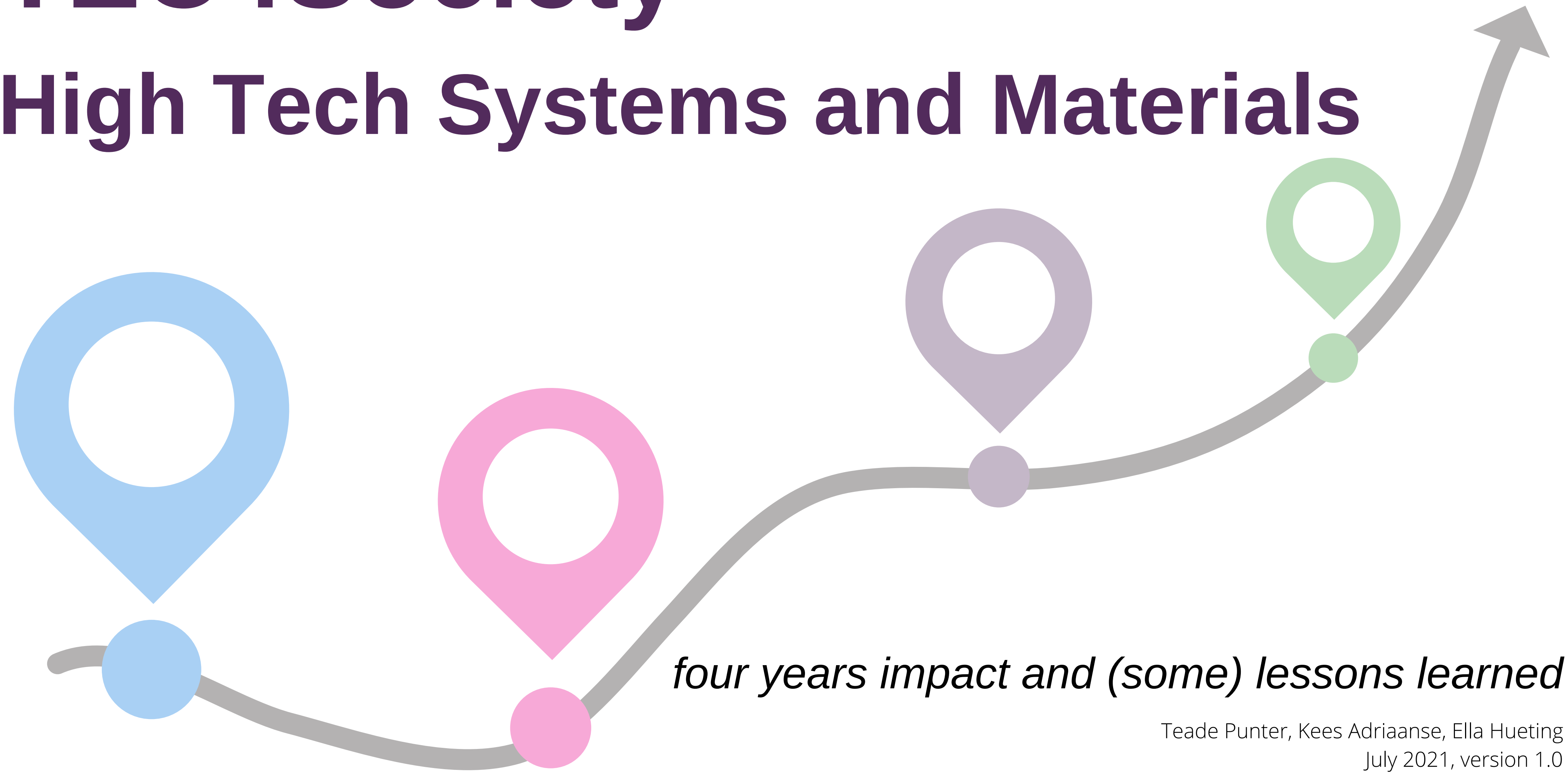
> FOR SOCIETY

TEC4Society

High Tech Systems and Materials



four years impact and (some) lessons learned

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Introduction

This document is an analysis of the Tec4Society HTSM research program. It provides an overview of the completed projects. We have asked ourselves: what have we learned with regard to planning and implementation? First an overview of project is presented (section 1). The second part heads up to factors that played a role in conducting practice-oriented research (Dutch: praktijk-gericht onderzoek).
This report provides (personal) insights to reflect from three perspectives: program management, project management and research execution. We think, these lessons learned might be useful for future applied and practice-oriented research in Fontys, such as for the strategic theme Enabling Technologies.

1. Project overview

Twenty-five projects were carried out under the flag of TEC for Society High Tech Systems and Materials (HTSM) in the period 2017 to 2020. The following principles were used in the awarding of these projects, namely:

- They address a relevant social issue,
- The project is seed money, to give new ideas a growth opportunity,
- A combination of companies, lecturer-researchers and students should participate in the project.

1. Project overview

HTSM-project	Research area (onderzoekslijn)	Fontys institute	Competence	Application area (Toepassingsgebied)	Fontys kennisthema
Big Data voor MKB	Business Service Innovation	FBIS	Procesoptimalisatie	MKB-innovatie, regio-ontwikkeling	Creatieve economie
iDawn	Big Data	FHICT	Data Engineering cyber security	Mensenrechten	Creatieve economie
ADES	Smart Manufacturing	FH Eng	Energie opwekken	Energietransitie	Duurzaamheid & circulariteit
BATMAN	Big Data + High Tech Embedded Software	FHICT	Sensoring	AI omgeving	Duurzaamheid & circulariteit
Battery Packs for Smart Mobility Applications	Distributed Sensor Systems	FH Eng	Control, besturingssysteem, sensoring	Energietransitie	Duurzaamheid & circulariteit
Biologische regel-systemen / Aquaponics	Applied Natural Science	FH TNW	sensoring, biologische modellering	voedselproductie / circulaire transitie	Duurzaamheid & circulariteit

1. Project overview

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Burger Snuffel Netwerk	Agro-Mechatronica + Business Service Innovation	FH T&L	Sensoring	Omgeving (mensbehoud)	Duurzaamheid & circulariteit
Duurzame klimaatsystemen	Future Powertrain	FH Eng	control, besturings-systeem, sensoring	Energietransitie, technical system	Duurzaamheid & circulariteit
Plasma makes blue hydrogen	Applied Natural Science + Distributed Sensor Systems	FH TNW	Energie opwekken, materiaalkunde	Energietransitie, circulaire transitie, technical system	Duurzaamheid & circulariteit
Re-kurk	Agro-Mechatronica + Business Service Innovation	FH T&L	Technical, scheidingstechnieken	Circulaire transitie	Duurzaamheid & circulariteit
Environmental DNA detection	Applied Natural Science	FH TNW	Biological sensoring	Omgeving, natuurbehoud	Gezonde & Inclusieve samenleving
Music Enabled Running	Move to Be	Fontys Sporthogeschool	Sensoring, AI engineering	Sport (gezondheid)	Gezonde & Inclusieve samenleving

1. Project overview

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Portable Respirator Systems	Distributed Sensor Systems	FH ENG	Sensoring, AI	Gezondheid	Gezonde & Inclusieve samenleving
SHoQR	Health Innovations & Technology	FPH	Sensoring, IoT	Sport (gezondheid)	Gezonde & Inclusieve samenleving
SARS-CoV2	Applied Natural Science	FH TNW	Biologie, diagnostiek	Gezondheid	Gezonde & Inclusieve samenleving
ToFu-MedVen	Distributed Sensor Systems	FH ENG	Sensoring, IoT	Gezondheid	Gezonde & Inclusieve samenleving
Wearable Sensors	Health Innovations & Technology	FPH	Sensoring, IoT, AI	Gezondheid	Gezonde & Inclusieve samenleving
ConnectBySense	Agro-Mechatronica	FH T&L	IoT, blockchain, data engineering	Omgeving	Ondersteunende technologieën

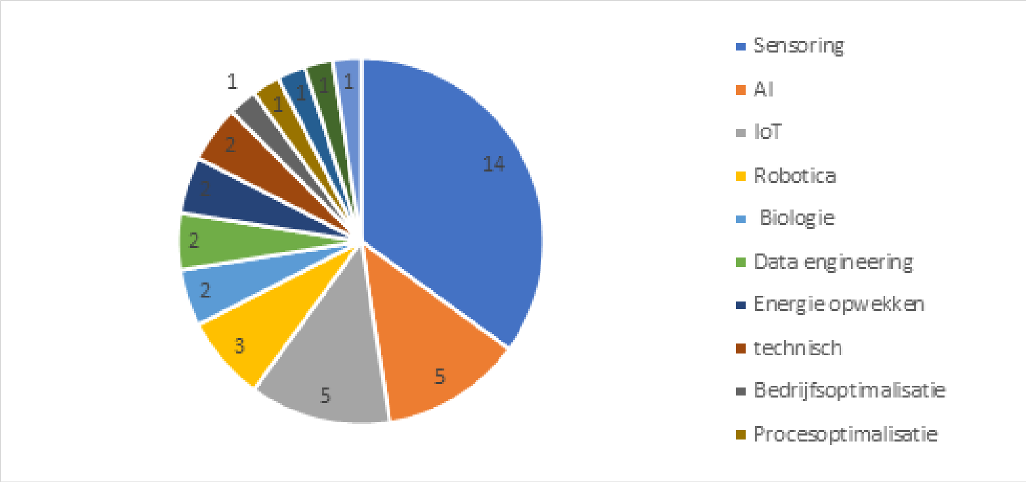
1. Project overview

HTSM-project	Research area (onderzoekslijn)	Fontys institute	Competence	Application area (Toepassingsgebied)	Fontys kennisthema
IoT4MKB	Business Service Innovation	FBIS	Bedrijfspositionering, swot-analyse	MKB-innovatie, regio-ontwikkeling	Ondersteunende technologieën
Robotiseren in de fruitsector	Agro-Mechatronica	FH T&L	Robotica, technical	Agro	Ondersteunende technologieën
DUSTERR	Distributed Sensor Systems	FH ENG	robotica, sensoring, modellering	MKB-innovatie, regio-ontwikkeling	Slimme mobiliteit
Energy efficient motor control	Distributed Sensor Systems	FH ENG	Drones, robotica	Smart Mobilty	Slimme mobiliteit
Exploring Social Learning Technologies for young children	Onderwijs ingenieurs	FLOT	Sensoring, AR/VR, didactiek	Educatie, pedagogiek, future of learning	Toekomst van leren

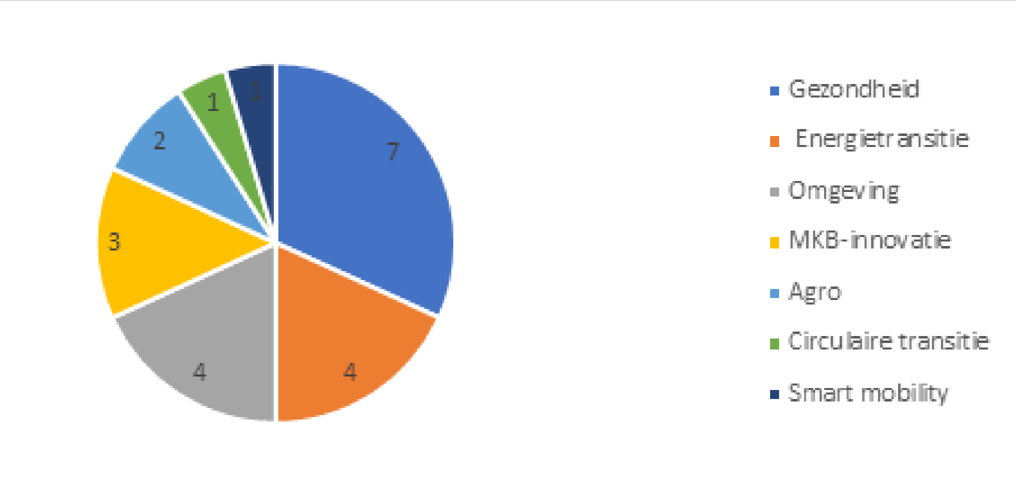
1. Project overview

In the course of program implementation, the projects are also classified according to competences (ideas or technologies to be deployed) and areas of application. Below are the overviews of the relevant criteria.

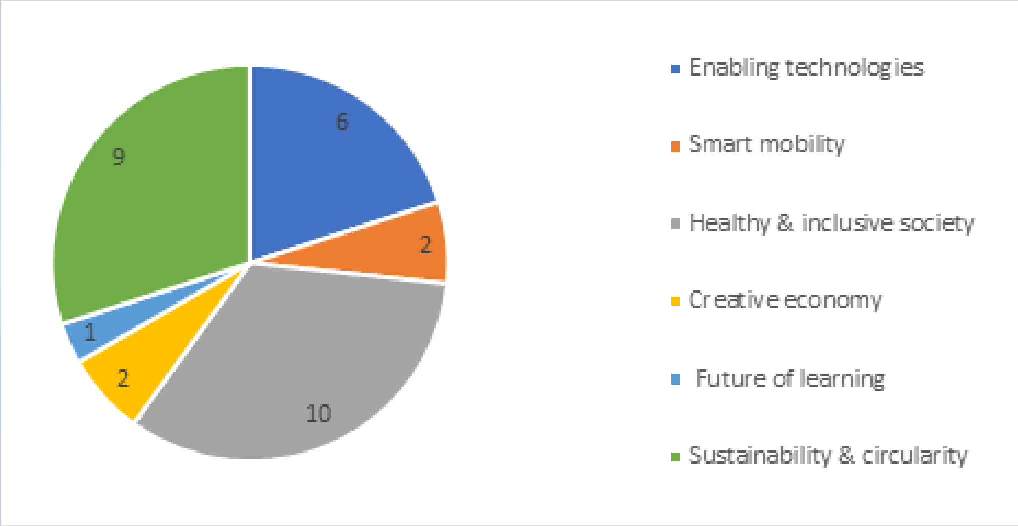
The distribution of the projects across areas of competence is as follows:



The distribution of the projects across application areas is as follows:



Finally, a connection has been made with the Fontys knowledge themes as derived from the key themes in the autumn of 2020.



A project overview can also be found via: fontys.nl/htsmonderzoek

2. Lessons learned for practice-oriented research

The remainder of this document is an afterthought from the program management of Tec4Society HTSM research projects. The question we have raised ourselves is: which factors play a role in conducting practice-oriented research? We intend to describe what determines successful practice-oriented research, but it is too limited to draw strong conclusions. The following sometimes gives substance to the factor, sometimes it is more observational or anecdotal.

2.1.Research question and technologies to apply

It is obvious that research question should lead every iteration of an practice-oriented research project. After all, it is this question that must be answered methodologically. Questions could originate from different origins, like scientific roadmaps (such EU roadmaps on IoT or robotics), as well as regional research agenda's, like Brainport, Brightlands and Midpoint. The questions did also originate from company's directly without having a direct scientific link.

Often, the questions did already have a direction for solution in which a high-tech perspective has been formulated, which enables the application of the answer to be provided. For various projects, the question was a guiding principle, but the question was also adapted and evolved during the project. This was not experienced as a problem by the companies because often a better understanding was achieved.

A research question can be formulated from an idea for a solution. There may also be a ready-to-use technologies that can be applied. We did not observe a clear relationship between the readiness of the applied technologies in the projects (expressed as TRL 2 3) and project success. This implies that projects at a University of Applied Science can be successful when conducting it with ready to use technologies, as well as when the research is more explorative.

Research can be done in several ways, in the context of High Tech Systems and Materials the research is done both the empirical and the design-oriented research. Empirical approach, especially in the research of materials. Design-oriented at Engineering and ICT. Empirical – materials.

2. Lessons learned for practice-oriented research

2.2 Project management

In practice-oriented research projects, the project management is different compared to projects in industry. The educational heartbeat and its working methods, like having semesters, school schedules, study progress, holidays, determines to a large extend how practice-oriented research project are conducted. We present some (project management) considerations that impact practice-oriented research:

- Scattered time – Research is (often) not scheduled at school. Especially for those researchers that have educational tasks as well, the research time becomes easily fragmented, which makes it harder to progress on research. The educational tasks do often have short term urgencies, while research got a priority for the long term. This also makes staff feel that research is place in their leisure time, e.g., evening hours. Another scenario that program management observes that a project is approved, the education semester begins and after a few weeks or months the researchers start to think “Oh yes, there is also something that needs to be done for the research…” For this same subject, but from the perspective of researchers is that they face a variety as well as large amount of tasks that they have to fulfill. Team members might have many responsibilities and tasks, also out of the scope of the project. Usually they are overloaded, must prioritize and select from a various set of activities to do now or to postpone. In this selection education often gets priority over research because students urgently demand attention (and educating is what inspired most of them to work in higher education).

- Selection and assignment of research staff. In some projects the project manager did not select his team-members; and he/she felt like jumping on a running train which makes it harder to make the project goal yourself.

- Accountability of the staff. It varies to what extend colleagues are accountable for their responsibilities and on the fulfillment of agreements. This might apply for staff as well as for students. For example, if a student stops, he or she will receive an unsatisfactory assessment at the end but not executing the assignment does also ‘hurt’ the project.

2. Lessons learned for practice-oriented research

2.3 Cross-over projects

Fontys Enabling Technologies in which HTSM an AI are both subthemes, as well other Fontys' kennisthema's, apply and require a broad range of competencies which could be matched to many challenges or application areas. This brings in the need for cross-over project: projects that look with multiple disciplines, and with different companies incorporated, together at the same research topic.
Working with crossover projects is felt by to have really adds value. It brings new perspectives on the question at hand and brings integral solutions or approaches that has value for society. Cross-overs helps to communicate more thoroughly about options and assumptions. In general this helps understanding and to design more sound solutions.

A characteristic of cross-over projects is that the projects have high ambitions, a relatively short duration that makes them challenging an exciting to execute. We have observed that it is not yet a natural process to work together amongst institutions in education. Cooperation requires attention, planning, organization and significant effort to establish a good cooperation.

Some of the challenges are:

- Student schedules are not synchronized, different education execution models are applied. For example, two days a week in the beginning, full time in the end versus three days a week all semester. As well as financial and purchase procedures in supporting offices might differ.
- Student groups have different working methods that is required by their educational institute; e.g. waterfall/V model versus agile/scrum.
- Student trade-off: Private concern of making the semester versus generic and longer term project goals that may hinder individual progress.

Acknowledgement to Cees van Tilborg on experiences with cross-over project

Example Robot is no super spreader (RIGS) project – Social distancing robot

An example of a cross over project is Robot is geen superbesmetter. Covid-19 is the origin for this HTSM-project. People who contact with many others are potential super infectants. Several occasions in which people are vulnerable for infection exist. One is the situation in bars and restaurant. The pressure to open up terraces was discussed a lot in the Dutch news in 2020 and 2021. Bartenders are receiving guests and deliver orders. These are tasks that a robot might easily take over, just because it is no super infector. The robot might help us in social distancing. But what are the appropriate interfaces between human and robots? And how to develop a low cost robot for this purpose? Robot solutions for social distancing are already on the market, but they are either expensive to purchase or limited in functionality. The professionally deployable solutions do also require a high level of technological infrastructure and specialist personnel.
In the Robot is geen superbesmetter (RIGS) project five research groups of four Fontys institutes have united to work on a social distancing robot. We look at the robot from a variety of disciplines and in close cooperation with four companies.

2. Lessons learned for practice-oriented research

2.4 Participants and stakeholders

Usually, various participants are involved in the research projects: lecturer researchers (D: docent onderzoekers), students and company representatives. Its combination is regarded to be important for practice-oriented- research. However, we observe that role fulfillment is still to be explored.
Generally speaking, lecturer researchers (Dutch: docent-onderzoekers) have the attitude that the company's question needs to be solved. As such, this is positive for the inclusion in the company problems. However, we did also observe that some of the lecturer researchers see it their role to steer the research instead of defining a mutual responsibility between research group and company. Companies, i.e. their employees, see themselves as customers of the research. Often, they have been portrayed as such by the Fontys researchers. But from the point of view of educational institutions, companies would also like to participate in the research project, the so-called participatory research. However, companies participate to a limited extent in the research. The role of companies in the project is partly determined by the attitude of the teachers. The relationship with companies must be well managed. Companies do expect an answer, but often also want to develop a better understanding of the topic at hand.

Students – one of the program principles was student involvement, see section 1, which has been successful in the HTSM projects: all projects were (partially) carried out with student support. On average 5 – 10 students were involved per project.

As in every project it is recommended to conduct stakeholder analysis on a regular basis, so along project execution. Roles that are useful to define in practice-oriented research projects are:

- Project owners (PO) are preferably a company representatives, but researchers focusing on a particular topics could be a good PO as well.
- Technical specialist – could be company representatives, as well as teachers

Developing technologies and system by working with student groups is different to the usual way an engineering organization will do. Students are after all in a learning modus and do the project principally to get a degree, they might be unexperienced, project employees, and might be motivated different compared to employees. Especially this learning environment leads to special attention for learning. A mix of roles is needed for successful practice-oriented research projects. In addition to the students and the tutor also technical specialists in medior or senior positions will be needed.

A closing remark is that the intention of HTSM was to work as public private partnership. At the program level this lived. However, this not yet always perceived at project level.

2. Lessons learned for practice-oriented research

2.5 Knowledge transfer

A starting point of the TEC for Society program was student participation. Student group project has an own dynamics when it comes to knowledge transfer. In general one could state that “knowledge is fluid” and that knowledge could codified only partial. As well as that knowledge is in general intangible.
A situation that we did see often occurring is when the entire student crew is leaving a semester and having a good results, while a new team of fresh students starting have difficulties to get acquainted with the project again. As a consequence practice-oriented research has to be prepared for this ‘brain drain’ when aiming at larger project in which goals have to achieved along several semester, each semester with a new team. Some considerations for knowledge management are:

- Require transfer documentation, by asking the question: “Next semester your colleagues are starting the next iteration of your project. What should they know and do?”. A transfer document can be denoted as 4D-document: “doe dit, doe dat”.
- Involvement of lecturer researcher in the transfer. A simple check when examining students’ work by a lecturer could raise the awareness for knowledge transfer.
- Knowledge gathered in the project execution can be codified untill a certain level. Another part of the knowledge is in the heads of people. Means for the codification are wiki, git, and proper documentation.
- We found also that apart from the in-depth knowledge on a particular project, it is also important to provide open access to all of the project that have been conducted already by previous projects and groups. HTSM has a database on the researches that were conducted over the year.
- Testing helps to make results and expectations tangible. Enable testing facilities could help to show that project results are really working.
- Empower students and research staff to raise question about previous results, in a constructive way. A way to go is by making the criteria to judge results explicit and apply these when student are delivering their work as well as when a fresh group of students start their project.