ORGANIZATION BACKGROUND

THE HAGUE UNIVERSITY OF APPLIED SCIENCES (THUAS) HAS AROUND 25 000 THOUSAND STUDENTS OF OVER 140 NATIONALITIES AND 1900 STAFF. THUAS IS LOCATED ON FOUR CAMPUSES IN THE HAGUE (MAIN CAMPUS), DELFT AND ZOETERMEER. IT OFFERS OVER 65 BACHELOR PROGRAMS SUPPLEMENTED BY OTHER PROGRAMS AS ASSOCIATE DEGREES, MASTERS, POST-GRADUATE, AND OTHERS. THUAS OFFERS FIVE EPS PROGRAMS AT TWO FACULTIES (WWW.THEHAGUEUNIVERSITY.COM). THUAS HAS A STRATEGIC FOCUS ON WORLD CITIZENSHIP, INTERNATIONALIZATION, NETWORK UNIVERSITY, AND QUALITY. THIS IS TO BE PRACTICED BOTH BY STUDENTS AND STAFF. THUAS STARTED EUROPEAN PROJECT SEMESTER (EPS) IN 2014 BECAUSE THE CURRENT FAST-CHANGING WORLD REQUIRES ENGINEERS, IT SPECIALISTS, AND DESIGNERS WHO ARE PREPARED TO LOOK AT PROBLEMS FROM DIFFERENT PERSPECTIVES AND WHO HAVE LEARNED TO COLLABORATE WITH PROFESSIONALS FROM OTHER DISCIPLINES (ANDERSEN, 2012). EPS NETWORK PROVIDES EXPERTISE AND SHARING OPPORTUNITIES WITH HIGHER EDUCATION INSTITUTIONS FOCUSED ON DESIGN (PUYUELO ET AL., 2016) AND SUSTAINABILITY (DUARTE ET AL., 2020). EPS WAS ALSO PROVED AS A GOOD APPROACH FOR COMPETENCE-ORIENTED PROGRAMS (FUENTES-DURÁ ET AL., 2014).SETTING THE STAGE

This chapter describes a special edition of the EPS on Sustainable Packaging Design & Innovation provided by the Industrial Design Engineering course program of the Faculty of Technology, Innovation and Society. The special edition was held in the fall semester of 2017. The uniqueness of this edition lies in the fact that it involved twelve parties working closely together. The edition was not only a success in terms of cooperation but also highly beneficial to the participating students. The benefits for the students were achieved by a large series of lectures, presentations and workshops by experts and scholars in (packaging) sustainability, marketing, design and research. This makes the described EPS edition stand out as an extraordinary event compared to the usual program. The usual EPS set-up offers a design project focused upon a problem where sustainable packaging should be designed by the participating students. An external party usually gives the design project, typically a company supplying a realistic design assignment. The design project is supported by lectures, both by regular staff as external speakers, workshops, brainstorm sessions, excursions and other activities as team-pitches and presentations (also by participating students). The main objective of this large variety of educational activities is to give students a broad view of the project, to stimulate teamwork (in the international set-up of EPS, six nationalities involved) and to practice working on complex problems with multiple stakeholders.

The EPS has joined a unique collaboration between three research institutes, six universities, and three companies for the special edition. More specifically, the parties are given here:

- **Research institutes:**
    - Netherlands Institute for Sustainable Packaging (KIDV), an institute advising and inspiring companies on sustainable packaging by offering tailor-made advice, factual knowledge and practical tools (https://www.kidv.nl/)
    - Top Institute Food & Nutrition (TiFN), a public-private partnership for multi- and interdisciplinary research in food and nutrition (https://www.tifn.nl/)

    - TNO, an independent research organization, connecting people and knowledge to create innovations that boost the competitive strength of industry and the well-being of society in a sustainable way (https://www.tno.nl/)
- **Universities:**
    - University Twente (UTwente, Enschede) (https://www.utwente.nl/)
    - University of Groningen (RUG, Groningen) (https://www.rug.nl/)
    - Wageningen University & Research (WUR, Wageningen) (https://www.wur.nl/)
    - HAS University of Applied Sciences (Den Bosch) (https://www.hasuniversity.nl/)
    - HvA Amsterdam University of Applied Sciences (Amsterdam) (http://www.hva.nl/)
    - THUAS University of Applied Sciences (The Hague), Industrial Design Engineering (IPO) (https://www.dehaagsehogeschool.nl/)
- **Companies:**
    - EasyFairs, an international company hosting trade shows, conferences, congresses, concerts and sporting fixtures (https://EasyFairs.com/)
    - Struik Foods Europe, a food company, specialized in soups and broths (https://struikfoodseurope.nl/)
    - Wessanen, a food company with a sustainable attitude towards health for both consumers and the planet (https://www.wessanen.com/)

All these parties have – at least – one thing in common. They all share a specific interest in packaging, packaging design & innovation and sustainability. The research institutes study these themes as well as the universities. The universities offer courses involving packaging design and marketing-related matters and do research. The food companies produce packaged food, and the trade fair company organizes specialized trade fairs about packaging.
The collaboration was initiated by KIDV. KIDV launched an initiative in 2015 called Scientific Research Program 2015-2019 – Interdisciplinary approach to sustainable packaging (KIDV, 2019). In brief, this initiative is named WOP, abbreviated from the Dutch name *Wetenschappelijk Onderzoeksprogramma.* The following parties are included in this initiative: KIDV, TiFN and TNO research institutes and UTwente, RUG and WUR universities.
The main objective of this initiative is to provide answers to urgent and relevant questions, which contribute to decreasing the environmental pressure of the product-packaging chain in The Netherlands (KIDV, 2019). Within the scientific research program initiative, eleven research themes are formulated. Three examples of these themes are the *Disposal behavior and packaging design*, *The plastic cycle closed* and the *Recycled PET in new bottles* (KIDV, 2019).
The connection with parties as the universities HAS, HvA and THUAS as well as with the companies EasyFairs, Struik Foods Europe and Wessanen is made at the research theme *Education module packaging design – From eco-efficient to eco-effective product packaging designs.* The first action was a pilot carried out at HAS (Sept./Oct. 2017). The company Struik Foods Europe joined the pilot. Evaluated and improved with the learnings of this pilot, the *Education module packaging design* was carried out at THUAS (fall semester 2017). The company Struik Foods Europe was not present at THUAS; company Wessanen took their role here as a provider of the actual design assignment. The WOP at HvA is carried out in spring 2019. In April of 2018, the company EasyFairs provided an exhibition stand for all involved parties at their packaging trade fair Empack. At the exhibition stand, the results of the *Education module packaging design*, consisting of posters, digital presentations and prototypes were presented to the public. For this reason, the results of the IPO-EPS teams couldn't be displayed to a larger audience at an earlier stage.
This chapter describes the participation of THUAS in the WOP, the scientific research program. Within this specific participation, Wessanen provided the design assignment: design a sustainable (preferably circular) packaging for on-the-go drinks (fruit-based beverages) of the brand Zonnatura.
To summarize, the research theme at THUAS was carried out with the partners of the WOP (three universities and three research institutes) and two companies (Wessanen and EasyFairs) – see Table 1. A list of acronyms is given at the end of this chapter.

Table 1. Scheme of cooperation of all involved parties

Initiative & organization (WOP partners)	Providers of design assignments	Participating universities	Provider of publicity and exhibition stand
Universities: • University Twente • University of Groningen • Wageningen University & Research Research institutes: • KIDV • TiFN • TNO TN	• Struik Foods Europe • Wessanen	• HAS (Den Bosch) • HvA (Amsterdam) • THUAS (The Hague)	• EasyFairs

Within the EPS of THUAS the participating 16 students worked in four groups of four students. The EPS class consisted of five exchange students (from Bulgaria, China and Germany), two international students (full course) and nine students of the hosting Industrial Design Engineering (IPO) course, see Figure 1.

Figure 1. The EPS group, staff and jury members at the final presentation

CASE DESCRIPTION

The set-up of the special edition of EPS fall 2017 is composed by the integration of the WOP research theme *Education module packaging design* in the regular EPS Sustainable Packaging Design & Innovation (in brief *Education Module*). The *Education Module* provided the design assignment of company Wessanen. During the preliminary preparation phase, all involved parties carefully tuned their objectives, expectations, preconditions, constraints, and other related matters. This was done in a series of meetings. The first meetings had an exploratory character: *can we cooperate, and if so, how will we do that?* Later meetings were focused upon timetables, topics, working procedures, grading, evaluation and other practical matters. The special edition of EPS was located at the THUAS main campus in The Hague. English is chosen as a language throughout the course for all activities, presentations and written communication.

Once full cooperation was agreed upon, a detailed timetable was made, covering all ten weeks of the EPS. It was decided to replace predominantly a set of regular EPS lectures by activities of the *Education Module*. The justification to skip these lectures was found easily: most of them were covered by lectures of *Education Module*. IPO formed groups of participating students. They were all given the same design assignment. The *Education Module* has included a design game in the course. Every group member is given dedicated roles during the course within each group. The roles were: manager, engineer, designer, marketeer and Sustainable Guardian. The last-mentioned role is a newly introduced role, developed by researchers of WOP. In brief, it is a role with special interest and focuses upon sustainability within design processes. The *Educational Module* also offered a newly developed Life Cycle Assessment

(LCA) tool, which could be used by the students to do assessments of the to-be-designed packaging throughout the process. Figure 2 shows one of the workshops.

Figure 2. Workshop LCA tool

Besides this project work, IPO asks EPS students to prepare student lectures supported by literature research. This was maintained during the course.
The *Education module packaging design* has five perspectives included in the course:
Perspective 1. Integration of sustainability considerations in design processes

Perspective 2. Environmental impact of product-packaging combinations in terms of Life Cycle Assessment

Perspective 3. Consumer behavior at purchase and consumption of product-packaging combinations

Perspective 4. (Sorted) waste collection behavior of consumers and subsequent sorting steps

Perspective 5. The efficiency and effectiveness of (plastic) recycling chains

These five perspectives are subsequently offered to the students by lectures and workshops, given by guest lecturers invited by WOP.

- **Typical week of the course.**
    - Monday and Tuesday: regular EPS activities
    - Wednesday and Thursday: *Educational Module* (lectures, design game and workshops)
    - Friday: regular EPS non-mandatory consults

The timetable of the reworked EPS is given in Table 2. This table does not include detailed regular EPS activities neither detailed activities of the *Educational Module.*

Table 2. Timetable of special edition EPS (Nov. 2017 – Jan. 2018)

EPS Week	Activities and Perspectives of Educational Module	Design process phase
1	Introduction, Design game	Introduction, Analysis, Ideation
2	Perspective 1. Integration of sustainability considerations in design processes, Perspective 5. The efficiency and effectiveness of (plastic) recycling chains	Analysis, Ideation
3	Perspective 2. Environmental impact of product-packaging combinations in terms of a Life Cycle Assessment	Ideation Pitch
4	Perspective 2. Environmental impact of product-packaging combinations in terms of a Life Cycle Assessment	Concept
5	Perspective 3. Consumer behavior at purchase and consumption of product-packaging combinations	Concept Pitch
6	Perspective 4. (Sorted) Waste collection behavior of consumers and subsequent sorting steps	Materialization

7	Excursion, Perspective 5. The efficiency and effectiveness of (plastic) recycling chains	Materialization
8	Project workshops, feedback sessions	Materialization, Prototyping
9	Final presentation, wrap-up, evaluations	Final Presentations
10	none	(retakes)

The Educational Module provided one or more trained and dedicated guest lecturers for all perspective-related lectures and workshops. These were researchers, scholars or other specialists with specific experience and knowledge on the field of the relevant perspective. This led to a total of ten guest lecturers. The manager of the *Educational Module* evaluated and reported each contribution.

The final presentation of the projects was held at THUAS and attended by representatives of all involved parties (EasyFairs, *Educational Module* representing UTwente and TNO, HvA, KIDV, THUAS and Wessanen). Student groups have presented their results through a PowerPoint presentation, supported by posters and prototypes of the on-the-go drinks packaging. Students have also prepared a process report to be included in their grading.

At the start of the course and at the end, students were asked to fill out a questionnaire by the organizing party of the *Educational Module.* The results of these questionnaires are described in a journal paper by Mulder-Nijkamp et al. (2018). Both achievements and shortcomings of the offered *Educational Module* are discussed here as well. In brief, the objectives of integration were well met and at the same time, the team results paid more attention to LCA aspects at the cost of recycling aspects.

Both THUAS and representatives of the *Educational Module* had prepared a grading form for the students' results (reports, prototypes, presentation). It was decided to merge these grading forms into one dedicated grading form.

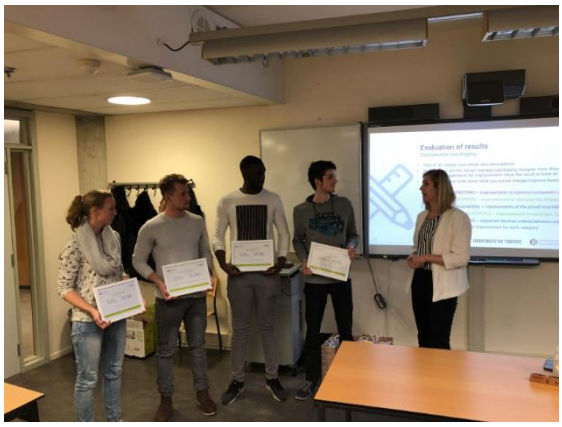

Figure 3. The final presentation and best group award

The results of the student groups were evaluated by a four-party jury formed by representatives of EasyFairs, KIDV, THUAS and Wessanen. The jury used five evaluation criteria (equally weighted): Innovativeness (originality, checked on state-of-the art solutions), relevancy (solution for the problem), potential (feasibility), credibility (well described and motivated) and presentation (narrative, graphics, prototype quality). The best group award was given at the end of the session (Figure 3). Finally, the posters and prototypes were shown at the packaging trade fair Empack on a unique stand, hosted by EasyFairs. The poster is shown in Figure 4 (right). The winning design consists of a set of concentrated fruit juices to be poured in a dedicated bottle and fill up with water. The winning prototype is the packaging on the left and front, as shown in Figure 4 (left).

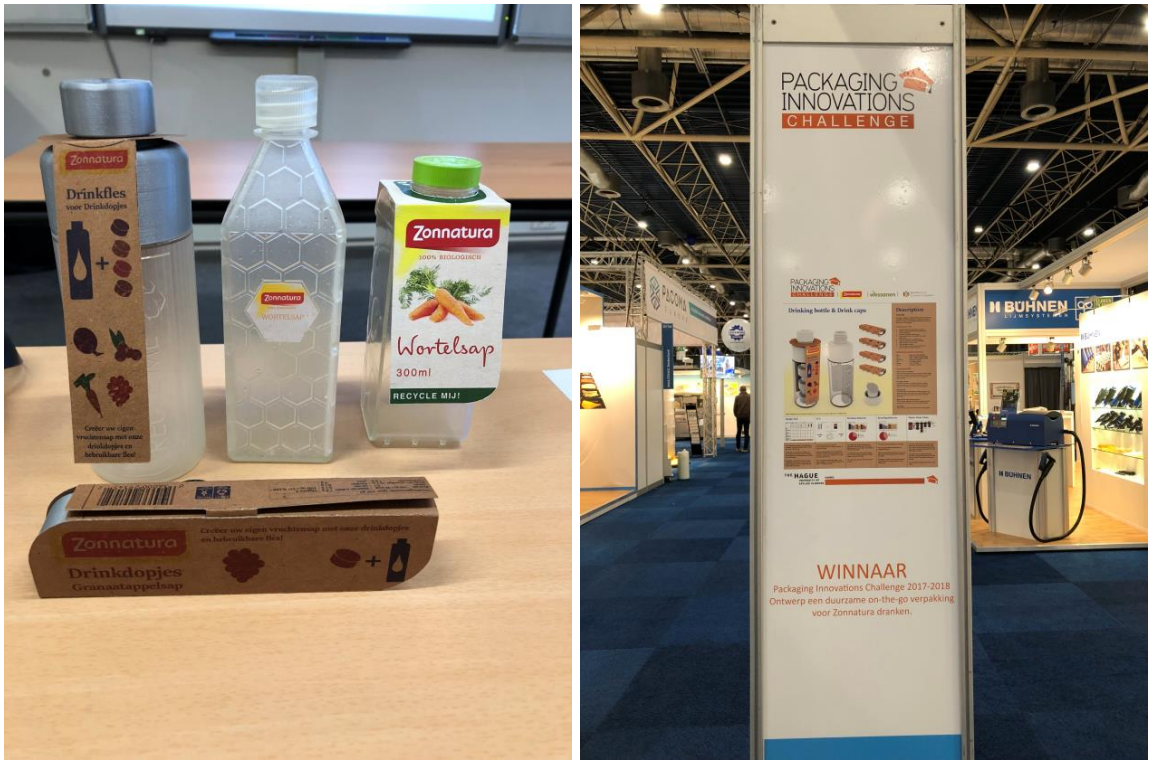

Figure 4. Some prototypes (left) and the poster on Empack (right)

The jury chose this design as a winner because of its reusability aspects and the fact that it needs less water along the packaging and production chain. Further details are not given here.
Epilogue: the WOP results were presented in an official presentation, attended by all involved parties and many relevant representatives from universities, governments, businesses and press, including over 150 guests. This final presentation was held on January 17, 2019, at Utrecht. All outcomes are given in a brochure (KIDV, 2019) with QR-codes referring to relevant scientific reports, papers and even dissertations. The brochure is given in Figure 5. Publications that particularly address the issues of the *Education Module* are reported by Maaike Mulder-Nijkamp et al. (2018).

Figure 5. Brochure KIDV

Technology Concerns

The main technological component in this EPS was the application of a newly developed Life Cycle Analysis/Assessment tool by TNO called Envpack (Ansems & Ligthart, 2018; Ligthart et al., 2019a; Ligthart et al., 2019b). The tool is based on a large database, indicating the environmental impact of a given packaging. The database is the backbone of the LCA tool. TNO has subsequently developed a user-friendly interface, tailor made for student use. Lastly, TNO has developed the combination of software and hardware. TNO has chosen to use MS Excel as a base for the tool and has done this so that the entire tool, including database and user interface, fit on a standard USB-memory stick. This has led to a cost-efficient solution that made it easy to make copies and give all four student groups their own stick with the tool. The only practical requirement was to have at least one laptop per group. The concerns here were found at the updates: the students had to hand in the tools to have them updated, which could be done relatively fast and easily.
The tool was ready for use and WOP used the students to improve, update and debug the tool. TNO has frequently reviewed the tool together with the users: the students involved. Figure 6 displays one of the outcome graphs of an LCA calculation.

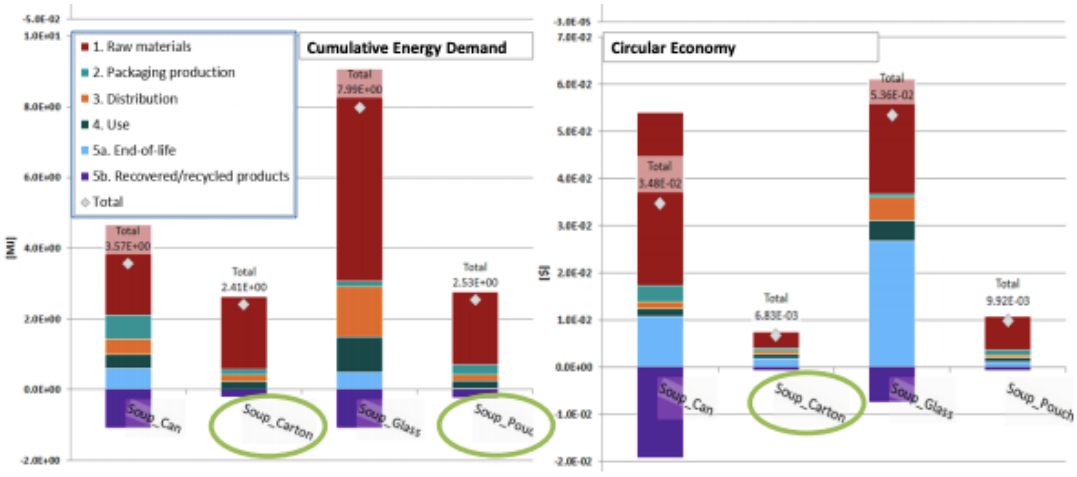

Figure 6. Screenshot of the LCA-tool Envpack in use Source: Ansems & Ligthart (2018)

Other technology used in the EPS were the application of Three-Dimensional Computer-Aided Design (3D-CAD) software (primarily SolidWorks) and rapid prototyping equipment, laser cutters and 3D-printers facilitated in the prototyping lab of IPO at THUAS. The prototypes shown in Figure 4 (left), were made this way. Not all participating students master the required software nor the use of the prototyping equipment. By composing the groups, attention was paid to having at least one student per group who was qualified enough to use this technology.

Technology Components

In the regular EPS there are no courses included for the use of a LCA-tool, neither for 3D-CAD software and belonging prototyping equipment. For this special edition, the *Educational Module* provided a specialist of research institute TNO to give multiple lectures and workshops to use the LCA-tool. Within this edition of EPS, there were no courses for 3D-CAD and prototyping. The students had to make their own choices about how and where to make technical drawings and prototypes. THUAS facilitates only the software and the equipment.

Management and Organizational Concerns

Before the actual start of this particular EPS, the parties involved had several meetings to ensure that the *Educational Module* was well-organized and embedded in the regular EPS. This cooperation had some organizational, educational and practical implications. Organizational implications were for example: who has the lead? In other words, who is running the EPS and who is responsible, especially

towards the participating students? Who will grade the students? THUAS and the board of the *Educational Module* decided to embed the course in the regular EPS. This led to the conclusion that THUAS was still responsible for the whole course module. THUAS had to skip a substantial number of lectures and workshops out of the regular EPS. This was to make room for the *Educational Module*.
A special remark is made here about the financial aspects. In fact, there was no finance involved. The *Educational Module* had no fees (it was already financed and the WOP had to find selected student populations/educational courses to test, run and fine-tune their module).
There were some educational concerns to be solved. THUAS/IPO is educating the course of Industrial Design Engineering following a methodological and systematic approach. This had not to be disturbed or alternated too drastically in order to maintain the essential set-up of the EPS. The question was here: how can the educational program of EPS be tuned to the *Educational Module*? Before the start of the EPS, all involved parties discussed the methods to be used as well as the educational formats (lectures, workshops, etc.). Special attention was paid to the aforementioned five perspectives of the *Educational Module*. THUAS/IPO looked for course components which were double or conflicting with the five perspectives and decided to include these in the to be skipped items.
Since many parties were involved, their representatives often live quite remote from THUAS in The Hague. Some of them had to travel over 250 km to get to THUAS for 2-day lectures and workshops. The question here was: how to solve this? In most cases, the representatives organized overnight stays to make the most out of the day.

CURRENT CHALLENGES FACING THE ORGANIZATION

The most important challenge currently is the continuation of the described *Educational Module*. So far, it has only been run once at THUAS. Both staff and students of THUAS/IPO are very satisfied with the followed process and the achieved results. They would like to do this again. Clear evidence is found in the evaluation questionnaires done by the staff of the *Educational Module* and THUAS/IPO. The WOP has reached its final stage and the researchers are moving on to other activities. Even if the staff could find suitable lecturers to run the program again, another problem occurs: how to finance this? This challenge is not only felt at THUAS but also at the other participating universities of applied sciences HAS and HvA. Currently, the staff of the *Educational Module* is working on a solution. There are lectures ready to be given. There is a LCA tool ready to be used and the entire operation has been thoroughly evaluated. Time is a constraint, too: all the generated material has to be kept updated.

SOLUTIONS AND RECOMMENDATIONS

So far, a solution has not been found to rerun the special edition. Motivation is not the problem here. All involved parties would like to continue the cooperation. After the last debriefing meetings, the parties are still in contact and looking for solutions. One of the possible solutions is a web-based course, to be given and maintained by the staff of the *Educational Module*. There are some concerns at the receiving universities of applied sciences about this solution. They fear that the personal and direct contact of the lecturers and specialists gets lost here, at least to some extent.
Furthermore, there might be financial consequences as well. When the *Educational Module* would charge the receiving universities, it will be most unsure if there are resources available to finance this. To summarize: a solution for continuation is welcomed, all parties are still thinking and discussing this, but a final decision has not been taken yet.

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