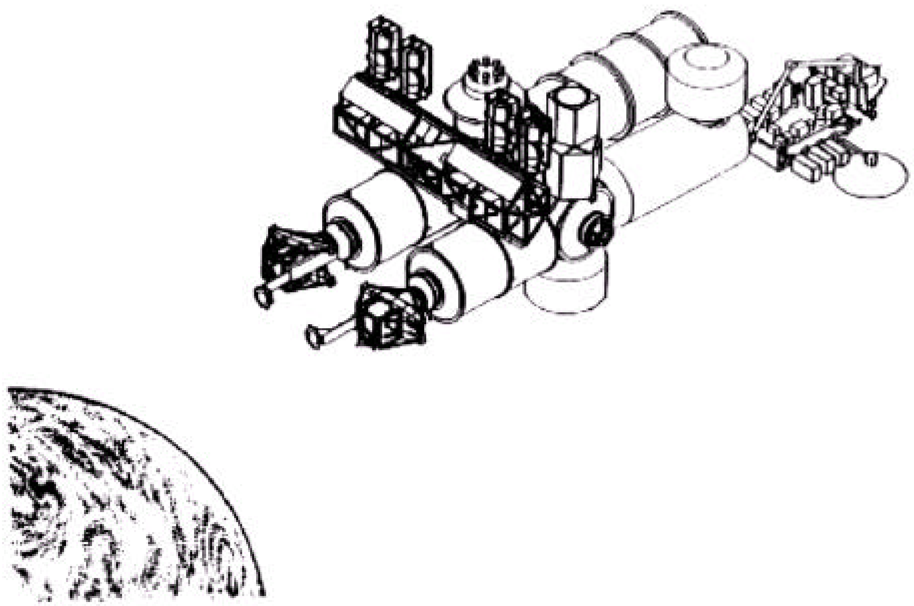
2300AD



Colonial Architect's Manual

Based on material by Terry McInnes and Dave Nielsen. Additional material by Ben Levy, Thomas Vickers, and Andy Goddard.

Colony Building

So, you want to build a colony? Just how much does that cost? Besides the enormous cost of transporting colonists and equipment to a new world, there are the forgotten costs of a colony's infrastructure.

Interface Services

The first step in building most colony is to dead drop construction equipment from orbit. This initial landing of equipment should be just adequate to level and build a temporary runway for interface craft. Once a temporary runway is built, usually of or a similar substance, some portable shelters are landed. Then the really heavy equipment is brought down from orbit. Once this is done, a real reinforced concrete runway is built to handle the increase load that a growing colony will need.

Runways

Most runways are constructed from reinforced concrete. Very similar to concrete roads, runways are usually the equivalent of 3 lanes wide. Construction cost: Lv15000 per kilometer; maintenance cost Lv900 per kilometer per year.

Fuel

Once a permanent runway is built, a large scale fuel processing plant is then assembled. The following chart shows several different plants and the power required to crack the fuel. Without this fuel, the construction vehicles can not run and the colony can not be built. If no water is available on the surface of a planet, this presents a problem. Water or fuel must be shipped in from orbit which increases the cost for the colony.

Fuel Storage

Fuel storage can take many forms. It can be above ground tanks or underground facilities. Either one is designed to safely store liquid hydrogen. The costs for building a storage tank is as follows.

Tons of Fuel	Volume of Tank (M3)	Mass of Tank(Tons)	Cost
1	1.65	.23	Lv1,000
5	8.25	1.9	Lv5,000
10	16.5	3.8	Lv10,000
50	82.5	19	Lv50,000
100	165	38	Lv100,000
1000	1650	379.5	Lv1,000,000

For underground tanks, increase cost by 10%.

Infrastructure

Colonists on a new world may be content with dirt streets for a while, but eventually they will want paved roads. As soon as the colony can afford it, the colonists need to begin developing an industrial infrastructure that enables them to produce the industrial products needed to improve their and standard of living. They also need to develop transportation systems to transport their products, raw materials, and agricultural goods to where they can be processed and/or shipped off-planet.

Power

The first thing any society needs if they want to move beyond the hearth and candle stage is a source of electrical power. There are a number of stationary power sources available, depending on the supporting tech level. However, for a power system to be developed, a world must have a supply of copper or aluminum, preferably copper so that a power transmission grid can be built.

Power Load

Before you build a power station for a colony or city, you need to determine your power load requirement. This depends on the local tech level and the number of homes, businesses, and industries in the power stations service area.

User	Power Load
Homes	1 Kilowatt per 500 square meters
Retail Stores.	1.5 Kilowatts per 500 square meters
Offices	2 Kilowatts per 500 square meters
Industries	Varies, see specific industry
Public Lighting	500 watts per 1000 square meters

Nuclear Power

Any of the nuclear power production plants listed in the NAM Power Plants Tables may be used. Fission power plants must have a supply of radioactives, either from local sources or from off-planet. Typical stationary nuclear plants are in the 500 to 1000 MW range.

Hydro Power

Wet worlds can support hydroelectric power installations. These are built where there is flowing water to turn a turbine. This may be along streams or rivers where sluices run water over small turbines, or at dams where stored water is run through large turbine installations.

Hydro Turbines

Size	MW	Mass (Tons)	Price	Volume(M^3)
Small	.01	.0005	Lv5,000	3
Large	50	20	Lv20,000	20

Dam construction requires years of time, thousands of workers, and the movement of millions of cubic meters of earth. Because of this, worlds would have to be fairly well developed before major hydroelectric projects are attempted. However, from an energy standpoint they are worthwhile, as the largest hydro projects have generated up to 20,000 Megawatts of power. Installations generating about 6,000 megawatts are more common.

Wind Power

If there is a location such as a gap between mountains or sea cliffs where winds blow constantly, you can erect wind turbines to generate electricity. The amount of electricity generated varies with the diameter of the turbine blades and the wind speed. Commercially available wind turbines with 10-meter turbine blades generate 100 kilowatts from winds blowing at 6.25 meters per second. An individual wind turbine masses 0.005 tons and costs Lv1000. It must be mounted on a 15 meter pylon costing Lv500. 100 or more wind turbines are usually built grouped together as 'wind farms' to extract as much energy as possible from a windy location. As winds are not totally reliable, wind energy is most often used to supplement other power sources.

Solar Power
Solar power arrays described in Andy Brick's Technical Architecture (http://www.caco.demon.co.uk/2300ad/2300ad.html) may be assembled in ground installations to provide supplementary power during daylight hours. However, unless sufficient storage batteries are available, a solar array is useless at night. Orbiting solar arrays capable of capturing stellar energy from synchronous orbit and beaming it to surface rectifier/antenna installations can overcome most of the daylight limitation. The solar arrays would transmit their power through what are effectively large masers with a megawatt rating equal to the megawattage produced by the solar array. The following information is based on a 1AU distance from Sol, based on Andy's Tech Arch and other sources for the Maser information. Power sats include the Maser transmitter and solar arrays necessary to power the maser.

Power Sats

MW	Volume(M^3)	Mass(Tons)	Area(M^2)	Price
1	.030	.040	1001	Lv65,000

Multiply by the MW output to design larger Power Sats.

Rectifier/antenna (rectenna) installations are needed to receive the microwave power and to step down the frequency to a standard electrical range (50-60 hertz). The rectenna installation area should be 100 square meters per maser megawatt. Rectenna installations cost Lv200 for every 100 square meters.

Transmission Grid
Any power plant is useless without a way of getting power to the people. A power transmission grid must be built for this purpose. It consists of two components, long-distance high voltage carriers and local distribution grids. These both require three elements: a conductor, an insulator, and a support structure. The conductor is most often wire. Copper wire is most common although aluminum wire can be used in its place at less efficiency. The planet where the grid is built must have a convenient source of one of these elements. Insulators are made from glass or other non-conductors. They are needed to keep the current from the supporting structure and draining away into the ground. The supporting structure consists of steel or wooden towers for the long distance cables, and steel or wooden poles for the local grid. Construction costs for a long-distance power line runs Lv1000 per kilometer. Costs for a local grid total Lv100 per building supplied with power.

Surface Transportation Systems
To move food from farm to market, and to move resources from mine to factory, surface transportation systems must be developed on colonial and recovering worlds.

Roads

Gravel Roads
These are roads surfaced with crushed gravel from nearby quarries. Vehicles moving on gravel roads move at their cross-country speed + 20 kph and do not have a mud penalty in rainy weather. Sustained use of tracked vehicles will destroy the gravel surface, however, and reinstitute a penalty after 6 hours of constant use. Construction cost: Lv 500 per kilometer; maintenance cost Lv50 per kilometer per year.

Asphalt Roads
There must be a hydrocarbon refinery nearby to provide asphalt for this type of surface. This is the basic road type found on mid-technology worlds. They are built with two or more lanes to allow

opposing traffic and passing. Each lane is 3 meters wide. Vehicles moving on asphalt roads move at their road speed and do not have a penalty. However, sustained use by tracked vehicles destroys the road surface in 12 hours, reducing speeds to cross-country speed.
Construction cost: Lv5000 per kilometer per lane; maintenance cost Lv500 per kilometer per lane per year.

Concrete Roads
An alternative to asphalt roads, concrete roads require a supply of sand, gravel, and limestone which has been thermally converted into cement. Concrete roads affect vehicle speed the same as asphalt roads and are somewhat more durable; tracked vehicles can use them for 18 hours before speeds are reduced to cross country. Also, their annual maintenance cost is less because their frequency of repair is lower.
Construction cost: Lv5000 per kilometer per lane; maintenance cost Lv300 per kilometer per lane per year.

Railroads
The flanged steel wheel rolling along a steel rail is the most efficient transportation system available for the overland movement of goods and people until the advent of cheap contra-grav transportation. This is because the rolling resistance of a steel wheel on a steel rail is up to 90 percent lower than a wheel rolling along a road. Railroads consist of two basic parts: track and rolling stock.

Track

Building track and its associated right of way is similar to building a gravel road with the addition of steel rails and their wooden or concrete cross ties. Rails are made of iron or soft steel . A standard straight rail is 10 meters long by 0.03 meters high by 0.01 meters wide. It has a volume of 0.003 cubic meters, weighs 24 kilograms, and costs Lv5. Curved rails are similar but cost Lv7. Iron rails cost Lvr20 credit per kilometer per year to maintain while more durable steel rails cost Lv10 per kilometer per year. Standard gauge (width between rails) is 1.44 meters. To calculate the cost of laying track, first determine the cost of the road bed by multiplying Lv250 per kilometer per track (equal to a half-width gravel road per track). Then calculate the cost of the rail by multiplying straight sections by Lv500 per kilometer per track, and curved sections by Lv700 per kilometer per track. Add the costs of switches at junctions and marshalling yards. These costs Lv300 per switch.

Maglev and Airfilm trains do not require standard tracks. Instead, an elevated monorail Track is constructed. Each section of Monorail is composed of a T-shaped support tower and track section. The support tower can vary in height, according to local need, but the standard track section is 25 meters long, approximately 4.5 meters wide with a 2 meter tall support tower. Each track section costs Lv750 to construct, this includes curved track
sections. For each extra meter of support tower height above the 2 meter base, add Lv50 to the cost. Annual maintenance costs Lv35 per kilometer per year.

Speed Limits
The road construction techniques available impose a speed limit on trains as shown in the speed limit table below.

Train Type	Speed Limits
Standard	200kph
Airfilm/Maglev	500kph

Rolling Stock

Rolling stock consists of locomotives and cars. The weight and prices below are for Maglev/Airfilm trains.. Standard trains will be at least 3-5 times heavier and 1/3 of the price.

Rolling Stock Type	Weight (tons)	Price
Engine	130	Lv275,00
Passenger Car	50	Lv75,000
Cargo Car	30	Lv20,000

Tunnels

Roads and railroads may need tunnels to pass through hills and mountains. Tunnels may also be built as underground dwellings. In the case of road and rail tunnels, determine the height and width of the vehicles passing through the tunnel and add 10% to these figures to provide sufficient clearance. Then multiply this square meter result by the horizontal length in meters to determine the tunnel volume. Calculate the price in Lv by multiplying the volume by the price per cubic meter (Lv200 per cubic meter).

Mines

Deep mines require vertical shafts and horizontal tunnels. Vertical mine shafts have a volume equal to the depth of the mine times a cross section of 36 square meters, large enough for an ore elevator and a personnel elevator. Horizontal tunnels, called 'drifts,' have a volume equal to their length in meters times their cross section of 9 square meters. Rooms may be dug at the ore face to allow rooms for digging machines and other

heavy equipment. Vertical shafts cost Lv1000 per vertical meter of shaft. Horizontal drifts cost Lv500 per horizontal meter.

Buildings

Buildings are similar to starship hulls in several respects, and they can be designed in a similar fashion. They have specific shapes and they enclose volume. To design a building

Volume

Determine the volume of your building. As a guide, the average height of an enclosed room in a building is 3 meters. The average area of a house is 500 square meters. Therefore, the volume of an average one-story house is 1500 cubic meters. Our example will be a 1400 cubic meter building.

Shape

Select the house's shape. Cylinders, Boxes, Spheres, and Domes are commonly used for buildings, with Boxes being the most common. We select Box for the house.

Volume Formulas

Shape	Formula
Cylinder	Pi *x* Radius^2 *x* Height
Box	LxWxH
Sphere	$^4/_3$ *x Pi x* Radius^3
Dome	(Pi *x* Radius^2 *x* Height)/.5

Construction Material
Select a construction material from the Construction Material Table. We select stone because it is readily available. Because we are concerned about possible native attacks, we want our house to have some armor value. Our walls will be 6.7 centimeters thick with an armor value of 1 (AV per cm x 6.66). Our construction material volume equals 1 cubic meters per 100 cubic meters of volume(14) times the mass multiplier(2.5) times the
thickness (6.7). We need 234.5 cubic meters of stone to build our house. The construction material costs Lv500 per cubic meter or (100 x 234.5) Lv 23,450.

Construction Materials Table

Type	AV per cm	Mass Multiplier	Price per M^3
Loose Dirt	.03	1.5	Lv1
Stone	.15	2.5	Lv100
Wood	.025	.7	Lv500
Masonry	.25	3	Lv1000
Reinforced Concrete	.5	4	Lv1,500
Hardened Steel	1.0	8	Lv1,600
Construction Steel	.8	8	Lv1,700
Aluminum	1	3	Lv1,500
Glass	.01	2.5	Lv1,000
Aligned Crystal Steel	1.5	6	Lv2,000
Construction Composites	2.0	3	Lv2,500
Composite Matrix	3.0	4	Lv4,000

Interior Structure
Simple homes have their load bearing structure within their exterior walls. Wooden buildings may not be built more than three stories high without an interior structure. More complex buildings taller than three stories require interior structures. These are commonly built of iron or steel beams. Other buildings may use their interior structures for support, with their exterior not bearing any load. It's possible for buildings to have a steel interior structure and glass exterior walls. If non-load bearing interior walls are desired in a building, add them at 5% multiplied by the number of rooms in the building times the cost of the exterior walls. We want 5 rooms in our home so we add interior walls for Lv5,862.5

Power
The wiring for electrical power costs Lv500 per 1000 cubic meters of structure. Since our structure has a 1400 cubic meter volume, electrical wiring will cost (Lv500 x 1.4) or Lv700. If the building is in a remote location, it may have its own power plant selected from those listed in the NAM. This home would require a power plant capable of supplying 1 kilowatt.

Plumbing
Piping to supply water and remove waste costs Lv300 per 1000 cubic meters of structure or (Lv300 x 1.4) or Lv420.

Cost
Add up the cost of each component. This is the cost of the basic building, it does not include carpeting, furniture or other amenities. This house costs Lv30,432.5.

Construction Times

Every project has its construction time measured in days. There is no set scale for how many man days a project takes. The following section will give some modifiers for how long the basic man days of a project are increased/decreased.

Benjamin Levy's Universal RPG Construction/Engineering Task Modifier Table

Site Quality	Labor Modifier
Wide Open and Level	.75
Some brush, gentle slope	1
Rolling Land	1.25
Thick Vegetation	1.5
Ruins or Demolished Structures	2
Congested Urban Area	2.5
Swamp	3
Mountainous Rainforest	4
Underwater	5
Hellish	7

Equipment Quality	Labor Multiplier
Everything they want and then some	.7
The supervisors Wish List	.8
State of the art	.9
Well Equipped	1
Foreman read catalogues and sighed	1.2
Moderately Equipped	1.5
Minimally Equipped	2
A few power tools	2.5
Hand tools only	3.5
Mostly "field expedient" tools	5

Environmental Conditions	Labor Multiplier
Indoors	.9
Shirtsleeve comfort	1
Heavy Clothing	1.1
Very Hot	1.25
Very Cold	1.5
Very Cold, with protective gear	2
Very Hot, with protective gear	2.5
Scuba Equipment	3.5
Pressure Suit	5
Heavily Armored Environment Suit	7

Crew Quality	Labor Multiplier
Elite Military Engineers	.4
Military Engineers	.6
Top Notch professionals	.8
Professionals	1
Unskilled laborers with good leaders	1.2
High spirited amateurs	1.5
Spoiled and lazy union	2
Co-opted Peasants	3
Slaves/Prisoners	4
Disgruntled Slaves/Prisoners	5

ALL MODIFIERS ARE CUMULATIVE!

Example: a 100 man-day task, performed by: Elite Combat engineers, in light clothing, with state of the art equipment, in open and level ground takes: .75 x .9 x 1 x .4 x100 Man days or 27 man days . An illiterate mob of peasants with axes and shovels, in a very hot swamp takes: 3 x 1.25 x 3.5 x 3 x 100 Man Days or 3938 man days! (Always Round UP)