MYCODRAIN

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FACT

Fungi have been proven to be a very cheap, effective and environmentally sound way for helping to remove a wide array of toxins from damaged environments or wastewater.

They can break down hydrocarbons in oil up to 98 percent and digests and neutralize E. coli bacteria.

MUSHROOMS
first brainstorming

mushroom city

Whole fungi energy circle?
fungi runs the city

Imagine a city solely run by biological processes

on Paul Stamets, a mycologist:
"Give him an insoluble problem and he'll toss you a new way it can be decomposed, poisoned, or healed by a fungus,"
-Merlin Sheldrake

wonder for nature

fix cracks in buildings, or added as growing insulation?

The result is a scientific worldview that encourages looking at nature not objectively, not from the clean, well-lighted bench in the laboratory, but subjectively, from the unexpected path in the dappled forest—looking not at nature but as being part of nature; *and with the help of mycelium, being able to imagine the view from within, the eye-view of the animal, plant, microbe, or fungus.*

evaporation

an unnoticed, rather poetic process?

mycelium

fungus turned into building materials
organic material can grow at a rapid rate, can help to reduce greenhouse gases

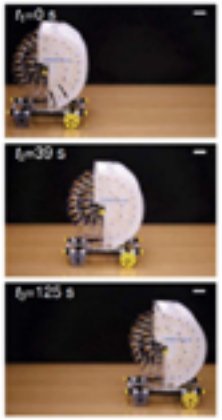
mycelium packaging:
grows arround it´s mold, heat it to prevent further growth

mycoremediation

fungi based technology to decontaminate the enviroment

Fungi have been proven to be a very cheap, effective and environmentally sound way for helping to remove a wide array of toxins from damaged environments or wastewater.

The byproducts of the remediation can be valuable materials themselves, such as enzymes (like laccase), edible or medicinal mushrooms.



mycelium as a drug to experience unity:
psilocybin

Stamets:
solution for colony collapse disorder, feeding bees a fungal potion that can squelch a virus they may carry from environmental toxins

-mechanical properties of bacterial spores
-machines can run on pure water
-powerful humidity controlled muscle (water vapour- spore muscle relaxes, water evaporates- muscle closes)

"This method, if scaled up, could be extraordinarily effective considering that ***almost 90 percent of the atmospheric moisture is the result of evaporation from air-water interfaces.*** *The team believes their technology can match existing green-energy alternatives, but* ***without the intermittency issues of solar and wind."***

"If you're aware of your environment, you're responsive to changes in your environment."
Paul Stamets

can dissolve petroleum waste, can transform cardboard boxes into tree seeds

WATERBODIES
first brainstorming

wastewater and rivers

in cities:
rainwater flows of into the drain before it can seep in the ground or evaporate

"We do not have to save the enviroment, the enviroment is us"

What if there were no drains?

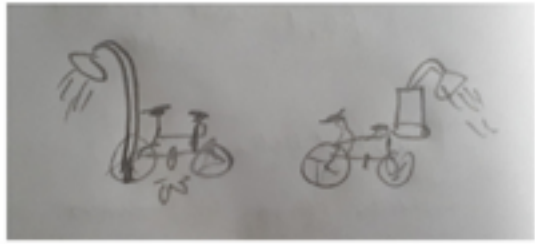
bottling up the drain as protest?
building reversed cones/gutters for greens in the street

What if the rivers were our new main roads?

heat water for outdoor showers through energy of the river

we would swim to work
clean the rivers?
not use cars
revive watersports?
collect trash with our canoe
shower in public?
green our roads
make the most of our river banks
we would follow the stream?
we would broaden the riverbeds
flood our streets?

rain shower mycelium cleaned + bike heater



bike barrel to spread collected rainwater

An average flush for a modern, Western-style toilet uses 6 liters (1.6 gallons) of water, and the average adult pees about seven times every 24 hours. a day:
42 liters (11.1 gallons) of toilet water to flush away. Assuming that people urinate the same way every single day, this means in just one year, ***the average person uses 15,330 liters (4,050 gallons) of toilet water.***
recommendation of website: pee in the shower

pee outside in nature?
make it easier for people assigned female at birth

combine toilet with shower with sink ?

sewage plant as botanical garden (Budapest)

wastewater purified by microorganisms that feed of the roots of plants

understanding:
chemicals in wastewater would kill plants

STRAW&STREETS

first brainstorming

strawbale and streets

straw bale farming

Heat islands in the city

cities produce 80% of worldwide emissions (ecopolis)

community projects like Himmelbeet

bales can be made from any organic material! (gras, sugar cane...)

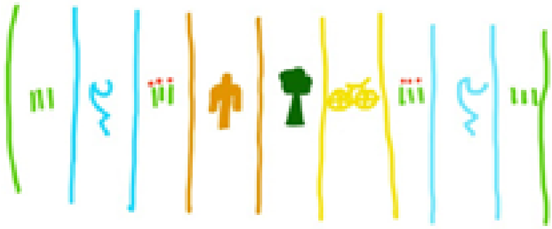
needs two weeks (kept wet) to become soil

could be set up on parking lots, rooftops etc.

straw- great capacity to absorb and hold moisture

streets and pavements

like pop-up bike tracks: pop-up street occupations,
marked with road signs
pop-up straw bale gardening for a harvest
solar cooking
energy production
rain showering



miro

WATER X FUNGI
brainstorming

water available in the city

- rainwater (everywhere when it rains)
- evaporation
- rivers and lakes
- groundwater
- tapwater
- wastewater from households
- wastewater in the sewage
- wastewater from industry

water need in the city

- to water plants, trees, grass
- water in households:
  -drinking water
  -cooking water
  -cleaning water
  -flushing water
  -shower water
  -water for radiator?
  -washing machine
  -dishwasher
- to cool the city
- water for mobility/sports
- public drinking water
- water to wash yourself with
- water as social enjoyment?

(water) pollution in the city

- farming: **overfertilization + pesticides** lead to water pollution
- households: **wrong disposal of toxins**; through household waste or flushed down the toilet into sewage system
- heavy downpour leads to **overload for treatment plant**: wastewater directly into nature
- water from streets often **contaminated with oil**

mushroom/ mycelium abilities

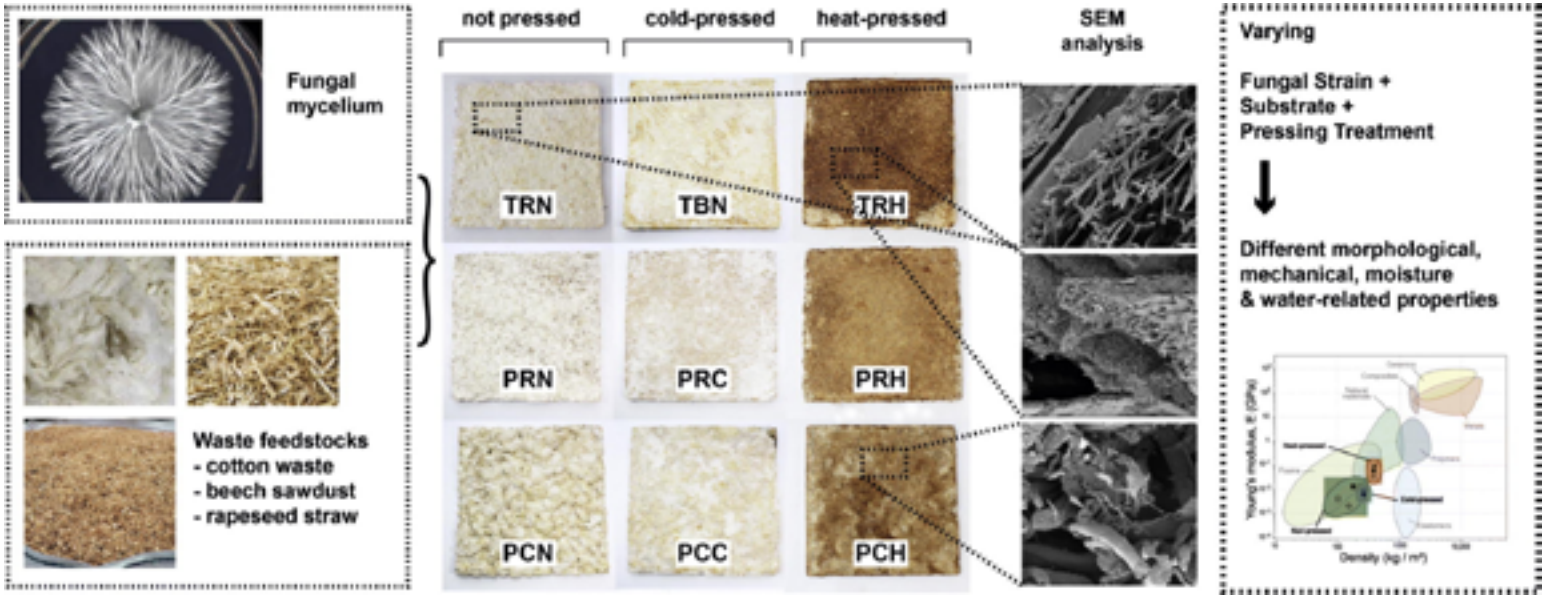
- can **remove wide array of toxins** from damaged enviroments/wastewater -**produces byproducts** such as enzymes, edible or medical mushrooms
- produces antibiotics
- **can dissolve petroleum waste**: e.g, turn motor oil into healthy soil
- can break through pavement
- can kill insects like termites better than pesticides
- can **reduce bacteria** like e.coli from the enviroment of a farm
- "Straw that has been inoculated with Oyster mushroom mycelium floats, **making it a potential candidate for use in water-borne mycelial containment/filtration systems"**

MUSHROOMS research

Oyster mushroom mycelium can break down hydrocrabons and digest bacteria. Grown on straw or woodchip is already used in mycofiltration around farms to break down bacteria like e. coli. These biofilters can last up to three years and it´s waste can be used as humus rich compost.

MUSHROOMS research

Mycelium processing: after mycelium has spread thoughout the whole substrate, it forms a solid structure; mycelium foam. This foam can be removed and dried to stop the mycelium from growing and producing mushrooms and spores.
Moisture- and water-uptake properties can be tuned my varying substrate (straw, sawdust, cotton), fungal species and processing technique (no pressing or cold or heat pressing).
Drying: dried out, the fungus is preserved in a `hibernated`state and restarts growth when moisture conditions are favourable again.




ACT

FUNGI X STREET

concept 1

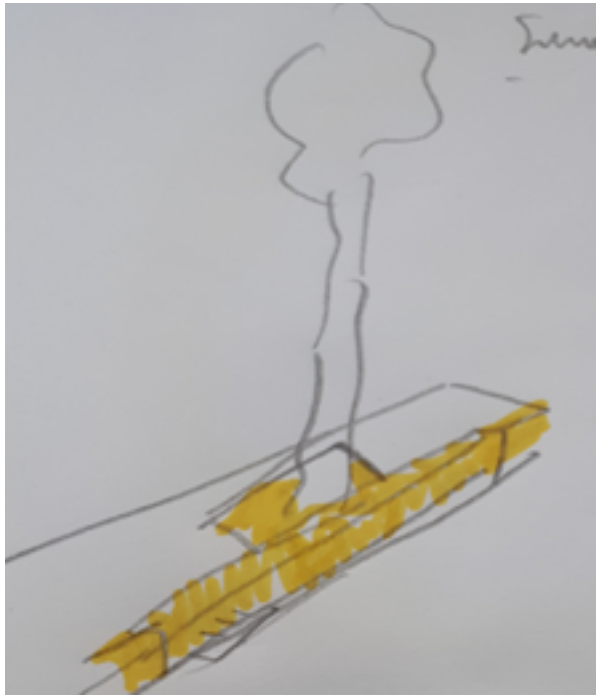
Concept: Placing mycelium structures on the street to filter motor oil, metals and dirt from the rain water, before it flows into the sewer system.
+ Creating new biological, green spots on busy roads.

? Where is space? How can it be a postive addition not a disruption?

1. parking space mycelium coating
2. addition to the curb, connected to trees
3. bags on the road side, replacable

1

2



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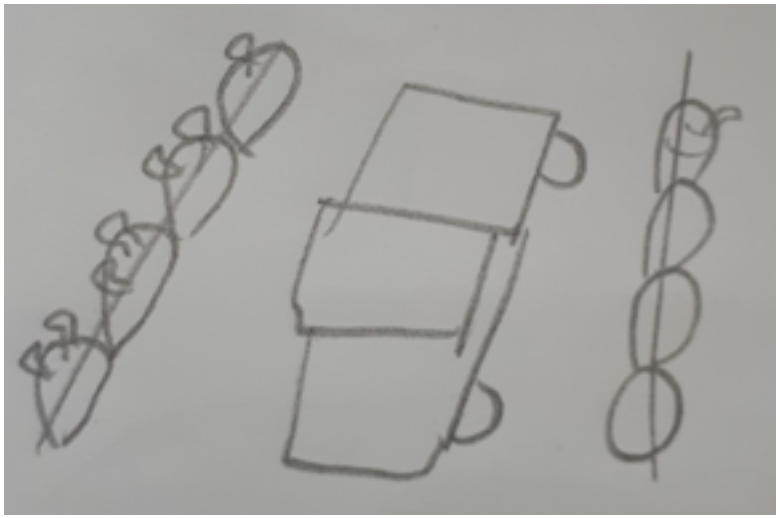


FUNGI X HOUSE

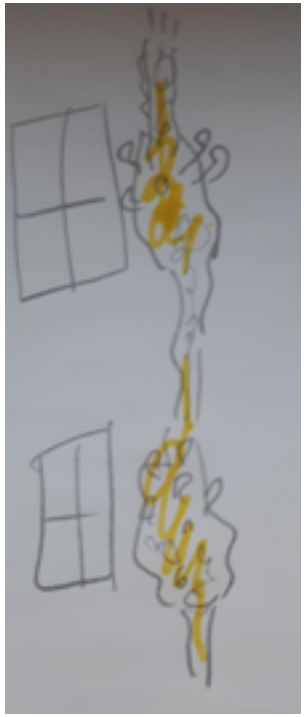
concept 2

Concept: Adapting an old system of laziness; emptying chamber pots out of the window. By adding mycelium elements to the rain gutter, people can pour their cooking water out of the window, wastewater and rainwater are filtered by the rain gutter and the mycelium elements could even provide edible mushrooms.

? how could this structure work/be built/ not be too complicated?

1. mycelium raingutter
2. modular mycelium part
3. bag that collects, cleans water at the end of the gutter
4. the system
5. raingutters connected to the trees, providing a structure for shading in summer and water for the plants

1



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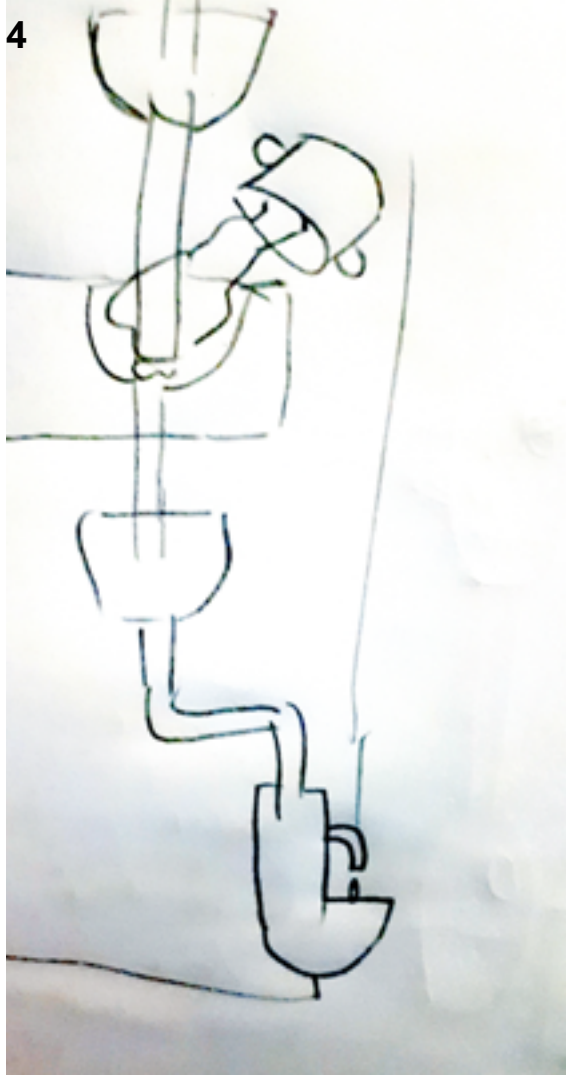

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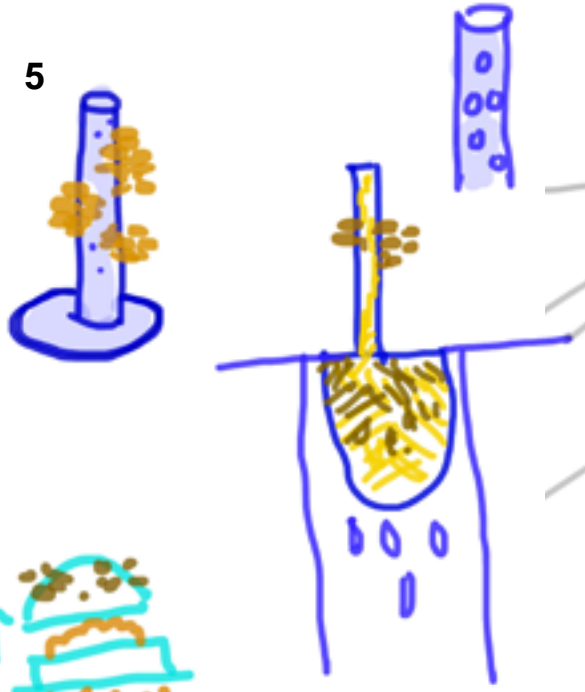
DRAIN
integrating mycelium

1. drain for rainwater on the side of the street: 53 x 50 cm
2. manhole cover to acess the sewer system, usually in the middle of the street: diameter 77cm
3. interesting drain but not implemented in Germany
Therefore drain for rainwater was most fitting for the project.

4+5. posts and drain + mushroom harvesting
6. drain out of dried mycelium (unstable)
7. small drain garden filter

5



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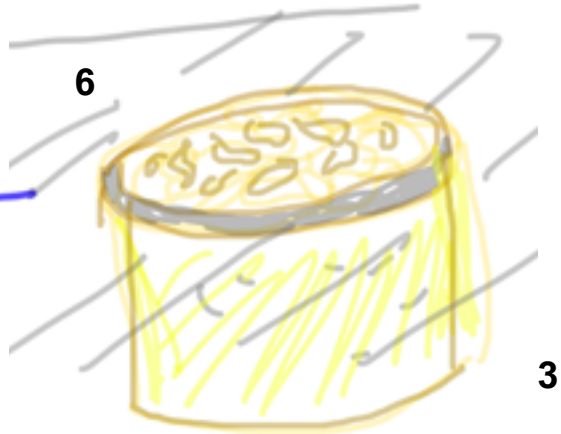

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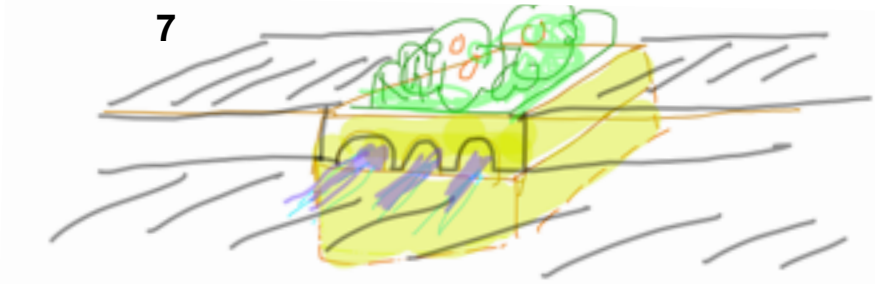

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2

3

MUD BUCKET

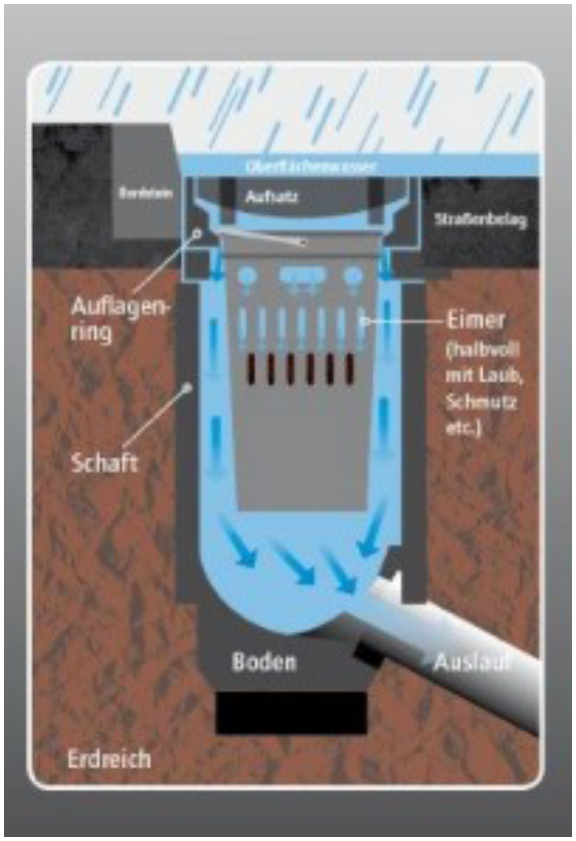
reserch

Muddbuckets are made out of galvanized steel and are installed beneath the drain to filter bigger parts of dirt out of the water.

Interview with Mr. Keppler from the BSR:

The buckets are cleaned minimum once a year by the BSR, streets with a lot of trees are cleaned 3 times. The mudd from bucket is sucked away or emptied out, the bucket is taken out with rope winch and hook.
The BSR uses a vehicel only for cleaning of the drainage, it weighs 18 tons. The waste is sorted into „machinery trash“.

Mr. Keppler isn´t in need for improvements concering the handeling of the muddbuckets.
Right now: new mudd buckets are in a process of beeing installed into drains.

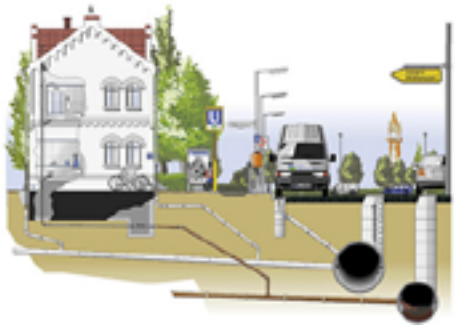


Ø 395/255x575 mm

SEWAGE SYSTEM

research on Berrlin

mixed system:
-waste water and rain water flow together through sewer
-used in city centers, metro and pipes take up to much space for two systems
-berlin: build in old city center; area inside of the S Bahn Ring
-mixed sewer system problem: wastewater from the city causes most of the pollution concerning rivers like the spree;
rain spillway basins that normally lead to the treatment plants spill over during heavy rains and run directly into rivers (streetdirt and wastewater from households)
-this happens 20 to 30 times per year!
-a lot of water storage space is build underneath the ground, but can never prohibit overflowing entirely



separating system:
-waste water and rain flow in seperated sewers
-rainwater is led dierectly into rivers
-problem: rainwater carries dust, air pollutants, particles from car tires and the street, oil, leaves, animal excrements, road grit in winter and metalls
-especially in smaller, standing waters this leads to fish dying after heavier rainfall
-first solutions: rain filter beds often used for water from bigger streets + retention soil filters, but:
has limits, not enough areas available

Conclusion: Both systems struggle with wastewaters in rivers. Especially percipitaion runoff from streets contains highly polluted waste.

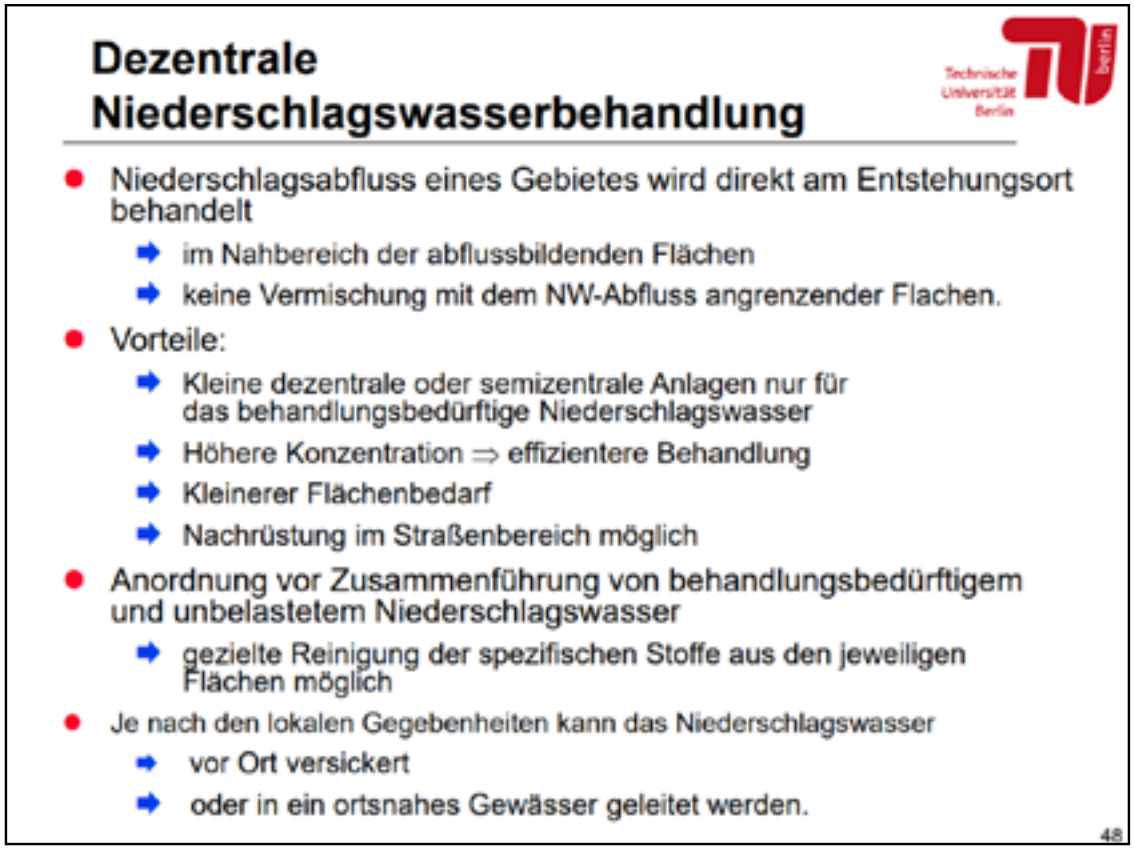
DECENTRALIZED

research on wasterwater systems

Why is it useful to work with decentered cleaning systems?

The pollution of rainwater from the street is significantly higher than of rainwater from living and comercial spaces. 90% of the rainwater that needs treatment comes from traffic areas.
Still in the drainage rainwater with very different amound of pollutions is drained together, this leads to mixed rainwater in large amounds with middling pollution.
Treating this high amound of rainwater is expensive and not very effective. Often there is not enough space in cities for bigger filter systems.

So it is more effective to clean the highly polluted rainwater on the spot before it flows into the sewer system.

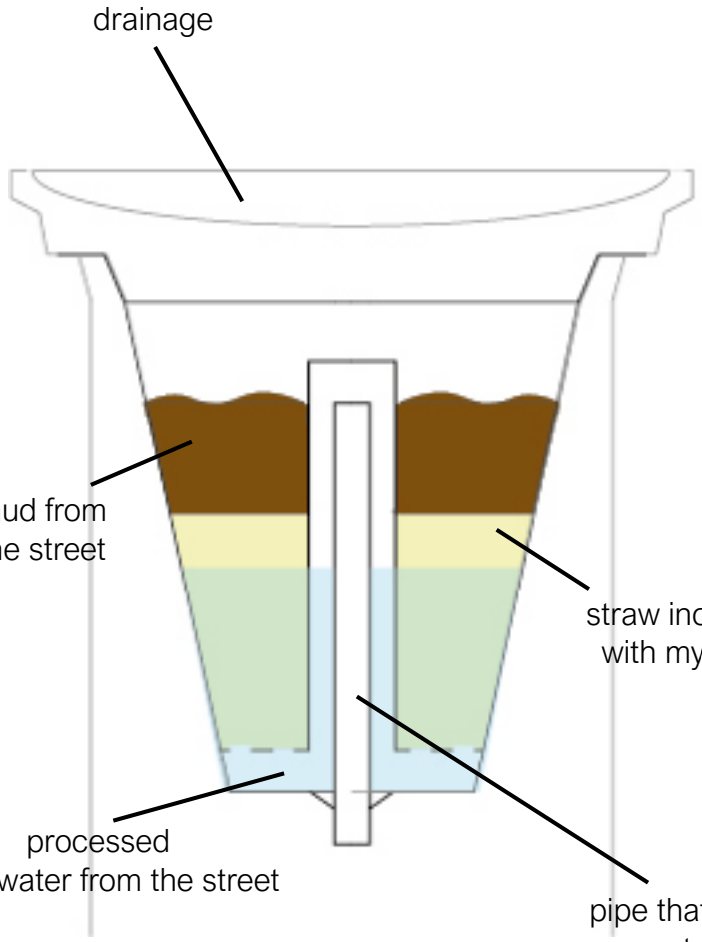


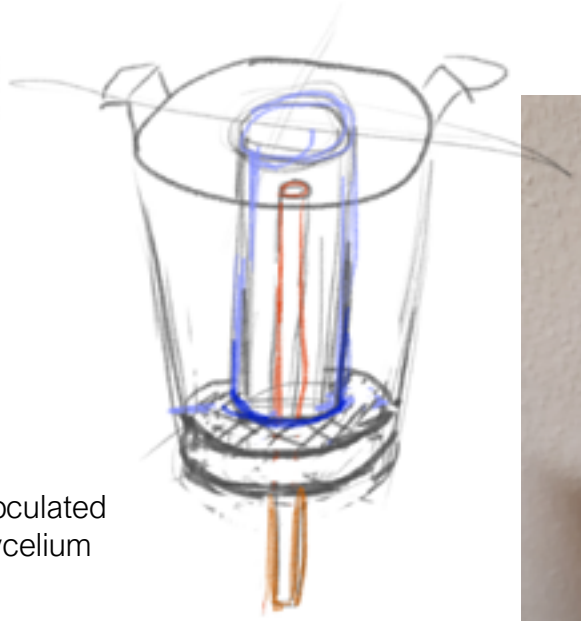
MYCODRAIN
first concept

MycoDrain applies the cleaning properties of oyster mycelium to the mud-bucket system located in the sewer to break down the contaminated rainwater ~~and turn the street waste into usable soil.~~

Because of it´s abilty to absorb fine metals and other pollutants that can not be broken down like hydrocarbons, the mycofilter must be treated as machinery waste.

1. The greedy cup system works with two pipes, when the water level rises to the height of the smaller pipe, the whole cup runs out. I concidered this system in order to ensure that the mycelium could have time to break down the pollutants in the wastewater, but would´t suffer under too humid conditions.





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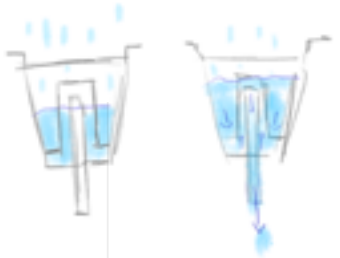

MYCODRAIN
prototype parts

1. bucket with first tube, hole at the bottom for second pipe- possible to clean
2. second pipe
3. sieve
4. sealing ring
5. handle

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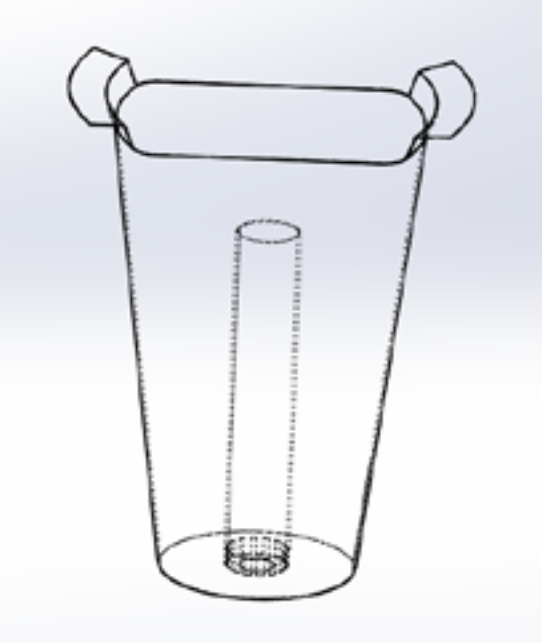

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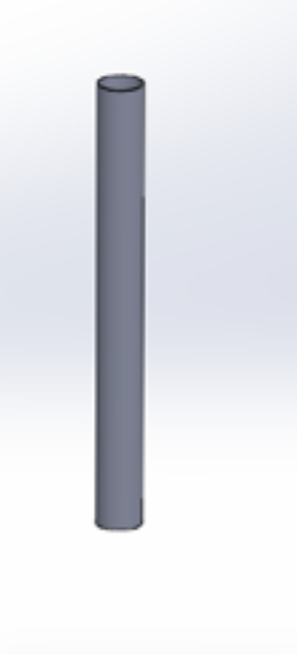

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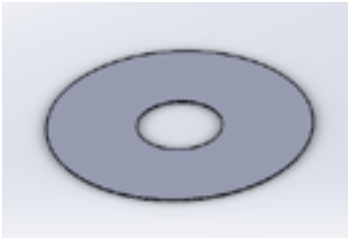

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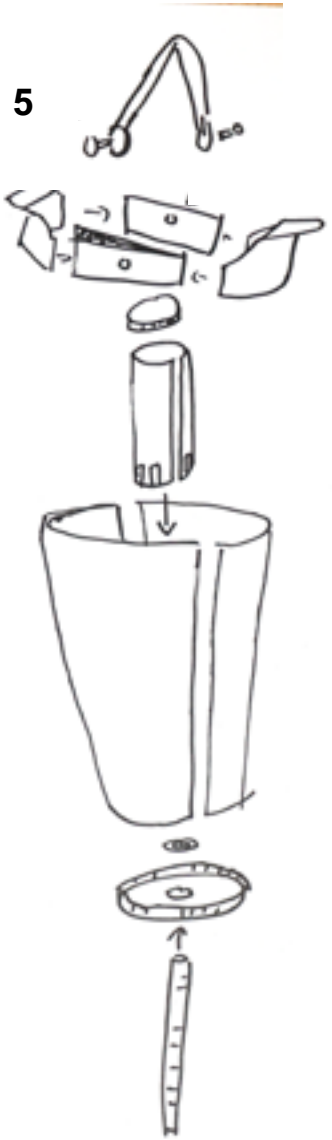
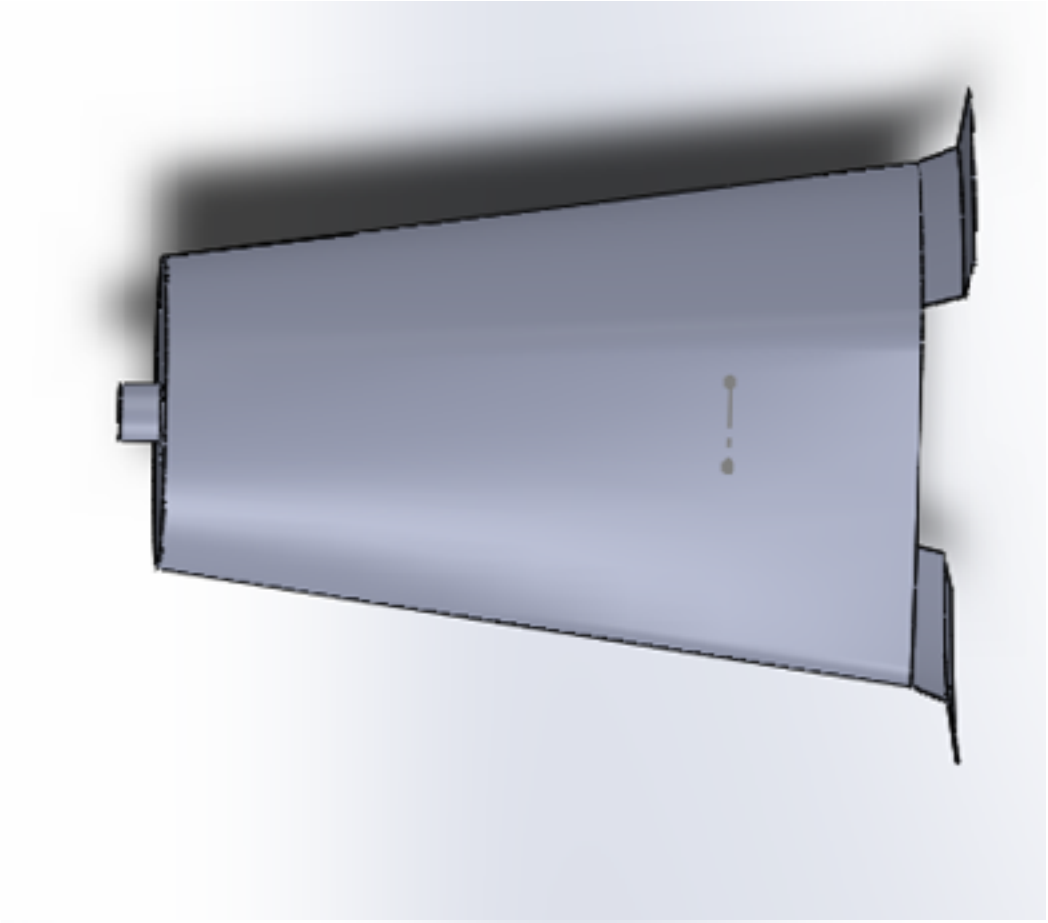
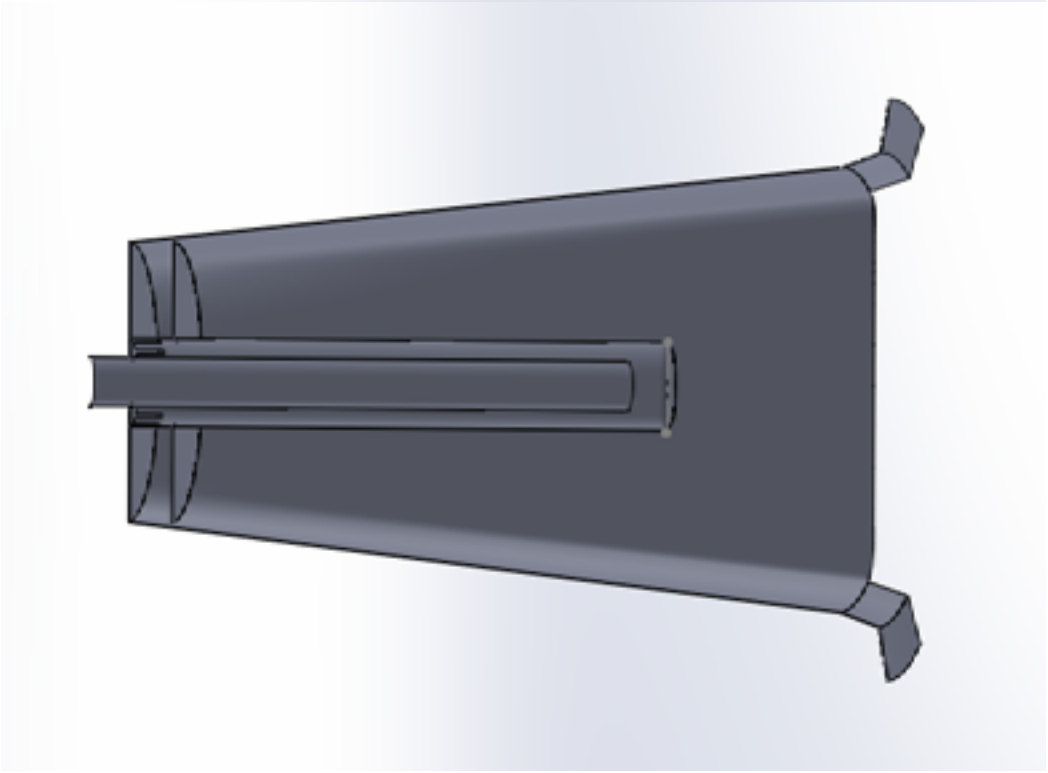


MYCODRAIN

prototype





EXPERIMENTS
water quality

left: tap water
middle: rainwater
right: water from the street (Reinickedorferstr., Schererstr.)

EXPERIMENTS
water quality

	Tab water	Rainwater	Rainwater from the streets	mycofiltrated streetswater (runthrough)	mycofiltrated streetswater (two days)
Free Chlorine (PPM)	0,5-1	0,5-1	0,5-1	0,5-1	0-0,5
Iron (PPM)	0-5	0-5	0-5	0-5	0
Copper (PPM)	1	1-3	1-3	1	0,5-1
Lead (PPM)	0-20	0-20	0-20	0-20	0
Nitrate (PPM)	0-10	0-10	10-25	0-10	0
Nitrite (PPM)	0	0-1	1-5	0	0
Total Hardness (PPM)	120	25	25	0-25	120
Total Alkalinity (PPM)	120-180	40-80	40-80	40-80	40-80
pH	7,6	6,4	6,4-6,8	6,4-6,8	6,0

nitrate: high levels of nitrate in drinking water can be dangerous to health, esp. for infants and pregnant women, nitrates are produced by plants animals and are released in smoke, industrial or automotive exhaust

tested with: teststripes

Conclusion:

If the streetwater would run though a bucket of mycelium inocculated subtrate, the mycelium could filter copper, nitrate and nitrite from the water, to reach a normal rainwater- or even better quality.

If streetwater would be kept longer in the bucket, the PPM of iron, lead, nitrate and nitrite would go down to zero, copper and free clorin would go down to 0,5 PPM (better percentages for these factors than tab water) and the water would have the same hardness as Berlin tab water.

EXPERIMENTS
water quality

left: rainwater from the street
right: mycofiltrated streetwater runthrough

EXPERIMENTS

standing water

test: 15g mycelium on woodchip+straw subtrate with 50, 75 and 100 ml water

left: 50 ml water
middle: 75 ml water
right: 100 ml water

Conclusion: Mycelium really profits from standing water, no matter how high. As long part of the mycelium is still above the survace, the mycelium grows. A lot of water dosen´t seem to be a problem, dryness is the issue that stops the mycelium from growing.

EXPERIMENTS

oil filtration 1

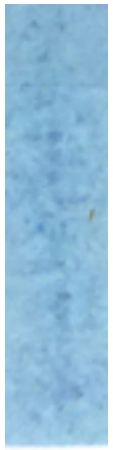
test: 200 ml water + 12 drops oil

oil: motor oil; most likely to runout on the street

neutral
oil test strip

test:
200ml water +
12 drops oil

run through:
substrate without
mycelium:
small darker droplets



run through:
substrate with
mycelium:
no significant oil
in the water

Two days in
substrate with
mycelium:
no significant oil
in the water

Conclusion: Fresh mycelium is able to filter smaller amounds of oil nearly completely out of the water, it is unimportant whether the water just runs through or is in contact with the mycelium for a couple of days.

EXPERIMENTS

oil filtration 2; endurance

test: 75g mycelium + subtrate + 5 times: 200 ml water + 12 drops of oil

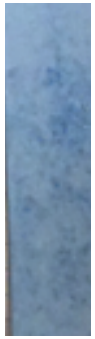
test: 200 ml water + 12 drops of oil

200 ml water + 12 drops of oil run through: substrate with mycelium

2 x 200 ml water + 12 drops of oil run through: substrate with mycelium

3 x 200 ml water + 12 drops of oil ““

4 x 200 ml water + 12 drops of oil ““



5 x 200 ml water + 12 drops of oil ““

Conclusion: The abilty to filter the oil decreases slightly, but not drasticly when process is repeated.

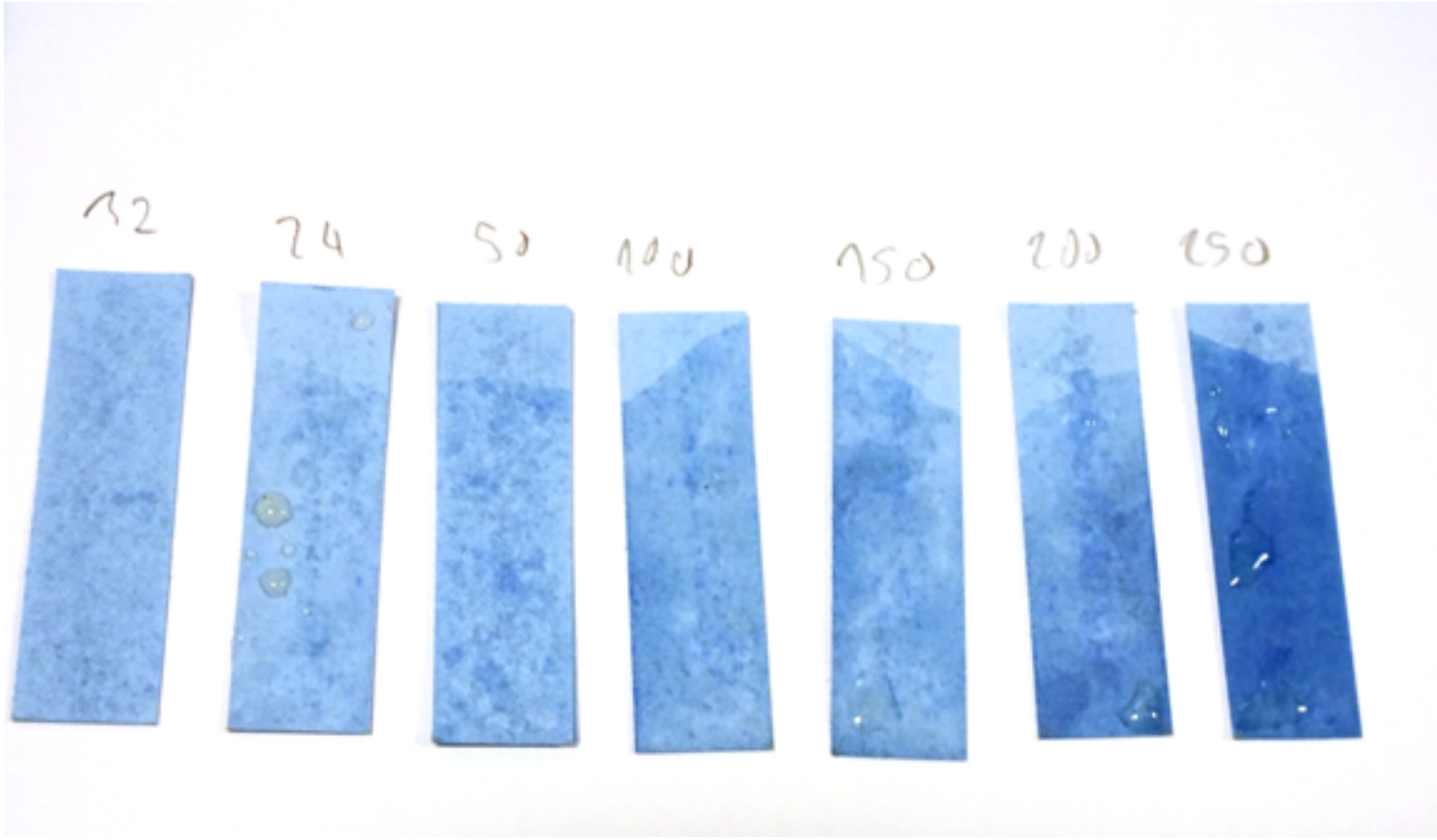
(note the image of the test stips is darker on the right, that´s why the last strips seem darker than they were)

EXPERIMENTS

filtering oil 3; limits

testing the limits of oil absorption:
75g mycelium + subtrate
+ 200 ml water + 12, 24, 50, 100, 150, 200, 250 drops of oil

-250 drops of oil as limit = arround 12,5 ml



Conclusion: 75g inocculated substrate can filter oil up to the limit of 12,5 ml oil in 200ml water.

EXPERIMENTS

reaction to oil longterm

test: 40g mycelium + subtrate
with 100% oil; 50% oil and 50% water; 25% oil and 75% water

25% oil and 75% water:
developes a mushroom layer on the surface

50% oil and 50% water:
seems to work arround/ with the oil as well

100% oil:
only a few white mycelium roots

Conclusion: Mycelium even grows in 50% oil fluid, is robust against high amounts of oil.

EXPERIMENTS

reaction to dirt

test: 50g mycelium and mixed substrate
+ 15g streetwaste (containing leaves, dirt, a cigarette bud, plastic)

In a couple of weeks mycelium overgrew the dirt.

Conclusion: Mycelium reacts positively to street waste, even seems to be nourished by it.

EXPERIMENTS

conclusions for the design

1. water quality: it´s okay when the water only runs through the filter; the water ist already cleaned in bigger parts- **it doesen´t need greedy cup**

2. standing water: the mushroom would profit from standing water at the bottom of the bucket to ensure not drying out- **closing the bottom of the bucket**

3. oil filtering: mycelium can filter smaller amounds of oil completly out of the water and continues to grow even in 50% oil water

4. reaction to dirt: mycelium seems to profit from street waste, treats it like a source of nutrition- **dirt and mycelium don´t have to be separated**

Interview with Loni Ronnenbaum from fungi perfecti:

5. temperature: after the inocuation of 40 days, mycelium is able to overwinter fine-**40 days growing period**

6. endurance: changing filters every 6 months- **buckets would be emptied out half a year**

MYCODRAIN
rethinking

While my first concept was redesigning the existing muddbucket into a mycofilter, in my process and while talking to Mister Keppler from the BSR it became evident, that most decentralized cleaning systems projects had failed, because of overly complicated technologies and migh maintanace costs, they also didn´t work in a collaboration with the BSR.

The system I needed to propose had to be: simple, easy to apply, easy and cheap to produce and with the lowest possible mainance for the BSR.

So rather than changing the whole bucket I decided on working on an insert for the bucket.

hessian jute

advantages:
-natural fiber: eco friendly and bio degradable
-inexpensive in comparison
-can be easily manufactured with a sewing machine
-provides good filtering abilities without clogging
-is used in outdoor mycofiltration
-BSR can install the hessian sack an doesn´t have to refill the substrate

disadvantages:
-it´s a one-way product, probably can´t be used again

challenge:
needs to be fixed to bucket and easy to install

metal sieve

advantages:
-is stable on it´s own
-can be reused
-can be emptied without lifting the whole bucket

disadvantages:
-could possibly clogg
-has to be cleaned
-material and production is more expensive/complex
-is probably heavier
-hassian jute sacks are still needed for refill

challenge:
needs to fit around bucket handle

plastic sieve

advantages:
-softer than metal but still more stable than jute
-can be reused
-can be emptied without lifting the whole bucket

disadvantages:
-could possibly clog
-has to be cleaned
-material and production is more expensive/complex
-material is bad for the environment
-hessian jute sacks are still needed for refill

challenge:
needs to fit around bucket handle

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insert concepts

1. **challenge: working around the handle, that´s positioned inside the bucket**; using soft bendable materials?
2. + 3. smaller filter bucket only at the bottom of the bucket, contains mycelium and substrate, avoids the handle
4. burlap sack with hooks
5. burlap sack with harder rim
6. burlap sack with collaspible rim

1

6

2

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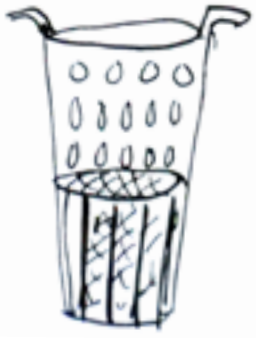

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prototype

Concept: a sack out of burlap with pockets at the top to fit around the ´ears´ of the bucket.
+ no additional waste, burlap sack can be used throughout the whole process of building and implementing

problem: bag bulges out at the bottom, it becomes difficult to get sack into the bucket -
conclusion: using a conical cutting pattern

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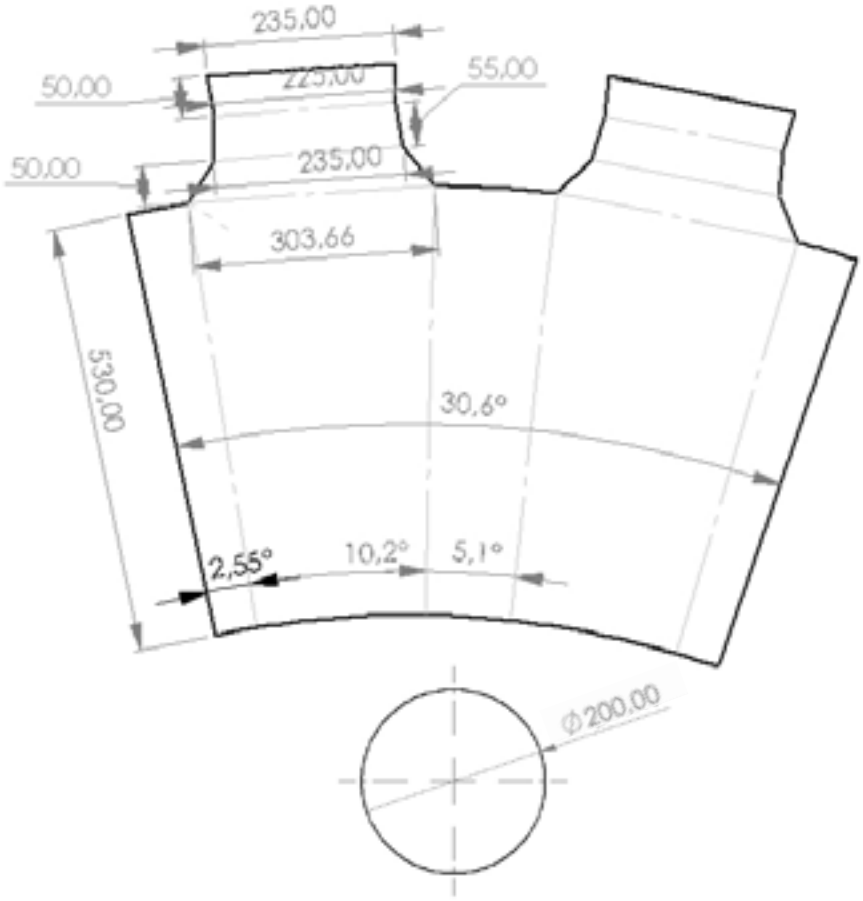
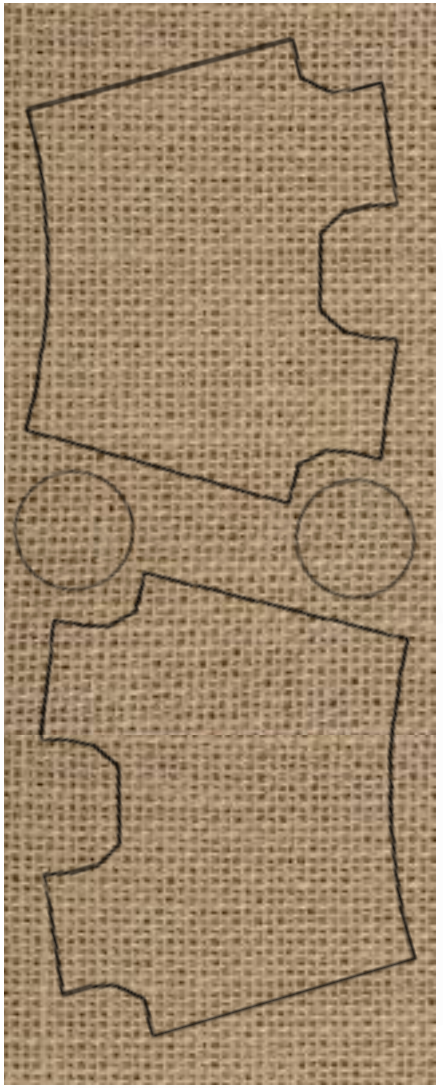
final model: Mycobag



cutting pattern for burlap sack



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final model: Mycobag

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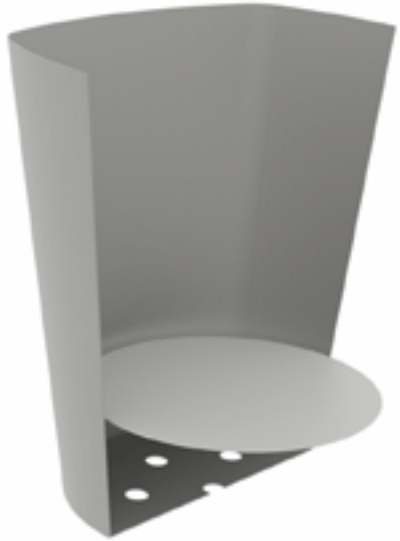
farming, transport and additions

1. solidworks model for farming and transport system: adapted to the size of the muddbuckets (bottom half)
- size of the plate: size of an euro pallet; 1.200 x 800 mm
-made out of robust plastic- light to carry

2. metal plate to close the bottom of the muddbucket; keeping a level of standing water inside the bucket for the mushrooms

2



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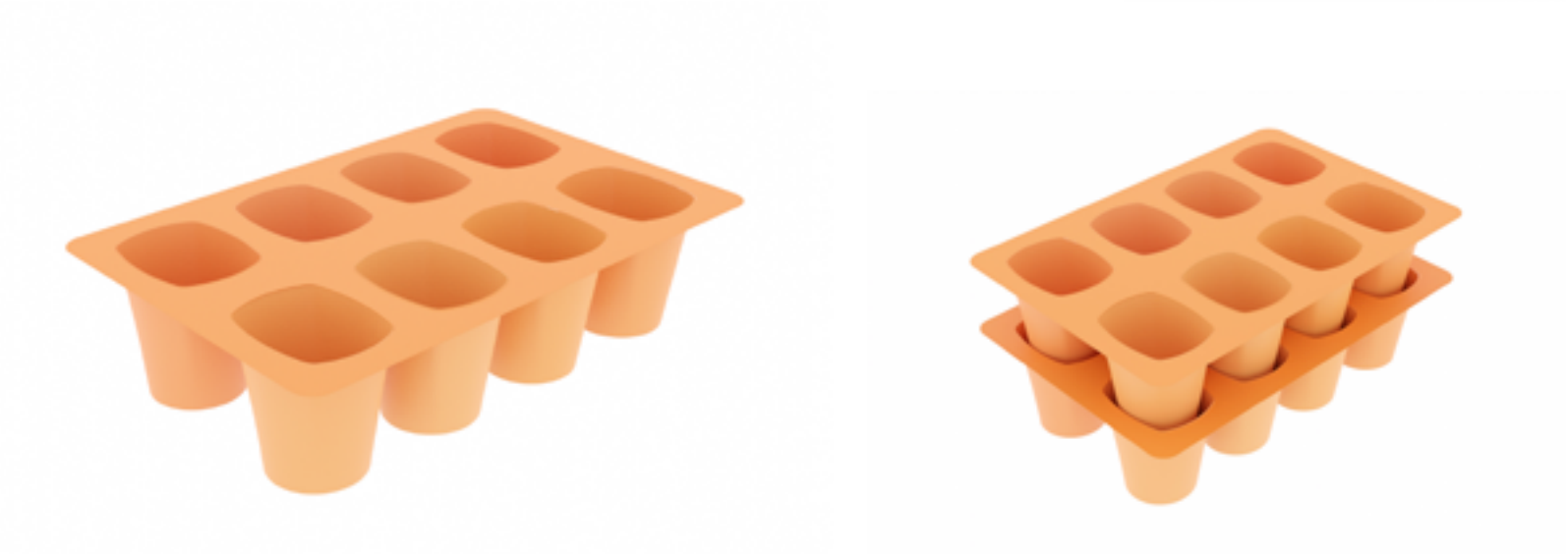



IMPACT

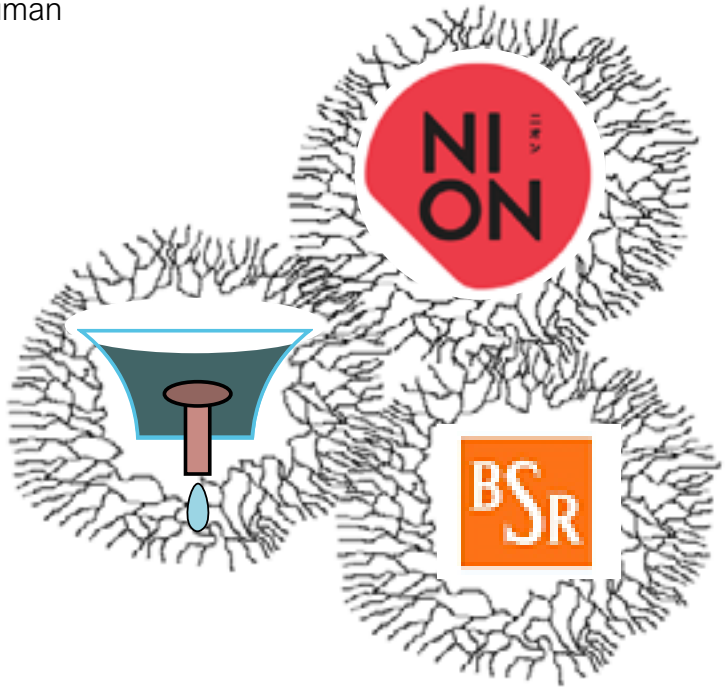
SYSTEM

the possible collaborations

Nion house: an intercultural, social, initiative
The fungi farms in the Nion house could provide the mycelium for the 40 days growing period.

BSR: cleansing department of Berlin
Instead of emptying out the muddbucket at least once a year, the BSR could replace the Mycobags twice a year.

The waste:
Because of the probable accumulation of heavy metals the mycelium has to be treated as toxic waste and be aftertreated and burned, which produces energy or be transformed into e.g. insulation material, where it doesn´t pose any risks to human health.



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impact

Impact:
Mycodrain is a decentered cleaning system for polluted streetwater that runs on the biological process of mycofiltration.
With low maintanance and costs it can break down contaminated streetwater so that it can be led back safely into the water bodies of Berlin. The Mycobags could prohibit high polution in lakes and rivers and ensure the wellbeing of local species.
While working underground, it is part of the progress of integrating nature and non-humans into the landscape of our city and educating about their potential.