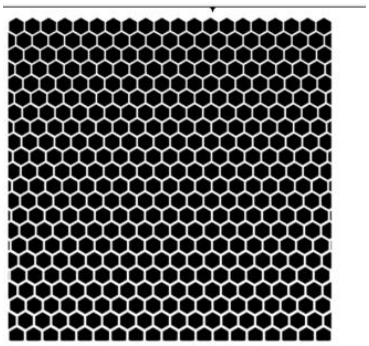
How four biology students explored an innovative way to avoid undesired water accumulation on a surface

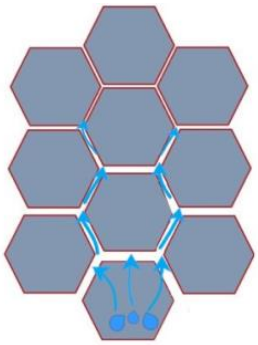
It all started when we, four undergrad biology students, came across a crossroad whilst walking towards our final destination, a biology master degree. The four of us chose the unknown path of bio-inspired innovation and sustainability. This is where we got a project, for which we had to find a problem we encountered in our daily life and which we could resolve with a **bio-inspired solution**. The four of us got together and brainstormed, using many post-its, about problems that each of us had experienced before. One mutual thing combined us all: hiking. We summed up the problems we had encountered whilst hiking and came upon **condensation**. Condensation is the process where water vapor is turned into liquid water. When lying in a tent, this takes place when breathing at night, when the inside and outside temperature differ. Tiny drops of water are being formed and accumulate onto the inner sail. As a consequence, you wake up in a wet tent, one that you cannot pack in its casing. So you need to wait until it has dried. This can lead to lost hours of walking, especially if you are on a tight schedule to achieve daily miles. As we continued to thinker about the problem, more and more situations emerged where condensation turned out to be problematic. When showering on the shower curtain or even on a festival, where drops start to fall down from the roof of large festival tent, drops you know are not rain …

So, we found our problem that we wanted to tackle. Next step was to look at nature, with the questions like "*How do animals cope with condensation?*" and "*Do they either use or ignore it?*". When searching, we came across a small reptile living in Australia: the Thorny Devil (*Moloch horridus*). The skin of this critter is covered with thick spikes, built in such a way that water drops can be led to his mouth to gain drinking water. How does a small reptile lead water drops from his body to his mouth in a horizontal way, against gravity? Turns out, **capillary forces** are making this possible. The make water drops to bind to a surface, which are then transported to a channel system of narrowing channels, that with increasing downsizing they produce a continuously pulling force onto the droplets.

So, what if we could design a pattern that mimics this function, which would conduct droplets over a surface in any direction we want and solve the problem of undesired water accumulation. As nature has a magnificent and complex way of building structures on different scales we needed to convert this to a designable and manufacturable scale, applicable for human use.

Using python programming skills by one of our group members, we generated an abstract version of the complex system. Scales of the thorny devil were reduced to **hexagons** and the channels





were set to be formed by spaces between the hexagons. A gradual narrowing of channels was created by placing hexagons closer to each other along a gradient.

Our research brought us in contact with dr. Benny Malengier, an engineer of the Department of Materials, Textiles and Chemical Engineering at UGent. With him, we set on a quest to find a way to turn our idea into an actual prototype.

In the meantime, we tried to identify who would be possible **customers** for our product. Flanders has one of the largest textile clusters in Europe, with the high-quality textile manufacturing being one of the fastest growing segments. We found companies that are eager for innovation and sustainable processing. They want to find new technologies, new markets and new opportunities. As such, these customers could be the key in launching our anti-condensation design.

Our product had the potential for **multiple applications**, because of the many situations that we could find where undesired accumulation of water on surfaces occurs. With the help of the research and development facilities of the different companies, we set the goal to together create and supply an innovative design to an end-user.

To make our idea more tangible, we made visualisations of what an end-user could expect from this collaboration. The first one is condensation leading to a wet tent. If we would add our water conducting pattern to the inside of the tent sail, we should be able to keep it dry. We would finally have a tent where, after a good night of sleep, you could now get up and immediately start packing your stuff.

Another avenue we explored was the problem of condensation on shower curtains. Don't we all hate that moment when you feel a wet shower curtain against your body, after a warm and relaxing shower? By adding our pattern, that would no longer happen, as water droplets would be guided away, with a dry shower curtain as a result.

A third direction we explored was related to the comforting sensation while partying or enjoying music in a large festival tent. With so many people together, however,

temperature rises, people sweat, breathe, drink, … That brings the necessary atmosphere to a good party, right? But not when drops of sweat accumulate onto the ceiling of the tents and start to 'rain' down. Party tents with our water conducting pattern would prevent this. Drops would be directed towards the sides of the tent and people can continue to enjoy the music without the fear of dripping sweat.

These are all examples linked to the textile industry. But we are convinced that that with the right contacts, we could even expand our market to a much broader scale. Ideas of using our pattern to keep dry roads, to implement them in air circulation systems, to use them on windows and even to prevent something from freezing, already popped up in our heads.

Ain't nature an inspirational thing?

Marie De Wilde, Iris Dumolein, Arne Verdonck and Thibo Kamoen

Master students Biology – Minor Bio-inspired Innovation and Sustainability - UGent