THE GREEN THREAD

EXPLANATION AND EXAMPLES

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1. What is the Green Thread

Firstly, in case this is your first time getting to know us, GreenTU is a student organization dedicated to stimulating sustainability in education, research, operations and community engagement at TU Delft. Thus, ***sustainability in education*** is one of the main priorities of the GreenTU board. Research conducted by faculty-specific GreenTeams (surveying students) consistently recommended more integration of sustainability in curricula. To achieve this, the Green Thread initiative was developed and piloted by GreenTU during the 2020-2021 academic year. The Green Thread is based upon the value of student and teacher participation, aiming to empower students, diversify perspectives on sustainability, and provide enthusiastic teachers with new opportunities without increasing their workload. Ultimately, the Green Thread should give sustainability an integral place in all educational programmes, by ***incorporating sustainability horizontally*** into the existing curricula.

The Green Thread is realized by reinforcing the educational tasks of the GreenTeams. The GreenTeams work with academic staff to replace or extend their teaching materials (e.g. case studies, project topics) with materials centered around sustainability. Whilst teachers come up with the outline of the changes they wish to see, the GreenTeam finds a ***TA (teaching assistant)*** who can support the teacher and work on the implementation of the desired changes.

2. Why the Green Thread works

By incorporating sustainability horizontally into curricula, the Green Thread makes the topic relevant to ***all students regardless of their discipline***. The choice to do this horizontally is mainly due to the density of the curricula; although TU Delft could consider a stand-alone (mandatory) course on sustainability for all bachelor students in the long term, this requires making room for such an additional course. Plus, sustainability is a very broad concept, and may mean different things to different disciplines. This is another reason to integrate the concept per discipline.

Lastly, by mobilizing the GreenTeams to find a TA, the Green Thread ***requires little extra workload*** for teachers wishing to make a change to their course. Teachers of course want to guarantee the quality of their education, regardless of their busy schedules. Our initiative offers teachers the opportunity to realize the ideas and concepts that are on their agenda, but which have not been executed yet due to other important tasks and responsibilities. Consequently, it allows teachers to critically evaluate their course content and brainstorm with an enthusiastic TA on how to make improvements. The combined efforts of teachers, TA's and the GreenTeam can result in a lasting sustainability shift which takes all parties' interests and needs into account.

3. What has been accomplished thus far

The Green Thread initiative was first put into action during the second quarter of the 2020-2021 academic year. A pilot was initialized at the Applied Sciences (AS) and Civil Engineering and

Geosciences (CEG) faculties, making use of the GreenTU budget and through close collaboration with the GreenTeams of the two faculties. During this time of the 2020-2021 academic year, three courses at the CEG faculty were adapted through the Green Thread:

- ***Introduction to Civil Engineering*** - First year bachelor course of the BSc Civil Engineering. Students were given an introduction to sustainability during the first week, as well as a workshop to assess the environmental impact of civil structures in Delft. In the remaining weeks, each lecture was dedicated to a specific aspect of civil engineering, during which the interaction between each aspect and sustainability was discussed.
- ***Financial Engineering*** - Core course of the MSc Construction Management & Engineering. Practices of sustainable finance and the circular economy were introduced.
- Thirdly, the Green Thread was (and is) useful for the redesign of the ***Environmental Engineering track***, which is currently still part of the Applied Earth Sciences master programme but will kick-off as a standalone master programme in the 2022-2023 academic year. Note that this application of the Green Thread involves the redesign of a programme, not a course. This means a higher workload for the TA, thus, a higher budget.

The Green Thread pilot was extended to the AS faculty after taking off at CEG. The Green Thread was employed to adapt six bachelor courses at the AS faculty, of which four are part of the bachelor of Applied Physics:

- ***E&M*** (Elektriciteit & Magnetisme) - First year bachelor course of the BSc Applied Physics. Three exercises were provided in a contemporary and sustainable context.
- ***Introductory Practical*** - First year bachelor course of the BSc Applied Physics. A new practical set-up with solar panels was developed. In the course material, a brief introduction into the relevance of renewable energy and photovoltaics basics was included, as was a paragraph written by a former chief of the TU Delft Solar Boat Team's electronics department.
- ***Computational Science*** - Second year bachelor course of the BSc Applied Physics. An assignment about the plastic soup was introduced into the course.
- ***DEF2*** (Design Engineering for Fysici) - Second year bachelor course of the BSc Applied Physics. Alternatives were found for some of the course material, which are equally as educational as the original material but more focused on sustainable design.
- ***Lab Course*** - Bachelor course of the BSc Nanobiology. The GreenTeam created a chapter on sustainability for the Lab course booklet.
- ***BFTM*** (Bio farmaceutische technieken en maatschappij) - First year bachelor course of the BSc Life Science & Technology. A list of sustainable topics was created for this presentation course. Via a short list with sustainable topics and example theses, students can choose their own topic or can get inspired by this list.
- ***Transport Phenomena (fysische transportverschijnselen)*** - Second year bachelor course of the BSc Molecular Science & Technology. The GreenTeam created examples of sustainable exercises, which were used in this year's presentations for the course.

4. Current and future goals

Currently, the Green Thread pilots of the 2020-2021 academic year are being evaluated by the 2021-2022 GreenTU board, in order to improve and extend the initiative. Evaluations have been conducted through interviews with the involved TA's from CEG (see section 5) and with the involved teachers from CEG (see section 6). Evaluations with the students who attended the courses are still underway (via surveys posted on Brightspace), as well as with the Green Thread participants from AS.

Using the pilot evaluations, the 2021-2022 GreenTU board is making an effort to expand the Green Thread to other faculties. To do so, teachers willing to participate need to be identified. GreenTU approaches this task through networking, as well as by talking to faculty-specific GreenTeams and study associations. As per January 2022, two teachers at the Aerospace (AE) faculty have indicated interest, thus they will be the first new Green Thread participants in the 2021-2022 academic year. In addition, all GreenTeams have been informed about the Green Thread. They are all encouraged to actively search for interested teachers themselves, as the GreenTeams generally have a closer connection to the faculty staff. Still, the GreenTU board will be supporting and encouraging the GreenTeams every step of the way.

In the future, GreenTU hopes that the Green Thread can be unrolled campus-wide, across all faculties and within as many courses as possible. This way all students, regardless of their field of expertise, will gain insight into the relevance of sustainability. Furthermore, if a (mandatory) stand-alone course on sustainability is indeed established for all (bachelor) students in the future, this can supplement or build upon the Green Thread project.

5. TA's experience with the Green Thread

In September 2021, GreenTU interviewed the TA's of the CEG faculty who were involved in the Green Thread pilot during the 2020-2021 academic year. The goal of these interviews was to evaluate the process and results of the pilot. The specific tasks and experiences of these TA's are summarized below:

- Britt Zandbergen: Conducted an ***elaborate literature study*** for dr. Daan Schraven (see section 6) on ways to incorporate sustainability into the course of Financial Engineering. Through her appointment as part of the Green Thread, Britt collected and organized course material about sustainability within finance. Her results were delivered to Daan in July 2021, and will be used to create two lectures about 'frontiers of sustainability in finance'. She found the collaboration with Daan very pleasant, mostly because Daan was already highly interested in sustainability and was happy to get a TA.

- Marguérite Willemsen: Worked with prof.dr.ir. Luuk Rietveld to incorporate sustainability into the course of Introduction to Civil Engineering. She ***conducted research and added***

2-3 slides to each weekly lecture, specifically about sustainability and its relation to that week's topic. Marguérite liked that she was linked directly to Luuk, so they could start their collaboration quickly and could take clear steps. Like Daan, Luuk was enthusiastic about sustainability and willing to make changes. Together they found a way to incorporate the topic into a dense bachelor course, which was challenging at times.

- Emma Little: Worked on the ***redesign of the Environmental Engineering master track***. Specifically, she spoke to numerous representatives from Environmental Engineering degrees around the world, to gather information useful for the redesign of the track at TU Delft. The research at the other universities Emma had been in contact with was done under supervision of dr. Francesco di Maio, research director of the Recycling Laboratory at TU Delft. Furthermore, Emma worked on the development of a ***Knowledge Pool***, a database of circular projects in Environmental and Structural Engineering. This process was supervised by Assistant Professor Wen-Jun Cao. Naturally, the redesign of an entire track is broader than the redesign of a course. However, as illustrated, Emma achieved a lot of progress and she was met by lots of enthusiasm from the people she worked with, including many teachers and faculty staff.

6. Teachers' experience

As stated, the main goal of the Green Thread is to provide students with some knowledge of sustainability *without* asking too much of teachers' time and efforts. Therefore, it is important to know what the Green Thread process is like for teachers and to take their feedback into account. In January and February of 2022, GreenTU members of the 2021-2022 board evaluated the Green Thread experience of two teachers, together with a member of the CEG GreenTeam:

- ***Prof. Dr. ir. Luuk Rietveld***, Professor of Drinking Water & Urban Water Cycle Technology at the CEG faculty who teaches three bachelor courses, including the aforementioned Introduction to Civil Engineering course. Whilst his overall experience with the Green Thread and the collaboration with his TA was positive, it was unfortunately not possible to fully implement all the proposed changes due to COVID-19. Lectures had been pre-recorded instead of given in person, and re-recording the lectures to include all adaptations was too time-intensive. However, he is actively looking for ways to follow through in the upcoming year. Luuk agrees institutionalizing sustainability into education, similar to ethics, is ideal. As a teacher he is always trying to find ways to improve his courses and students play a key role in this process. He believes student initiatives are powerful and recognizes the importance of the impact students can (and should) have on the programmes, as is the case with the Green Thread.

- ***Dr. Daan Schraven***, Assistant Professor for the master Construction Management & Engineering (CME) at the CEG faculty. Before GreenTU's evaluation, Daan already gave an interview about his Green Thread experience in The Educator (the newsletter of the

Teaching Academy) in June 2021 (see this link). Daan was already highly interested in sustainability in his work and teachings, thus his participation in the Green Thread was a win-win situation. He states that the collaboration with both the GreenTeam and the TA they brought forward was pleasant and inspiring, costing him no more than half an hour per week. This little extra effort granted him the opportunity to make his ideas concrete and actually implement them, whereas on his own he would not have had the time to do this. Now, together with a new TA, Daan will continue his efforts for the Green Thread and implement sustainability throughout the master program of Construction Management and Engineering.

7. Practicalities

Budget: Initially, the Green Thread pilots at the CEG and AS faculties relied on the GreenTU budget. However, if the Green Thread is to be implemented across all faculties, this dependence on the GreenTU budget will not suffice. Thus, the GreenTeams wishing to work on the Green Thread are encouraged to discuss with their faculty management, possibly setting up a faculty-specific fund.

Where to start: Are you a teacher who's interested in participating in the Green Thread? Email us at greentu@tudelft.nl or directly contact your faculty-specific GreenTeam. The main steps of the process are summarized below: