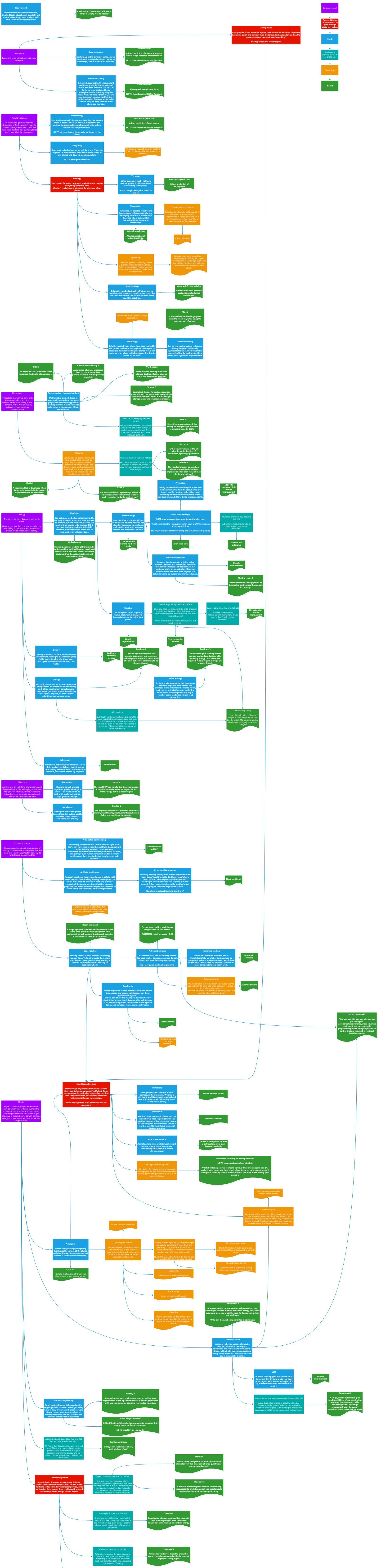


Starting research

Prerequisite for other research, or 'pass through' study for realism.

Study

Study which requires a hot lab or orbital lab

Suggestion

Result

Basic research

Improvements to scientific methods, tweaked tests, education of our staff, and a lot of other things need study as well; that's what basic research is for!

Random improvements to efficiency/ random (small) morale booster

Astrophysics

Basic physics of our new solar system, which includes the orbits of planets (including ours!) and some of their properties. Without understanding the physics involved, we can't launch anything!

NOTE: prerequisite for aerospace

Astronomy

Everything to do with planets, stars, and asteroids.

Basic astronomy

Looking up at the sky is not sufficient; we need more advanced methods to give us knowledge, and to warn us for asteroids.

Meteorite alert

Allows prediction of meteorite impacts, with a rough expected impact location.

NOTE: should require DIRT to function?

Stellar astronomy

Sol, which supplied Earth with sunlight and thereby enabled life to form and thrive, has been known to 'act up'. On Earth, we were protected by an atmosphere and a planetary magnetic field. We don't have either here, so we need to protect ourselves. A first step is to find out when flares are about to hit, and for that, we need to know more about our new star.

Solar flare alert

Allows prediction of solar flares.

NOTE: should require DIRT to function?

Planetary sciences

In our rush to get away from the destruction of Earth, we didn't have the time to investigate our new planet. We need to understand how our new planet works, and what the dangers are.

Meteorology

We don't have much of an atmosphere, but that doesn't mean it doesn't affect us. Massive dust storms can destroy the whole colony, and we need to be able to understand and predict them.

NOTE: perhaps change the description based on the planet?

Dust storm prediction

Allows prediction of dust storms.

NOTE: should require DIRT to function?

Geography

If we want to find where we parked the truck, "Near the big rock" is not sufficient. We need to make a map of our planet, and devise a mapping system.

NOTE: prerequisite for GPS?

The planet is mapped properly, resulting in tile coordinates, which increases truck efficiency.

Geology

'Geo' stands for earth, or ground, and this is the study of everything related to that.
We don't really know a lot about the structure of our planet.

Tectonics

While our planet might not have tectonic plates, it still experiences devastating earthquakes!

NOTE: change description based on planet?

Earthquake prediction

Allows prediction of earthquakes

Vulcanology

Vulcanoes are capable of delivering huge amounts of raw materials, and destroying whatever is in their way. Knowing where they will hit beforehand is of the utmost importance.

Volcanic prediction

Allows prediction of volcanic activity.

Vulcanic defence systems

Rerouting lava flows by building walls or somethin'. Vulcanism wasn't implemented in the original, and if it is implemented here, then there'd be a need for some form of defences

Volcanic defences

Speleology

There are layers of caverns right under our feet, just waiting to be utilized. Safety concerns have held us back, but it's time to look at ways to make these caverns usable.

Unlocks more underground layers: Depending on difficulty, less layers available initially (Mars-type starts with two UG layers), others start with one. This enables one or two additional layers.

Road building

Driving in the dirt isn't really efficient, and we don't have the resources to make actual roads. But we should be able to use the dirt to make some road-like substrate.

(Automatic?) road building

Roads can be built between destinations, shortening travel times.

Mineralogy

Only the most obvious places have been marked by our probes, and we're in danger of running out of resources. In understanding our planet, we've had some hints on where to find resources. It's time to follow up on these.

Enable new mine location finding/ explorer bot.

Terrestial mining

Our current mining system relies on a hastily designed, universally applicable facility. Something that is more suited for the environment here would yield significant improvements.

Mine 2

A more efficient mine design yields twice the resources, while using the same amount of energy!

Mathematics

"The subject in which we never know what we are talking about, nor whether what we are saying is true."
- Bertrand Arthur William Russell, philosopher, mathematician, historian, writer

System analysis (requires hot lab)

Mathematics by itself does not have much practical use, but when proper mathematics is applied to existing systems, it can be used to make those systems more efficient and effective.

DIRT 2

An improved DIRT allows for faster responses, leading to a larger range.

Administrative facility 2

Automation of simple processes frees up one in every three people, as well as reducing energy footprint.

Warehouse 2

More efficient packing and better storage doubles effective storage space, and lowers energy usage.

Storage 2

Specialized storage for certain resources, more efficient checks for leaks, and multiple other improvements result in a doubling of storage space, and lowers energy usage.

Molecular bookkeeping (requires hot lab)

Our air comes from the CHAP, which uses energy and carbon dioxide to produce oxygen and carbon. This is a very simple method, and can be improved quite a bit.

CHAP 2

Several improvements result in a halving of energy usage, while the output increases by 200%!

Statistics

Conclusions are based on data, but data by itself does not really do anything. That's where statistics comes in; advanced analysis will allow us to use smaller datasets and faster methods, as well as generate more reliable conclusions. This benefits research greatly!

Advanced statistics (requires hot lab)

With the advance of science, and the creation of the hot lab, we see a need for more advanced methods of data analysis.

UG Lab 3

Further improvements to the lab allow for easier logging of discoveries, speeding up research.

Hot lab 2

The new lab is less of a powerhog, while it's ameneties have been improved to allow each researcher to do the work of two!

Hot lab

A specialized lab is developed where large-scale, potentially dangerous experiments can be performed.

UG Lab 2

The new lab is less of a powerhog, while it's ameneties have been improved to allow each researcher to do the work of two!

Biology

The science of life or living matter in all its forms.

Growth, structure, function, and reproduction, everything from the smallest bacterium to human medicine falls under biology.

Medicine

We got some medical supplies from Earth, but they're bound to run out. First, we need to produce our own medicine. Second, we need to train people to be doctors. Third, we need to design equipment like MRI scanners, blood machines. We're also in dire need of an inflation room.

Medical centre

Medical personnel tends to gather around a coffee machine, which this newly developed medical centre provides. There's also some equipment for diagnosis, treatment, and prevention available.

Pharmacology

Basic medicine is not enough; our colonists will develop diseases and disorders that we're currently not equipped to treat, such as cancer, strokes, and Parkinson's disease.

Life extension beyond medieval levels

Alien pharmacology

NOTE: only appears after encountering the alien virus

The alien virus is the first ever proof of alien life. Unfortunately, it's trying to kill us.

NOTE: prerequisite for terraforming bacteria, advanced genetics

Alien virus cure

Prevention

Curing a disease is like draining the water from the basement after it has flooded. Better is to inspect and fix the pipes before they burst. Preventing disease and disorder saves doesn't just save time and effort, it also improves health.

Little life extension, little morale improvement

Advanced pharmacology (requires hot lab)

Advances in medicine showed us better ways to treat certain disorders.

Further life extension

Subclinical medicine

Disorders like rheumatoid arthritis, celiac disease, diabetes, and many other 'non-life-threatening' diseases and disorders are still putting a strain on our colonists. If we can alleviate these disorders, even slightly, our colonists would be happier and more productive.

Morale improvement

Medical centre 2

Improvements to the equipment of the medical centre more than double its capacity!

Genetics

The 'blueprints' of an organism, be it a bacterium, a plant, or a human being, are locked in their genes.

Health improvement

Genetic engineering (requires hot lab)

Changing the genetic information of an organism can yield great benefits; plants that grow faster, bacteria that degrade industrial waste, and even medical benefits!

NOTE: prerequisite for several things, figure out which ones later

Food production increase

Genetic corrections (requires hot lab)

Disorders like Parkinsons, Alzheimers, and many, many others can be 'fixed', with genetic techniques.

Life extension, morale improvement

Botany

Some plants don't perform well in this new environment, leading to disappointing crop yields. Understanding why these plants don't perform well will increase our crop yields.

Agridome efficiency increase

Agridome 2

The new agridome requires less people, less energy, less resources, and still produces twice as much food! The taste still leaves something to be desired, though.

Ecology

On Earth, nature was an enormous network of organisms, all dependant or influencing each other, in extremely complex ways. Here, we've got plants in pots. Introducing other species of plant, or even animals, might improve our crop yields

Niche ecology

Ecology is a large network, but some parts are more 'separate' than others. For example; a lake influences the nearby forest, and vice versa. Including other ecological networks in our food production might result in easier (and more varied) food production.

Agridome 3

A breakthrough in farming further doubles our food production, while reducing energy costs, resources required! It does require more people to work, though.

Alien ecology

Eventually, we'd want to change our planet to a more hospitable environment. We don't know how to do that, or how that environment should look, but we do know we're going to need a lot of bacteria and plants making an atmosphere for us.

Terraforming facility

Start of terraforming. It'll take a couple of thousand years like this, but it's a start. Maybe some random tile changes, to signify some small changes?

Embryology

Infants are not doing well; for some reason their survival rate is lower than it was on Earth during medieval times. We don't know the cause, but we can't stand by anymore!

More babies!

Chemistry

Alchemy was an early form of chemistry, and is frequently associated with trying to turn lead into gold. But what would we do with gold? Using chemistry, we can turn rocks into air, which is far more valuable here.

Biochemistry

Humans, as well as most organisms, produce biological waste. This waste has to be dealt with, preferably without any 'gaseous spillage'.

SPEW 2

The new SPEW can handle five times more waste! It requires more resources, more people, and more energy, but to a lesser degree.

Metallurgy

Getting ore out of the ground is one thing, but getting usable materials out of the ore is something else entirely.

Smelter 2

The improved smelter uses twice the amount of energy, but efficiency improvements result in ore being processed four times faster!

Computer science

Computers are amazing things, capable of making our lives easier, more productive, and more fun! However, computers can only do what they're programmed for.

Automated bookkeeping

How many students does it take to switch a light bulb? We're not sure, since we don't count them changing light bulbs. Actually, we don't count anything. Automated algorithms that monitor production, research, and perhaps even human behaviour can tell us where problems are likely to arise before they become, well, problems.

Administrative facility?

Artificial intelligence

Research has shown the average human is able to hold seven items in their working memory. A computer can hold a huge amount of items in memory, but is not capable of the same operations. Creating computer programs that are somewhat intelligent can take care of some issues that we do not have the capacity for.

AI personality problems

AI is only partially coded; most of their capacities come from being 'taught' what to do. However, AI's have been know to misinterpret and misunderstand, resulting in unwanted behaviour. Figuring out why some AI is fine in one situation, while another is not, might give us better ways to teach them.

(Question: what problems did they have?)

No AI problems?

Create a new repeatable study that generates an AI (those things need to be trained, rather than programmed)

Robot command

A single operator can direct multiple robots at the same time, given the right equipment. This equipment, as well as some simple repair supplies, is maintained in the Robot Command.

Basic robotics

Making a robot is easy, with the technology we now have. Telling it what to do, is more complicated. Some general programming is needed, before we can start working on specific solutions.

Advanced robotics

Our robots break, and are severely limited. We need smaller components, more durable alloys, and more flexible programming.

NOTE: requires electrical engineering

Proper servos, wiring, and simpler design allows for less defects.

FUNCTION: robot breakage * 0.25

Humanoid workers

"Would you like some more tea, Mr. J?"
Simple tasks take up a lot of time, and can be dangerous. Robotic workers can take care of those simple tasks, which frees up valuable colonists for more complex (and less nasty) work.

Humanoid workers

Automatic trucks

Driving for days, in a rocky desert, in a plastic box the size and with the smell of a small bathroom, is a recipe for boredom and irritation.
It should be simple to automate our trucks; it's not like there's a lot of traffic out there.

Automatic trucks

Repairbots

Proper inspection can see potential problems before they appear, and proper maintenance can them problems altogether.
But we don't have the manpower to inspect every single thing; we can barely keep up with maintenance as is! A supporting robot can do most of the legwork for us, and perhaps even do some small repairs

Repair robots

Maintenance of all structures decreases?

Robot command 2

"Yes, yes, yes, dig, yes, yes, dig, yes, are you there yet?"
More complex commands, more advanced equipment, and more versatile programming allows a single operator to control twice as many robots without breaking a sweat.

Physics

Physics consists mainly of 'experimental physics', which tries to figure out how the universe works by performing experiments. These experiments can tell us how to get planes up in the air, how to convert light into energy (and vice versa), and how to talk over long distances.

Satellites and probes

Monitoring every single satellite isn't feasible; they need to be somewhat self-sufficient. Some programming is required to ensure they can deal with simple situations, like course corrections, with minimal human intervention.

NOTE: are supposed to be constructed at the spaceport.

Meteorsat

Falling meteorites can cause a lot of damage, without warning. We should develop a satellite network to detect and deal with these rocks, before they wreak havoc on our colony.

Meteor defence system

Weathersat

We don't have that much of weather, but we do have a need to predict when the weather changes; a dust storm can cause a lot of damage to an unprepared colony. A weather satellite should give us enough advance warning.

Weather satellites

Solar power satellite

A single solar power satellite was brought, but our energy needs have grown substantially since then. It's time to develop more.

Launch a solar power satellite → extra solar power plant becomes available

Geologic penetrator probe

Diggind in the dirt can tell us where good mining spots are, but a satellite dedicated to scanning the underground could tell us a lot more, a lot faster.

Automated discovery of mining locations.

NOTE: makes explorer robots obsolete

NOTE: bulldozing old mines should 'remove' their mining spots, and this probe should make sure there's only about ten or so extra mining spots. If one spot is taken by a mine, then in the next few turns a new mining spot appears.

Comsat/navsat

We're limited to a small part of the planet, because we have no way of communicating if we move too far beyond the horizon, nor do we have a way to figure out how to get back. Small communication and navigation satellites would enable use of the whole planet.

Communication over other sectors of the planet?

Aerospace

Planes and spaceships; everything that leaves the surface of the planet, and flies through the atmosphere and beyond is studied under aerospace.

Space port

Rockets, shuttles, and other vehicles; they all need a spot to launch from.

Orbital space stations

We need a space station to facilitate orbital activities; certain forms of production and research can only be done in orbit, and there are some resources we're keen on.

Orbital station construction

Getting something in orbit is relatively simple, but getting something to move from one planetary body to another is quite hard. Making it land safely is even more complex. And we want it to come back as well…

NOTE: there was something in the original that requires this, I think. In any case; asteroid

Asteroid capture probe

NOTE: for realism, maybe capturing an asteroid could take an equivalent of a month or six.

Asteroid mining station

Construction of an automated mining station, on the asteroid that is in orbit.

Space dock

Construction of interplanetary stuff?

Space factory

Increase in factory efficiency?

Space lab

Enables some extra studies (those I guess need something extra, like the hot lab or the space lab, are made in the blue+green colour).

Communications

A simple radio has a range of about a hundred kilometres, under good conditions. The radios we're using are too simple, which limits our communications. Using more advanced radio's will increase our communications range.

Commtower 2

Advancements in communication technology lead to a doubling of the area of effect at half the energy cost, while automatic protocols lower the need for human interaction to a minimum.

NOTE: can the AoE be implemented in some way?

SETI

On of our lifelong goals was to find extra-terrestrial life. It's time to start up that project again. Who knows; we might pick up a transmission from another human colony!

Morale improvement

Harsh environment signals processing (requires hot lab)

A good radio has a range of about two hundred kilometres, under good conditions. Unfortunately, conditions are not good. Advanced signal analysis and processing should increase our communications range.

Commtower 3

A single, mostly automated spire handling all kinds of communications protocols simultaneously, while harvesting half of its energy requirement from the energy contained in the transmissions itself!

Electrical engineering

Small electronics used to be produced in large high-tech factories. We've got a very basic factory system, which produces very simple components. A more advanced factory is required, and our facilities can also use some better components.

Factory 2

Automating the most obvious processes, as well as some improvement of the equipment results in double production with less energy usage, as well as less wasted materials.

Power usage decreased

All facilities benefit from better components, lowering their energy usage by five to ten percent.

NOTE: shouldn't be too much?

Alternative power generation (requires hot lab, and a localized steam vent)

We found that this planet has active thermal vents! These vents radiate heat from the planet's' core, and therefore is a good source of near-infinite energy, and we should be able to tap into this without too much work.

Geothermal thingy

Energy from subterranean heat, with minimal effort!

Theoretical physics

Several fields of physics are extremely difficult - and in some cases even impossible - to test. Those fields are collected under 'theoretical physics', since we develop theory upon theory, with verification of our theories often being a distant dream.

Superconductivity (requires orbital lab)

If you run a current through a wire or electrical component, it gets warm. This heat is energy loss, and is due to the resistance of the material. However, certain materials under certain conditions can have no resistance, resulting in superconductivity.

Monorail

Similar to the rail systems of earth, the monorail allows for very fast transport of large quantities of resources and people.

Mass driver

A massive electromagnetic cannon, for shooting resources into orbit. Equipment and people would be squished, but rock survives quite nicely.

Plasma physics (requires hot lab)

If you heat up solid matter, , eventually it melts. If you heat it up more, it becomes a gas. If you heat it up even more, it becomes plasma, which has all kinds of interesting properties.

Tokamak

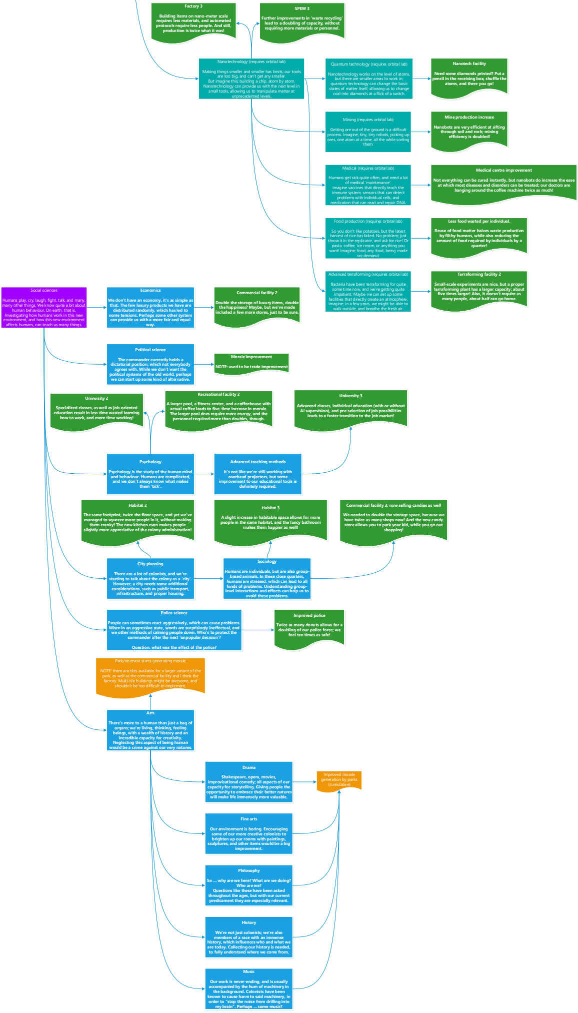
Superheated plasma, contained in a magnetic field, where hydrogen fuses to become helium, releasing massive amounts of energy.

Antimatter (requires orbital lab)

Antimatter is roughly the same as normal matter; it can form atoms, bonds, and everything. But if matter and antimatter meet, they annihilate each other, releasing huge amounts of energy.

'Tokamak' 2

Antimatter yields over twice the amount of energy, but also requires double the amount of people. Safety, right?



Factory 3

Building items on nano-meter scale requires less materials, and automated protocols require less people. And still, production is twice what it was!

SPEW 3

Further improvements in 'waste recycling' lead to a doubling of capacity, without requiring more materials or personnel.

Nanotechnology (requires orbital lab)

Making things smaller and smaller has limits; our tools are too big, and can't get any smaller.
But imagine this; building a chip, atom by atom.
Nanotechnology can provide us with the next level in small tools, allowing us to manipulate matter at unprecedented levels.

Quantum technology (requires orbital lab)

Nanotechnology works on the level of atoms, but there are smaller areas to work in; quantum technology can change the basic states of matter itself, allowing us to change coal into diamonds at a flick of a switch.

Nanotech facility

Need some diamonds printed? Put a pencil in the receiving box, shuffle the atoms, and there you go!

Mining (requires orbital lab)

Getting ore out of the ground is a difficult process. Imagine; tiny, tiny robots, picking up ores, one atom at a time, all the while sorting them.

Mine production increase

Nanobots are very efficient at sifting through soil and rock; mining efficiency is doubled!

Medical (requires orbital lab)

Humans get sick quite often, and need a lot of medical 'maintenance'.
Imagine vaccines that directly teach the immune system, sensors that can detect problems with individual cells, and medication that can read and repair DNA.

Medical centre improvement

Not everything can be cured instantly, but nanobots do increase the ease at which most diseases and disorders can be treated; our doctors are hanging around the coffee machine twice as much!

Food production (requires orbital lab)

So you don't like potatoes, but the latest harvest of rice has failed. No problem; just throw it in the replicator, and ask for rice! Or pasta, coffee, ice cream, or anything you want! Imagine; food, any food, being made on-demand.

Less food wasted per individual.

Reuse of food matter halves waste production by filthy humans, while also reducing the amount of food required by individuals by a quarter!

Advanced terraforming (requires orbital lab)

Bacteria have been terraforming for quite some time now, and we're getting quite impatient. Maybe we can set up some facilities that directly create an atmosphere. Imagine; in a few years, we might be able to walk outside, and breathe the fresh air.

Terraforming facility 2

Small-scale experiments are nice, but a proper terraforming plant has a larger capacity: about five times larger! Also, it doesn't require as many people, about half can go home.

Social sciences

Humans play, cry, laugh, fight, talk, and many, many other things. We know quite a bit about human behaviour. On earth, that is. Investigating how humans work in this new environment, and how this new environment affects humans, can teach us many things.

Economics

We don't have an economy, it's as simple as that. The few luxury products we have are distributed randomly, which has led to some tensions. Perhaps some other system can provide us with a more fair and equal way.

Commercial facility 2

Double the storage of luxury items, double the happiness? Maybe, but we've made included a few more stores, just to be sure.

Political science

The commander currently holds a dictatorial position, which not everybody agrees with. While we don't want the political systems of the old world, perhaps we can start up some kind of alternative.

Morale improvement

NOTE: used to be trade improvement

Psychology

Psychology is the study of the human mind and behaviour. Humans are complicated, and we don't always know what makes them 'tick'.

University 2

Specialized classes, as well as job-oriented education result in less time wasted learning how to work, and more time working!

Recreational facility 2

A larger pool, a fitness centre, and a coffeehouse with actual coffee leads to five-time increase in morale. The larger pool does require more energy, and the personnel required more than doubles, though.

Advanced teaching methods

It's not like we're still working with overhead projectors, but some improvement to our educational tools is definitely required.

University 3

Advanced classes, individual education (with or without AI supervision), and pre-selection of job possibilities leads to a faster transition to the job market!

City planning

There are a lot of colonists, and we're starting to talk about the colony as a 'city'. However, a city needs some additional considerations, such as public transport, infrastructure, and proper housing.

Habitat 2

The same footprint, twice the floor space, and yet we've managed to squeeze more people in it, without making them cranky! The new kitchen even makes people slightly more appreciative of the colony administration!

Sociology

Humans are individuals, but are also group-based animals. In these close quarters, humans are stressed, which can lead to all kinds of problems. Understanding group-level interactions and effects can help us to avoid these problems.

Habitat 3

A slight increase in habitable space allows for more people in the same habitat, and the fancy bathroom makes them happier as well!

Commercial facility 3; now selling candies as well

We needed to double the storage space, because we have twice as many shops now! And the new candy store allows you to park your kid, while you go out shopping!

Police science

People can sometimes react aggressively, which can cause problems. When in an aggressive state, words are surprisingly ineffectual, and we other methods of calming people down. Who's to protect the commander after the next 'unpopular decision'?

Question: what was the effect of the police?

Improved police

Twice as many donuts allows for a doubling of our police force; we feel ten times as safe!

Arts

There's more to a human than just a bag of organs; we're living, thinking, feeling beings, with a wealth of history and an incredible capacity for creativity. Neglecting this aspect of being human would be a crime against our very natures.

Park/reservoir starts generating morale

NOTE: there are tiles available for a larger variant of the park, as well as the commercial facility and I think the factory. Multi-tile buildings might be awesome, and shouldn't be too difficult to implement.

Drama

Shakespeare, opera, movies, improvisational comedy; all aspects of our capacity for storytelling. Giving people the opportunity to embrace their better natures will make life immensely more valuable.

Fine arts

Our environment is boring. Encouraging some of our more creative colonists to brighten up our rooms with paintings, sculptures, and other items would be a big improvement.

Philosophy

So ... why are we here? What are we doing? Who are we?
Questions like these have been asked throughout the ages, but with our current predicament they are especially relevant.

History

We're not just colonists; we're also members of a race with an immense history, which influences who and what we are today. Collecting our history is needed, to fully understand where we come from.

Music

Our work is never-ending, and is usually accompanied by the hum of machinery in the background. Colonists have been known to cause harm to said machinery, in order to "stop the noise from drilling into my brain". Perhaps ... some music?

Improved morale generation by parks (cumulative)