use two identical rockets together (as one big one), they keep the same efficiency per ton of propellant – that is, the same ISP – but their Thrust goes up by one. Four rockets gives Thrust +2, eight gives +3, and so forth. If the problem was too little thrust on a landing, despite a lander, then maybe you need a bigger lander. If the problem is too little thrust for a fast transfer, maybe you need a bigger main rocket. You pay the full costs (except Guidance, which you only need once) for however many multiples of the original rocket you decide you need. Record it as a "Double Chem Rocket" or similar. Watch out for what the increased mass does to all your steps – not just the one that was in trouble.
- ❖ **Use more power.** Two of the rockets, the Laser Therm and Laser Sail, can get more powerful without having to add more rocket mass. They do this by adding more beamed power channels, instead. This is cheaper, in the sense that it never makes sense to pay for a "double laser therm" rocket... but it can get very expensive in power costs.
- ❖ **Pick a different type of transfer orbit.** You may have gotten greedy and tried for one of the high-speed transfers when a slower one would do. Or maybe you tried to do a Hohmann transfer but your rocket's just too wimpy, but a Spiral might work. Go back there, work out the new time and minimum thrust, change anything on your design that the time increase affects (i.e. life support), and redo your propellant calculations if necessary.
- ❖ **Pick a different rocket.** Maybe you tried to build a cheap electric rocket but it just doesn't have the oomph; rather than multiply up that rocket (along with, say, your beamed power requirements), maybe you'd do better to pick one which has a better ISP, even with the same thrust, or with a higher thrust plain and simple. Either one could bring your performance in line with the limits of the job.

***This isn't trivial.*** It is, in fact, rocket science. Knowing generally how to avoid having to back up and correct a thrust problem is one of the underlying skills which you'll need in order to become a master at High Trader. But it's not something which will kill you; you haven't spent any resources so far, this is all a plan. It's okay to decide you need a better plan.

In our example, did you notice that Vince is in trouble? He's got a thrust of seven on his landing, but a minimum thrust of eight. He's facing a crash if he tries it as it stands. Doubling his chem rocket brings him up to mass 5.5, rounded up to 6, but it will also boost his intrinsic Thrust up to nine, meaning that he can manage the takeoff even with a -1 Thrust. Vince decides, rather than carry the extra lander mass home again and pay even more fuel on that step too, he'll just leave the chem rocket in Lunar orbit when he leaves for Earth. Maybe he'll come back for it someday...

Once you've worked out your initial wet mass, right at the beginning of your trip, it's trivial to get your total propellant mass. Take this initial mass, and subtract the mass of everything that *isn't* propellant; the result is your propellant needed for the whole mission. This is why we usually don't bother to work out the actual propellant usage for any given leg; it's easier to do it at the end in one shot. This will go into the Accounting section in the next step of our worksheet.

## Using the Nomogram

Hopefully at this point you understand what the nomogram is for... it's a tool to answer the question, *given this much mass, at this ISP, going this far, what are my Start Mass and Net Thrust results?* Here's how to use that tool to do exactly that.

## 1. Flip it to the proper side.

One side is for long trips; it has Delta-V cost up in the top lefthand corner, and covers delta-vee costs from one dot to sixteen dots. The other side is for takeoffs, landings, and ballistic hops; it has Escape Velocity at the top left, and shows the exact escape velocities for almost every body in the game large enough to have grav dots. They cover different scales of ISP and Thrust, appropriate to the types of rockets which can reasonably do these trips.

Choose the side which matches the type of leg you're dealing with.

## 2. Find your Delta-V cost along the top of the left hand side.

For long trips, this is the value you wrote down in your Route Plan, for this leg. It's labeled  $\Delta V$  there. For takeoffs and landings, this corresponds to the vertical line for the body you're trying to take off from or land on. If you don't see the body you're dealing with, then either (a) it's too small to have grav dots, (b) it's Earth or Venus, or (c) you're in the wrong solar system.

You'll be following this line down. Feel free to mark it with an erasable marker or grease pencil; the nomogram is laminated for exactly this reason.

*If your delta-vee cost is too large to show up here:* Does the chart show half your delta-vee cost? If so, mark that, and in the next step use half your ISP. Half the delta-vee and half the ISP cancels out and gives the right answer. Still not working? Try a quarter of your  $\Delta V$  instead and a quarter of your ISP, and think about a less hyperfast route. Unless you're flying an Annihilation Drive, you bastard.

*If you are trying to take off from Earth, Venus, or Alpha Centauri Prime:* Earth and Venus both have an escape velocity of very close to four dots. So either you can use the "long trips" side, four dots, or, more likely, you will need to treat this as two "stages" each of two dots (see the bottom of the left-hand-side of the takeoff nomogram), and run through the last stage of the nomogram twice, using the start mass of the second stage as the final mass of the first one. This is actually pretty easy to do, but you'll find that the fuel costs to get off either body are *really, really high* as a result. Sorry; that's just physics. Alpha Centauri Prime, similarly, is taken to have exactly one dot, and thus uses the exactly 2.5km/s line for landings and takeoffs.

*If your body doesn't have grav dots:* It's a minor body. **You don't need the nomogram to take off or land.** Your fuel burn for this takeoff or landing is zero on game scale. If you've listed this landing/takeoff as a leg anyway, no problem. Just write the same mass in the Departure spot as you did in the Arrival one. Your acceleration (see the last step here) is based on this mass – do check to make sure that this is sufficient for the body in question.

## 3. Find your specific impulse (ISP).

The green curving lines on the left side of the nomogram correspond to the possible ISPs in the game. Find yours. If you're marking the lines with dry-erase, mark it.

On the takeoff nomogram, there are also purple curved lines. These are purely there for interest's sake – these are the actual ISPs of various well-known rockets and propellant mixes in the real world. Our game ISP of 0.5ksec for "Chemical Rockets" assumes a bit of an improvement over the current real-world best mix of liquid ozone/hydrogen, but as you can see it's pretty close.

*If your ISP is too large to show up here:* Show-off. You and your fancy-pants rocket both. Divide both your ISP and your Delta-Vee cost in half as many times as you need to, until your ISP shows up on the chart. Half the ISP and half the  $\Delta V$  cancels out in the actual rocket equation to give the same result.

## 4. Find their intersection.

Trace straight down on the Delta-Vee line (dashed gray for long trips, primary colours for specific-body takeoffs or landings). Trace along the green line. Find the point where they meet. Mark it, if you're marking things.

*If your intersection is off the top of the chart:* If you try to intersect ISP 16 and less than six dots, for example, then the answer is off the chart. In this case you can skip the nomogram; your fuel expenditure is small enough to be considered zero in game terms. You can probably afford to shave some travel time off your route with a faster transfer orbit. You can almost completely ignore the nomogram; all you need is the acceleration modifier (last step), which you'll get based on your mass – start or end mass, they're the same for you. However, there's one gotcha... if your next leg also comes to zero dots in this way, then you must add the dots for this leg to the dots for that one. If that's still free, fine, but in that case if the next leg is free you add the cumulative total to it, too. In this way, eventually, a long enough sequence of "free" legs will eventually cost you something.

*If your intersection is off the bottom of the chart:* Similarly, the nomogram won't cover you if you try to combine, say, ISP 2 and ten dots. This is fairly common if you're going with cheap rockets. The answer is to break your trip up into stages, where each stage fits on the chart. ISP 2 and ten dots can be calculated as two sub-legs of five dots each. Note, though, that this means that you'll be paying more than 1.5 times as much mass *just in propellant* as your entire rocket and payload put together. Really what you're finding here is that your rocket isn't efficient enough for the route you picked; consider using a more fuel-efficient transfer, or a higher ISP.

## 5. Find the nearest blue line.

There are blue horizontal lines on the nomogram. Find the one that passes closest to the intersection point you just found. Mark *that*.

See the mnemonic picture on the long-trip side, showing a green line meeting a gray one, and a blue one emerging? That's your reminder of these steps for next time.

The blue line is your *mass ratio*. It's translated to real-world numbers in the middle of the nomogram, and again on the far right-hand side. If you're not marking the nomogram, just tracing it with your finger, it's very useful to note this number; it helps you find your line again if your finger slips. This is the ratio of the *initial mass* at the start of this leg to the *final mass* at its end.

So, for example, if you hit the 2.0 line, then that means that your mass will drop by exactly 50% as you expend propellant during this leg of the trip. If this isn't your last leg, then that final mass will probably include propellant which you *don't* burn now, it's for later; what you're working out here is not only how much propellant it's costing you to move your rocket, you're also paying to move the propellant you need for later use. This is a large part of what makes rocketry so expensive.

## 6. Follow the blue line to the right.

Your focus now shifts to the right hand side of the nomogram. Follow your blue line through the center. Mark it on this side of center, if you're marking things.

The right hand side will turn that mass ratio into an actual mass. Sure, if you had hit a mass ratio of 1.5 and your final mass is going to be 20, then you could do this without the right-hand side. Go ahead, with a caveat about rounding which we'll explain in a sec. The right-hand side exists so that you don't have to multiply 1.7 times a final mass of 29 and come up with an answer without a calculator.

## 7. Bring in your arrival mass.

This is the number at the bottom left of this leg's destination stop, on your worksheet. If this is your first use of the nomogram for this mission, this is also the final dry mass at the end of your trip. Find that along the bottom of the right hand side. Note that we've provided lines, but not labeled them (from space constraints), for various values between 9 and 23.

Mark this line. It's purple.

*If your actual mass isn't listed, use the next highest value that is. You may be able to obtain better precision by using half your mass, and then doubling the mass you get out as the nomogram's answer in a few steps. That's fine, just watch that you use the actual mass, not the half mass, to get your net thrust at the end.*

## 8. Find the intersection of blue and purple.

Follow the purple line up until it meets the blue line you established earlier. Find, and mark if you like, their intersection.

You can follow the purple line down from the top also, but it tends to be more confusing that way. Your eye has an easier time following the purple line up from the bottom.

The mnemonic picture on the right-hand side of the long trip nomogram should suggest to you what the next step will be.

## 9. Find the nearest red line.

Yup. From that intersection, locate the nearest red line. If it's really, truly ambiguous, use the one to the left of the intersection point.

*If you're to the left of the leftmost red line, then you're hauling a heavy load indeed. Can you find a red line matching half your mass? If so, you can use that, like in the trick under step seven, doubling the final mass result to make up for having halved it here.*

*If you have an end mass of 1 or less, then the nomogram won't cover you. End mass 1 is really easy; your start mass equals your mass ratio, rounded to the nearest integer. For smaller values, try multiplying your end mass by 2, or 4, then working out the start mass and dividing back down.*

## 10. Follow that up to obtain your start mass.

The red line goes up and left. Follow it all the way to the top of the nomogram. The number it meets is your Start Mass. This is what you write in the right-hand hexagon for this leg, on the Worksheet.

The difference between the initial and final masses you can work out for yourself; that's how much actual propellant mass you had to burn during this leg. Occasionally this will be relevant, but usually you can just do it at the end, after all legs are computed.

*If the result isn't one of our listed masses along the top, but the mass ratio gives an exact answer, you can use that. For instance, a mass ratio of 1.3 times an arrival mass of 10 gives an exact, unrounded answer of 13; you may use that instead of using the right hand side of the nomogram.*

If your group allows, you may use direct calculation of mass ratio times your arrival mass and then round the resulting value, or interpolate between the lines... the nomogram is very forgiving of approximations, it still gives clear answers anyway. Just make sure everybody at the table has not only the same opportunity but close to the same facility with the math.

*If your final mass is the same as your initial mass, that's okay. (This can happen with relatively high ISPs, short trips, and relatively low mass, of which there are a couple examples – ISP 4 and mass 2 over 3 dots, for instance.) This just means that your propellant expenditure rounded down to zero in game terms. Enjoy. However, if you chain multiple 'free' trips together, sum their dots until one of them ends up not being free; see step 4, above.*

## 11. Find your Acceleration modifier.

Under your start mass is a fat black line with a circle at one end. Your red line will have crossed one of these black lines; the circle applies to everything on its line. The number in the circle is the acceleration modifier due to your mass. Add this to your rocket's Thrust value; the result is your Net Thrust. Record this on the Worksheet, over beneath the right-hand side of the leg.



*If you ended up off the chart due to using one of the halving/doubling tricks above, note that Acceleration modifiers drop off by another point for each doubling of the mass. So, for instance, up to mass 128 is Acceleration -4, and so on. Similarly, the Acceleration modifier for mass 0.5 is +4.*

Repeat the nomogram procedure for each leg of your trip.

***Remember, propellant cost are ALWAYS done last leg first. Fuel costs get calculated back-to-front, because this is the only way to make sure you can afford to get home.***

You can sometimes shortcut the procedure a little. For example, if both the ISP and the delta-vee cost of two legs (for example, out and back) are the same, then you know the mass ratio will be the same too, and if you remember it you can probably start reading the nomogram from there. (Chem rockets on Luna, for instance, will always be mass ratio 1.4, no matter what their load is. No need to trace the green curves repeatedly.)

Once you've worked out your propellant needs for the trip, flip the sheet back over. It's time to pay for all this glory.

## Accounting

The next thing that you need to do is to figure out how you're going to pay for all of this, and how long it will take. There are three pieces to this one. The primary one shows each of your resource requirements for your mission this turn, and how you've bought them – either from other players, from your own resource cards, or from the bank at the default rates listed on the sheet. The second one, beneath that, gives you spaces to record any complicated deals or contracts used to meet these requirements; you'll be able to refer back to these contracts in both the Manifest and the accounting parts of the sheet. And the third one, at the bottom, gives the actual total costs of the mission – the bottom line, in both money and time.

The currency and resource icons – Money, Time, Macro, Nano, Research, Propellant, Earth Boost, and Power – are going to do **very** heavy lifting here. Make sure you're rock-solid on which icon is which. Some good mnemonics: think of money as a coin, time as an hourglass, macro as a silhouette of a cube (for solidity), nano as a perspective view of a microchip, research as a viewscreen or aperture, propellant as a drop of fuel, earth boost as an arrow pointing at the sky, and power as a light bulb being powered over time.

### Your Needs

The first thing you need to know is what you need in terms of each resource. Transfer the Macro, Micro, and Research costs from the bottom of your Rocket Manifest section, and write them in the appropriate blanks here in the Accounting section. Flip the page over and find your total Propellant needs for this mission; write that in the droplet here. Usually, you don't yet have an Earth Boost need, so you'll leave that blank; you'll probably end up needing Earth Boost as you pay for other things, it's like an intermediate currency. If you're going to require beamed power for the mission, put the number of channel-months you need into the Power icon. (You need one per month of flight or of operations, per channel you need.)

In order to launch, you have to get every one of these resource needs satisfied somehow. You might build them using the default equations, extract them from resource cards or facilities you own, buy them from NPCs, buy them from other players, or barter them from other players for resources of your own.

Filling those orders is going to be your priority for the next little while. Next we'll show you how.

### Resource Equations

Every player has their own in-house ability to make, or contract out to nameless vendors, every resource. This uses a fixed set of resource equations; these are printed beside each resource on your worksheet. Players who hold resource cards will have resource equations on them. Some factions have special resource equations of their own, separate from resource cards.

A typical resource equation goes like this, in words: "It costs me one money and one Earth Boost to make one Macro. This takes a month." This is the basic default equation for Macro... building it on Earth and then lifting it into space. Anyone can use this equation (unless their faction card overrides it with something else). On the play aids, it's shown with icons:

**[money: 1][boost: 1][time: 1] > [macro: 1]**

Now, we'll find in a bit that time's rules are a little different than money's. There are good reasons for this, but we'll save those until the first part is clear. For now, ignore the time part of the cost. Focus on the rest.

The triangle is a separator. It says "equals" or "yields" or "is needed for". Whichever interpretation you're most comfortable with, works; they're all the same thing. The thing to the right of the triangle is what you get. For a Nano resource, it'll be a Nano icon, and so forth. To the left of the triangle is the costs for this. There are no plus signs, but they're implicit... in our example, one cash plus one Earth Boost plus one time. You can repeat this as many times as you need to... so, to flesh out our example, if you've got a five-mass object, it's going to cost five cash and five Earth Boost to build it. (It will also take at least five time but the time cost depends on other things too, so, again, hang on for that part.)

One of the Macro resource cards, Orbital Salvage Ops, reads **[money: 1.5][time: 2 > [macro: 1]**. (*Designer's note: This pricing and its restrictions are under adjustment on the actual Salvage Ops card. Thus the example may not match the card, but the example is still self-consistent and you needn't worry about that right now.*) Because Earth Boost is quite expensive, this is a *much* better deal! This price is the resource owner's *cost* to produce one Macro in this way. His price to you will probably not be the same... he has to make a profit, after all. As long as what he offers works out to less than it would cost you to build it in-house, you come out ahead.

For reference, here are the default equations which everyone can use unless otherwise specified:

<b>[money: 1][boost: 1][time: 1]</b>	<b>&gt; [macro: 1]</b>
<b>[money: 2][time: 2]</b>	<b>&gt; [nano: 1]</b>
<b>[money: 1][time: 4]</b>	<b>&gt; [research: 1]</b>
<b>[money: 4][time: 2]</b>	<b>&gt; [boost: 1]</b>
<b>[boost: 1][time: 0.5]</b>	<b>&gt; [propellant: 1]</b>
<b>[money: 1.5]</b>	<b>&gt; [channel-month: 1]</b>

Occasionally, you may see an equation which produces more than one of a resource. For example, the Laser Thermal Heavy Lift boost resource card uses seven money (& three time) per three Earth Boost. This isn't just because 7/3 is an awkward fraction. The three after the arrow is a minimum batch size. If you're using Laser Thermal Heavy Lift to boost two mass, it still costs you seven money. You can aggregate demand, so if one customer wants two and one wants four, that's two trips.

Default rates on power work much like anything else, except for figuring out the amount. If you're supplying a rocket, you'll need enough channel-months for the duration of the trip, and enter the purchase on your mission. If you're supplying a facility, you'll need enough channel-months for its longest lead time this turn; enter this as a transaction in the amount of "Pwr" with whatever the cost works out to, on your Vendor's Log. These costs are high enough that you won't want to do this for very long, anyway. Typically, once you have beamed power of your own, you'll simply lock in a single channel to pay the costs of a single facility indefinitely; this is much simpler, and almost always the excess power would have been wasted anyway in such a situation. NPCs who supply power have finite channel counts they can supply, and otherwise operate under the same terms as Earth. Any power purchase from Earth or from NPCs must pay for a minimum of six months.

## Bargains and Getting Your Needs Met

The kind of negotiation we sketched above happens *all the time*. It's a standard transaction. You need five Macro; your friend Clayton with Orbital Salvage can supply that for eight money (seven point five rounded up). Perhaps he'll offer it for twelve, or fifteen, or twenty. Depends on how the competition, including the Earth Boost market, looks lately. Once the two of you reach a deal, say fifteen, you fill the appropriate blanks in your needs area, in this case in the Macro line. Orbital Salvage Ops also has a unique letter code associated with it, in this case "O".

**[macro: 5] from [O] for [money: 15][boost: 0][time: blank].**

Often this will create Earth Boost needs, which will in turn have to be met. The total Earth Boost cost from the Macro and Propellant rows (plus any required for prebuilt items, over in the Manifest) is recorded as the Earth Boost need, on the left. Players with Earth Boost resources will have their own equations for what that costs them, and the bargaining continues. No resource inherently requires Earth Boost; it can only be incurred explicitly, by a resource which carries an Earth Boost cost or by boosting already-built (but currently Earthside) items.

On the other side of the deal, Clayton needs a place to record his costs and profits. This is what his Vendor's Log is for. In our example, Clayton's log sheet lists his resource's name, letter code, and basic equation at the top. Then below that, he's got lines for individual transactions.

Once Clayton's made a deal with you, he puts that into this line, like so (again ignoring time for now):

**[5] to [your name] for [money: 15] = cost [money: 7.5] + profit [money: 7.5] [time][time]**

If he goes on to make another deal with someone else, he'd record that on the next line of his log sheet. He'll probably be happy about this, too... he doesn't have to round his costs up (and his profits down) until after everyone's deals are in, so if Kathy ordered eleven Macro from him, then together your orders will come to a cost of 24 money (11 plus 5, times 1.5), and a profit of.... probably a lot. Anything that's not a standard transaction, money-for-resource-points, should also record a cross-reference to a deal on Clayton's worksheet. For example, if Clayton swaps me macro points for a tech, we'd each enter that as one of the contracts on our worksheet.

If your Accounting section (or any other section) gets too messy, do use the margins, the back, or even a second Worksheet. Whatever gets your mission done and the data recorded in the formats the Worksheet uses. (We will also be releasing PDF variations of the Worksheet designed for more complicated missions, which spread it out to more than one page but have much more space in each section. You won't need these until you start getting really ambitious.)

## Time Constraints

Now it's time for us to come back to those time costs. What those tell us is how long it takes to get a particular resource. The catch here is that time does, pretty naturally, behave a little differently than money. Here are time's rules in the accounting phase of things:

**Rule #1: The lead time for any given order is the time it would take for that order, *plus* the total time for all the orders before it this turn.**

We use a specific term for the nominal time cost (number of resource points times the time cost per point): that's the order's *commit time* or simply its commit. But you don't quote commits. You quote lead times, and each lead time you quote has to take into account not only the commit for that order, but also the lead time for the order before him. In our example, if Clayton's Macro costs 2 time per point, and Kathy already bought 11 from him, when you ask to buy five Macro, Clayton will tell you that

it'll cost the money total we worked out before, fifteen, and also  $(11+5) \times 2 = 32$  months. Unless he's deliberately trying to slow you down, there's no point in charging you more time than this, since time's nontransferable anyway. If Clayton was also using his resource himself, for three Macro, and following the default practice of doing his own order first, then your Macro lead time would be  $(3+11+5) \times 2 = 38$  months. The lead time is what you enter into your Macro line in your mission costing section.

Warning: some players will initially assume that this implies that you're delivering on precisely those dates. This is incorrect (see the Black Box Model below); our time calculation in rule #4 uses estimates of total time which assume that these dates actually end up shifting around somewhat. We do not model those slippages in detail for any given resource, so you don't know what it ends up at – these quotes are just that, estimates of the true time impact of this part.

The tally of commits does not carry over from turn to turn. Next turn the resource will be available afresh.

**Rule #2: The resource owner can bump people (even himself) up or down in the list as much as he wants, during the planning phase.**

Nothing's final 'til the planning is all done. If you don't want to wait 38 months, you could offer Clayton a little extra to get priority over Kathy. If he accepts, then your Macro lead time is going to be based only on the resources he's producing for himself and for you...  $(3+5) \times 2 = 16$  months. Much better. Times two is still a pretty slow resource. Maybe cheap isn't everything.

The default standard is that if you have already quoted a delivery to someone, that's where they come in the lineup – ahead of any other orders that ask later in the turn. Having this be the default helps prevent confusion... but as the vendor, you are free to change it at any point until all turns are in.

If you think it through, the corollary to Rules 1 and 2 is that *somebody* – at least one person – always has last priority and will be waiting for the total of all the orders' commit times. I can't have priority over you, and you over me, at the same time; so one of us is going to have to wait.

**Rule #3: If I'm getting a resource from multiple sources, that resource has to wait for the *sum* of the times they take.**

This might seem wrong but is necessary because otherwise it would negate all our simplicity gains from the timing model. Think of it as gaining time due to parallel streaming... but losing the same amount due to communication overhead and part dependencies.

**Rule #4: The total time for my mission is based on the *highest* resource time I have to deal with, plus half the *second highest* one. The other ones don't matter.**

This is an abstraction like Rule #3, but the other way. This rule is the black box, the secret magic which rolls up all the nitpicky details of real-world timelines into one simple sum. We have designed things like the Research cost structure to help account for the fact that you should have to (at least mostly) finish researching before you can start building. Rather than make you work out in detail which of your activities can be parallel-streamed with which, we've built correction factors into the timing models for the resources and the costs for the objects.

There are reminder blanks which you can fill in to help you remember rule #4 on your worksheet, where you calculate the mission's totals.

The cycle on time costs, then, runs like this: We make bargains with each other to figure out money costs. For the stuff we're making in-house (using either the defaults or our own facilities) we can work out the times right away. When we're ordering stuff from other players, they specify a lead time, or they ask us to wait until they see who else needs their resource, and then they tell us a lead time at that point. We write down the lead times for each resource on our Worksheet. Then we use the bottom section to work out the mission's total costs to us in money and time

The final money cost here is called the Mission Cost. The final time cost here is the Mission Time. You'll need to refer back to both, shortly.

## Tracking Your Sources

If you look at each resource's line in the Accounting section, you'll see that there's one thing we haven't yet discussed. That's the bit just after the amount you need, where you show where you're getting those resources. There are four alternatives here:

1. **You're using the default equation.** These are printed right there on your worksheet, and they're the same for virtually everybody. (The factions which alter these defaults will say so clearly on their faction sheet.) In this case, the source (the folder icon) is left blank.
2. **You're buying it from a vendor, either another player or an NPC, using a standard transaction.** That's a deal of the form: X resource points for Y money, in lead time Z. Their vendor's log has a code letter on it, either from the resource card they drew or one that they assigned when the facility came online. Fill in that letter code in the folder icon to show where you bought the goods.
3. **You're using one of your own resources.** Enter the resource's code letter here, and the cost to you of using it for this amount. Always sell it to yourself *at cost*, not for zero money, to prevent confusion. On your vendor's log, there's a checkbox for "To me" instead of writing in your own name, and you can simply leave the "For" and "Profit" spaces blank, filling in just the "Cost" part. With regards to time, you quote yourself a lead time just like for any other customer; typically you'll put yourself first in the queue, but hey, if the price is right...
4. **You're getting the resource points as part of a specific side deal or swap.** In this case, the deal goes in one of the Contract blanks on your sheet, and you fill in the Contract's roman numeral as the source. The dominant forms of deal are either a straight-up swap of some kind ("Five macro for four nano? Deal!"), in which case the money cost here is zero (and each vendor will be taking a loss on it), or a promise to sell at cost, in which case the money cost here is just the vendor's cost. In either case it still needs a lead time quote; even if you're trading nonmonetary objects for it, the resource still doesn't pop out of thin air.

If you're obtaining one resource from many sources – for example, you made a swap for five points of macro, but need to buy another three points at normal rates from someone – then you can either try to fit the multiple sources into the source blank, or simply sketch in another resource line above the Accounting section. Remember that lead times from separate sources of a particular resource are added together – not parallel-streamed in any way – to give the total lead time for that resource, within a given mission.

## The Black Box Model

There are some factors in the accounting model which tend to confuse players during their first game. To help with this, we use an analogy called the Black Box. The Accounting section is the box. Resource needs go in – I need eight Macro, three Nano, and ten Research for this mission. Final costs come out – I'm going to be paying 23 money and 55 time chits for this mission. The actual

mission products – a rocket about to launch, its payload, a stockpile of parts in LEO, a set of plans for a particular tech, or all of the above – also come out of the black box. They come out all at once, as soon as the money and time costs have been paid, on the launch date of the mission. Satisfy all inputs (including time), get all outputs.

This seems simple, but often it's not. The major area it impacts is in the question of finished product sales. Say a friend funds me to build two MPD electric rockets, one for me and one for him. As soon as the rockets are available in LEO, his mission calls for him to take possession of his rocket, load the payload he has built, and head off somewhere. When does he receive his rocket? The black box model tells you: on *my* date of launch. It doesn't cost my friend any time chits; the rocket's resource costs don't appear in his Accounting section. It just "appears." (For this reason, make others *pay* if they want to offload their construction activities into your missions instead of theirs.) If my mission is ready before his, he won't even notice an interruption in service. But if my mission is ready after his – whether because I had fewer time chits going into the mission than he did, or because my mission had a longer Construction Time than his, or both – then there will necessarily be a pause between the readiness of his payload-only mission, and the time when it can actually depart. This pause won't cost him time chits either; it'll just mean he can't depart before the rocket's ready.

You do not need to worry about this if it's not being done on the same turn. If I submitted a mission to research Advanced Radiators and build a Factory on turn 2, and I was able to finish it off that turn (it wasn't delayed)... then on turn three I can sell the tech or the finished Factory without even looking at scheduling issues. I possess both things fully at that point. It's only within a turn that the Black Box Model can sometimes force some issues with purchasing finished goods.

None of this applies to vendor services and standard transactions. If, instead of buying "the blueprints to Advanced Radiators" from someone, I simply pay someone with a science station for 15pts of research as part of my turn, which I happens to use producing Advanced Rads tech for myself... that's what the normal rules cover, and dates are all hidden inside the normal mechanics of the vendor's time quote to me for the research. This usually works out better for both parties involved. For this reason, we mostly suggest avoiding sales of finished products from one mission to another on the same turn. Buy something they had before, or make your own for the mission you're doing now. Either works fine without restriction.

## Bargaining With Earth

Players who have resources they really don't need may choose to bargain them to Earth. The algorithm for doing so gives you only two options: **Earth will buy half, or all, of a resource equation (or a power channel), for the entire duration of the turn.** You cannot sell any other fraction of a turn's services; for several reasons both mechanical and conceptual, it simply does not work that way. Your major clients are the other players, Earth lease is a backstop. In exchange for this lease, it gives you an income boost based on the quality of the resource. Resources being bartered to Earth must be available in LEO; mine outputs not being shipped, nanofab outputs in situ, powersats without range to reach Earth, and the like are not saleable. (Research resources can always sell to Earth.)

If you choose to sell half the resource to Earth, then you can still access it at double the time cost, and you also use double the time cost in the calculation of how much Earth will pay. If you sell the whole thing, use the resource's normal LEO stats to work out how much Earth will pay.

To figure the income that Earth will give for this, consult the following table. Add together the time and the money costs of the resource equation. If the resource needs beamed power and you are not going to continue providing the power (often you'd simply lock a channel to supplying the resource), add the number of channel-months per point as well – this will be the same as the time cost per point,

times the number of channels consumed. If it produces a batch size, divide this total cost by the batch size. Round up to the nearest half-point. Find the result in the table; the result is an income multiplier, X, in **[money: [Turn Length]xX]**.

For power channels, the most commonly sold resource, the income per channel depends on the *total* number of channels being sold to Earth by all factions. If there are any NPC factions with power channels available (not being tapped by players at the table), then yes, the NPC will also be selling to Earth, and you must include those channels in the total.

<i>Total Cost</i>	<i>Channels</i>	<i>Income</i>
≤1		x6
1.5		x5
2		x4
2.5	1	x3
3	2	x2.5
3.5	3-4	x2
4	5-6	x1.5
>4	7+	x1

These prices suck. They exist to set a bottom end, not to provide a guideline to players for pricing. The default resource costs are a better place to look if you're trying to figure out how much you should charge for something.

## Trading with NPCs

The Accounting phase is the place where those NPC (Non-Player Character) factions most commonly come into play. Many of them may either have drawn resource cards to provide, or they may have a special resource equation on their faction sheet, or some other special effect on the game.

NPC resources are sold at a listed price, well above cost. Not only does this represent the NPC's profit, but it allows players who end up with the same kind of resource to potentially compete with the NPC's prices. It's still better to be competing with just the defaults if you can, though! NPCs selling power do so on a "per month" basis, like Earth (see earlier in this chapter).

NPCs sell in a first-come, first-served manner by default. If Joe says to the table, "I'm buying ten Macro from the ESA," then his order gets processed first. You'll see why this is important once we talk about time costs in a minute. However, NPCs will happily accept extra money to give priority to someone; this is done on an open bid, per-player basis, with no distinctions made for how large a volume each player is ordering or any other such factors. The NPC's cash reserves are not tracked; the money goes to the bank.

If a player calls 'dibs' on an NPC's resource and then defaults away later in the turn, that NPC will automatically give priority over them next turn to players who have not done so. Misuse dibs rights, lose dibs rights. If there's any real doubt about who called dibs first, then the NPC won't sell until one of you actively outbids the other.

Similarly, some NPCs will buy resources – most often beamed power – from players if it's available. They have a listed rate they will pay (such as [money: [Turn Length]x4] for one channel); this is exactly analogous to selling it to Earth and is bound by all the same rules. They only want one channel, unless otherwise specified. If more than one player wants to sell to an NPC, the players bid on who



gets the contract (redoing the bidding each turn, if desired) by bidding income multiplier discounts they are willing to give to the NPC.

## **Selling Tech and Sharing Research**

It is perfectly possible, even commonplace, to include tech knowledge that you have researched as part of a deal – or even as a goodwill freebie – to another player. As long as you possessed the tech at the start of the current turn, you can sell it as part of this turn, no problem; see the Black Box discussion, above.

If, however, you're researching the tech during the current turn, then the blueprints for this tech are one of the outputs of your mission. Meaning that they become available at your launch date, and not before. If another player wants to buy those plans from you and use them this turn, then we assume that two approximations cancel out: one, that your research is of course finished long before your mission is ready, but two, that they needed it long before then as well. The net result is exactly the same as the sale of any other finished product from one player to another: the mission that's *buying* the stuff can't depart before the mission that's *making* it is complete. The actual dates of launch are used for this on both sides.

Thankfully, there's a simpler way to share a tech on a given turn. (ed: Yes, this is new, or rather reintroduced, as of 2.0.5.) Shared research works like this: we all have to be doing it using the same research equation (same lab). It's only researched once by our impromptu consortium. We can split the money costs however we see fit. We each see the full lead time for this object, though; that doesn't get split.

When selling tech, or distributing the costs on collaborative research, there's a distinction which has no game force but is nonetheless useful. To have the tech in full means that you can build with it or sell the tech to someone else. Frequently, whoever's selling you the tech would prefer that they keep the ability to make money from sale of the tech, rather than having you undercut them in the tech market. In this case, they can sell you a *license* to the tech. This is exactly the same thing as owning the tech outright, except that they've asked you (strongly) to use it only for yourself... not to resell the tech to other players. Licenses are not binding, but the term is nonetheless a useful shorthand for a common request in play.

## **Using Resources that Don't Yet Exist**

Sounds like nonsense, but there are several cases where it's not. As you'll see when we get to the execution section, there are two classes of things that have been submitted in past turns but haven't happened yet in play: *pending* milestones, such as finishing your long and weary already-launched journey to Titan, and *delayed* missions, such as that massive project that you weren't able to finish paying for last turn. A third alternative exists, but it's one of the advanced modalities of the game – see Appendix B.

We handle each of these slightly differently. Some of this won't make sense until you understand the Execution Phase; feel free to skip this bit and come back to it later.

A pending milestone (from some previous turn) can produce a resource equation. Because it's a pending milestone we know exactly when, pending really serious calamity, this will come to pass. The typical case would be the date on which you finish setting up that shipping route or factory from last turn, which you'd like to use in the current turn. No problem. Work out how many months into the current game turn this readiness occurs – for example, if the milestone date for assembling your nanofab is 05/2033, and the Game Year is currently 2032, that's 17 months into the turn. This number

is a delay that all users of the resource will have to cope with, this turn only, in order to access the pending resource equation. Treat it like an initial commit. (If, by the way, that really brutal calamity does occur and the resource is ready late, the lateness affects all lead times quoted by that source. Whether they like it or not. And if it means that the resource never actually comes online, then all missions dependent on it must choose to abort, see Execution phase, with the abort cost based on what they had expected to pay.)

A delayed mission can't be predicted to the same extent. It's dependent, for example, on whether you gain sufficient income this turn, which in turn (even it's time chits you're shy) relies on the other bids, the Event cards, and on whether you spend those time/money chits on cards instead. So you simply cannot use a resource which exists in a delayed mission until it's no longer delayed. Sorry.

The advanced modality is called 'Intrinsic Use' – it allows you to make a plan in which you build both a resource and something that needs it, all in one plan. For example, building a solarsat and a laser thermal rocket, and using the former to drive the latter, or carrying a mine to a comet, and using it to harvest the fuel to keep going within this mission. This is unavailable in the basic game, but in more advanced games you could choose this pattern. See Appendix B for the details. Note that dropping off relay sats during a voyage so that the voyage can keep going is technically a special case of this, but it's a trivial one which we allow all players in all games to use. You can "unreel" your lifeline behind you even in the basic game. Just remember to course-correct to place each one in a stable orbit.

## ***Time Bid***

The small section in the bottom right is next, and is the last thing you'll do right now. Even if you have been doing your mission openly, hide this part. Fill in your Construction Time in the blank here; count up your stock of time chits, and write the result in the Player's Time space. Construction Time minus Player's Time is the Time Needed blank – this is in months, like all other times up to this point. This simply expresses how many months you need the turn to move forward, in order to complete the mission. If you already have forty months 'banked' and the mission only costs thirty, then you don't actually need the date to move forward at all; you can do it all on banked (that is, already finished but unannounced until now) effort. But if it costs fifty time chits, then you'll need to get ten from somewhere in order to do the work. And the only place time chits come from is from the movement of our perspective... the progression of game time. The turn length.

You're going to name a bid in years. Your bid will be the length of the current turn, if you win the bidding – more on how bids interact in a sec. So you need a bid which will at the very least be enough to get the mission done. On the bottom of your budget sheet, there's a chart of possible bids (years) and the number of months they enclose. Look for the smallest one which will contain your Time Needed. You can use this value as your bid, or (if you want a little leeway for disasters and the like) you can go higher. Be warned, though – there are some very nasty disaster cards which await you if your bid is too much higher than anyone else's. Don't overshoot by too much! Conversely, if you have faith that other players will end up controlling our common timeline, you can even bid lower than you need, to a minimum of zero.

Once you've picked a bid, write it in the blank provided. That's the last thing you'll write down in the planning phase. Your worksheet is all done, except for the actual timeline of events on the Plan side – and you won't know that until the organic wastes have encountered the rotary blades, later in the turn.

## **Submit plan or pass**

That's the planning phase in all its gory detail. This is the meat and bones of the game; the next two phases are essentially just synching up different peoples' plans and finding out how well they survive contact with the enemy.

When you're done your plan, place it on the edge of the map, roughly midway between yourself and the center of the table. This indicates that you're ready to proceed. If you wish to keep it secret, put a blank worksheet or something similar on top of it. You can unsubmit a plan at any time unless someone's under scrutiny (see below).

If you want to, you can pass. Just say so. You submit no plan, and you'll collect your income throughout the turn in any case, ensuring that you don't actually lose out on any funds or months. You're sacrificing certainty in the near term (and possible VPs or resource outputs that might come of this), in exchange for additional resources and perhaps a better economic landscape next turn.

If everyone but you has either submitted their plan or passed, you are under *scrutiny*. If your plan was secret, you must reveal it (so that others can help you). If you take a lot too long, you could be forced to pass. Your maximum time under scrutiny is the time it takes for all the other players to get drinks, finish a snack, or (if appropriate) a meal; if you're still not done at that point, you must pass, and we'll resolve other missions this turn. You'll collect full income just as if you'd passed normally; don't sweat it too much, and don't outthink yourself – next turn, just finish off this mission, don't try to reinvent it from scratch.

# CLOCK PHASE

## 1) *Reveal Time Bids and set the Turn Length*

Each player, without revealing the rest of his plan, announces ('calls') his Time Bid. Players who passed should remain silent.

The **second-highest** bid becomes the Turn Length for the turn. This will dictate how many Event Cards to draw, how much income to take, and so forth. If there are two equal highest bids, one of them is the "second-highest", it doesn't matter whose, and their bid is the Turn Length.

Add the Turn Length to the start year of the turn (recorded in the worksheet header). The result is the end year for this turn – we will pause again for Planning at the very beginning of that year, and this turn we'll resolve everything that happens up to that point. Write the end year in the header to close the header off.

## 2) *Draw Event cards*

Global Events can be good (white background), neutral (grey), or bad (black background), or one special type which is none of these; not only does this give an immediate indicator of what the effects will be, but some factions interact in particular ways with good or bad events.

Unless instructed otherwise, you will draw as many Event cards as the Turn Length. This is usually changed only by card plays.

Resolve each Event completely, before proceeding to the next one. The one exception is Doomsday Clock cards. Make your Doomsday Clock roll (if any) only once all Events have been drawn and all other ones resolved.

### **Doomsday? Or triumph?**

One important type of Events, neither good nor bad nor even neutral, are labeled Doomsday Clock events. If you draw a Doomsday Clock card during a turn, at the end of the Event draws roll 2d6. The number of Doomsday Clock cards currently in the discard pile is added to this number (the one you're rolling for doesn't count). All Doomsday Clock cards modify the roll based on one or more conditions about the state of the game as well.

Only one Doomsday Clock card is rolled each turn – the last one drawn. If you've got a Doomsday Clock threat pending and then draw another, the first one goes straight into the discard pile, and as such will add +1 to the roll.

If the die roll is **thirteen or more**, an Endgame comes into play - which Endgame depends on the card and possibly other factors.

An Endgame will bring the game to an end. There are three kinds of Endgames; Sudden, Play Out, and One More Turn.

- ❖ A **Sudden** Endgame actually interrupts the turn; stop now, do not pass go and do not complete the current missions. Modify VPs according to the Endgame's instructions, and see who won. Players should be aware that this could theoretically happen at any time!
- ❖ The majority of the Endgames are **Play Out**, which means that you finish the turn, and after the turn you add a special phase during which all pending milestones get finished off, in sequence, earliest to last. Effectively a Play Out endgame says that no further missions get launched this game, but everything else wraps up naturally.
- ❖ A **One More Turn** Endgame means that the game still has one more turn to play after this one. Usually there will be some kind of constraint or bonus you could achieve, if you act in certain ways on that turn. On the last turn, ignore any Doomsday Clock events; the end is already nigh.

Note that a Doomsday Clock card which does not trigger is not a "close call" with this possibility; it just doesn't come up at all in this version of history. This is part of why Doomsday Clock cards and actual Endgames are kept separate.

### 3) *Distribute Time and Money*

The Turn Length is the base number which gives everybody their resources.

Every player has a time income of **[time: [Turn Length]x12]** by definition – every year of Turn Length gives you 12 time chits (months). This is easy to work out – just look at the chart of turn lengths on your worksheet. Time chits are provided in denominations which also make this easy, such as twelves and sixes; make sure that you take some small change to make it simple to pay for your mission in a sec.

Each player also multiplies the Turn Length by his income multiplier, and takes that much money from the bank. For example, if China (income **[money: [Turn Length]x11]**) is in play and this turn's Turn Length was 5 years, then China would pick up 55 money as well as 60 time.

The last step of the income phase is to reconcile all the Vendor's Log sheets. Each player tallies up the total profits earned by their resource card this turn, and adds this to the money income derived from the turn length. At this point the Vendor's Logs can be tucked entirely out of sight until next turn.

Various effects can a player's income multiplier; this includes the lease of resources to Earth or to an NPC, as well as card plays, Event results, and faction special powers. It's usually fastest to add all of these together into one big income multiplier and take the result, but it won't hurt anything to do them separately either.

### 4) *Draw Cards*

In whatever order they please, players may purchase one or more Harbinger cards. There is no limit on how many cards a player may buy in one turn.

Each card costs three money, three time, three cards from your hand, or any combination of these things. You can't spend cards you bought on the current turn. You can only spend money or time you actually have, or money that someone is willing to lend you; the bank doesn't give credit, and time is non-transferable between players.

The maximum hand size is nine. If something would make you draw above this, you just don't draw.

# EXECUTION PHASE

Note that several steps here must be done in a specific order, called bid order. This means that the lowest bid will go first, and so on, through to the highest. In a tie, the one with the lower time chit total goes first; if it's still a tie, break the tie randomly and keep that order for the rest of the turn.

## ***Unfinished Business***

Skip this step on turn one; it deals with previous turns' aftereffects.

Go over all your previously resolved missions which still have pending milestones on them, and check their milestone dates. If the end year of this turn is bigger than the year of the milestone date, the milestone resolves now.

If one of your missions hits a milestone in this way, mention it to the table; in particular, if it will generate VP, announce it clearly, together with which achievements it will be taking. If two players are both going for the same Achievement, it's best to spot this now so that proper timeline comparisons can be made to see who got there first; technically the resolution of pending milestones occurs in bid order, though in practice everyone can almost always do it in parallel with one another.

Pending resources used on the turn they come online will quote an additional time cost on anything they build this turn, equal to their milestone date minus the turn's start year. Ships returned to LEO (or some other useful place) will use their milestone date as a date constraint for whatever they're coordinating with; if my rocket arrives 23 months into the current turn, then even if my construction time is only 15 months, I'll have a forced delay while I wait for the rocket.

After dealing with pending milestones, deal with delayed missions (in the order they went onto the delay stack). If the player can pay the costs owing on a delayed mission, then resolve it now, according to the procedure below. Delayed missions always pay their costs before new missions. If the player can't pay the costs owing, then he pays what he can, records the remaining debts, and puts it back on the delayed stack for next turn. Odds are this'll leave his current mission delayed, too.

Delayed missions' results can *not* be counted upon in the same way that pending milestones' can. So if your delayed mission expects to produce a powersat 10 months into the current turn, you will (unfortunately) have to wait for it until next turn. This is due to the presence of Events and card draws, which can (voluntarily or involuntarily) throw off this expected timeline, whereas the timing on a pending milestone was known with near-certainty during the planning phase this turn. If mission delays cause you problems, the solution is to bid a little higher next time, or aim lower.

## ***Reveal Missions***

Do this in bid order. Turn over your mission and rotate it so that the rest of the players can read it. Describe and explain what you're doing, especially if you've kept it secret up to this point. They get to look it over in as much detail as they want, and ask you to clarify anything that is unclear. If you've done it right there shouldn't be!

If you have made an error and someone spots it in this phase, you must rectify the error. Treat the impact of any error-corrections you do just like impacts from disasters – they might increase your bottom line, they might cost you time, they might not do anything if they affect a resource whose time was very short. If another player spots an error which it would be to your advantage to correct, they

have the right to point it out but not have it be corrected. When working out the costs of a correction, use the average per-point cost you paid for that resource this turn, or the defaults if you had none; if the other players are kind they might let you slide in a quick negotiation to get whatever it is you missed, but they don't have to.

Incidentally, if someone spots an error later, during later turns, you still rectify it, but you get more leeway. Milestone dates are not changed; the timing of events from previous turns is preserved intact (exactly how is left to the imagination). You just pay the difference in actual currency – money and time chits.

## ***Draw Bluffs and play***

After all the missions have been examined, it's time to head to the cards. Each player who wishes to do so may draw Bluff cards. As many as he likes, and they're free, but the hand size of nine must still be observed. Mix your Bluff and Harbinger cards together so that the others can't tell which is which.

Then each player plays cards on each other player. You must play at least one card on each of your opponents; there's no limit, apart from leaving enough that you can satisfy this with respect to the other players as well. Simply play the cards face-down on top of the player's revealed mission.

Sometime after you're done playing, discard any remaining Bluff cards in your hand. You can wait until folks are distracted, though, if you want (and you think you can get away with it). When we hit scoring you must discard all remaining Bluff cards in any event.

Once all players are done playing cards on each other, each player does the following steps in bid order:.

## ***A) Suffer Disasters***

Shuffle the cards that have been played on your mission so that you're no longer sure of their order. Then reveal them all. If you have leisure, one at a time gives the best entertainment value, but it makes no game difference if you simply flip the lot. These cards are your *disaster stack* or just 'stack'.

Cards in the stack will fall into one of the following categories:

- ❖ **Bluff cards.** Bluff cards have some small text associated with them; this adds to the flavour of the game. You don't need to carry through (or even read out) any Bluff card you've already suffered once this game, unless you feel like it.
- ❖ **Protective cards.** It's generally rare to see one of these in the stack – it's either as a result of a random draw, or as a sloughed card from one of your opponents (probably one who has so many protective cards that he couldn't play anything else). If a protective card shows up in your stack, you *can* use it to protect yourself from a disaster in the same stack – but you can't hang onto it for later.
- ❖ **Nulls.** These are disasters which specify a type of target (a manned rocket, a metastable hydrogen drive, etc) that you simply do not have. These are effectively bluffs and should be discarded immediately – most importantly, they can't suppress other disasters, nor count toward VP conditions.
- ❖ **Suppressed disasters.** If two or more disasters with the same icon are in the stack, keep only the worst (highest-level) one. If there is a tie, pick one at random. All other disasters with that icon are suppressed. If the primary one is cancelled by a defensive card, however, then the next-highest with that icon becomes unsuppressed and needs to be dealt with in turn.

- ❖ **Valid disasters.** Everything that's left is a disaster of some kind. These are the disasters you're considered to have "suffered" for the purposes of victory points.

Some valid disasters will strike home, but with a condition. A good example is the Launch Window series of cards. If the card is played on you and not blocked, then *if* the specified conditions are met, bad things happen. If the specified conditions are not met, you get off without significant effects – but you *did* still "suffer" the disaster as far as scoring is concerned. The same thing applies to cards which, for example, increase one of your resource time costs – but that resource is still neither your largest nor second-largest time.

Once you have seen the full stack, you are free to fend off these disasters as best you can, using defensive cards in your hand. (Exception: ships under basic Robotic Guidance can't fend off disasters which occur after launch, and facilities under Robotic Guidance can't fend off construction disasters, and so forth – even if you've got a counter card in your hand. That's the basic disadvantage of unmanned spaceflight. Many will argue that it's still cheaper anyway.)

In general, players are not required to reveal who played which card. However, there are several cases where this information is required. One of these is claiming the Worst Disaster Inflicted achievement. As long as you "fess up" before the scoring phase of the turn, you do get credit for it. Be honest.

The cards are addressed to the victim – the player whose mission is being affected. In general, if the cards allow a choice of legal targets, the victim gets to choose. However, if the person who played the card fesses up to it, then they get to choose instead.

Ties in any of the disaster achievements – First, Worst, etc – go to the ones played on the mission which went first (bid order as above) in the turn. Ties within the stack are settled randomly.

The effects of most disasters is obvious. However, several of them instruct you to damage a crew unit (the occupants of a hab or colony) but do not have room to list what this means. A damaged Large Colony scores like a Medium one, a damaged Medium scores like a Small colony, a damaged Small Colony can no longer score as a colony but can still take crew actions as if it were a Hab, and a damaged Hab is rendered entirely lifeless.

## ***B) Recalculate Costs***

Once the onslaught has finished, if the mission still appears viable, tally up all the added costs.

Money costs will be easy to handle. Since money just adds up at every step, it doesn't parallel-process, you can just add any additional money costs to the bottom line. The only reason why cost overruns might have a "flavour" to them is that sometimes a card might prevent disasters which add to macrofacturing costs, but not one which adds to the cost of research.

Time costs are slightly more complex. If they add to a resource's time cost, such as Macro, then add it to that section and then see how that affects the "highest plus half of second highest" calculation for the total Construction Time. General delays, such as launch delays, add directly to the time cost of the mission. Most other disasters will state exactly where their effects should be recorded. (When you're following through on timelines, don't forget that a delay at one step delays all the later milestones by the same amount.)



Now you know the total money and time costs of your mission. Check if you can still afford this. If so, great - you can launch. If not, that's a problem. It means you're not going to be able to launch this turn.

### **C) *Abort, Delay, or Launch***

If you can't afford to carry it out, you can choose to *abort* the mission, or *delay* it. You can also abort or delay voluntarily if you want, even if technically you could afford it.

**Aborting** it will cost you 10% of the time and money (disasters included!) it would have cost to complete it. Your turn is done and you can do as you like next turn.

**Delaying** it means you pay what you can now, and note the remaining time and/or money owed on the mission. Set the mission aside. Next turn you can plan a followup mission as normal, although of course none of the resources you might have produced with the current mission are available. When we come to the Execution Phase, the first thing that will happen is that you must pay (if you can) the costs owing. If you do, the mission resolves at that point. If you can't, then you pay what you can, note the remaining debt, and set it aside again for the turn after.

In other words, delaying it doesn't cost you very much. So if you're consistently the highest bidder, and ending up with your missions delayed because of it, don't fret too much.

There's just one caveat, though. No matter what, the actual launch date of a delayed mission cannot come before month one of the start year for the turn on which it actually resolves. If you lacked the money to launch on our turn that covered all the way up to the start of 2056, we know for sure that 2056 is the earliest year during which your launch could occur. (In general, this can only happen if you could have afforded the time cost of the mission, but couldn't afford the money cost. Damn those funding delays.)

In addition, for purposes of victory points, a mission which was revealed on Turn 3 might achieve a particular milestone on date X, and collect the victory points that turn. Then, due to a surfeit of time chits or a delayed mission, someone else might achieve the same thing on Turn 4 (or later), but their timeline reveals it to have occurred on a date earlier than X. *They will not get the achievement in that case.* Missions from earlier turns always count as "earlier" for scoring; only within a turn are the dates used for comparison. So delaying it could also cost you in that way.

If the mission was neither aborted nor delayed, then you're good to go.

**Launching** it means you pay the final costs of the mission, in money and time. Do that now; costs are paid to the bank. Proceed to calculate the Timeline as we will describe in the next section.

### **D) *Set Timeline***

You now need to work out which milestones you've entirely completed, and which ones might have to wait for future turns. Flip your worksheet back to the Mission Plan side.

First, you'll need to calculate your launch date. Take your remaining stock of time chits in hand. This amount is, by definition of how the time chits work, how many months *before* the current turn's end year your mission was good to go. We're going to tie this to the calendar and find the actual launch date, by counting backwards. There's an easy two-step trick to do this.

First, add imaginary months to your chits-in-hand until you have the next highest multiple of twelve. So if you had 15 time chits left, you would add 9 imaginary chits and have 24 chits. *The number of imaginary chits will be the month of launch.* "Next-highest" is deliberate: if your chits in hand began as a multiple of twelve, add twelve imaginary months, putting you in December; otherwise this trick would put you in month zero, which doesn't exist. Record months in numeric, not named, format – unless you have an easy time thinking in "May plus fifteen" terms, keeping the months numbered will make things much easier shortly.

Second, divide your chits (real plus imaginary) by twelve; this will divide evenly, yielding a number in years. From the current turn's end year, *subtract* that many years. The result is the year of launch. Now forget the imaginary chits and hang onto your actual chits; you're not paying, here, just calculating.

Greg is spending 31 time on his mission this turn, out of 56 he had before paying for the mission. This leaves him with 25 time at this point – two twelves and a one. The years covered by the current turn are 2033 through 2037. Greg would need to add eleven to his hand to make it a multiple of twelve, so his launch date will have 11 (November) as the month part; then from 2037 he drops the three years he would own at that point, which takes us back to 2034. That's his launch date... 11/2034.

Now, for each remaining milestone of interest, we'll give it its own date. To get the arrival date for your first milestone, add the trip time (the "months" value from the trip leg) to the launch date. To get the milestone date, add the onsite time as well. And so forth. Usually, but not always, the departure date is the same as the milestone date, and can be left blank; this space is provided for the cases where they turn out to be different (usually because the rocket kept going and left an away team behind).

Milestones from years before the turn's end year are milestones that have already happened. Milestones from within the end year or later haven't yet. (Our definition of the turn's span assumes we're doing our review of events on January first; a January launch is still in the future, but one from last December is done.)

You can also use the margins to record other dates of record. Perhaps an ally's ship comes to your base on a particular date, or you'll be receiving a payload on another date and can't launch before then. Or perhaps you're cutting things close enough that it's worth recording a date for "die gasping" and hope for once that this milestone *doesn't* arrive...

Example: Greg's trip takes 16 months to arrive, has an onsite time of 7 months, and a return trip time of 16 months again. Greg adds 16 months to his 11/2034 launch, and gets 03/2036. (11+16 = 27, so 2034 month 27 is 2036 month 3.) End year 2037 with an arrival in 2036 means he's already landed. Onsite seven months puts his completion milestone at month ten of the same year – also already finished. His next milestone is to come back to LEO, and its trip arrow adds another 16 months, arriving at LEO on 02/2038. That's the soonest he can plan to launch another mission using the same rocket.

For completed milestones, you resolve them now – see the next section. Milestones which haven't happened yet are *pending* milestones. On future turns, during the Unfinished Business phase you'll be checking to see if the game has progressed to the point where they happen, and firing them off if it has.

## ***F) Milestone Completion***

Milestones are the accomplishments of the game. The "completion" milestone listed on your sheet is a catchall for the first accomplishment you'd planned; you may have more coming after that. These

are the triggers for Achievement tiles and gaining victory points. There are a few specifics depending on the mission type... so even though your mighty victory may be pending for another turn, we'll discuss how to handle it now.

A completed **exploration** has one more step, particular to itself, before it finds out what Achievements it may have won. Bring out the bag or cup with the *exploration tiles* in it, and draw one. Take a look at it; the anatomy of an exploration tile is discussed in the Appendix. If the spectral class of the site is on the tile, keep it; otherwise, set it aside, and draw again. If three draws doesn't give a tile which matches the spectral class, then it is dry and without modifiers. The tile shows you (a) the mineral find, if any, (b) the find's resource equation, and (c) sometimes a modifier like a bonus to Cool Factor or the addition of Hazardous. Set the tile down on the map, on top of the body you just explored. You can place it face-down if you want to, though you'll notice that if the site is Hazardous the icon shows on both sides – necessary if people are to be given the chance to play cards on you there. A Cool Factor bonus might win you an achievement you wouldn't have gotten; the Hazardous might open you up to a disaster at the last minute. If another player explores the same site, later, he will get to peek at the tile if secret, and can publicize it if he wants.

A completed **facility** often (but not always – infrastructures, etc) produces a resource for you to use. If so, the resource equation becomes available to you for your next turn after the milestone was completed. If it was a pending milestone you will even have had access to it on the current turn, with a delay on its production. Assign it a code letter or symbol (the Greek alphabet is good, but anything that the other players can reproduce easily is fine), and start a new Vendor's Log for it.

A completed **colony** mission doesn't trigger anything special apart from the high victory points of the colony achievements. Note that you don't need colony infrastructure to win the colony awards; you just need it if you want your colony to last. Both colony and facility achievement tiles are lost (check who should hold it now based on each player's holdings), if you lose the thing that won you the award; it's okay to temporarily suspend operations of it (such as to move a colony to another site), you only lose the credit if it's actually gone.

## Scoring

At the end of the turn, once everyone's missions have resolved one way or the other, check for achievements – things that players did which are worth victory points (VPs). Many achievements also have a consolation (or 'runner-up') award associated with them.

The simplest way is to go down the list of possible achievements and glance at each one. During early turns this may be quick, and you'll be able to skip whole sections (such as the Colony awards). Later on it will pay off to go through the list one at a time – in the course of your endeavours, you'll often achieve noteworthy things you didn't expect!

Almost all Achievements have minimum requirements – a minimum disaster level, a minimum resource quality, and so forth. These need to be met in order to be considered for the prize. If there is currently someone holding the gold and/or silver, you need to do **better than**, not just tie, the current holder's record. The one who got it **first** keeps it until someone does better.

"First" when it comes to achievements refer to the earliest occurrence of something in play. It refers to *turns*, not to *dates* – although dates are used as the tiebreaker if you both manage it on the same turn.

Joe builds a colony on 09/2035 during Turn Four. Thanks to a big stockpile of time chits, I build one on 06/2035 during Turn Five. Joe retains the prize; he's already got it by the time turn five's scoring comes around. But if Joe's mission had been delayed on Turn Four, such that it resolved during Turn Five's "Unfinished Business" phase, then I'd win it... my colony went up three whole months earlier.

If you hold gold and someone beats you, you slide down to silver (and displace whoever had it). If you beat the silver record but not the gold, you take the silver.

If a player started with a particular resource or technology which would normally be worth victory points, he **does not** get that award automatically. He *can* count that resource towards a total count (such as Most Facilities), and if he improves that resource somehow such that the new one would indeed beat the old one, he can count it then. Until that point, he's got a "ghost presence" in the gold spot for that Achievement. His record is the one everybody else (and he) needs to beat to win Gold; tying it isn't good enough, as usual. But he doesn't get the points for something he was handed for free.

(Specific tile FAQs will probably go here, but there are none as yet identified.)

# OBJECTS IN THE GAME

This section provides in-depth descriptions and rules for each of the possible objects in the game – rockets, facilities, colonies, and any add-ons and modifiers which may be available for them. This is much more detail than is provided on the tech library pages; if the point-form notes on a complex item don't make sense, refer to this section for their full text.

Some objects can be purchased with a *rating*. This rating describes certain specifics of the design. For example, since "one Generator" implies a given amount of power, a set of solar panels with this spec made for Photon Flux +1 (aka the orbit of Venus) is much lighter than one made for Flux -2 (out in the asteroid belt). A given Photovoltaic Generator is therefore specified with a rating equal to the Flux it was designed for. Researching an item once gets you access to all its possible ratings.

If the stats on an item are flagged with an asterisk, see the full text for details.

## ROCKETS

### **Chemical Rocket - ISP 0.5, Thrust 8**

Macro 0.5, Nano 0, Research 0

The energy in chemicals is easy to extract, and easy to make powerful... but it takes a lot of chemicals to extract, what is, on this scale, not all that much actual energy. Not recommended for trips longer than to Luna (and even then, really expensive for large payloads), but invaluable as a lander for the last stage of a trip.

### **Solar Thermal Rocket – ISP 1, Thrust 1\***

Macro 0, Nano 1, Research 2

A huge balloon, half silver and half transparent, concentrates the sun's rays on a reaction vessel. It adds the Photon Flux value of the zone it is in directly to its Thrust. If crossing Flux boundaries, the thrust may be different at each end - use whichever end gives the smaller thrust, to calculate the rocket's thrust for that leg. May not be stacked to increase its thrust. A solar therm with only zero-mass items in its payload counts as mass 0.25 for working out fuel costs.

### **Fission Reactor/Rocket - ISP 2, Thrust 7**

Macro 2, Nano 1, Research 1; Cooling 8, Radiation Shielding; can satisfy (Generator)

A nuclear reactor works as a generator because it produces heat; the same heat can be used for propulsion. In game terms, the stats are equivalent whether it's configured as a generator or a rocket. You can even convert one into the other; this is instantaneous on the scale of the game. When used as a rocket, it is often Open Cycle Cooled (see Modifiers section) down to ISP 1 because of its high heat. When used as a generator this is not an option, so it may be a high-mass solution in many applications.

### **Arcjet Electric Rocket – ISP 2, Thrust 2**

Macro 1, Nano 1, Research 1; Generator requirement

The simplest kind of electric rocket. An excellent starter engine if you have beamed power available (because of the receiver's low mass), but often trumped by more exciting designs by mid-game.

### **Mass Driver – ISP 3, Thrust 3**

Macro 5, Nano 1, Research 4; Cooling 8, Generator

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*OBJECTS IN THE GAME - ROCKETS*

A linear accelerator (it could be a coil gun, rail gun, or one of a few other configurations) makes a highly versatile drive. Its characteristics as a rocket aren't the best, but its nature allows it to use anything – spare parts, expended consumables, garbage, rocks – as reaction mass (see the Gather site action). If set up attached to a facility, it can be used to fire off shipping packets; see the Extraction Mine facility for more details on shipping. And, to top it all off, it's a weapon system in its own right. Just in case. Note – ISP 3 rounds to ISP 2 if halved (such as by Open Cycle cooling).

### **Metastable Hydrogen Rocket – ISP 4, Thrust 5**

Macro 2, Nano 7, Research 10; Disaster Target

The theoretical limits of chemical energy storage are much higher than we manage with our conventional chemical propulsion. This is one proposed alternative which takes chemical fuels to a new level. Its characteristics as a rocket compare favorably to other alternatives – especially with the lack of requirements. Unfortunately, it's highly unstable. There are disasters in the deck which specifically target this type of drive, and it has the Disaster Target keyword which can itself be a problem.

### **Laser Thermal Rocket – ISP 4, Thrust 5\***

Macro 1, Nano 4, Research 7; Beamed Power, Cooling 2

By leaving the power source far away, this "teakettle" rocket manages to pack a solid ISP into a lightweight package. Lasers focused on the reaction chamber of this rocket and concentrated by a laser mirror bring the propellant to plasma-high heat. Unfortunately, this means that you'll never be able to go more than three orbitals away from a laser source (Earth, a Powersat, or a Microwave Relay in stationary orbit). The key advantage of a laser thermal rocket is that you can increase the thrust by adding more beamed power channels... every doubling of the number of channels provided adds +1 to the rocket's base thrust (thus with two channels its base thrust is six, with four the thrust is seven, and so forth). Note that this means there's never any point in doubling the rocket itself, since that would double the energy requirements too, but cost more.

### **Orion Pulse Rocket – ISP 4, Thrust 9**

Macro 10, Nano 0, Research 3

A big steel plate, some massive coil springs, and a 1kT nuke every few seconds out the back. What could possibly go wrong? This is, actually, a remarkably effective design, it's just quite massive. Players with Earth Boost or offworld Macro resources might want to look into this one as their first rocket. The design means that it has very high heat, but it cannot be cooled using anything other than Open Cycle cooling – so those modifiers are already included in the base stats. As a bonus, the drive itself is not only a weapon, it also provides protection from many weapons in case of piracy. It also counts as radiation shielding for any crew present, thanks to the massive shock plate.

### **JxB Accelerator Rocket – ISP 8, Thrust 1**

Macro 2, Nano 3, Research 8; Generator, Cooling 4

Magnetically accelerating the output of an electric rocket gives a boost to the reaction mass exit velocity, increasing the ISP. JxB (pronounced "Jay cross bee") is the basic equation governing this behaviour. A good step up from the ArcJet Electric, but lower thrust.

### **D-T Fusion Reactor/Rocket – ISP 8, Thrust 5**

Macro 1, Nano 8, Research 24; Cooling 8, Radiation Shielding

Inertial or magnetic confinement of deuterium-tritium fusion yields a high-energy source suitable for use as an exceptional drive. A high research cost provides an initial obstacle, but after that you'll

seldom be sorry – this drive puts out both good efficiency and high thrust in a compact package. Like the Fission Rocket, any Fusion rocket can be converted to a generator.

### **Ion Drive Rocket – ISP 16, Thrust 1**

Macro 4, Nano 1, Research 2; Generator, Cooling 4

Accelerating ions to very high velocities yields a very high specific impulse, with very low thrust. Well suited to moving unmanned cargoes a long way at high efficiency and low speed. Used today on a number of missions, the minimal research cost is actually just the time it takes to design one *this big...* hundred-kilo versions with micronewton thrusts are common today.

### **Magnetoplasma (or MPD) Rocket – ISP 32, Thrust 3**

Macro 5, Nano 6, Research 19; 2x Generator, Cooling 10

The heavy lifter of the electric rocket world, MPD rockets such as the VASIMR project have a higher thrust-to-weight ratio than other electric drives, and exceptional efficiency... but also a high power usage, heat output, and complexity.

### **H-B Fusion Rocket – ISP 128, Thrust 6**

Macro 3, Nano 16, Research 29; Cooling 10, Radiation Shielding

An even higher-energy fusion reaction than deuterium-tritium, the H-B fusion rocket requires exotic and unproven theoretical steps (like magnetic monopoles) to get working... but if you do, it will make for a truly exceptional drive.

### **<sup>3</sup>He-D Fusion Rocket – ISP 256, Thrust 7**

Macro 6, Nano 20, Research 36; Cooling 24, Radiation Shielding

The highest-energy fusion drive in High Trader. If you've got one of these, you'll be flitting about at brachistochrone rates anywhere you want to go.

### **Annihilation Drive – ISP 512, Thrust 9**

Macro 16, Nano 27, Research 54; Cooling 16, Radiation Shielding, Disaster Target

Matter-antimatter reactions are awesome stuff. Building them into a drive is dangerous, tricky work... but the resulting rocket is literally the best one you can get in the game. Players have spent their entire games working toward one... and not been sorry. Like the Mass Driver, the Annihilation Drive can quite simply use anything it wants for reaction mass (see the Gather site action), although in this case it does suffer a penalty of half its ISP when using dirt and rocks, rather than conventional hydrogen propellant. It's also a very effective weapon. Just don't screw up; if it goes, it goes big.

### **Photon Sail – ISP infinite, Thrust -1\***

Macro 1, Nano 5, Research 10

Some designs of solar sail are built to use the solar wind (helium nuclei), others focus on using pure light pressure. Both alternatives are equivalent in game terms. When using a sail, you simply ignore propellant costs. Dots on the trip count as additional orbitals of distance instead. Your major limitation is the minimum acceleration of the transfer orbit you wish to use, but this limit is a big one. The base thrust of -1 (minus one) is added to the Photon Flux value of the zone it's in to yield the actual base thrust (don't forget that your fully-loaded mass will also enter into the thrust calculation). This will confine most sail operations to staying as close to the sun as Earth, or at most perhaps out to Mars orbit; past this, and the thrust-mass ratio will make it simply impossible. If crossing Flux boundaries, use the poorest Flux to calculate the rocket's thrust for that leg.

## **Laser Sail – ISP infinite, Thrust -2\***

Macro 1, Nano 7, Research 15; Beamed Power (one or more channels)

Another sail approach is to build one engineered to fly using the light pressure of a focused laser beam. This gets around the limitations of worrying about where you are compared to the sun, but leaves you dependent on your launching lasers instead. The base thrust of -2 is achieved when the sail is driven by a single channel of beamed power (the usual range of three orbitals applies). You can increase this thrust by increasing the number of channels: two channels increases the laser sail's thrust by one (to -1), four channels increases it again (to 0), and another +1 Thrust per doubling of the number of channels. As with photon sails, you pay no fuel, but count dots as added orbitals instead.

# **COOLING SYSTEMS**

## **Standard Radiator (for Cooling X)**

Macro X, Nano 0, Research 0

BeO dust systems enable reradiation of heat into the depths of space at a reasonable efficiency. The rating, X, is based on how much cooling the object needs – the object's requirement is listed as Cooling X. Basic radiators of various ratings may add their ratings together to cool an object.

## **Advanced Radiator (for Cooling X)**

Macro X/2 (round down), Nano X/2 (round up), Research 15

Liquid metal droplet radiators and other more sophisticated systems enable a better mass-to-dissipation ratio, at the cost of added complexity. A must if trying to get the best possible ISPs from many rockets. Advanced radiators cannot be added together with each other (it screws up the rounding), although they may be combined with basic radiators if desired.

## **Open Cycle Cooling**

Macro 0, Nano 0, Research 0; ISP x1/2, Thrust +1, rockets only

A common, and very effective, solution to heat on a working rocket is to design it to dump the heat out the back with the rocket's exhaust. For many systems, like fission rockets, this would in fact be the default. This costs nothing, apart from designing for it, and satisfies the full Cooling requirement of the rocket, and even increases the effective thrust... but it does reduce the rocket's efficiency considerably. (Round fractional ISPs up, in the one case where this is relevant.)

Note that this can't be used to dump the heat of anything but the rocket it's built into... onboard systems like weapons or life support have to find their own cooling, as do stationary facilities. Rockets with no Cooling requirement cannot be fitted with Open Cycle Cooling in an effort to improve their Thrust; it has to have at least Cooling 1 to qualify. Also note that unlike all other add-ons, Open Cycle is intrinsic to the rocket's design, and thus cannot be retrofitted either out or in.

## **Dirtside Cooling**

Macro 0, Nano 0, Research 0; grounded facilities only

Compared to dumping heat in the vacuum of space, sitting on any body – no matter how small the asteroid – makes it a piece of cake to dump heat. Cooling requirements are automatically satisfied for any grounded operation. Note, though, that this doesn't cover operations in transit – and colonies usually put out significant heat even enroute, for things like, oh, not freezing to death, and breathing, and stuff like that. Dirtside Cooling also counts as Radiation Shielding, for free.



# GENERATORS

## Photovoltaic Generator (up to Flux X)

Macro (by chart), Nano 1, Research 0

Simple photoelectricity is effective and simple, but can get pretty heavy. The mass of a generator using photovoltaics is based on the lowest Photon Flux zone it can operate in. Even one Flux Zone outside of its rated area, and it's only half a Generator... much less useful. Because of overvoltage protections, it does *not* become a "double Generator" in higher-Flux zones than its rating, but it doesn't lose output, either. Probably not cost-effective outside of roughly Martian orbit.

Flux Rating	+2	+1	0	-1	-2	-3	-4	-5
PV mass	0.5	1	2	4	8	16	32	64

## Advanced Photovoltaic Generator (up to Flux X)

Macro (by chart), Nano 3, Research 15

Biomaterials, advanced nanostructures, and other novel approaches all offer the promise of lower mass photoelectricity. Advanced Photovoltaics follow all of the same rules as Basic Photovoltaics, except for the different cost characteristics.

Flux Rating	+2	+1	0	-1	-2	-3	-4	-5
AdvPV mass	0	0.5	1	2	4	8	16	32

## Microwave Receiver

Macro 0.5, Nano 1, Research 1; Beamed Power requirement

Often the lightest generator is the one where you don't carry the generator with you – you just send the power via zero-mass photons! Also known as Myrabo power after one of its strongest proponents, Anton Myrabo. Needs one channel of beamed power, and satisfies one Generator requirement.

## Palmer Aerosol Lens

Macro 0, Nano 1, Research 12; Beamed Power requirement

If even the mass of a Microwave Receiver is affecting your payloads, one solution is an advanced design which uses an aerosolized liquid lens design, making it so lightweight that in game terms it weighs nothing at all. Still turns one channel of beamed power into one Generator of onboard power, but obviously you can pack as many of them as you can afford to build.

## Fission or Fusion Reactor

Any fission or fusion rocket can be converted to a nuclear power generator. Designing them with that capability is free on gamescale. The most common is obviously the Fission Reactor, but there are situations where the D-T Fusion Reactor may be worth its price.

## Magnetohydrodynamic Generator

Macro 0, Nano 2, Research 5; onboard rockets with Thrust 4+ only

This is the science of extracting usable energy from the exhaust of a rocket. In game terms, an MHD Generator allows any qualifying rocket – it must have Thrust 4 or higher before adjusting for mass – to also function as one Generator for some onboard system while in flight. It can't supply it to the rocket itself – you can't get power from nowhere! But it could be a weapon, or a colony, or whatever else may need power. You can mount more than one per rocket, but the minimum Thrust increases by one per extra MHD.

# TOYS, TOOLS, AND THREATS

## Robotic Guidance

(not an item, has no cost)

This "item" is included here for completeness. It's not actually an object as far as the game is concerned. It's a default. If you do not have a Hab, Colony, Cyborg Guidance, or AI Guidance object present at this location (whether it started that way or not), then anything that happens here occurs under Robotic Guidance instead. You may not play defensive cards on behalf of something which is under only robotic guidance. Bot teams (see below) perform less efficiently under robotic guidance. And you risk being slowed down even further by the Software Glitch disaster card. But... on the plus side, it's free, doesn't eat or breathe, and never asks for a pay raise.

## Bot Team

Macro 0.5, Nano 1, Research 2 (or 0, see below)

When pursuing a program of unmanned spaceflight, you still occasionally need hands and eyes on location. Or grippers and CCDs, as the case may be, not to mention spectrophotometers, leak detectors, and laser drills. In order to do a surface exploration, or turn a facility from an inert payload into a functioning structure, you need either crew or a Bot Team. Unless you've put a Bot Team under the control of Cyborg Guidance or A.I. Guidance, it suffers from the usual disadvantages of robotic guidance, plus a less efficient performance of the job... the Bot Team uses the full object mass or full surface gee to calculate onsite times, not half the mass/gee (the value used by crew). However, since it's not sucking up consumables the whole time, many mission planners feel it's well worth the wait. You can omit researching the tech if all you want is a *Limited* Bot Team, able to perform only a single crew action specified upon construction – "Explore Lunar North Pole" or "Assemble Extraction Mine on Khufu". After two points of research you can instead build regular Bot Teams, able to perform any crew action you desire.

## Microwave Relay

Macro 0.5, Nano 1, Research 2

A microwave relay is made up of an antenna which receives beamed power, and a laser array which sends it out again refocused. If it is supplied with beamed power, up to two channels per Relay, then it can send those channels anywhere within the usual three spaces of itself. In this way you can build up a network of beamed power which has more reach than just the range of the original satellite. Typically dropped off by itself without even a rocket attached, to orbit the sun and do its job. Remember that it will need to be deposited in a stable orbit (facing a corner), you can't just drop it off while flying by.

## Radiation Shielding

Macro 0.5/1/2/4, Nano 0, Research 0

A massive "Storm Shelter" protects crew from harmful radiation from various sources, including drives and generators which produce harmful radiation, Van Allen belts and other radiation zones in space (see the Route Plan section), and the Solar Flare disaster card. The mass of the shielding is 0.5 for a hab, 1 for a small colony, 2 for a medium colony, and 4 for a large one. This reduces your chance of getting hit by a Solar Flare disaster or Solar Storm event, and is required if your drive emits dangerous radiation and you want to put people onboard.

## Extended Life Support

Macro 0.5/1/2/4, Nano 0, Research 0

A consumables package for use by habs and colonies, this allows them to last beyond the six months which is standard with those items (see Manned Exploration). For a hab this masses 0.5 and adds three months to the life support clock; for colonies it adds one month, and masses 1 for a small colony, 2 for a medium colony, and 4 for a large one. Not replenishable (unlike the six-month base).

## **Cryogenic Hibernation**

Macro 0, Nano 10, Research 15

Modifies any Hab or Colony. Target's Macro cost is reduced by 25% and its Cooling requirement by 50%, it does not consume life support, does not provide guidance, and gains the Disaster Target trait. There are disaster cards which affect only frozen colonies. Defrosting the crew takes three months, during which time it *does* consume life support. Does not collect Achievements until fully defrosted.

## **Closed Cycle Infrastructure**

Macro 1, Nano 4, Research 7; Cooling 2, Generator

Genetically engineered vegetation and nanofiltration systems extend life support on a Hab module (not a Colony!) to indefinite; you can stop counting months. Be careful – disasters can still put you back on the clock.

## **Cyborg Guidance**

Macro 0.5, Nano 1, Research 13

If robot guidance is leaving you too exposed, but the mass and time limits of manned spaceflight are still prohibitive, one solution is the good old Brain In A Jar method. Whether it's a neuron net grown in-situ, or an actual once-human "volunteer", is up to you. Plentiful sensors, radiation shielding, robot waldos and Facebook page included. Ships with cyborg guidance no longer suffer the defects of robotic guidance... mostly. If they attempt to play a defensive card, roll a die; on 3-6 it works, but on 1-2 set the card aside and either try a different one or take the hit. Return the card to the owner's hand.

## **A.I. Guidance**

Macro 0, Nano 1, Research 32; special build cost: Research 1

Another solution to dealing with the limitations of so-called "expert systems" and robotics is to invent Artificial Intelligence. It's a big project, but the payoff is fully functional guidance without any of the limitations of robots, mess and variability of cyborgs, or biological needs of people. Note that the build cost of one A.I. Guidance system are unusual – one Nano and one Research, separate from the initial Research cost to develop the technology. Copying A.I. over and over is cheap; making it *just* individual enough not to go insane takes a little effort. Note that this requires custom hardware, different than for simple robotic guidance, and thus must still be physically shipped.

## **Long-Range Crawler**

Macro 0.5, Nano 0, Research 3

Maybe you want the ability to pick and choose your sites before settling down on a large body, maybe you want to stage a raid cross-country... if you need to move mass overland, this is the tool you use to do it. The long-range crawler consumes effectively no fuel, and takes as long as an exploration (half the surface gravity in months, the full grav if robotically guided), to move itself plus up to two mass from one site to another on a single body. If this sounds long, imagine trying to get from Rio de Janeiro to Vancouver, without roads or a reliable map, carrying fifty tons. Multiple crawlers may be aggregated to transport larger items.

## **Weapons System**

Macro 0.5, Nano 1, Research 5

These costs are the generic costs of various possible ways to hurt each other in the depths of space. Each time you research this, you gain one of the following subtypes; further types cost another 2 research each. See page 51 for piracy and combat; this will go into the further details of the (fairly minor) differences between the types of weapon.

- ❖ *Nuclear Warhead* – No further requirements. Destroys own ship.
- ❖ *Weapons Laser* – Requires Cooling 1.
- ❖ *Laser Mirror* – Requires Beamed Power. Otherwise same effects as a weapons laser.
- ❖ *Particle Beam* – Requires Generator.
- ❖ *EM Cannon* (railgun, coilgun, etc) – Requires (and expends) 0.5 macro of ammunition per combat. Regolith will suffice; see Mass Driver rocket and piracy section.
- ❖ *Boarding Gear* (armored spacesuits, personal weapons, drones, etc) – No further requirements.

## FACILITIES

### Solar Power Satellite (Flux X)

Macro (by chart), Nano 2, Research 4; Cooling (by chart)

A solar powersat provides beamed power channels. It can also be used to represent a ground-based solar array, but the output is halved (round down) for being subject to night/day cycles, and halved again if the body has an atmosphere. On the plus side, it can use Dirtside Cooling if grounded, which may yield a net win. Normally

these are placed in the player's choice of stationary orbits. They have a transmit range of three orbitals. Do not require assembly

Flux Rating	+2	+1	0	-1	-2	-3	-4	-5
Solarsat Mass	5	5	4	3	2	1.5	1	1
Channels	8	4	2	1	½	¼	1/8	1/16
Cooling Req.	12	6	3	2	1	0	0	0

time, but all solarsats belonging to one player at one site are considered only a single facility for scoring. A solarsat built for one flux may be used at a different flux; the channels and cooling requirements are based on whichever is worse, the flux it's in or the one the sat was built for.

### Science Station (Cool Factor X)

Macro 6, Nano 10, Research 6; Generator required

By setting up a permanent facility to study the characteristics of an interesting site, all kinds of research from pure physics to practical engineering is possible. A science station's effectiveness scales with the unusual qualities of a site in the same way that human interest does (Cool Factor). A science station's resource equation at Cool Factor 0 is **[money: 1][time: 2] > [research: 1]**; for every Cool Factor point above this, either the money cost is halved, or the time cost is halved, player's choice when designing the station. Changing the equation (so as to move it somewhere else or change your time/money priorities) can be done but requires a two-nano package of supplies. This equation assumes human, cyborg, or A.I. guidance; robotic guidance doubles the time cost.

### Extraction Mine

Macro 6, Nano 1, Research 3; Generator and shipping arrangements required

An extraction mine is very simple – an operation to dig the most valuable items out of the ground and refine them as much as is feasible before shipping them home. This works for metal finds (Macro), carbon finds (Nano), water finds (Propellant), and rare isotope finds (sold to Earth for money); the procedure is the same in each case. This facility gives you the goods onsite, in large enough quantities and cheaply enough that the rate limit is usually based on your shipping capabilities.

Propellant is often useful just left onsite, needing no further processing for use. A Propellant find with an Extraction Mine is a propellant resource with equation **[as chit] > [propellant: 1]**, where the costs

are given by the mine's exploration chit. Everything else will need to be shipped to Earth or to a facility which can use a resource equation directly (a Factory/Nanofab).

### Shipping the Output of a Mine

Shipping by rocket is very complicated to do accurately, but for our purposes we use an abstraction. In brief, you "remove" a rocket from play, work out the money and time costs of the route based on the rocket's characteristics over the trip taken, and use those costs as a resource equation at the other end. The detailed procedure:

- ❖ Pick a rocket (or a set of rockets, or crawlers, or stationary mass drivers flinging cargo) to dedicate to the route. They must be *able* to reach the destination with the propellant onboard (or be sitting at a propellant supply), that's all we ask. The trip itself is behind the abstraction wall and does **not** consume propellant outside of the abstraction. The rockets thus dedicated are locked into the route as of the moment your mission tells them to "Begin Shipping" as a site action. They are not still available for anything else; they have become part of the resource equation. A cargo packet fired out of a land-based mass driver is treated exactly like a "rocket" with ISP 3, Thrust 6, and dry mass one.
- ❖ Plot a sample trip from the mine to the destination using this ship, empty. (Ignore the trip back to the mine again, for this.) A Hohmann transfer is always your best choice for the purposes of this abstraction, unless your thrust dictates a Spiral transfer; if a Spiral is used, double the time cost you calculate later. Don't forget takeoffs and landings (including a lander is okay).
- ❖ To get the money cost of the route, work out the **mass ratio for the trip**. The mass ratio is that blue line on the nomogram, remember. If a takeoff or landing is involved, use the worst mass ratio – the landing, the takeoff, or the trip in between. For crawlers, sails, or ISPs off the top of the chart, use zero. If what you're shipping is nano or rare isotopes, subtract [money: 0.5]. If you have an offworld propellant resource at either end, halve the result. The money cost of the shipping route's equation is the result, or the site's money cost, whichever is higher.
- ❖ To get the time cost, count the **distance** of the trip. Also find the *hauling thrust* – that's the **net thrust of your rocket**, again assuming it's empty of cargo, minus the **required thrust for your trip**. If takeoffs or landings are needed, use the worst hauling thrust of any leg. Overland distance equals the surface gee, and crawlers have a hauling thrust of 0.5 each. Sails' added dots-as-orbitals do count toward the distance here. Divide the distance by the hauling thrust. Divide by the number of identical ships (or mass drivers or crawlers) you assign to the route. The time cost is the result, or the site's time cost, whichever is higher.
- ❖ Round money and time costs under 1 to the nearest 0.25, under 3 to the nearest 0.5, otherwise to the nearest integer. Write down the resulting resource equation on your faction sheet and on this mission. You can access the equation at either end of the shipping route. If the shipping "chokes" the money or time costs of the site, you may even be able to use the equation with different efficiencies at either end; it still maintains one common queue of jobs to be done.

### Von Neumann Colony

Macro 0.5, Nano 6, Research 25; Generator and shipping required

Self-replicating micro- or nano-bots are programmed to spread through the mineral deposits of a site, store the most valuable parts, use the rest to build new copies of themselves, and return to base once full. The Macro cost is mostly the base station; the actual Von Neumanns are miniscule by game standards. Performs all the functions of an Extraction Mine, this just has better stats.

## Offworld Factory

Macro 12, Nano 1, Research 5; Cooling 8 and Generator required

Mineral resources are richer in some places than others, but macroconstruction is possible anywhere. An offworld factory includes a mine, refinery, and automated shop floor, for construction of various structures. On a high-quality metal find will this be really valuable – it counts as a Macro resource with **[as chit] > [macro: 1]**. Even at a site with no Macro discovery, the factory can still build at **[money: 1.5][time: 2.5] > [macro: 1]** at most sites (which could have drawn macro if you'd been lucky), or **[money: 2][time: 3] > [macro: 1]** at an icy site (where there was no chance). If it is at the end of a Macro shipping route it can use the route's equation if you prefer. Objects built are at this location, not in LEO, and may need to be brought back to LEO or to have their Nano components brought to them. If you have a functioning Extraction Mine (or shipping route) feeding Macro to the Factory, you can save 4 macro from the Factory's cost.

## Factory add-on: Nanostructure Tanks (Nano X)

Macro X, Nano X, Research 10

For those who want to put all their construction in one place, the Nanostructure Tanks offer a way to include some Nano in their Macro assembly capabilities. This does not require a Carbon find; the rating includes a stock of irreplaceable parts, and the rest uses materials available onsite and byproducts of the Factory's operations. The Nanostructure Tanks give an Offworld Factory the additional equation **[money: 2][time: 2] > [nano: 1]**, with the primary advantage over defaults being that it is built onsite. However, it can only be used for objects whose individual Nano cost is no higher than the rating of the tanks.

## Offworld Nanofab

Macro 8, Nano 8, Research 7; Cooling 7 and Generator required

Carbon is a highly versatile material, and a prized find. Microgravity and vacuum are very useful for many of its uses, like crystallization, carbon nanotube growth, and nanoassembly. The equation on a Nano discovery is **[as chit] > [nano: 1]**. At most sites (where you could have drawn nano if you were lucky), you can still build at **[money: 1][time: 3] > [nano: 1]**, and even on a metallic or stony site (where you had no chance) at **[money: 1.5][time: 4] > [nano: 1]**. Or, if it is at the end of a Nano shipping route, you can use the route's equation. As with the Factory, objects built are located onsite and may need transport. If you have a functioning Extraction Mine (or shipping route) feeding Nano to the Nanofab, you can save 3 macro from the Nanofab's cost.

## Nanofab add-on: Carbon Fiber Macrofab (Macro X)

Macro 2X, Nano 4, Research 8

Carbon isn't the ideal structural material for everything... but sometimes it's awfully close. Make use of your Nano find for big things too, by including a Carbon Fiber Macrofab with your Nanofab. Grants the Nanofab the additional equation **[money: 2][time: 1.5] > [macro: 1]**. Can only build objects whose Macro is no higher than the rating of the Macrofab.

## Outpost Infrastructure

Macro 6, Nano 5, Research 6; requires Offworld Factory (or Macrofab)

A collection of blueprints, facilities, supplies, and tools sufficient to provide life support to a Small Colony indefinitely. An Offworld Factory or Macrofab must be present and operational before the Outpost assembly can begin; the required facility's equation isn't reduced and is still usable as normal.

## Settlement Infrastructure

Macro 7, Nano 5, Research 7; requires Outpost Infrastructure and a Propellant (water!) income

The equipment necessary to expand the colony, dig in away from solar radiation, troubleshoot larger problems both technical and social. Extends a Medium Colony's life support to indefinite. You need a functional Outpost Infrastructure facility (though it can be empty), and you need a propellant resource available with a time cost of less than **[time: 4]** per point; this doesn't actually consume the output of these requirements, they just have to be present. A propellant find onsite plus an Extraction Mine will do it, or you may need to set up shipping from a propellant Extraction Mine somewhere else.

### **Dome City Infrastructure**

Macro 6, Nano 7, Research 12; requires Settlement Infrastructure and an Offworld Nanofab (or Nanostructure Tanks)

Though it's called a Dome City, there are many other strategies – tenting a crater, hollowing out an asteroid, living in caves on Ganymede, or stranger plans. This object represents the mass and costs to expand the settlement to an actual (if small) city, regardless of how you decide to do it. As ever, this does not actually consume the output of the required facility.

# MANNED SPACEFLIGHT

Note – these objects include both the actual structure and the crew onboard. In most cases the two are synonymous. Occasionally, however, events may reduce the size of the crew units inside – from medium to small, from small to hab, or from hab to all dead. This does not affect the mass of the item.

The basic life support allowance of a Hab or any Colony is six months. See the Extended Life Support item or Cryogenics (both in the Toys and Tools section) if this is insufficient for your needs, and/or look into the appropriate Infrastructure in the facilities section.

Damaged crew units or used up life-support months can be fully replenished (back to full size or six months) on any stop in LEO or at any colony larger than itself which has full Infrastructure. If the colony is built outside LEO, the crew units start out depleted to zero and must be replenished somewhere – you can't just build the *people* in your macrofab.

## Hab Module

Macro 1, Nano 0, Research 0

A small crew of three or four people locked in a tin can for months on end. Sounds like fun! The hab is the smallest unit of crew. It's not a "colony" and can't fulfill colony missions, but it can do guidance, exploration, troubleshooting (defensive cards), onsite assembly, and a host of other useful functions.

## Small Colony

Macro 8, Nano 3, Research 5; Cooling 8, Generator

A small community of about fifteen to twenty people is the smallest useful community for long-term homesteading on another world. Only elites will make the cut. Some disasters refer to a colony's "size" – a Small Colony is size one. Almost always supported by an Outpost Infrastructure facility.

## Medium Colony

Macro 12, Nano 3, Research 6; Cooling 12, Generator

A larger community of up to fifty people makes a colony capable of more than simple subsistence. Art and culture distinct from the home planet can develop. Still limited to the best and brightest applicants available. You can also create a Medium Colony by merging two functional Small Colonies. This is considered size two. Supported by the Settlement Infrastructure facility.

## Large Colony

Macro 16, Nano 4, Research 7; Cooling 18, Generator x2

With over a hundred people, a Large Colony has a legal structure and a governing philosophy, unique art and a cultural identity, and complex group dynamics. Humanity is finally beginning to learn what it is really like to live, as social animals, off the world of our birth. Size is three. You can also create a Large Colony by merging two Medium Colonies. Supported by Dome City Infrastructure.

## Colonial Metropolis (size Y)

Build requirements: special

A Colonial Metropolis is the term for multiple Large Colonies merged together to get an even larger colony. Each one is built separately, and supplied separately with Infrastructure, but together they constitute a Metropolis of size Y. The smallest possible Metropolis, made of two Large Colonies, counts as size four; three counts as size five, and so forth. If you use Dome Cities to support a Metropolis, one Nanofab/Tanks suffices for all of their requirements – you don't need one for each.

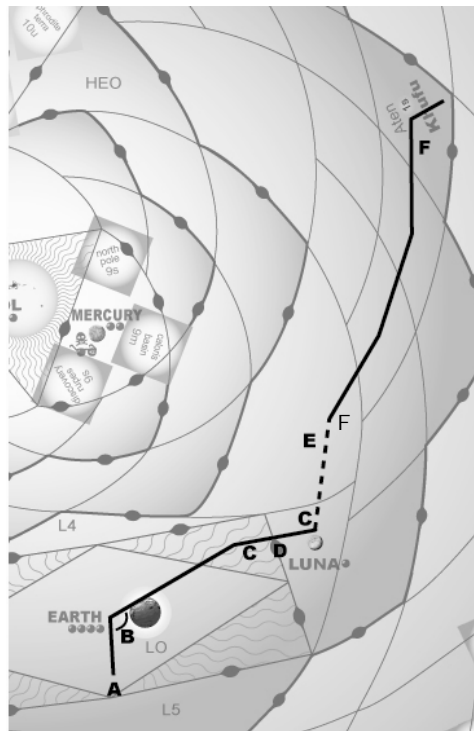


# SAMPLE MISSIONS

Each of these missions is a verbal sketch of a legit, productive High Trader turn. If you're feeling lost, try replicating one of these... this should get you comfortable with trying out something fancier next turn.

## Earth-Grazer Exploration

- ❖ Concept: Explore a nearby Aten-class asteroid, Khufu, using robots. One way mission.
- ❖ Distance 5 including lunar slingshot. Dots 4. Hohmann Transfer time 10 months,  $\Delta V$  4. Onsite time one month (half the surface gee, doubled for robots).
- ❖ ArcJet Electric Rocket with Photovoltaic Generator (Flux 0), Universal Bot Team. That's Macro 4 (3.5 rounded up), Nano 3, Research 3.
- ❖ End mass 4 as we arrive at Khufu. One way trip at ISP 2 departs at 7 mass. Mass 7 leaves us our full thrust, which is plenty to touch down on any of these little guys.
- ❖ Doing it all in-house will cost a total of 41 money (4 for Macro, 6 for Nano, 3 for Research, 28 for Boost); talking to whoever's got a Boost resource, or some offworld Macro or Propellant, would be a big help. The biggest time if you do it all in-house is the boost, 14 months, followed by the Research, at 12 months, so the Mission Time is 20 months. I'd say time bid of two, which probably won't be the high bid anyway.
- ❖ If the Turn Length was five, turn running 2019-2024, and this was our first turn so we've got no time stockpile, we gain 60 time and (if all goes well) spend 20. Forty left. If we add eight imaginary months to get a multiple of twelve, then we can subtract four years from 2024, and launch on 08/2020. Arrival on 06/2021 and our exploration data on 07/2021 will arrive easily within the turn, and we've got lots of time chits left over to get more ambitious next turn.



The route of this mission on the map looks like this.

- ❖ At A, we boost and assemble the mission in a stable (corner) orbit in LEO.
- ❖ At B, we make an orbit change to change facings so we can leave LEO. This costs a dot.
- ❖ At C, we pick one side of a triangular orbital to face as we enter it; this is free.
- ❖ At D, we cross a burn dot on the map. This, too, costs a dot.
- ❖ At E, we use a Lunar slingshot to move into this orbital for free – it does not count against our distance.
- ❖ At F, we make two more orbit changes, once near E to change sides of the orbital, and once at the end to enter a stable orbit near Khufu.

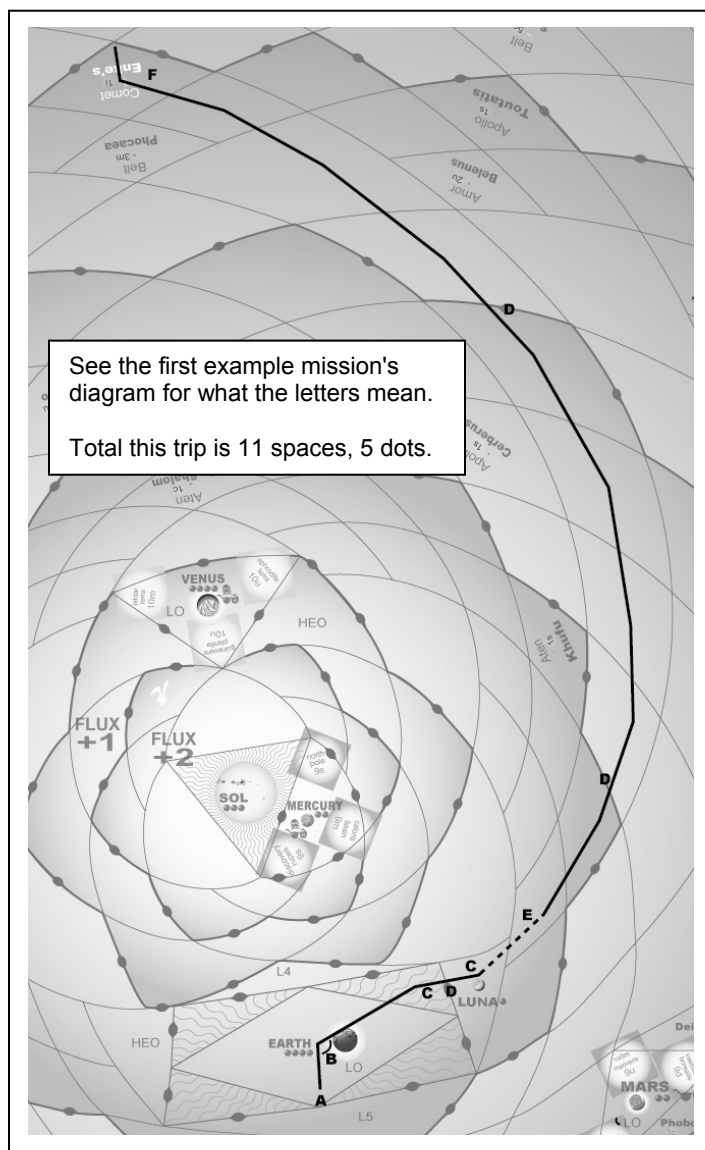
Total for this path is five spaces, four dots.

## Solar Powersat in LEO

- ❖ This is a common first-turn mission for players who don't want to pay default prices for power for their stuff, or who want to spend a turn increasing their income for the long run. Technically it's a prep mission to LEO.
- ❖ The entire Mission Plan side of the page is blank – we're not going anywhere.
- ❖ No rocket needed in this manifest. Payload is a Solar Power Sat for Flux 0 plus three mass worth of basic radiators. Macro 7, Nano 2, Research 4.
- ❖ Doing it in-house with the default prices, you pay 43 money (7 for Macro, 4 for Nano, 4 for Research, 28 for Boost) and 23 time (16 for Research plus half of 14 for Boost). Getting some help with boost and/or with macro in LEO will make an enormous difference. A friend with a research resource, or just buying the tech from someone who started with beamed power (if they'll sell), would also help. A bid of two should be just enough to do it, especially on the first turn when disasters are unlikely.
- ❖ Since there's no travel time, and no assembly time (see Solar Powersat description), the mission is done immediately upon launch. Next turn you'll have access to two channels of beamed power in LEO.

## Ice Mine on Enke's Comet

- ❖ Facility mission to Enke's Comet (see diagram at right). Site action to assemble the mine.
- ❖ Distance 11 including Lunar slingshot, Dots 5; Hohmann Transfer time 22 months,  $\Delta V$  5. Onsite time left blank right now.
- ❖ Metastable Helium Rocket, Extraction Mine with Fission Reactor (shut down during transit, dirtside cooled at destination), Bot Team. Costs are Macro 10.5 (rounds to 11), Nano 11, Research 17. Assembly time is the Mine+Reactor's mass, in other words eight months.
- ❖ One-way trip at ISP 4. Arrival mass 11, departure mass 16. Thrust is no problem.
- ❖ This is a somewhat research-heavy first mission, so let's only do it if we're not doing it all in-house; let's say we're outsourcing research to an L5 lab at **[money: 1.5][time: 1] > [research: 1]**, and macro in LEO at **[money: 2][time: 2.5] > [macro: 1]**. With those terms, our manifest will cost us 90 money (22 for Macro, 22 for Nano, 26 for Research, and 20 to Boost our propellant) and 39 months (28 for Macro plus half of 22 for Nano). Time bid needs to be at least four, which is probably enough buffer here.



- ❖ Say the Turn Length is our four, turn years 2027-2031, we had 23 time chits as the turn started, and disasters cost us an extra 5 money and 7 time. We collect 48 more time, spend 46 (39+7), end up with 25 time chits. Eleven imaginary time chits puts our launch on 11/2028. Arrival on 07/2030 (done), completion on 03/2031 (pending). Next turn, we can use the onsite mine to get us propellant cheaply (the default icy world chit guarantees us **[money: 1][time: 1] > [prop: 1]**) with a small automatic time penalty equal to the three months we are into the turn, and take the rocket elsewhere. Or, if we want, we could dedicate the metachem rocket to a supply route home and the math (see Extraction Mine for details) works out a resource of **[money: 1][time: 2] > [propellant: 1]** in LEO, with again a three-month lead time this particular turn. Not bad either.
- ❖ As a free bonus, add a site action to the trip: *Explore comet*. Either before or after our factory assembly depending on whether we want to hurry to leave, or wait to find out before building our mine; doesn't matter much, it will take them one whole month (the surface gee) to find out if anything else interesting is here.

## ***Mars Colony Part I***

Colony missions are complicated and expensive! Don't try this one as your first mission. In this example we show a common mistake as part of the process, and how to fix it. You'll want to actually get out a Worksheet and follow along; trying to parse this straight up while *imagining* work that we wrote down methodically **will hurt your brain**. In the boxed set this (with the work properly shown) might even be best presented as a little illustrated tutorial booklet.

- ❖ Facility mission to Mars South Pole. Let's assume I've got ready access to beamed power for this scenario, including a Microwave Relay which reaches as far as Mars. Those might make good starter missions if I don't have 'em at first. We'll parachute the stuff down. Onsite we'll be doing an assembly, with robots, twice – once to assemble the Factory requirement, once to assemble the Outpost proper. Blank right now.
- ❖ Earth to Mars via L5 is seven orbitals, three dots, plus aerobraking and parachutes. (See if you can find the route – remember that in triangular orbitals you get to pick.) I'll take my time and send it by Hohmann Transfer, so it'll take 14 months,  $\Delta V$  3.
- ❖ We've got power so electric rockets are where our eye naturally falls. Let's try a JxB Accelerator Rocket, with a Microwave Receiver, Robotic Guidance and Open Cycle Cooling. Our payload is an Offworld Factory (we'll cannibalize the Microwave Receiver for it) and an Outpost Infrastructure, plus a Bot Team to put it all together. Say the Microwave Receiver and Bot Team are known techs, the rest is new. Total comes to Macro 21, Nano 11, Research 19. Onsite time is going to be 19 months, the combined masses of the factory and the infrastructure plant.
- ❖ Our open-cycle ISP is four. We need to arrive with all 21 mass of rocket & payload. Nomogram says we need to leave with an initial wet mass of 24.. Thrust check... oh oh. Base is Thrust 1, +1 for Open Cycle, -2 for mass 24, is... not enough for a Hohmann Transfer.
- ❖ Back to the drawing board for a sec. One solution to needing more thrust is to build a bigger rocket, and our rocket's pretty light, so let's try it. Another JxB with receiver will cost us +3 Macro (2.5 and then we round the whole thing up), +4 Nano, and another channel of power during flight. Raising our arrival mass to 24 from 21 will mean we need to start out at mass 28 instead of 24, but now we have the thrust to do the job.
- ❖ Twenty-four Macro, four propellant, a bunch of nano and research... we wouldn't try to do such a mission using defaults. For this example let's assume we can get everything for half the in-house cost and time; this might be optimistic but if we're sharing research costs and giving up concessions elsewhere, it's probably reasonable. At those rates, we're looking at 81 money

- ❖ We only take one significant disaster, a Software Glitch which ends up making our assembly take 8 months extra. If our mission began in 2023, time-broke, we launch on 02/2027, arrive on 04/2028, and finish construction on 07/2030. Using robots to assemble this stuff is cheaper than using up life support, but slow.

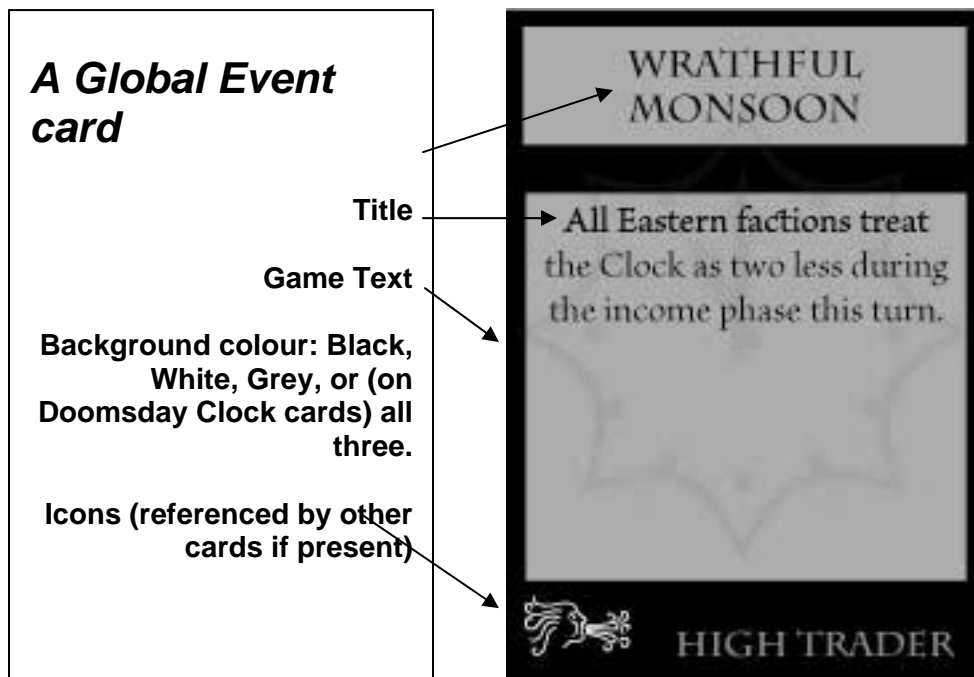
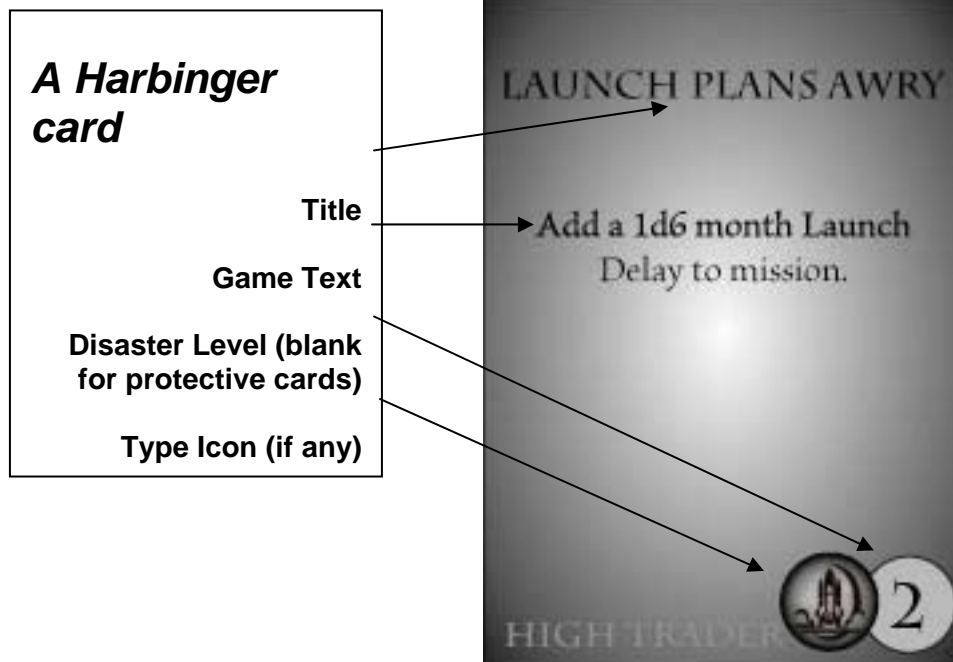


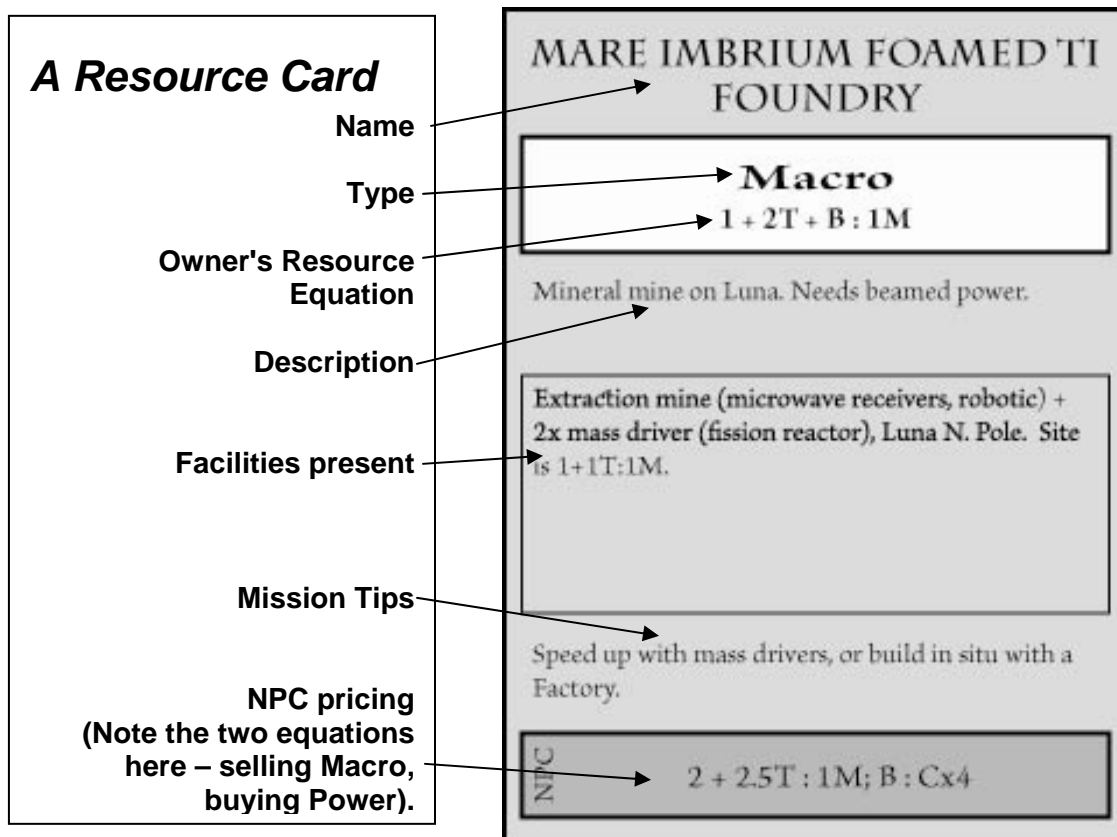
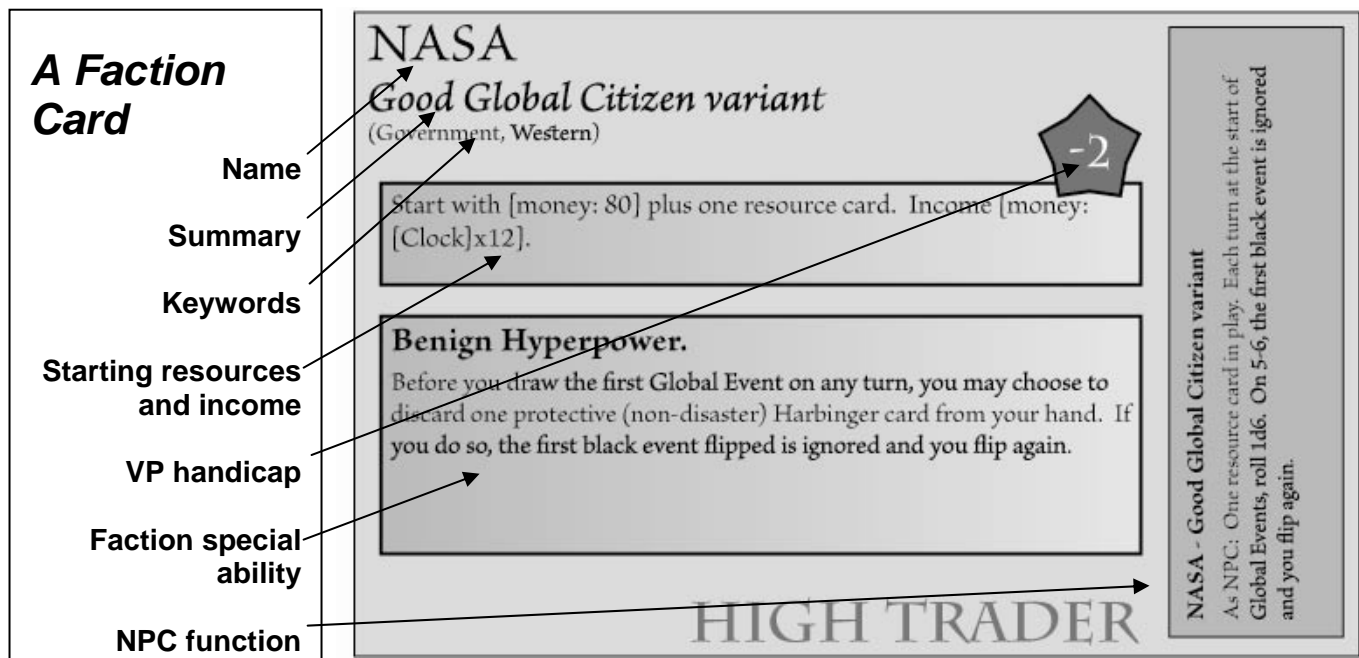
- ❖ Colony mission to Mars South Pole. I've still got beamed power like in the previous one.
- ❖ Same route, seven orbitals three dots. This time, however, I'm going to be prioritizing speed, because life support can get expensive. So let's use an Elliptical Transfer this time, which comes out to seven months and  $\Delta V$  seven. Onsite time is zero – we spent all that time letting robots hammer the thing together, we can just move in. We'll leave both rockets in Mars orbit (last turn's and this turn's) just in case we want them later.
- ❖ Reusing our Double-JxB rocket design, we need another one plus a Small Colony. The Colony will need a Microwave Receiver of its own, and some cooling; after a trial run with Basic Radiators we decide to spring for Advanced Radiators. Total cost is Macro 18, Nano 16, Research 20. But wait – that only gets us six months of life support. Our trip takes seven. One month extra at one Macro per (see Extended Life Support under Tools). So our Macro cost is actually 19. We'd like to include an additional buffer, but after getting caught up by insufficient thrust last time, we'll wait and see if it looks like we can afford it.
- ❖ With ISP 4, seven dots, final mass 19, we'll be looking at a departure mass of 32. Ow! Luckily, we still just barely pass the Thrust check... our rocket's Thrust of 3, minus two for the mass, leaves us just barely able to pull off an Elliptical Transfer. Looks like we can add as many as three mass and still get on the same red line, though... so let's add a buffer of three months' food and air to our trip. Brings our Macro up to 22.
- ❖ Let's assume that last turn while we were setting up infrastructure, someone else brought online a Research asset which can offer it at 1 time per point. They owe us from before and

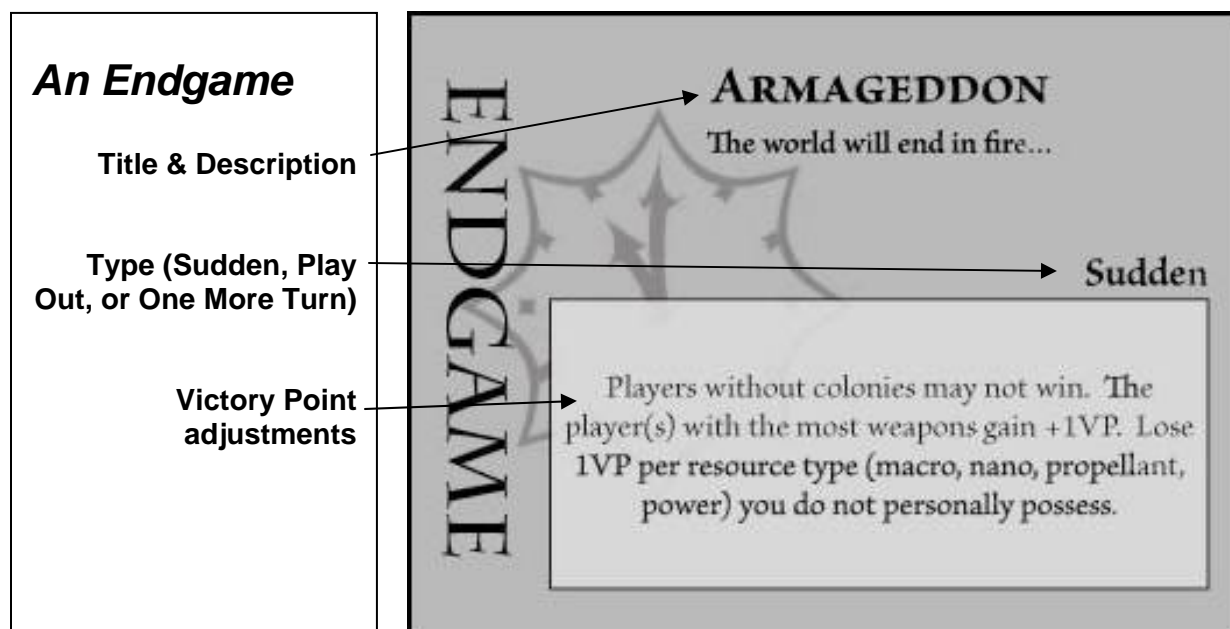
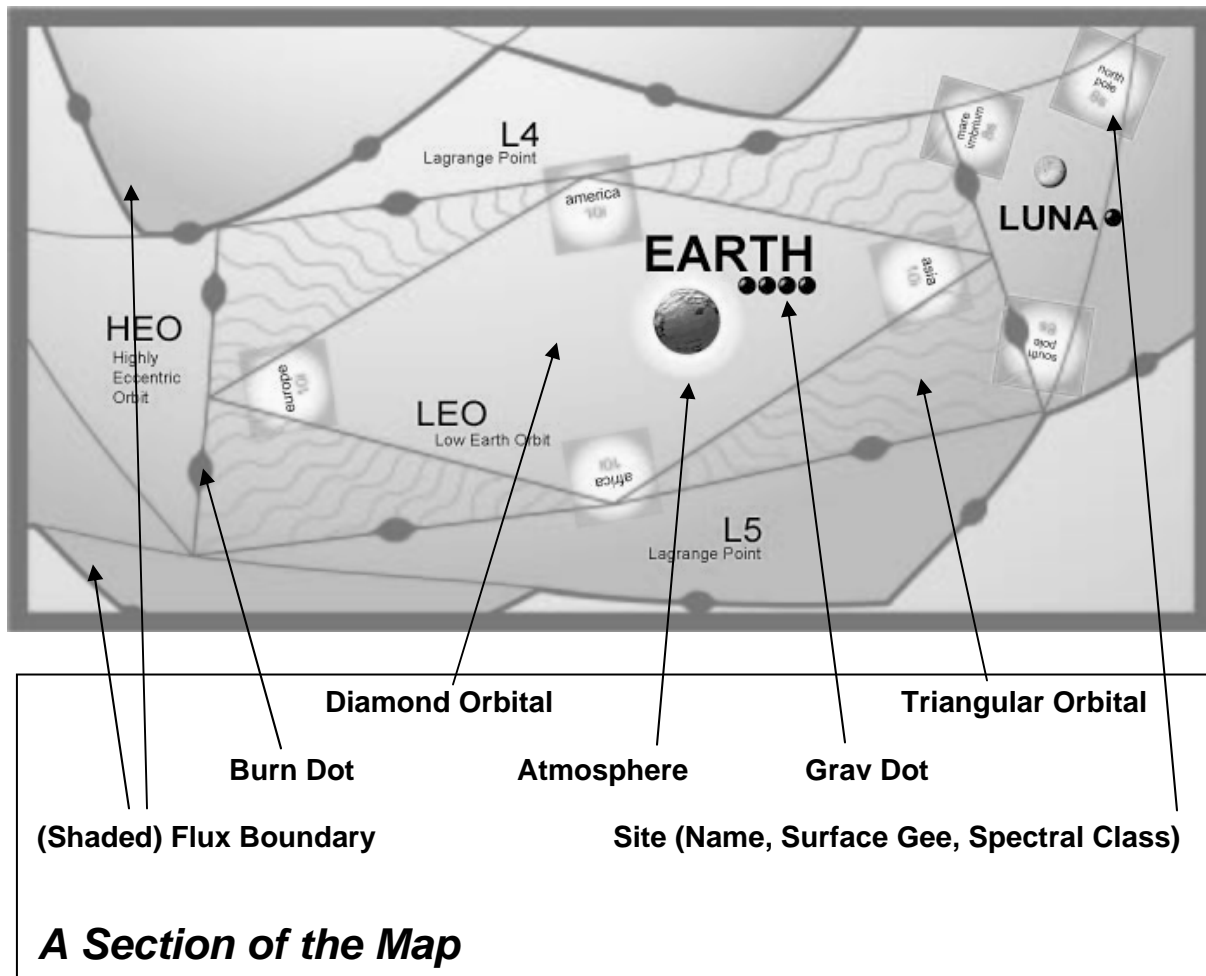
are willing to cancel the debt by giving us priority. Thus, this mission will cost us another 81 money (11 for Macro, 16 for Nano, 10 for Research, and 44 for Boost) and 32 months (22 for Boost plus half of 20 for Research).

- ❖ Construction time 32 months, and another seven to arrive and move in. From the previous turn's time chit expenditure, regardless of the bid our launch date this turn would work out to 10/2029 (32 months after the previous launch). If we launch then, we'll actually arrive there too early – the robots finish in July, but we arrive in May. Problem. We could explicitly delay the launch date... but here's a better idea. Let's spend some of our stock of time chits on cards before mission resolution time; that'll both delay our launch a few months to give the robots time, *and* give us better odds of surviving anything that the other players may throw at us.

## APPENDIX A – THE OTHER PLAY AIDS









## APPENDIX B – ADVANCED MODALITIES

Each of the following rulesets covers a situation which, while realistic and arguably permissible, is too complicated to include in a basic game which is already quite complex enough. We deal with them using a scale of game sophistication. The possible levels of sophistication for High Trader are:

- ❖ **Basic Game** – None of these advanced modalities are permitted. Let's face it, a "basic" High Trader game is as sophisticated as the advanced versions of many other games. It is **strongly recommended** that any game which includes even a single player new to High Trader be conducted at the Basic Game level.
- ❖ **Advanced Game** – Each player is allowed to invoke *one* of the following modalities per game. You need not have any idea which one you might want, at the start of the game; you simply have permission to include one in a plan when it does come up. From then until the end of the game, you are allowed to include this one modality in your missions.
- ❖ **No Holds Barred** – Groups which have played several times and become comfortable with the fundamentals can probably, if they choose to do so, handle lifting all restrictions and considering all of the advanced modalities available to anyone as desired. Not recommended for single-session games regardless of level of experience; this level of complication is better suited for episodic games (one turn a week, for example) or PBEM play.

There are currently six advanced modalities in the game. They are each covered in detail in the following pages. The list is:

- ❖ **Intrinsic Resource Use** – Needing a resource, and building it, within a single mission plan.
- ❖ **Conditional Mission Plans** – Set a course based on details unknown at planning time.
- ❖ **Quickstep Missions** – Use an especially heavy stack of time chits to plan an extra mission.
- ❖ **Player Faction Equity** – Put yourself on the block to raise capital... or buy someone else.
- ❖ **Piracy and Raiding** – The use of violent means in an otherwise peaceful game.
- ❖ **The Rule of Clarity** – A controlled means for allowing the group to rule on unusual situations.

## ***Modality – Intrinsic Resource Use***

An intrinsic resource is one contained within the current mission. The most common case here would be deciding to use beamed power, and constructing the powersat and the receiver as part of the same mission. Makes perfect sense, right? Put the sat up, power the rocket right away. By invoking this modality, this is indeed allowed.

The way it works: assign a site action to the resource (like the powersat) of "Use intrinsic for (time)." Then, when you're doing timelines later, work out a milestone date for when this channel is done being tied up with intrinsic supply. Only when that milestone is reached does the channel become available for non-intrinsic uses of any kind – effectively, as far as you're concerned outside this mission, it "comes online" at that time.

Similarly, you can set up a propellant mine and tap it for the fuel to get home again – or even to carry on throughout the solar system. (Yes, you could even pack up the mine and bring it with you – but you might want to look into mass drivers instead, for whom this pattern is way cheaper and not an advanced modality). With an intrinsic propellant mine, you *do* pay the time and money chits for the propellant you tap; these costs don't combine with the mission's normal accounting in any way, they do not enter into the rules-of-time or the like, it's simply calculated as a one-off cost in both money and time chits, and must be paid in order for that intrinsic-use milestone to be resolved. As with powersats, the mine won't be usable for normal ops until it has finished the last intrinsic use you assigned – no normal use "in the gaps" here, sorry; do that one as a separate mission.

Macro, nano, and research may not generally be used as intrinsic resources, as the things they produce are essentially part of some new mission. The exception is construction of objects from the tools/toys list, such as bot teams and long-range crawlers. Construction of these, assuming of course that you have the facilities (both nano and macro) required, is allowed using the same rules as for propellant above.

## ***Modality – Conditional Mission Plans***

You would put together a conditional mission plan if you anticipate receiving information prior to launch which will have an effect on how your mission resolves. Typically this affects the destination primarily, with possible secondary effects on other parts of the plan such as the propellant budget.

Two common examples show this in action. In each case, a waypoint's name is listed simply as "Conditional", with details given nearby on your sheet. The first case is where you have a delayed or pending exploration of more than one site, and wish to specify the destination not by name but by an unambiguous criterion, such as "Best macro found by my earlier missions by the date of launch," or "Water, preferably here over here." If you don't specify how to resolve ties, they'll be resolved by which one had its exploration date occur first, ties broken randomly. The second example is one of competitive prioritizing – where you wish to travel to Mars: Valles Marineris, except that if China lands at any Mars site before launch you wish to head to Venus instead. There are other examples which could apply, but they all share one thing in common – they rely on the outcomes of pending milestones, delayed missions, or other players' missions on the current turn, which you hope (with varying degrees of assurance) you will know by the time your mission must launch.

You (and your mission planners in the game) must budget for the **worst-case** situation. If you're not sure if you'll need a crawler, build the crawler. If you're not sure if you'll need 10 mass of propellant or eight, boost ten.

If you do this, then we do not resolve your mission in the usual order in the execution phase. Instead, we resolve your mission after all other missions upon which its condition relies. If, by the time you get to your mission resolution the criterion has clearly been established, then you can launch to the specified target. This will tell you exactly the timelines you need to fill in.

You may opt to stockpile any excess propellant you boosted or other materiel you built; you *can't* not boost or build it.

Conditional missions must meet stricter standards than other missions, to preserve gameplay for the other players. If the condition has not been satisfied by the time your launch date arrives, but is met on some later date during this turn, then you can launch belatedly on the date the condition is met. If the condition ends up not being met at all for some reason, your mission automatically aborts according to the normal rules. And if a conditional mission comes under scrutiny, it *immediately* passes; there is no time leeway.

## ***Modality – Quickstep Missions***

Having all players take the same number of turns generally works just fine, with the time chits making everything come out in the wash. High Trader has proven very robust in this sense. However, sometimes large asymmetries can still come up. Perhaps one player is a small-bit player in a game full of NASAs and CNSAs and the like, and is ending up with a massive accumulation of time chits simply because he cannot afford to keep up with the scale that the other players are managing.

This is a modality intended to rectify extreme cases only. Games can span a full hundred time chits from top to bottom, or a forty-point split between the most and second-most, without harm. The recommended guideline is that you should only use this if there's a player who has consistently had 50 or more time chits in hand, as compared with all other players, over the course of multiple turns, *and* the gap is getting larger, not smaller. (It could be, of course, that there's more than one player in the same boat; less likely, but possible.)

In that case, the player(s) with a continuing excess of time chits may opt to invoke quickstep and submit two missions in the space of one. Mark them as #1 and #2, near your name and the turn number. Plan fast! If any mission marked for quickstep comes under scrutiny, it automatically passes; there is no time leeway. This usually means it's a good idea to submit #1 well ahead of time, so that you don't end up screwed up by losing both (or putting a dependent mission #2 ahead of a passed but necessary mission #1).

Other players must play at least one card on *each* mission you submit. The missions maintain separate stacks. They are resolved in order, one at a time, including paying all costs and calculating all milestones, before proceeding to the next.

## ***Modality – Player Faction Equity***

Victory Points are not normally a negotiable commodity. They represent fame and success within highly individual frameworks, and what distinguishes one group doesn't necessarily mean the same thing to another. In particular, since several factions adjust the VP award from various activities, reconciling these factions with any kind of VP-splitting is difficult at best.

However, under this rule, a player can either offer his own shares to other players, or offer to purchase shares from other players. Either one is an invocation of this modality, and follows the same share rules. Obviously, for some factions this may not "make sense" in the context of the narrative; for fairness, the option is still open to those faction, and the players can rationalize it as they see fit while keeping the rule structure unchanged.

Once invoked, this allows any amount of money to change hands for various possible classes of shares in a given faction. The players on both sides of the deal are encouraged to keep records of the deal. Shares are expressed as a percentage of the owned faction. Shares can be:

- ❖ **Transferable or non-transferable** – Transferable shares can be bartered away to any other player by the stockholder. Nontransferable ones can't be sold to anyone but the issuer.
- ❖ **Voting or non-voting** – This is the most important distinction. Voting shares carry a proportionate share of the issuer's Victory Point total. Nonvoting shares do not. If this option is in play then VP totals can be fractional; do not round VP values. VPs lose all "type" when transferred in this way – no bonuses based on how the VPs were generated apply to VPs gained via voting shares.
- ❖ **Preferred or conventional** – Preferred stocks pay dividends... they entitle the stockholder to a share of the issuer's income, both regular and vendor-based, each turn. The share is equal to the percentage of stock held, times a dividend rate set at the time of issue. For example, if I hold ten percent of Joe's stock with a dividend rate of "half", then every time he takes income he'll give me 5% of that amount, rounded off. The dividend rate can be renegotiated but neither an upward nor downward adjustment rate is binding unless agreed to by both the issuer and the stockholder.
- ❖ **Redeemable or non-redeemable** – Redeemable shares can be turned in by the stockholder to force the issuer to give them money or even facilities. When the stock is redeemed, the net value of the issuer is calculated by summing the resource totals of all of their techs, rockets, facilities, and stockpiles... at one point per point of research (once per tech only), macro, nano, propellant, or straight cash. Developed site equations and provided power channels are worth 5x their current Earth lease value. Once the total has been calculated the issuer *must* redeem the stock for the appropriate percentage of this total, in any combination of assets they see fit. If they have to hand over something worth more than this (because they can't repay it without doing so, and can't secure a loan from the other players to bridge the debt), then so be it - they end up overpaying to buy back their stock. Obviously, the two players can always bargain as they like, within this context... the shares simply mean the issuer can't just say 'no.'

The default stock is transferable, non-voting, conventional, and non-redeemable... in other words, useless. In general, issuers will only be willing to add one of the perks (voting, preferred, or redeemable) to it... from a complexity standpoint if nothing else... and transferability is negotiable.

Equity is complicated and time-consuming (if sometimes really fun). As such, if two or more players have engaged in a transaction involving player equity in a turn, then if everyone else has submitted their turns, both sides of the equity deal (even if the deal itself is settled) immediately enter scrutiny.

## ***Modality – Piracy and Raiding***

### **ARRANGING TO BE IN THE SAME PLACE AT THE SAME TIME**

In order for combat to occur, the two combatants must be located in the same orbital at the same time. This always requires a dedicated mission. Raiding a stationary facility is relatively easy; just plan a mission to the destination and go on with the next steps.

Intercepting a flight in progress is more difficult, but can be done. Specify the target rocket as the waypoint. The raid mission must launch after the target's launch; small variations in launch timing would be sufficient to throw off any raid. The raider selects a target orbital along the target's route to intercept in, and plots a course to that orbital.

Work out the date of the target's presence in that orbital from the target's mission plan, as though they had been working that out as a leg on their trip; then work out a leg for the pirate which will match that time and place. This will often require a delayed departure on the part of the pirate, which is fine.

For the purposes of intercepting a shipping route, work out when the target ship departs by noting the date when shipping began (back on the mission which kicked it off) and counting forward by the round-trip time for the route.

### **TELEGRAPHING THE PUNCH**

The moment a raid mission is launched, the target will be aware that an intercept course has been set. There is no stealth in space, not if someone is looking, and there exist both vigilant men and corruptible men in plenty sufficient measure. So work out the game state at the instant of launch. For a facility raid this is usually again easy; for a pirate intercept this will require once again working out the travel-to-that-point as though it were a leg of its own. Any other interested ships and/or players may also calculate their position on that date the same way.

Intercepted shipping routes work out their position based on the launch time noted above. On the 'full' leg of their trip they are considered to have as much cargo onboard as their source facility generated in resource points this turn, up to a limit of what they can carry and still move in the designated transfer type. Frequently, of course, they will respond by jettisoning the goods, which easily makes them unrecoverable – but isn't a decision you can take back later in this phase!

Starting from that state, anyone who wants to may change any pending (or current) milestones they want. For example, the target ship may decide that retreating to home, or to a different destination, is the better part of valor. Or an allied ship may decide to intercept the intercept course. A friendly ship may change course in order to remove all the valuables from the target facility, or even the facility itself.

The pirate or raider now gets a chance to respond, but doing so will increase the delta-vee cost of their new trajectory, whatever it is, by one impulse. They could plan a new intercept, they could return home, they could have been bluffing and now head to their real target.

If the other players wish to respond to this revision, any courses they plan will also need to pay one extra impulse. The pirate then gets another chance to revise, but now the cost is increased by two impulses, and so forth, until one side or the other declines to respond. At that point the missions are fixed; record them as such, Route Plan and Route Details and all.

## WE CAN'T KEEP MEETING LIKE THIS

Combat occurs based on a series of range bands. We establish which range bands will be used, and for how long, based on two factors: the **relative orientations** on the map, and the **controller** of the fight – usually the player whose ship has the higher acceleration.

The player whose ship has the higher net thrust is called the controller of the fight. (Remember that even a +1 Thrust advantage amounts to a 2:1 advantage in real accelerations, which is pretty close to total maneuver control once you get close.) A groundside facility is considered to have an acceleration equal to its surface gravity for this purpose. An orbital facility or a rocket without a single impulse of fuel has an acceleration of minus one. It is possible for control to change hands due to damage later on.

Propellant expenditures can tip the scale. This is done by bids. Bids are expressed in impulses. Once the bidding ends, both the winner and loser of the bid expend reaction mass using the nomogram for its own ISP and bid. The winning bid gets an effective +1 thrust for determining control; this lasts for the duration of the fight.

If there is no controller then each player makes the controller's call and you split the difference, rounding in favor of the aggressor. This usually means that slow approaches stay at long range, and fast passes have their nearest approach at medium range.

Exactly how the control applies depends on the type of intercept. There are four ways that objects can be related to each other within a single orbital. The plans established in the planning step will tell you which one is the case.

- ❖ **Dissimilar corner facings** imply either completely different solar orbits of comparable energy, or being on different sides of a massive body. In either case no combat can occur.
- ❖ **Same facing** implies matched orbits and a combat that can last as long as either party can still fire. The fight begins at long range. After three firing rounds, the controller can change the range by one band in whichever direction he wishes. Repeat until neither party wishes to continue. This is the only orientation in which boarding actions are possible (and, obviously, to get there you'll have to pass through each range bracket in turn).
- ❖ **Facings 180° apart** indicate a very fast pass (relative velocities of five kilometers per second). Controller names a range - the point of closest approach. Only one firing round will occur, and it will occur at that range.
- ❖ **Any other combination of facings** means a moderately fast pass at 2.5 kilometers per second. Controller selects a range of closest approach. Starting at long range, one firing round occurs at each range bracket as you move inward up to the closest approach, and then one round per bracket as you move outward again.

## RANGES AND THEIR EFFECTS

❖ Too far	No weapons usable.
❖ Long range	Direct fire weapons roll half dice.
❖ Medium range	Direct fire weapons roll full dice, nukes roll half dice.
❖ Short range	Direct fire weapons and nukes roll full dice.
❖ Point blank	Direct fire rolls half dice. Nukes, kinetic kill, and boarding (same facing only) at full dice.

## SHOOTING THINGS

In each firing round, the two players roll six-sided dice for each weapon type in the following order, one weapon type at a time, both players rolling simultaneously within a given type. The weapons grant, in firing order:

- 1) **Lasers** – Two dice for the first laser, one die for each additional laser. Half dice vs. ground targets.
- 2) **Particle Beams** – Two dice per particle beam.
- 3) **EM Cannon** – One die for each EM cannon. Double dice vs. ground targets.
- 4) **Nukes** – Five dice minus the target's acceleration modifier (based on its mass), when using a nuclear warhead; nuke's own ship is destroyed.
- 5) **Self-destruct** – In an effort to prevent boarders from capturing it, any rocket or complex may target itself with a free five-die attack each round. (Self-destruction before combat begins is free and can be as thorough as desired.)
- 6) **Boarding Action** – Three dice for the first boarding gear object, one die for each additional instance. Half dice for robotic guidance. Crew may participate; habs roll one die, colonies add their size rating. If target's last guidance system is disrupted by boarding rolls, target is taken over immediately.
- 7) **Kinetic Kill** – Same facing – five dice to each player, minus their opponent's acceleration modifier (based on mass). 180° facings – triple these dice. Any other facings – double them.

Each die showing a *five* or a *six* disrupts one system on the target (see damage, below). Each die showing a *four* lets the attacker choose one of the damaged systems; remaining hits are assigned by the defender. Round fractional dice normally, after applying all halving/doubling modifiers. Damage is applied one point at a time before rolling the next weapon type in the list above.

Only a ship under entirely robotic guidance may detonate itself as a nuke, or initiate a kinetic kill (aka ramming). The **Orion** rocket's shock plate can cut all laser, particle beam, and nuke dice used against its ship in half... but precludes use of any weapons systems besides the drive, which inflicts half a nuke's dice in damage (but does not destroy the Orion). The **Metastable Hydrogen** drive is instantly destroyed if it sustains a drive hit. The **Mass Driver** rocket counts as one EM Cannon in combat. If used as a weapon the **Annihilation Drive** counts as one laser, one particle beam, one EM cannon, and a nuke attack like the Orion's. But if it sustains a drive hit, roll 1d6. On a 1, simply remove both rockets and everything else at this location from the game.

## KILLING THINGS

Each five or six showing on a die damages one system. The list of systems which can be selected follows. Note that you cannot select a system which doesn't exist on your target – the defender cannot assign Propellant hits to a groundside facility, for example. Disabling a system which has already been disabled destroys it completely.

- ❖ **Guidance** – one Hab or Cyborg Guidance is disabled (killed). Losing the last Guidance provider leaves the ship under robotic guidance only. Robotic Guidance or AI Guidance can survive Guidance hits by rolling 5-6 on 1d6.
- ❖ **Drive** – Reduces target's base thrust by 2 each time it is hit. Rockets whose base thrust is reduced to zero or less by damage have been destroyed; rockets whose net thrust is reduced to below zero cannot move (time to jettison the pool table!).
- ❖ **Generator** – One hit disables a generator. Objects dependent on the generator still have 1d6 firing rounds of stored power after this round ends. Generators may be reassigned to power whatever systems the rocket's owner wishes (within the usual limits such as MHD not powering itself, and so forth); backup generators may be brought into the mix, if available.



- ❖ **Propellant** – No immediate effect during combat, but each hit removes one mass of propellant from the ship's total and his route plan will need recalculating after the fight. If target rocket has no propellant on game scale (and is not a sail), this destroys even the rounding error and the target can no longer move or fight. In the right circumstances this is the deadliest hit of them all.
- ❖ **Facility** – Roll 1d6 times the number of facility hits this facility has suffered. If result exceeds the mass of the facility object, facility is disabled. If disabled facility is a colony's infrastructure, its colony retains 6 months of backup life support supplies, counting from the date of the fight.
- ❖ **Colony** – Note that the colonists are in spacesuits long since. Roll 1d6 times the number of colony hits this colony has suffered. If result exceeds the mass of the colony object, the colony's crew units are damaged. (A small colony is disabled as a colony but still considered a hab; if it suffers again, it's destroyed.)
- ❖ **Objects and tools** – Defender may not select these for damage, but the attacker can if he wants. Pick one object which is entirely separate from the target rocket or facility, such as a robot ground team, payload like a relay, or colony in transit, and damage it using its normal rules (use the facility disabling rules above for objects not otherwise covered).

## FIXING THINGS

The repair parts for a disabled object (facility, rocket, generator, etc) are a game object requiring half the macro, half the nano, and one research point (for troubleshooting). Build it as part of a mission. If you lack the appropriate construction facilities (LEO, any Factory, any Macrofab with sufficient rating for the original item) at the object's location, then repairs take as long as assembly ... the object's mass in months for robotic guidance, half that for human, AI, or Cyborg-guided repairs.

Repairing a manned system is also going to require replacing the people who were lost. This can be done at LEO or any colony larger than the damaged one's current size. It may occasionally be simpler just to treat that downsized Medium Colony as a Small one, and send out another Small Colony to merge with it back into a Medium one.

## PROFITS OF THEFT

If you board and capture a rocket or facility, it becomes yours for all purposes. If you capture a shipping route full of goods, you get to keep those goods, but their value is potentially reduced. If it's propellant then you just gain that much propellant. If it's shipping macro or nano then each resource point you capture is worth [money: 0.25] at LEO, or [money: 0.5] toward the purchase of that resource type.

If a shipping route is disrupted by combat (for example it opts to jettison everything long before the pirates arrive, or it is forced to run for shelter rather than continuing its flight) yet survives, that resource equation suffers a delay (inflicted just like a disaster) equal to half the round-trip time of the route.

Perhaps most importantly, a disabled Facility is considered lost for VP purposes, and a reduced or destroyed Colony is no longer standing in the way of the pirate's victory...

EXAMPLE OF COMBAT: A manned civilian Orion has come under attack by a terrorist-owned pirate vessel, a D-T Fusion destroyer mounting five weapons-grade lasers and a cyborg-operated boarding drone. The Orion jettisons its cargo rather than let it go to pirates, and thus has considerable propellant with which to try to escape. He can't quite get away, but as it works out the D-T can't afford the propellant to match orbits and they end up with a ninety-degree facing difference. The Orion comes down to mass fifteen including his remaining propellant, which gives him a net thrust of eight. The D-T (open cycle) has a mass of eight, which gives him a net thrust of six. Neither wastes propellant trying to get a mere +1.

The Orion uses that to get his optimal range for the closest approach, which as it turns out is point-blank.

*From this point the example needs reworking – E.* Our orientation assures three firing rounds, one at Medium Range, one at Point Blank, and another at Medium again; then the fight will be over. Round one: Laser fire, pirates roll three dice (six for their five lasers, halved for the shock plate), getting one six but no fours. The civilian player opts to lose a mass of propellant since he's still got lots. He blasts back with his nukes, but only gets one die at this range (five minus target's accel mod of zero, halved for the Orion not being a megaton device, halved again for range), and gets no luck. At point blank range, the pirates' lasers get a measly two dice against the Orion, but he gets lucky and gets a one, a four, and a six. He manages to breach the hab, killing everyone onboard. (Maybe not instantly, but certainly by the time anyone can reach them to help.) The Orion gets three dice, and gets two hits but no fours; however, the pirate's got almost nothing left he can freely lose, and so he winces and nails his D-T drive once and losing one of his lasers as well. Then on the third firing round, the pirate rolls three dice still (2.5 rounded up), and gets one hit, but no fours; the Orion's player opts to take this one to the fuel tank too, and heads very carefully home...

## ***Modality – The Rule of Clarity***

This game can become very complicated. It strives to be a playable and fun simulation of an extremely complex subject, and to simplify it down enough that you can focus on strategy and experimentation. However, by simplifying in this way, the rules cannot cover all eventualities. After playing for a few times, your group will undoubtedly come up with *something* – a plan, a financial arrangement, a combination of facilities – that has never been done before.

Most of the advanced modalities started life as invocations of the Rule of Clarity. A situation arose which was not anticipated, and this turned out to be the most fun way to handle it.

This is where this meta-rule kicks in. And it's pretty simple.

If the proposed action is:

- A) **A**greed on unanimously,
  - B) **B**asically consistent with the rest of the game, and
  - C) **C**lear enough to cover in one simple sentence
- ... then it is legal, at least this time.

The structure of the game will help with this. During the planning phase, haggling and deal-brokering will be all over the place. If you come up with a neat kind of deal, or an interesting plan for which nobody can find coverage in the rules, this will be your chance to discuss it. And nothing will be binding until you either formulate it according to the rule of clarity, or decide to drop it from your plans (at least for now). Just make sure it's clear before you submit your turn, and it's all good.

That being said, the rules will cover a rollicking wild ride around the solar system – there's absolutely no need to ever go beyond what's covered in this book, in order to have fun. With over twenty factions, and at least that many different basic strategies that each one could try, you'll have to play several hundred games to even begin exhausting all the possibilities.

If you do – write to us! There's plenty more that didn't make the cut for inclusion in this box. Terraforming, robust nanotechnology, other propulsion systems and facilities, and dozens of other faction contenders for the solar system await you in further expansions.