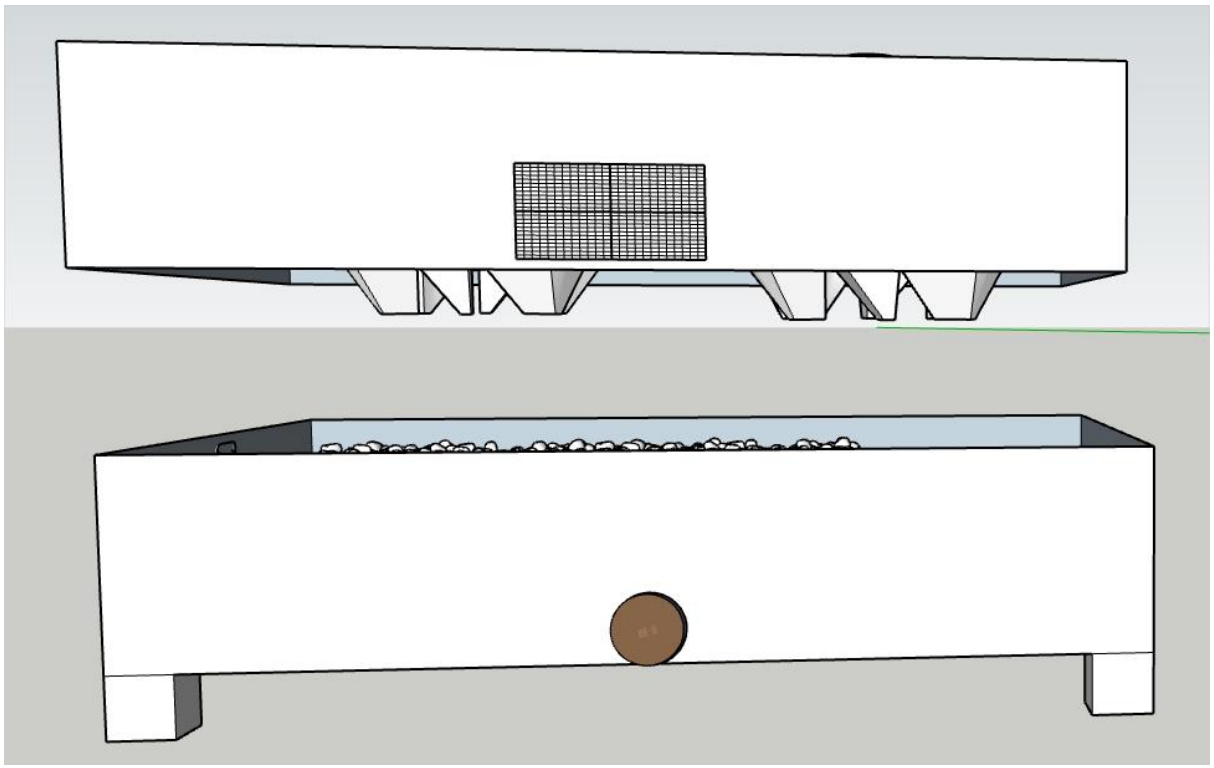
ECO-SMART Cat Toilet



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Introduction

The present project develops an idea of a cat toilet that is intended to be:

- hygienic
- compatible with the cat's needs
- ecological
- inexpensive

Cat litter, ecological sensitivity and cost

90% of the cat litters is of mineral origin (bentonite, sepiolite, clay derivatives), obtained by excavating quarries and soils, and taking from shorelines. Producers erode mountains, modify ecosystems (marine in the case of sepiolite), release carbon dioxide into the atmosphere by excavation, and then transport the extract by heavy vehicles to processing and distribution centers.
The above minerals are used for their ability to **absorb liquids** and related odors (urine specifically) to lengthen the life of the litter.
Daily cleaning involves removal of solid droppings and any lumps created by urine (for agglomerating litter), but in practice the life cycle is 2-3 weeks, after which a full litter replacement must be carried out.

It is estimated that each domestic cat consumes about 220kg of mineral litter per year. When one considers that there are about 127 million domestic cats in Europe and about 74 million in the U.S. and about 55 million in China, one can imagine the **devastating annual environmental impact**.
Moreover, it is not only domestic natural resources that are eroded, but one must consider the enormous amount of CO2 released into the atmosphere for **transportation**, and often for importation.
To complete the scenario, one must also take into account the cost of disposal in unsorted waste of used litter. In addition, decomposition in landfills releases methane gas, contributing significantly to **global warming**.
Finally, agglomerating mineral litter, now widespread, is a source of a wide range of cat health problems, including diarrhea, vomiting, kidney and respiratory problems, and lethargy.

The only **environmentally sustainable litter** is **vegetable** litter from various sources (corn, wood waste, barley, straw).
The drawbacks, however, are:
- the significantly higher cost than minerals
- the fatally shorter lifespan

- it generally releases dust that the cat's paws transfer around the house soiling sofas, chairs, etc.
- it is not always liked by the cat because of its organic odor
- it often incubates mold, moths, larvae and parasites that can harm the cat

About costs, considering an average cat life between 12 and 18 years, for mineral litter we can estimate a lifetime consumption of 4-5 tons, and thus a cost of 2500 to 4000 euros, at current prices. While for vegetable litter, from more frequent replacement, depending on the raw material the cost in a lifetime can be between 5000 and 8000 euros.

In summary, for mineral litter:

- **Devastating** environmental impact
- **Average** economic impact
- **Cat health risk** from agglomerating litters
- Annoyance in frequent garbage disposal and sack procurement

In summary, for vegetable litter:

- Minimal environmental impact
- **High** economic impact
- **Rejection** risk, **home hygiene**, and **cat health**
- Annoyance in frequent garbage disposal and sack procurement

This project focuses on **non-vegetable litters** with the aim of achieving the following objectives:

- Zero environmental impact
- Minimal economic impact
- Zero disposal and supply
- Safeguarding domestic hygiene and cat health

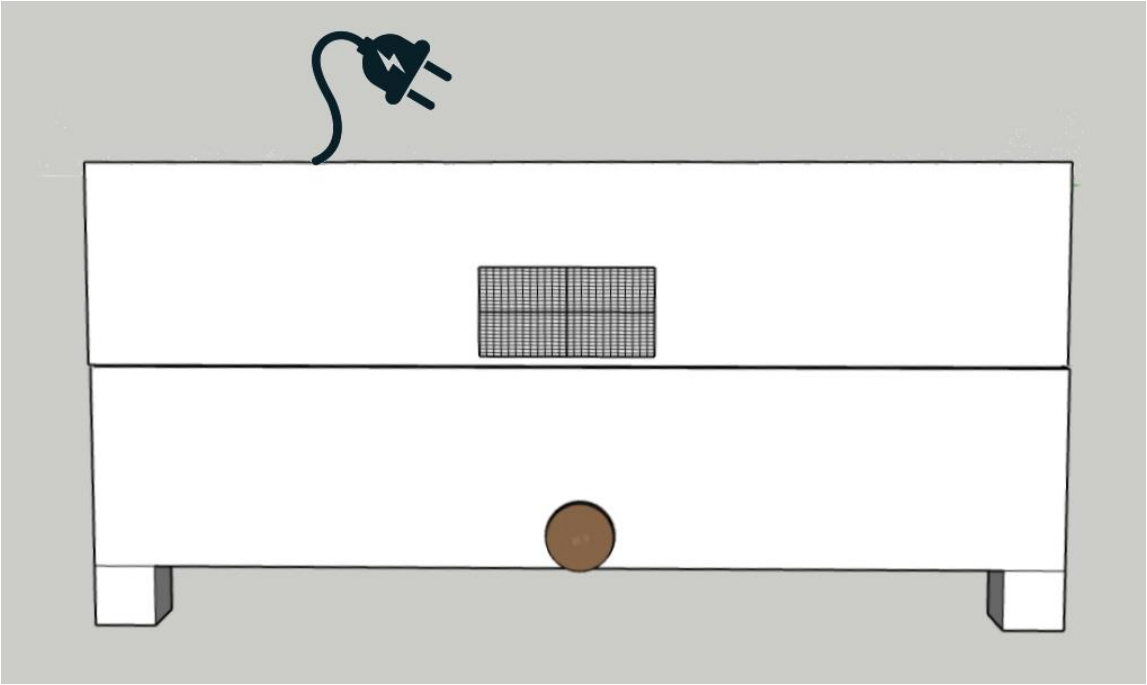
The password for achieving the said goals is only one: **reuse**.

Environmentally sustainable litter management

All of the above-mentioned cat litters, both mineral and vegetable, leverage the property of **absorption**. When the tolerance threshold is reached, typically 2-3 weeks, the material is thrown away as it is irreversibly impregnated with urine.
But if one gives up the principle of "**absorb as much as possible then throw away**", and introduces the principle of "**not absorb but clean and sterilize**" the litter can be recycled indefinitely.

Considering the grain cross section in millimeters, we define:
fine grain < 3mm
3mm <= **medium grain** <= 5mm
5mm < **coarse grain**

The idea of eco-sustainable toilet is based on **rinsing**, **sterilizing** and **drying** the litter.
Fine-grained, sand-like litter is intractable because it is not compatible with the rinsing and drying process.
Coarse-grained litter is intractable because it is generally disliked by the cat in the scraping process.
Therefore, litter that is compatible with the **ECO-SMART** toilet is **medium-grained** (mineral or synthetic).



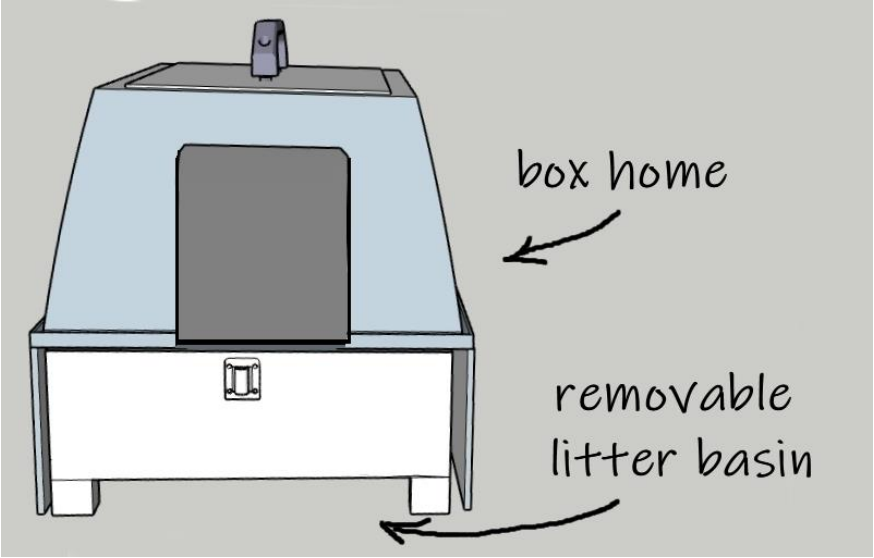
Let's look at it in detail.

Architecture

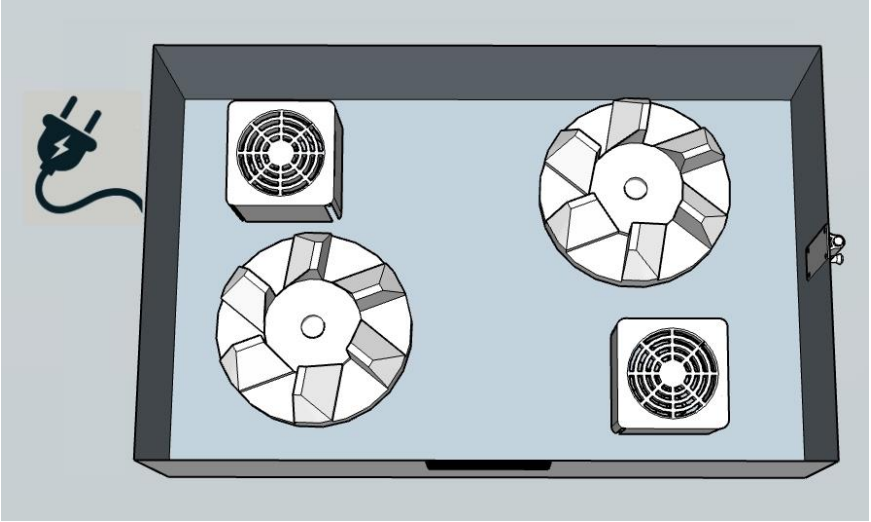
ECO-SMART toilet consists of 3 elements:

- box home
- removable litter basin
- dryer basin

box home with removable litter basin



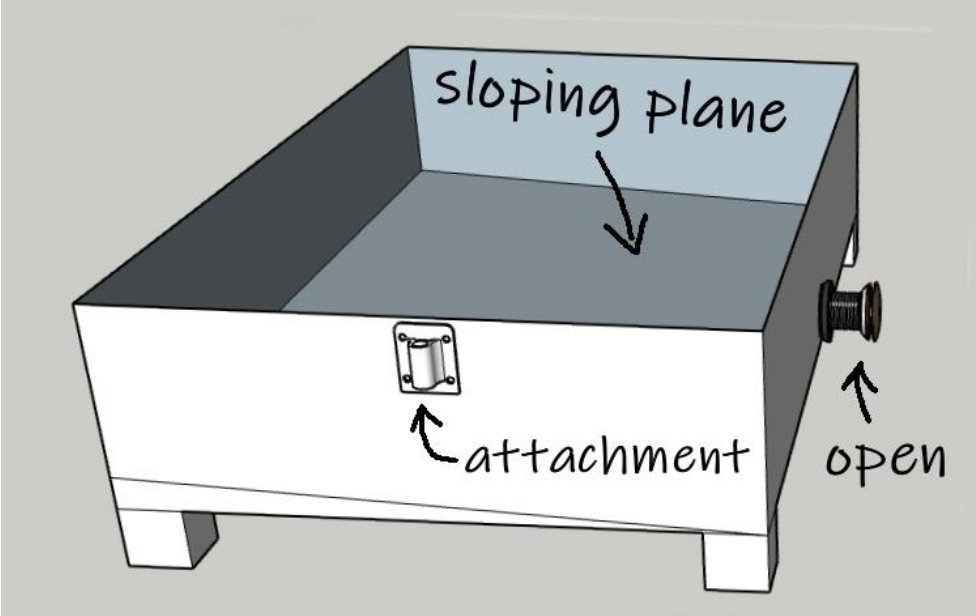
dryer basin

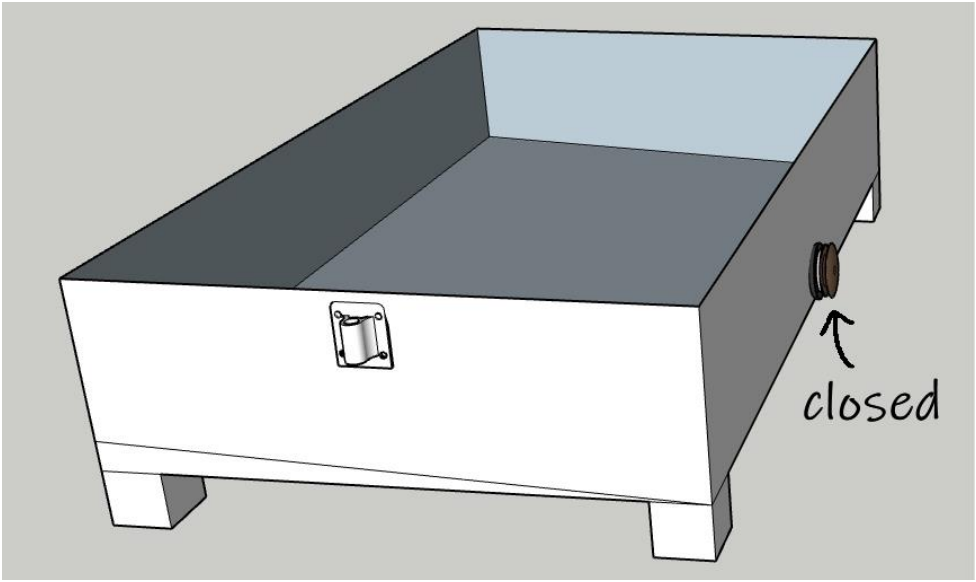


The **box home**, peculiar to enclosed toilet, has the task of shielding odors as much as possible, thanks to the tilting door and the appropriate odor-absorbing filter. At its base is the removable litter basin.

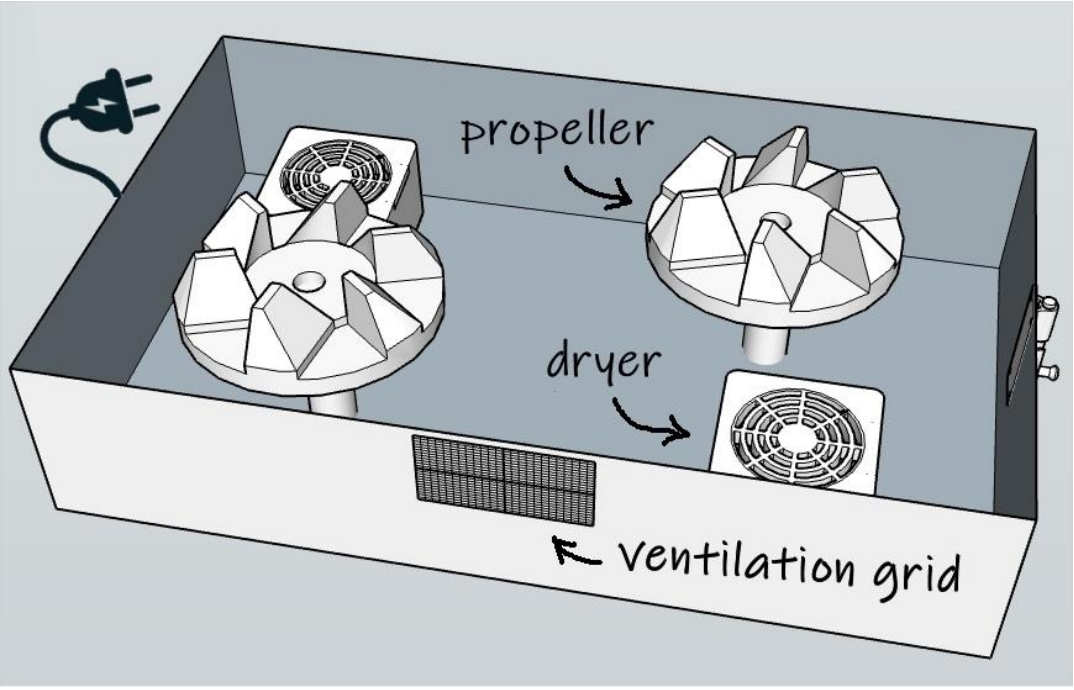
The **removable litter basin** contains the medium-grained litter, has dimensions functional to the needs of an average cat, so easy overriding and margin of tolerance of the litter jet during digging: standard 12 cm. It also needs to be compatible with the size of a sink, as it is resting on it during rinsing and drying. An acceptable size is 48 cm long and 32 cm wide.

The basin inside has a **slightly sloping plane**, converging to a **front plug** located in the center of the long side. It is used to run off water after rinsing, so it has a 2 mm gap to allow liquid but not litter grains to exit.
On the short side it has the attachment to the dryer basin.

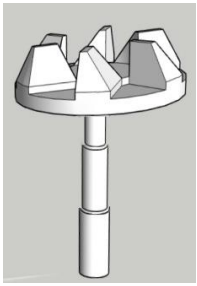




The **dryer basin** has the same dimensions as the removable basin. Its height is functional to contain the tools for drying the litter.
It contains:
- 2 rotating propellers to move the litter
- 2 hot-air dryers



dryer basin



telescopic axis

The power consumption of the basin in operation will not exceed 1.5kw. So rather than working in parallel at low power consumption, the optimal solution is to alternate functions.
That is, in cycle:
- Operates the 2 propellers to shuffle the litter for 20 seconds (each consumes max 750 watts)
- Stops the propellers
- Operates the 2 dryers for 20 seconds (each consumes max 750 watts)
- Stop the dryers

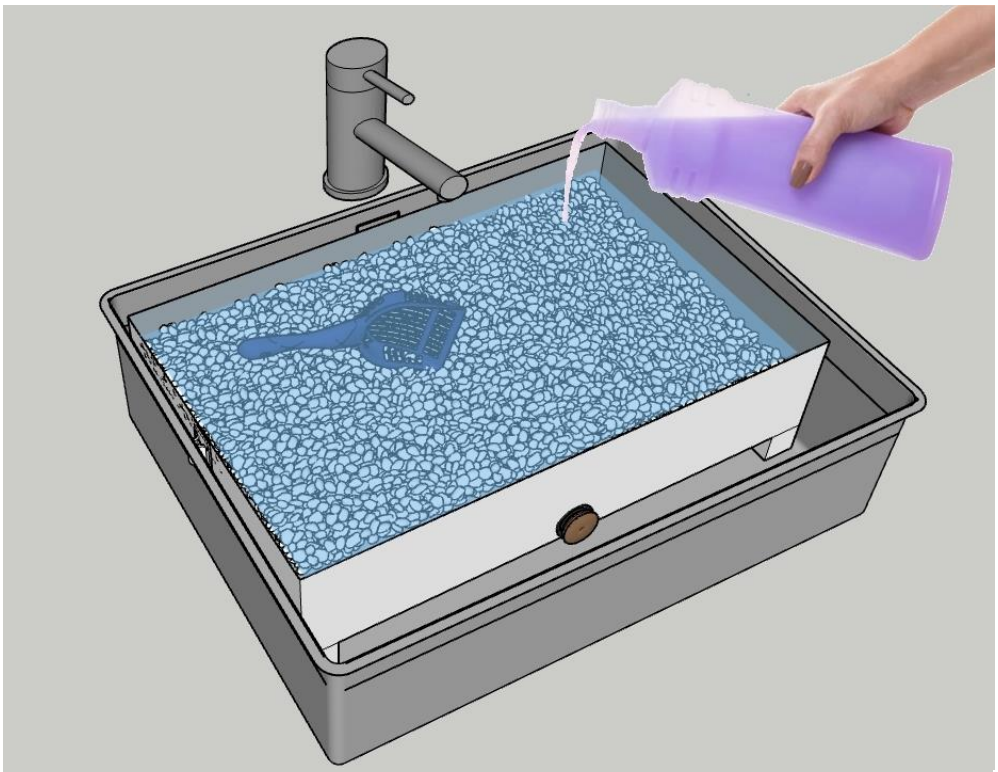
An average of 5 cycles, about 3 minutes, will be sufficient for acceptable gravel drying.
The optimal shape of propellers and dryers must be defined in design.

Rotating propellers have a **telescopic center axis**. That is, in idle condition they are contained within the height of the dryer basin, while in operation they extend beyond the edge to operate in the litter basin.
The dryer basin has **ventilation grids**, to prevent overheating, whose single hole does not exceed 2x2 mm, to prevent the grains from escaping.
The same type of grid protects the dryers.

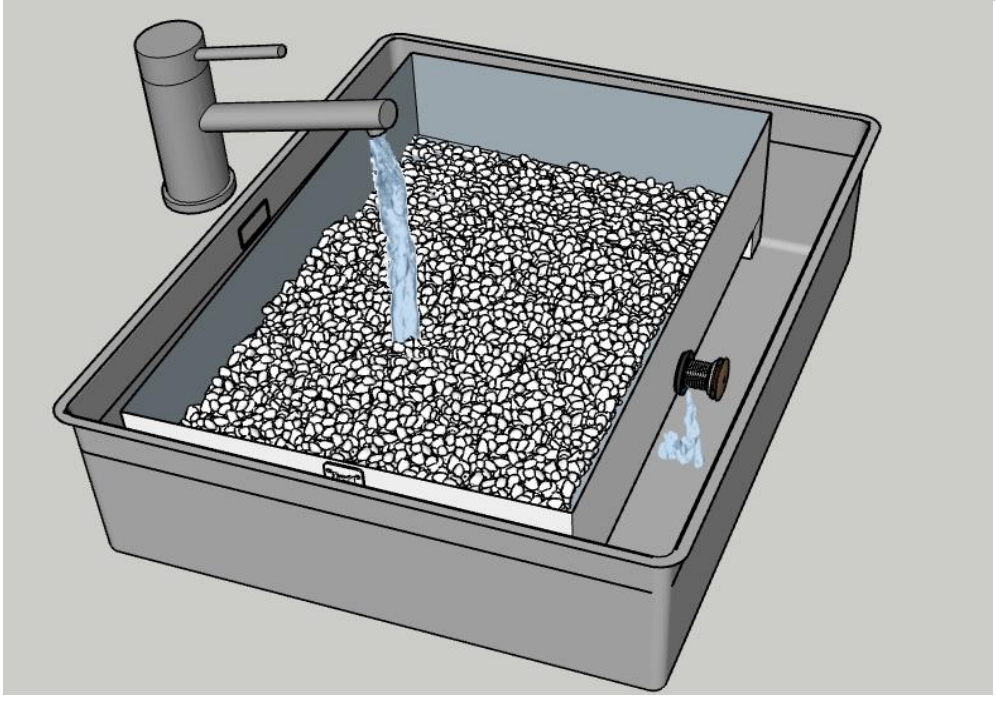
Use and cleaning

Litter cleaning is done as follows (average time **3 minutes**):

1. Solid droppings are removed with the scoop as usual
2. You place the litter pan in the sink by opening the front cap
3. You open the faucet and shake out the litter grains with the scoop to encourage the outflow of urine and its stench
4. **Once in a week** you can close the front cap to add a few drops of detergent and possibly a germicidal solution to the water
5. You reopen the cap, rinse the litter by shuffling it with the scoop and letting the water drain out

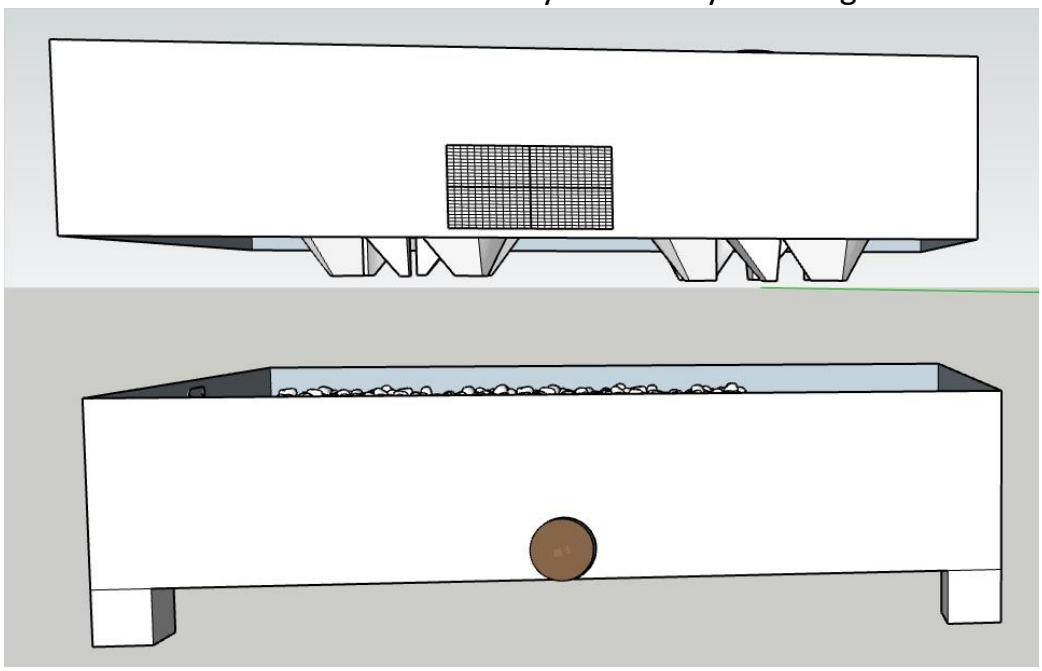


washing and sterilization

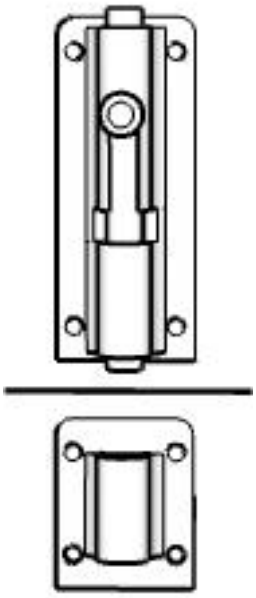


rinsing

After manual rinsing comes the most tedious step, **drying**, which we leave to the machine.
As much as the cat is used to a humid litter, it cannot be completely wet, so it must be partially dried quickly.
The dryer basin serves this purpose.
You cover the litter basin with the dryer basin by securing it with a hook.

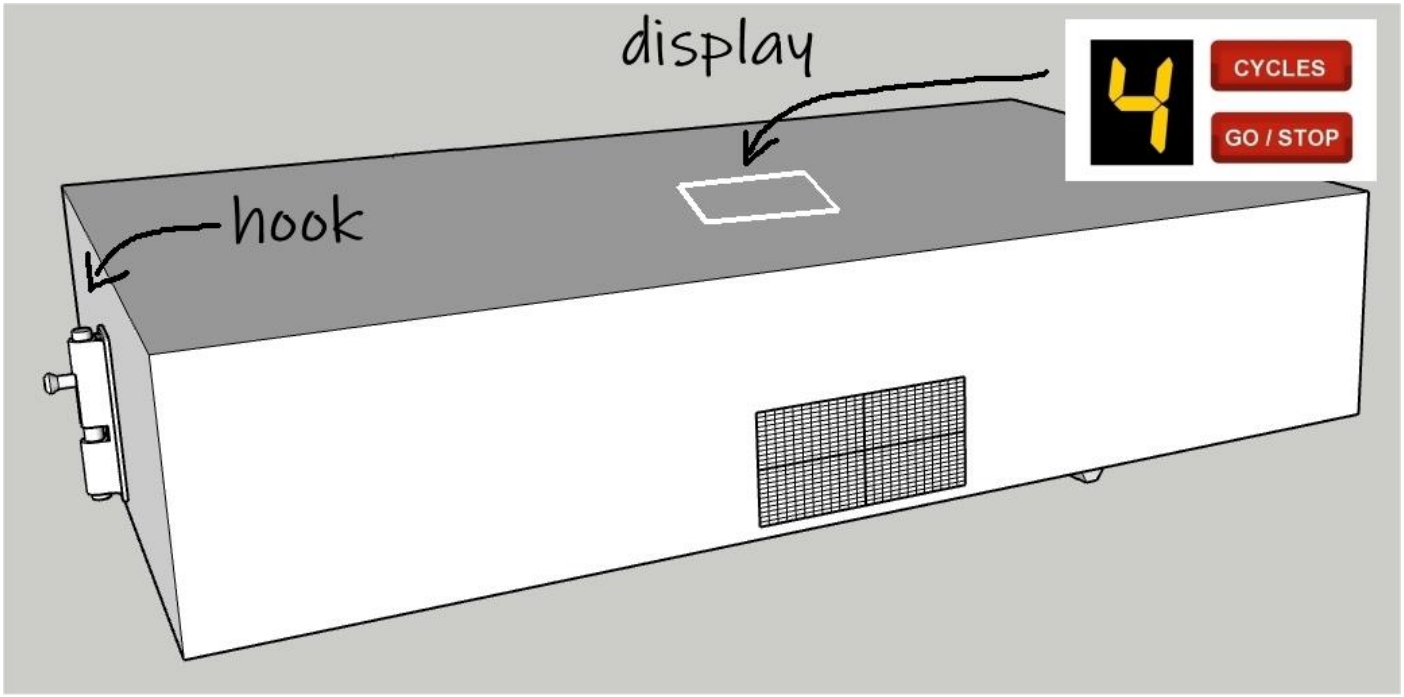


cover with dryer basin

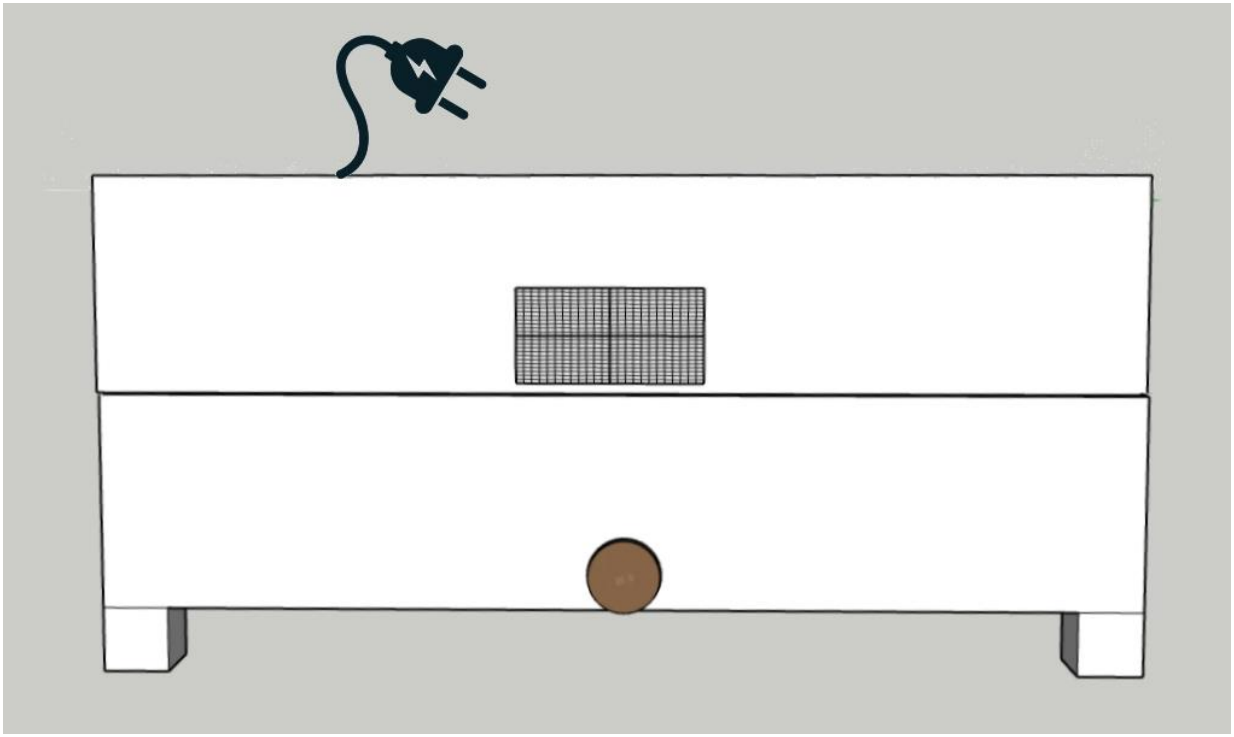


locking hook

You connect the dryer basin to the power.
From a mini keyboard and display on the top of the basin, you set the number of cycles and launch the process.



The telescoping axes of the propellers extend into the gravel, and the alternating sequence of rotation and emission of hot air begins, to allow for uniform summary drying.
At the end of the process, the drying basin is removed and the litter is clean, sterilized, and stench-free again.



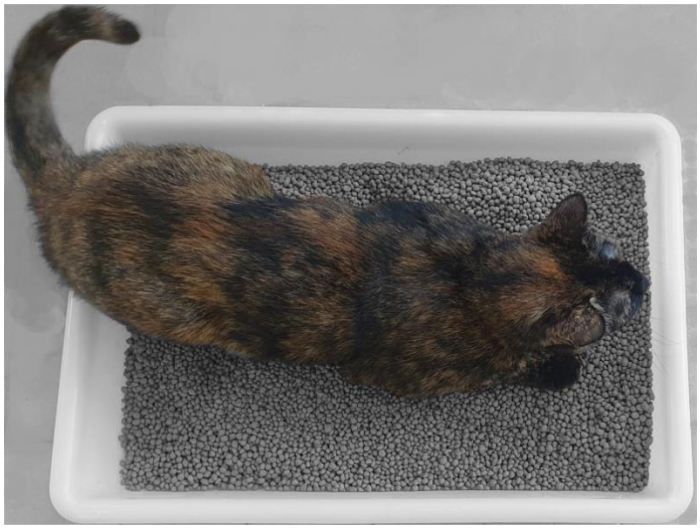
As a one-time cleaner you can use what you would ordinarily use for the container basin. Alternatively, one can use baking soda, or white vinegar decanting a few minutes.

Litter material and cat's liking

Considering mineral litters, the grains **should not be absorbent** but, on the contrary, **impermeable**, precisely because their function is no longer to retain the stench as much as possible before being thrown away, but rather to be rinsed.
As mentioned, to enable this operation, the litter must be of medium grains.
Many cats have no difficulty with that size; in fact, there are medium-grain bentonite and sepiolite litters on the market.
But cats accustomed to fine grain may reject medium grain.
The reason is that the grain of a mineral litter is a small stone, with relative roughness. If the size grows, sensitive cats feel discomfort in rasping.
But if the grain is **spherical**, or otherwise smooth, the cat will accept the eco-friendly litter.
For testing purposes, a medium-grain litter made of terracotta pellets was submitted to some sensitive cats, which reject bentonite and sepiolite medium-grain litter.
The litter was liked by all sensitive cats.
Obviously, the terracotta cannot be used full-scale, because urine and washing chemicals deform it, but it served only as a test of grain shape.

Possible compatible and nondeformable materials are therefore:
- Polished pebbles (mineral)
- Hard plastic balls (synthetic)
- Rough glass balls (synthetic)

Obviously, the synthetic solution is preferable so as not to use natural resources. Although, in our case, mineral litter would no longer be thrown away.



Frida kitten with terracotta litter

The current market

All so-called "self-cleaning" litter boxes merely remove the poop, assuming that pee-impregnated sand, mineral or organic, should be thrown away.

There is only one self-cleaning toilet, **Cat Genie [TM]**, that practices litter reuse: that is, it filters, rinses and dries.
It's a revolutionary and virtuous solution. But it seems to have the following problems:

- it is bulky, being a real toilet
- it is fixed, i.e., it requires connection to the water supply to receive rinse water, and to the toilet to dispose of waste (as in saying, in the bathroom there are pipes in evidence inside the toilet, embarrassing in case of guests)
- being automatic, it cannot notice grains of poop passing through the filter paddle (because they are too small or not solid) and thus remain in the sand during washing and drying
- transferring waste to the toilet does not involve operating the flush, so it stays there until the human operates it
- between washing and drying takes about 40 minutes (what does the cat do if it needs to in the meantime)?
- in case of more cats, if each cat uses its own litter box, it's complicated to think about having more than one of them

The ECO-SMART toilet, on the other hand, starts from the consideration that, unless you use artificial intelligence, **it's not possible to have a fully automatic management of the process**.
So, it is proposed a **semi-automatic toilet**, for reusable grain litter, demoting the washing to the human and the drying to the machine.
Compared to the fully automatic solution, the ECO-SMART toilet is **relocatable and transportable**.
And in the case of multiple cats, while each has its own box home, certainly one dryer basin (the only technological element) is sufficient.

Final considerations

For maintenance, compared to traditional litter management, the ECO-SMART toilet requires 3 minutes more, just the washing/rinsing of the litter, considering that the drying phase is unattended.
Actually, since it is a process that completely extinguishes odors and makes the litter new, **the washing process may not be carried out every day**, except for the daily removal of solid droppings.
After all, when compared with traditional litter, the hygienic conditions are far superior, if one takes into account that in the latter the presence of urine (only partially removed by the lumps of agglomerant) grows progressively until full disposal, every 2-3 weeks.

In summary:

Cons

- 3 extra minutes, **2 or 3 times a week**, for litter washing
- a few cents of energy **per month** consumption for drying

Pros

- environmental plunders (quarries, mines, shorelines, seas) are avoided
- chemical synthesis and consequent diseases of silicone litters are avoided
- hygienic risks and germ contamination of vegetable litter are avoided
- CO2 emission into the environment is avoided
- a gradually increasing urine stench during the 2-3 weeks life cycle of disposable litter is avoided
- you avoid carrying bags of sand inside, and bags of undifferentiated garbage outside, every few days
- you save thousands of euros/dollars over the cat's lifetime

At this time of great sensitivity towards ecological issues, offering animal lovers the chance not to feel guilty about the environment could be an important business opportunity.