Landing a large starship on a planet's surface would usually be an enormous construction problem. Keep it in orbit, and have it dispatch smaller task groups.

Spaceship Design Essentials

by Oton Ribić

"Realistic" is a slightly unusual adjective to use in the context of spaceships, isn't it? After all, we as a race don't have much of a spacefaring history (yet). But you may be one of those technically-minded builders who prefer even their wildest space creations to follow at least some principles of science and engineering. Or, in other words, one who wants to emphasize "sci" in their sci-fi, at least to the extent of space engineering as we can envision it today.

What goes where

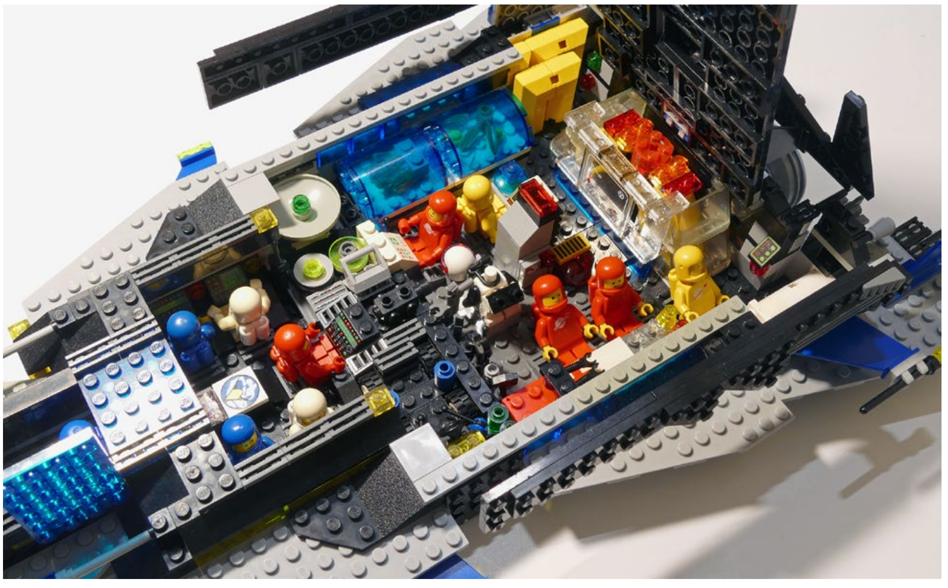
If you like the idea but have no clue where to start, let's consider the general spaceship design first–its layout, shape and form.

It is very convenient indeed to build spaceships from their floor upward, similar to any building. This typically leads to long (and possibly wide) but low, flat designs. They may look cool on the landing pad, but they are rather impractical in reality. The primary reason is their cumbersomeness: such designs actually provide relatively low usable interior volume in relation to the material needed for their hull. And any extra hull means extra weight, which means more fuel, which in turn brings much more complexity.

Therefore, efficient spaceship designs are rather chunky and compact. A perfect sphere would be a theoretical ideal case with the most volume enclosed in the lightest hull, but this is impractical for other reasons–within or beyond LEGO. The usual reason against such a design is the possible need for the ship to fly efficiently through an atmosphere–which would require it to be aerodynamic–and therefore usually more elongated, as is the case with most rockets fired from the Earth today. In such cases, a suitable compromise is needed.

Gravity and its directions

While on the topic of hulls, unless working with gravity generators, spaceships would spend

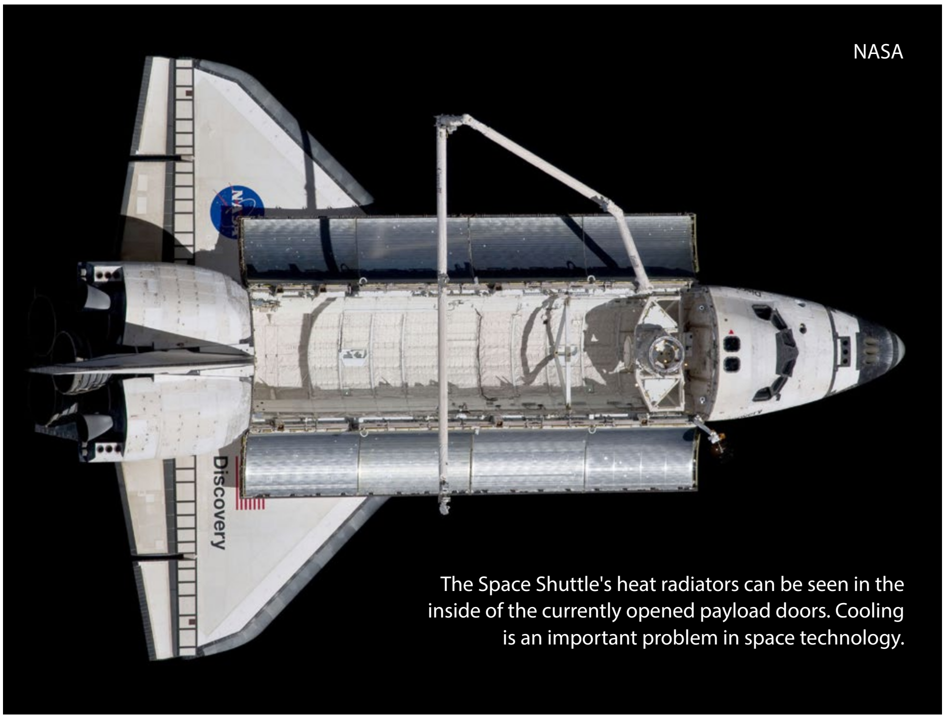


A classic problem with the crew sitting on the "floor". When the engines at the side start, that floor becomes a wall for the crew! Better prepare some gravity generators!

most of the time either at zero gravity or at light acceleration. This means there is no need for distinct floors and ceilings–everything is a potential work surface, just like in the real world, i.e. the International Space Station.

Furthermore, if there is some notion of gravity due to the acceleration by the engines, the “floor” will point in the contrary direction, towards the engines themselves. This is contrary to the usual design of the cabin floor pointing down, but the engines driving the ship sideways. That works fine for cars where the Earth gravity always points downward–but in space, it would make the spacefarers feel as if they were sitting on a wall.

An advanced trick, well-known to passionate fans of sci-fi movies, is to disregard these and create a proper artificial gravity environment by rotating the crew cabins, where the centrifugal force takes the same role. In LEGO ships, making the entire crew compartment rotatable requires some tough and proper, but when successful, very satisfying engineering!



NASA

The Space Shuttle's heat radiators can be seen in the inside of the currently opened payload doors. Cooling is an important problem in space technology.

Wings? No. Or actually, yes

The next point is–perhaps surprisingly?–the wings. Many aspiring Classic Space builders have been wrongly ridiculed for fitting wings onto their starships, with snarky comments about the space having no atmosphere, nor strong gravity to lift against. Those observations aren’t incorrect, but the wings conundrum is not that simple.

In space technology, cooling is a serious problem. Very serious. In contrast to to aeroplanes which can at least transmit some of their heat to the air they are passing through, space vehicles have no such luxury. One possible solution is to fit heat radiators to the ship, and these should be thin yet have a large surface area for efficiency–and wings fit that description perfectly. Even the real-life Space Shuttle had such radiators at the inside of its bay doors, and a hypothetical large spaceship dealing with much higher energies would need even larger ones.

Therefore, some kind of heat dissipation system would be needed, perhaps looking exactly like wings–and thus vindicating their presence on starships. By the way, every now and then, when filming a Sci-fi movie, writers who have done their homework will specify that the ships will need to have heat dissipators, only to have them removed later by production personnel for fear of being ridiculed my the misinformed–why would a spaceship need wings?

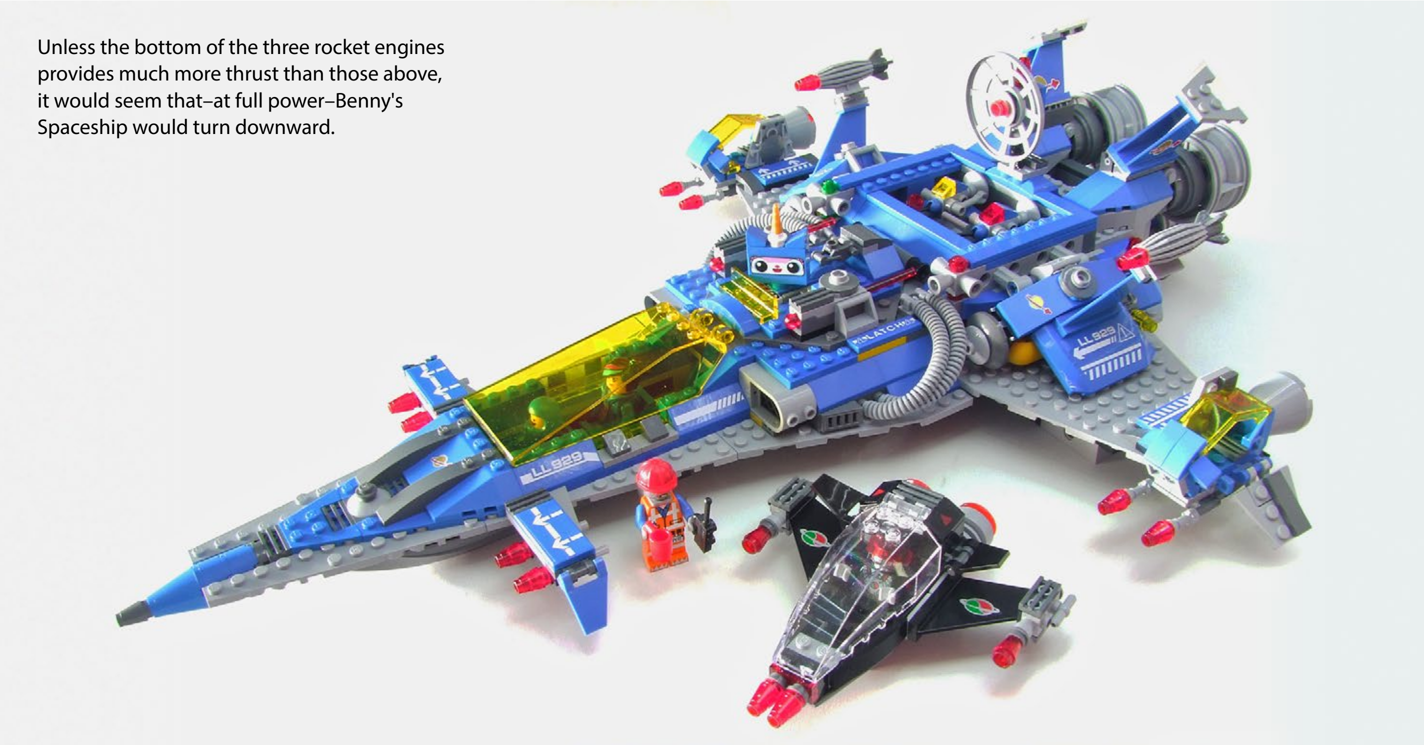
Space's Middle ages, in this case the Exploriens, detracted from the raw utilitarian construction of its predecessors in favor of more flashy stuff.

Space drivin’

Spaceship propulsion systems are another complex problem to consider. With our current knowledge, ships that require strong acceleration, or the ability to take off from a planet, require massive amounts of fuel. It is not without reason that the majority of today’s spacecraft are, as someone pithily put it: “flying fuel tanks with some additions”.

Even if we assume the future will bring much more efficient engines, and therefore require much less fuel, some kind of fuel will still be needed. But then the fuel tanks will have to either be directly in front of the engines, or spread symmetrically around the ship. Otherwise, as the fuel gets expended during the journey, the ship’s center of mass will shift, either deviating the ship off its course, or requiring constant corrections (again, using more fuel). This is actually a significant design problem in aeronautic engineering as well.

Furthermore, a ship with at least moderate maneuverability requires some kind of side thrusters to rotate it around its three main axes. They don’t need to be large because spaceships don’t need to fly through an obstacle course, but they should be there–and it’s delightful to see that The LEGO Group acknowledged this too in some of their Classic Space sets.



Unless the bottom of the three rocket engines provides much more thrust than those above, it would seem that–at full power–Benny's Spaceship would turn downward.

Keeping people alive (and happy)

Unless we're going for an automated vehicle, which is a rather rare occurrence in Classic Space, there will be a need for some kind of life support, at least if it is to house a crew for more than just several hours.

Many potential problems can be circumvented via the classic trick: assuming the hibernation technology is available and possible to implement in confined and energy-limited spaceship conditions.

But otherwise, if you want to keep your creation viable, keep in mind that any starship destined for long journeys requires a dramatic amount of life support goods. An average human will hardly survive without at least 2-3 kilograms of nutrition (food and drink) a day. With twenty crew members and the planned maximum mission time of one year, it amounts to no less than 15 metric tons of goods, or the size of a chunky van. Even with dehydration, recycling and rehydration of food, it cannot be shrunk by more than a half.

At least air can be compressed, and even filtered and reused providing there is enough energy. But any sensibly designed ship would at least have some emergency oxygen to recompress the cabin in the case of leakage, or worse, battle damage.

If you would like to keep the crew happy, an important aspect of life support is keeping them sane, as already well-known by designers of submarines, ships and similar vehicles. Long stays in confined space, especially with limited communication, tend to make people unstable–therefore, it is wise to dedicate some space to their pastimes, regardless of how expensive the mass and volume of starships actually are.

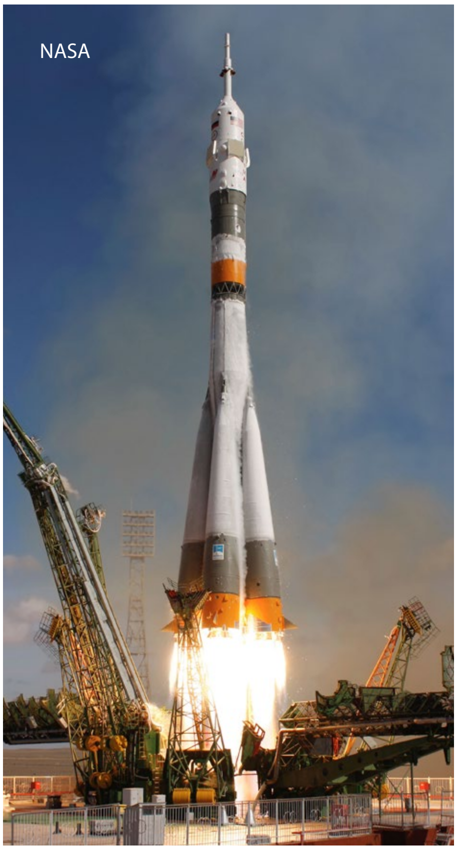
No planetary excursions, please

The requirement for a starship to be able to land on surfaces of planets is a devastating one for the spaceship builders. It requires the hull to be much, much more sturdy, and also the engines require enormous power in order to lift all that reinforced hull from the surface when it's time to go home.

As a consequence, a more sensible approach is to keep the large mothership in orbit, free from significant gravity and atmosphere, and have smaller ships, fit for landing on planets, do the actual transportation from the mothership to the surface and back.

This also lets the large mothership's propulsion systems be smaller. In fact, if the mothership gets assembled in zero gravity, and only ever travels to other stellar systems and their orbits, never to actually land on a planet, it can do so with only very slight acceleration (providing there is no rush). Standard movie scenes of the crew slamming back against their seats under the brutal acceleration of their massive starship undoubtedly look cool, but that would never be really needed.

However, they say that any crazy assumption is perfectly acceptable in science fiction as long as it serves a good plot. Therefore, the point is not necessarily to always follow everything that common-sense engineering might demand. Yet trying to balance many such requirements when designing a spaceship, especially those that are partially contradictory, brings its own delights as well. And even if you get asked why there are computers on the ceiling, or why three-quarters of the ship is just fuel tanks and food stores, at least you'll have a good answer ready.



Until a much more powerful or efficient fuel or propulsion is invented, spacecraft will largely remain "flying fuel tanks"