TU/e Ambition & Research Roadmap ‘Human Vitality and Technology’

Research report - March 2017

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This publication on the TU/e Ambition & Research Roadmap ‘Human Technology and Vitality’ has been produced by Elke den Ouden and Rianne Valkenburg of LightHouse, for and in close collaboration with Jan Mengelers (TU/e Executive Board) and Steef Blok (TU/e Innovation Lab). Many experts and stakeholders have contributed to the result.
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INTRODUCTION

Motivation
Increasing people’s vitality is considered as a very important goal to achieve a high quality of life. However, individual choices and lifestyles do not always support this goal. Programmes have been initiated at a number of levels — national, regional and European — to improve health and well-being. Physical activity and sports are considered important elements to achieve healthy lifestyles and increase vitality.

TU/e is already involved in various initiatives, such as “People, Sport & Vitality” and the Eindhoven Movement — which is recognised as a unique collaboration between TU/e and Fontys Sport Hasselt. TU/e is also collaborating with a number of players in the field, including the Agents & Technology cluster and the related Sport Field Labs, PSS, the City of Eindhoven, Fontys University of Applied Sciences, Tilburg University, Utrecht University (for example in Healthy Urban Living) and Leiden University. The increased attention for vitality of people is considered as an opportunity to strengthen the research programme, collaboration in the ecosystem and embedding of the activities in national and international programmes, and to seize the question of the scope and focus of vitality as a research topic.

Data sciences
The rise of data sciences creates new opportunities in the area of health and well-being. This field of knowledge is a strong driver for new research and technological solutions, which help to gain a deep understanding of the parameters that influence a health and well-being, as well as new solutions to monitor and influence a behaviour towards healthy lifestyles, for example by promoting physical activity.

Health and well-being
Health and well-being are important subjects for policy makers, and for the directions followed by research programmes. Although the past few years have been marked on the treatment of illnesses, there is a noticeable shift towards preventive programmes that address healthy lifestyles and the design of healthy living environments. Important programmes in this domain are Horizon 2020 and the Biobehavioral Health (BiH) cluster defined in — the ability to adapt and to stay in control in the light of physical, emotional and social challenges in life.

Horizon 2020
Various aspects of the EU’s Horizon 2020 programme address healthy urban living, healthy lifestyles and vitality.

Brabant Hockey Deal
The cities of Breda, Eindhoven, Helmond, ‘s-Hertogenbosch, and Tilburg, as well as the GGD (municipal healthcare service), Watersnoodregionen (water board) and the province Noord-Brabant have signed a deal to address healthy urban living.

Sports and physical activity
Sport has a long-standing prominent place, also as recreational and entertainment activity to increase social cohesion and health. People practice sports at professional, recreational and leisure, or just enjoy watching them. Important programmes have recently been set up: the Rotterdam Kennisagenda (National Knowledge Agenda) and the related Rotterdam Watersnoodregio Agenda (National Science Agenda) rules.

National Knowledge Agenda for Sport and Exercise
In April 2016 the Sport & Bewegen (Sport and Exercise) Top Team developed and formally endorsed the knowledge agenda: Van Traplopen tot Podium (from stair climbing to winners’ rostrum) knowledge agenda. The aim of the national knowledge agenda is on the one hand to connect various initiatives at regional, national and European levels to improve health and well-being, and to support the development of practical knowledge in this field through cooperation.

The knowledge agenda focuses on three themes: Bieller programma’s (bioneer performances), De trapren long bewegen (Lifelong exercise) en De made(n) van sport (The values of sport) — TU/e contributed especially with the emphasis on the role of big data and data science to link all these themes. The knowledge agenda is supported by NWO, ZonMw and SIA, and drives research programmes for the coming years, with a first milestone at the 2020 Olympic Games and Paralympics in Tokyo.

National Science Agenda Sport and Exercise
Based on the National Knowledge Agenda the NBA route Sport and Exercise route has been defined — the opportunity to translate some of the NBA cluster challenges. The route Bewegen op maat, voor ademelen, in elk Afdeleid (feel fast (Vote to measure, for everyone and all ages: it’s possible!) emphasises the importance of active lifestyles for physical, psychological and social health and well-being.

One of the ambitions is to create an Advance Research Centre at national level. In this context the TU/e will further strengthen its collaboration with Fontys Sport Hasselt, as well as with Utrecht University in the field of recreational sports and physical activity. Also, the collaboration with the Leiden University and Delft University of Technology in the cluster data science for sports and physical activities.

Position of the TU/e
TU/e’s primary contribution in this field is a “technology & vitality” — where sensor and data science technology are applied in solutions with a human focus (such as in the “Nine of our body” research programme).

TU/e has the ambition to play an explicit, prominent role in the area of technology and vitality. It recognises the connection to both the domain of health & well-being and sports & physical activity. A strong position in this domain will strengthen its core activities; in education, in research and in knowledge valorisation, but it will also enable a healthy and attractive working environment for employees and students.

Various researchers in different departments are already active in a wider range of projects, some of them within the Strategie Aanpak Gezond. To be able to play a strong role in collaboration with others and to position itself for upcoming programmes, there is a need for a coherent TU/e Sport & Exercise roadmap. This will enable the connection of internal ambitions of TU/e and external ambitions of partners in the collaboration. TU/e can and will play a central role to connect various initiatives at regional, national and international levels in collaboration with public organisations, companies and Fontys University of Applied Sciences.

The roadmap enables a focus on a limited number of strategic ambitions, builds on the strengths and competences of TU/e research groups and builds them in a powerful collaboration network with partners in the Brainport region and at national and international levels.

This report describes the approach and results of the process to create a shared "Human Vitality and Technology” ambition and research roadmap.
Approach

To gather the existing understandings and initiatives, as well as the opportunities for education, research and valorisation at TU/e-wide ambitions, and the roadmap to achieve them defined. I starts with a shared ambition, followed by the creation of a path to achieve the defined ambition. By involving all stakeholders in the process at the same time, an overview of current and planned initiatives and networks is made. A roadmap with future research directions is made by building on the relevant strengths of the TU/e community (e.g. Participatory Health and Quantified Self). This also enables further development of the ecosystem with existing and potential new partners for long-term collaboration.

The project is divided into three phases, each with specific activities:

1. DEFINING THE AMBITION
   - The project is divided into three phases, each with specific activities:
   - TU/e Ambition & Research Roadmap ‘Human Vitality and Technology’ Research report — March 2017
   - As stated above, vitality is considered as an important topic in a number of policies and research programmes. This section gives a short summary of the different themes:
   - Source: strategischprogrammarivm.nl
   - Vitality of employees is a crucial factor for companies. Eight out of ten employees have named the health of employees as the most important indicator of a successful company, according to a survey by the RIVM. But only four in ten are really taking action to increase employee health. Just providing a reduced fee for a sports club membership is not enough! So how do you keep employees vital and motivated?
   - Vitality requires an integrated view. Collaboration that they have met each other is low. Scientific research is required to address challenges and opportunities with a crucial role for technology and data.
   - Beter leven lang bewegen (Lifelong exercise) emphasises the role of a vital society in which an active lifestyle is the obvious choice. This requires knowledge of the role of physical activity in education, tailor-made activity programmes and the prevention of injuries.
   - De wreck(s) van sport (The value(s) of sport) deals with recreational or mass sports to connect people, make them stronger and help them to focus on physical activity that is beneficial for long-term health on the economic and societal value of sport. New knowledge is required to address challenges and opportunities in sport, the learning processes and the effect on everyday life.
   - Big data and data science are seen as vital links through all three of these themes.
   - Life expectancy over the past 50 years, due partly to environmental improvements, lifestyles changes and costs, good social relations, and of course a good school career and access to education and the job market, increased productivity and wealth, reduced healthcare needs and costs, good social relations, and of course a longer lifetime. Remarkable gains have been made in the past 50 years over the past century, and of course a longer lifetime. Remarkable gains have been made in life expectancy.
   - Source: oecdbetterqualityoflifeindex.org
   - People who do not smoke and only drink alcohol in moderate quantities, as well as those who are physically active, eat a balanced diet, and are not overweight or obese have a much lower risk of early death than those who have unhealthy habits.
   - Overweight or obese have a much lower risk of early death than those who have unhealthy habits.
   - Source: RIVM (Netherlands National Institute for Public Health and the Environment)
   - The RIVM (Netherlands National Institute for Public Health and the Environment) emphasises the importance of a healthy urban living environment for a long, healthy, vital, social and independent life in a clean, safe, attractive, sustainable and economically strong cities. A healthy city provides an environment that encourages healthy lifestyle. It includes three aspects:
   - Using the research roadmap, this third step focuses on the organisng the ecosystem. This involves both the internal organisation with key players from the various TU/e departments as well as the collaboration with strategic partners in the Brainport region, in the Netherlands as well as internationally.
   - The National Knowledge Agenda focuses on three themes:
   - • Better prepare(Better performance) deals with metabolic and coaching young talent to future top performance.
   - • De wreck(s) van sport (The value(s) of sport) deals with recreational or mass sports to connect people, make them stronger and help them to focus on physical activity that is beneficial for long-term health on the economic and societal value of sport. New knowledge is required to address challenges and opportunities in sport, the learning processes and the effect on everyday life.
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2. CREATING THE ROADMAP

Step 2 is to define the aim. For this purpose an analysis is made of the current situation, the starting points and the ambition levels for the shorter and longer term. People from the university community as well as external stakeholders are involved. Based on the results of the interviews, a focus is defined or TU/e, together with a set of core strategic ambitions.

As stated above, vitality is considered as an important topic in a number of policies and research programmes. This section gives a short summary of the different themes:

Vitality of employees is a crucial factor for companies. Eight out of ten employees have named the health of employees as the most important indicator of a successful company, according to a survey by the RIVM. But only four in ten are really taking action to increase employee health. Just providing a reduced fee for a sports club membership is not enough! So how do you keep employees vital and motivated?

Our challenges

- Important in the current lack of a coherent plan. Both internal and external parties recognise the large number of ad hoc activities. We may have over 20 vitality-related (and recreational) sports-related PhD’s, but they chance

3. ORGANISING THE ECOSYSTEM

In the roadmap phase the ambition is used to identify the relevant research competitors of TU/e. This is done through mini-workshops held in all TU/e departments to gain insight in the current strengths and future developments that will contribute to achieving the ambition. A research roadmap combines all the relevant research activities in a coherent research plan with clear development goals.

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1 DEFINING THE AMBITION

Approach

In the ambition phase the core activity was to gather the ideas of the important stakeholders in relation to sports and vitality and the strategic direction of the TU/e. A total of 32 interviews were held with all participants (see at right for a full list).

Each interview consisted of a short reflection on the current high lights and low lights, followed by a more in-depth discussion of aspirations. These were used to define the strategic ambitions. The result of the interviews is a rich collection of strategic ambitions, both from TU/e’s internal experts and stakeholders in the ecosystem. A cluster analysis was performed to identify the main themes in the ambitions.

The clusters were used in a workshop held within TU/e to discuss the focus and scope of the vision and roadmap. This resulted in a new title for the project — Human Vitality and Technology — and a description of the core strategic ambitions.

To create a rich description of these ambitions, the results of the individual interviews were placed in a complete overview, to allow themes to be defined within the ambitions.

Results

The results of this phase are described in a one-page overview of the ambitions of TU/e (see figure below), which is explained in more detail on the following pages.

Participants

- Tuur Booij - TU/e Electrical Engineering & Photonics Institute
- Harrie Biersteker - Innofuberein Sport & Beweeg
- Bert Bokhoven - TU/e Beukkuze
- Vessel Blok - TU/e Innovatieveleer
- Auke van Batenburg - Universiteit Utrecht
- Aarnoud Brouwer - Carolien Hamers & Steven Woes - TU/e Industrial Design
- Matthijs van der Steen - Driek Ants - Fortis
- Paul Gardien, Geert Christiaansen en Jeroen Buijnamers - Philips
- Ton Gerbrandy - PSV
- John van der Heide - Janneke Ebben
- Guus Nelis - Gemeente Eindhoven en Province Noord Brabant
- Jan de Jonge - TU/e Industrial Engineering & Innovation Sciences
- Maarten Kuipers - Gemeente Eindhoven
- Jaap Kink - Universiteit Leiden
- Edgar van Leerdam - Broekpoort Development
- Jan Mengers - TU/e College van Breda
- Michel Reijnders en Thatch Rijnhoffs - F stuck in Noord Brabant
- Bart Smolders - TU/e Electrical Engineering
- Carmen van Vilsteren - TU/e Strategic Areas
- Pieter van Wesemael - TU/e Beukkuze
- Ivo Wolters - Stratingh Sports & Technology
- Wijnand Steenbergen - TU/e Industrial Engineering & Innovation Sciences

[See overview - all participants - ambition ambition]
Strategic ambitions were formulated in all the ambition interviews. The ambitions were clustered, and the scope and focus of the TU/e ambition were defined in a workshop. The result was a decision on the main topic:

"Human Vitality and Technology"

Based on the main topic, three related core ambitions of the TU/e have been defined:

1. **Technology for healthy lifestyles**
   - The human body is the focus of our research. We make a difference through our research by the integrative power of analysis (sensor technologies and data science) and synthesis (engineering solutions for personalised interventions).
   - We approach vitality in a broad sense: physical, mental and emotional — and the impact of physical activity, exercise, food and sleep patterns.
   - We research solutions that make preventive, personalised and proactive healthy lifestyles and increase their vitality.

2. **The vital person**
   - We focus on vitality, and recognise physical activity as a key driver for the improvement of health.
   - We research solutions that make preventive, personalised and proactive healthy lifestyles and increase their vitality.
   - We address the full spectrum of people and the power of schools, clubs and associations to address the social context of people.

3. **In context and with partners**
   - We combine our strengths from sensor technology, data science, design, human movement sciences and psychology into a research programme that generates the required knowledge, we can create solutions that will have a real impact on the lives of many people.

TU/e’s main contribution will be in “technology with a human focus”. We focus on vitality, and recognise physical activity as a key driver for the improvement of health. As our stakeholders emphasised, “sport” is not an attractive topic for people with unhealthy and/or inactive lifestyles. As indicated in the inaugural lecture by our colleague Steven Vos*, we consider being active and feeling active as two aspects of a vital lifestyle, and we address the full spectrum of people — those who are active in sports through ‘normal’ physical activity to non-activity. Using smart technology, smart measurements, using sensors and (real-time) feedback systems, simulations and virtual reality applications, we can create a wide range of future opportunities for people to adopt healthy lifestyles and increase their vitality. If we combine our strengths from sensor technology, data science, design, human movement sciences and psychology into a research programme that generates the required knowledge, we can create solutions that will have a real impact on the lives of many people.

The ambitions from the interviews are clustered into themes related to the core ambitions, and are divided into themes that address the ambitions for the research contributions of TU/e, themes that we aim to address in collaboration with strategic partners, and themes that address general ambitions directly related to the overall TU/e policy.

The illustration on the opposite page shows all elements of the ambition in relation to each other. Please refer to Appendix A for more details.

---

2 CREATING THE ROADMAP

Approach

The strategic ambitions provide strong direction for the vision. They were used to conduct roadmap mini-workshops to collect the relevant research questions to achieve the strategic ambitions. These research questions are collected within the TU/e. An collaboration with partners is crucial; interviews and roadmap workshops were also held with partners in the ecosystem and external experts in the field. A total of 8 mini-workshops were held with 29 participants from TU/e, and 3 interviews were held with partners (see a full list at the right).

Results

The result of this phase is a one-page research roadmap (see figure below), which will be explained in more detail on the following pages.

How to read the roadmap

The roadmap shows the different research activities on a timeline, including (from top to bottom):

• Milestones to indicate the overall changes in the research over time: short-term, mid-term and long-term
• Research design and conditions to show how the shifting context of the research impacts the methodologies and the conditions required for successful execution of the research in that context
• The advancements of the research activities in the three core topics: technology, human behaviour and environment — represented in the circles — with the overall vitality index at the core

The roadmap is shown on the following pages, and the research topics addressed in the roadmap are explained in more detail.

Participants

TU/e experts

• Pauline van de Berg, Faculty Electrical Engineering
• Anne van den Nescio, Faculty Mechanical Engineering
• Steel Blok, TU/e Innovation Lab
• Arnoord Bomhoff, Faculty Industrial Design
• Jeroen Buijs, Faculty Mathematics & Computer Science, & Data Science Center (DSC/e)
• Jan Guppers, Faculty Electrical Engineering
• Lies de Kruif, Faculty Industrial Design
• Merel van Zandt, Faculty Electrical Engineering
• Corinne Hummel, Faculty Industrial Design
• Mark Janssen, Faculty Industrial Design
• Artur Kempf, Faculty Health
• Yvonne de Kort, Faculty Industrial Engineering & Innovation Design
• Yvonne de Kort, Faculty Industrial Engineering & Innovation Design
• Hans van den Berg, Faculty Electrical Engineering
• Dylan Nijsten, Faculty Built Environment & Smart City Program (SCP/e)
• Laura de Oude, Strategic Area Energy
• Wilfried Buskens, Faculty Mathematics & Computer Science
• Laurens Schefold, Faculty Built Environment & Smart City Program (SCP/e)
• Bart Smolders, Faculty Electrical Engineering
• Yves Tepepe, Faculty Built Environment & Smart City Program (SCP/e)
• Cornelia van Vliet, Strategic Area Health
• Steven Vrolijk, Faculty Industrial Design
• Bas de Vries, Faculty Built Environment & Smart City Program (SCP/e)
• Harold Wilff, Faculty Mathematics & Computer Science
• Stephan Wensnung, Faculty Industrial Design
• Peter van Wensung, Faculty Built Environment
• Peter de Wolf, Faculty Electrical Engineering

Strategic partners

• Shane Harker & David James, Centre for Sports Engineering Research, Sheffield Hallam University.
• Steven Rose, Birmingam City Council, Strategic Research Team
• Louise Vertegaal, Institute of Data Science & NWO

In non-full pages — contact team
Milestones & overall vitality index

Milestones

- Small-scale research in controlled environments
  - Use of virtual and/or actual experimental scenarios to gain understanding of vitality at an individual level.

- Limited-scale “real” experience research in Living Labs
  - Small-scale research in controlled environments for partners to enable larger-scale experiments in the field.

- Large-scale, longitudinal research in-situ
  - Longitudinal groups to create social impact by improving people’s vitality. By 2030, the aim is to create real impact on the lives of many people by improving their vitality. For this purpose, we aim to develop an overall vitality index.

Overall Vitality Index

Defining an overall vitality index to gain understanding
- Evaluating how an overall index can be used to understand the holistic impact of interventions on health (e.g. physical, social, emotional – and the impact of physical activity, food and sleep patterns). We research solutions that make preventive, intervention strategies directly correlated to the holistic data set on vitality and positive health.

Research

- The roadmap shows three related core ambitions of TU/e are defined:
  - Healthy food and sleep patterns. TU/e can make one of the most important considerations for people, and good health also brings many other benefits (economic, social, health & well-being).
  - Extending the scope of interventions now to involve the digitally excluded members of society also become “linked-in”.
  - The research will develop and grow in complexity, scale, time and context. The challenges here are to integrate all this knowledge from different disciplines into the rich context of research, and to scale that knowledge to the real world.

Goal

- 2020: We aim to create real impact on the lives of many people by improving their vitality. For this purpose, we develop an overall vitality index in a broad sense, including physical, mental and emotional well-being.
- For long-term research, this implies that we are able to define and monitor vitality using an overall vitality index. The research will focus on real-life situations, based on longitudinal measurements on people in their daily living and working environment and their social context.

The milestones and developments on the overall vitality index are visualised at the left (the purple elements in the research roadmap).

Research Design

- Research will develop and grow in complexity, scale, time and context. The challenges here are to integrate all this knowledge from different disciplines into the rich context of research, and to scale that knowledge to the real world.

Short term

- In the short term, research in the field of vitality will still be small scale, performed in controllable environments and aiming at gaining understanding of the barriers and enablers to vitality at individual level. Integrating the insights from the different disciplines will allow a 3-step approach to define an overall vitality index for personal health and well-being. A unified index will be defined to establish the holistic impact of interventions and lifestyles, including what and how to measure this impact.

Medium term

- The next step is to select and develop Living Labs to enable larger experiments in the real field. This will involve more people in real experiences, user-friendly and reliable prototypes will be developed in co-creation with industrial partners. The research aims at influencing individual behaviour, acknowledging the impact of the social community on individual behaviour.
- The overall vitality index will be monitored, using and combining data from all relevant sources to build a holistic data set on vitality and positive health.

Long term

- In the long term, the holistic data set will enable intelligent and adaptive systems and large-scale real-time measurements and interventions. These will allow longitudinal, “in-situ” research into sustainable effect of personalised interventions on vitality. The personalised intervention strategies are directly correlated to the overall vitality index, understanding barriers and enablers for different social groups to create impact on society (economics, social, health & well-being).
## Overall research design & conditions

### Research Design

#### Research Conditions

<table>
<thead>
<tr>
<th>Domain</th>
<th>Short term</th>
<th>Medium term</th>
<th>Long term</th>
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<tr>
<td>Human-centred research</td>
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<td>Contextual environments</td>
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<td>Integrated approach</td>
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### Milestones

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<tr>
<th>Research in context</th>
<th>Research in Living Labs</th>
<th>Research enabling technologies</th>
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<td>Involving stakeholders</td>
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<tr>
<td>Drive the development of new technologies</td>
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<tr>
<td>Creating attractive, high-quality products</td>
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<td>Integrated approach to research with e/uniFB00ects</td>
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<td>Longitudinal research</td>
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### Research

**Goal**
In 2020 we aim to conduct research on vitality in the real context of people and with partners. We want to play a pivotal role in the collaboration between technology and vitality.

The changes in the research design and research conditions are visualised at the left (the green elements in the research roadmap).

**Research**
Research on vitality will develop from small-scale and controlled environments, via Living Labs, towards research in the real lives of people. To do this, the research design and conditions will also develop over time. Especially the integration of technology, human behaviour and physical living environment in evidence-based design of solutions is crucial.

**Long term**
In the long term, research will take place in real-life situations, making use of adaptive systems to scale-up and accelerate iterative processes in the real user context. This process is supported by the grown-up 'digital natives' who form a significant part of the user group in 2020.

The research conditions to enable this real-life research is the availability of longitudinal evidence-based research into the effect of interventions.

**TU/e competences**
This changing research design is based on the integration of knowledge from different disciplines, spanning knowledge of technology, human behaviour and healthy environments. As a system integrator, knowledge from the Department of Industrial Design plays a pivotal role in these research lines of the roadmap, providing knowledge of both systems thinking and prototyping. Knowledge of marketing and technology entrepreneurship of the Department of Industrial Engineering & Innovation Sciences is also integrated, ensuring products and services that people want and that have a viable business model.

The essential underlying knowledge of technology, human behaviour and healthy environments is described on the next three pages.
Technology to increase the vitality of people

In 2019 we aim to be leading in technology for healthy lifestyles. The human body and people’s living environment is the focus of our research. We make a difference in our research by the integrative power of analysis (sensor technologies and data science) and synthesis (engr woring solutions for personalised interventions).

The development in research questions on technology is visualised at the left (the blue elements in the research roadmap).

**Research**

Research into technology to increase the vitality of people includes the following research lines:

- Data acquisition on and in people
- Data acquisition in the physical environment of people
- Data analysis to process the data
- Data representation
- Dealing with statistics
- Mathematics for intervention

**TU/e competences**

In this research area of the roadmap, the Data Science Centre and the departments of Electrical Engineering and Mathematics and Computer Science will play a pivotal role, providing knowledge of data acquisition, analysis, representation and synthesis.

The research questions and development in human behaviour are explained on the next page.

---

**Data acquisition on/in people**

- Improved data acquisition
- Combining data sources
- Combining tools and techniques
- Smart strategies
- Simulation methodology
- Real-time technology

**Data acquisition in the environment**

- Data analysis
- Data representation
- Dealing with statistics
- Mathematics for interventions

**Research Design**

- Integration of modelling and simulation of experiments in real life through the holistic impact of interventions and scaling-up
- Combining data sources to enable further research — long-term research design with partners.
- We play a key role in the collaboration and vital health and vitality.

**Impact of individual choices**

- Understanding the complexity of personal choices
- Impacts of individual choices (e.g. community apps like GameBus)

**Impact of the social context**

- Influencing behaviour of choices in the social environment on overall vitality index
- With impact on the social context into resilience accounts

**Impact of the indoor environment**

- Ventilation, position of e.g. stairs
- Understanding the complexity of living environment on personal level
- Influencing people to adopt healthy behaviour with the assistance of persuasive technologies

**Processing of sensor data to develop better prediction models and simulation methodologies to integrate multidisciplinary perspectives on measurement technology and behavioural resilience**

**Combining a human-centric research approach with design to create aesthetically and convenient solutions, and marketing to create solutions people love to use**

**Combining data sources to build a holistic data set for real-world and intervention in personal level applications to measure context of people**

**Dealing with big data sets, the uncertainty within the data and new methods for real-time analysis are developed to enable the next step to research in living Labs.

**Mathematical representation for decision making in the real world**

- Computational science and engineering to integrate different technologies in real-world problems
- Combining knowledge of influencing a personal level
- Integration of influencing factors to make better predictions

**Data security**

- Development of new methods for real-time medical monitoring and smart cities and open data

**Mathematics for interventions**

- Behavioural science and engineering to integrate different technologies in real-world problems
- Integration of influencing factors to make better predictions

**Holistic design approach**

- Including building, design for healthy living environments for people to become healthy
- Application of smart devices and apps as motivation to change their behaviour
- Social interventions for lasting changes for diagnosis (e.g. retina analysis to detect diabetes) and give timely and successful certain interventions, with impact on the holistic, disruptive solutions and accelerate iterative processes in the design approach to integrate people, their social context into social impact groups to create social impact

**Medium term**

- The next step is driven by the research context, demanding better, cheaper, smaller, integrated and self-sustaining sensor technologies to measure a different perspective on vitality. Data analysis creates a mash-up of different data sources to represent complex data sets through visualisation to enable intervention. Technology development will also grow towards prediction models and simulation methodologies to integrate different perspectives on vitality.

**Long term**

- In the long term, data acquisition, analysis and representation technologies will support real-time intervention, allowing ‘smart body maintenance’.
Influencing human behaviour to increase the vitality of people

**Goal**
In 2030 we aim for personalised interventions for lasting behaviour change towards healthy lifestyles, while people keep their autonomy.

The development of research questions on human behaviour are visualised at the left (the orange elements in the research roadmap).

**Research**
Research into influencing human behaviour to increase the vitality of people includes the following research lines:
- Understanding the effect of choices
- Influencing behaviour
- Including the social context of people

**TU/e competences**
Knowledge from the department of Industrial Engineering & Innovation Sciences and the Human & Technology Centre plays a pivotal role in these research lines of the roadmap, providing knowledge of the psychology of people.

The research questions and development on healthy environments are explained on the next page.

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**Short term**
In the short term, knowledge of individual behaviour is gained to understand the influencing of momentary behaviour at a personal level and its impact on individual vitality. Knowledge is also gained to understand differences in lifestyles, behaviour patterns and motives of people to adopt healthy behaviour with the assistance of persuasive technologies. The complexity of differences in target groups and the influence of social environments on vitality are investigated.

**Medium term**
The next step is to understand the impact of the social context of people on their behaviour. Technology will enable the application of smart devices and apps for personalised interventions to motivate people to change their behaviour toward healthier lifestyles.

**Long term**
In the long term, research will focus on societal change, including all societal groups and intervention for long-lasting behaviour change.
Living environments to increase the vitality of people

**Goal**

In 2050 we aim for a holistic design approach to vitality, integrating people, their behaviour and their social and physical environment.

The development of research questions on healthy environments is visualised at the left (the red elements in the research roadmap).

**Research**

Research on living environments to increase human vitality includes the following research lines:

- The outdoor living environment
- The indoor living environment
- The design of the living environment

**TU/e competences**

Knowledge from the department of the Built Environment, the Smart City Program and the Intelligent Lighting Institute plays a pivotal role in these research lines of the roadmap, providing knowledge of the impact and design of physical environments on vitality and well-being.

**Concluding**

This research roadmap on human vitality and technology provides an overview of all research contributions necessary to reach the goal: creating technology to help people to live healthier lives. At the same time the roadmap shows the impact of a common goal — vitality — as a bonding mechanism for diverse research areas on their specific research questions. Making a difference in technology and vitality, and being able to play a strong role in collaboration with others to position for upcoming progresses, will only succeed through the integrative power of all the knowledge for the involved. All research lines in the roadmap together can create solutions that will have a real impact on the lives of many people.

The research roadmap also enables the connection of the research ambitions of the TU/e with the external ambitions of partners. In the next chapter the ecosystem is described, connecting initiatives and partnerships at regional, national and international levels.
Based on a discussion in the Executive Board it was decided to appoint a programme manager to organise the internal and external ecosystems which are required to realise the research roadmap. This programme manager is tightly linked to the Strategic Area Health, and will be stationed in the departments Industrial Design and Electrical Engineering.

The programme manager's main responsibility is to connect all relevant players and activities — internal and external — who keep their own responsibility in contributing to the overall roadmap results. The image below shows how the programme manager is linked to existing organisations. It also indicates the roles and responsibilities of all players.

Organising the Ecosystem

Strategic Area Health

Data Science Centre Eindhoven (DSC/e)
Humans & Technology Centre (H&TC)
Intelligent Lighting Institute (ILI)

Smart Cities Program (SCP/e)

The programme in the universities are responsible for the scientific quality, setting up and submission of projects, proposals and execution of the research projects. According to the roadmap, the drivers of the projects will be the departments of Industrial Design and Electrical Engineering, in strong collaboration with Mathematics & Computer Science, Industrial Engineering & Innovation Science and the department of the Built Environment.

TU/e Executive Board

Research Roadmap
‘Human Vitality and Technology

TU/e Innovation Lab

Strategic direction & management support

Setting strategic direction

Strategic alignment & collaboration

Alignment of contributions

Programme management & research roadmap

Research support

Initiating integral research proposals to upcoming calls

Forming of project consortia

Brainport Region
Companies & clusters
Universities

Strategic cooperation will be built on existing and new networks of the region and Brainport Region, national and international companies and clusters, as well as national and international universities and research institutes.

Strategic cooperation will be built on existing and new networks of the region and Brainport Region, national and international companies and clusters, as well as national and international universities and research institutes.
### Ambitions in collaboration with the strategic partners

#### Core strategic ambitions of TU/e

1. **Technology for healthy lifestyles**
   - **Personalised interventions**
     - Concrete innovations for physical activity, food etc., are available.
     - The power of schools, clubs and associations to address lifestyles
   - **Social context**
     - Social structures influencing the quality of life and the social cohesion of difficult target groups
   - **Ecosystems**
     - Reducing obesity — e.g. children enjoying physical activity
     - Contributions to societal challenges — health: future proof approach supported by well-founded visions and strategies

2. **Science for society**
   - **Systemic view of vitality**
     - The human body is the focus of our research. We make a systemic view of vitality: physical, mental and emotional — and the impact of physical activity, food and sleep
   - **Scientific cooperation**
     - Multidisciplinary research and experiments leading to new knowledge and hypotheses
   - **International recognition**
     - The TU/e has a strong reputation in the ‘human vitality and technology’ domain:
     - International recognised ‘vitality index’, tools and research through our research by the integrative power of science through our research by the integrative power of disciplines.
   - **Evidence-based programmes**
     - Programmes like ‘augmented self’ and ‘mine your own body’
     - Personalised and proactive contributions to healthy lifestyles.
     - Addressing intrinsic motivation with achievable steps
   - **Social technology**
     - Multidisciplinary research and experiments leading to new knowledge, applied in practice, and to new business models
   - **Integral value of vitality**
     - People feel fit, recognise the importance of physical exercise and social activities and live longer independently.
   - **Living Labs**
     - A centre for the personalisation of technology and solutions
     - Ecosystems
     - The TU/e is a reliable partner for research
     - Governance of all programmes and collaborations
   - **Attractive educational programmes**
     - Smart City Programme for collaboration in the domain of healthy living environments
     - Excellent research
     - Attractive for students
     - Broad, and integrated cross-departmental curriculum
     - Strongly related courses from different knowledge domains
   - **Public sector and public good**
     - Socially intelligent solutions: technology to provide support for people developing and maintaining a healthy lifestyle
     - Accessible and attractive technology to remove obstacles to activity and encourage the adoption of healthy lifestyles
   - **Internationals and others**
     - Embedding our research in the ecosystem as a source of knowledge
     - Reliable partner for research
   - **Collaboration in and for the healthiest region**
     - Brainport vital technocity
     - ASML, PSV collaborating to prove impact of innovations and vitality to contribute to local business and economy
   - **5G and Big data**
     - Concrete targets and small projects to gain insight in what works and what doesn’t: scaling-up successes
     - Proving value through evidence based interventions
     - New measuring methodologies to verify the success of interventions
   - **International recognition through scientific contributions:**
     - New measuring methodologies to verify the success of interventions
     - New measuring methodologies to verify the success of interventions
     - New measuring methodologies to verify the success of interventions
   - **Positive impact**
     - People feel fit, recognise the importance of physical exercise and social activities and live longer independently.

#### APPENDIX

This appendix provides more details on the ambition of TU/e ‘Human Vitality and Technology’.

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*The ambition overview shows the different ambitions in relation to each other, and includes:* (from the inside to the outside):
* Core strategic ambitions in the center (white area).
* Ambitions related to TU/e policy in the periphery (in purple).
* Ambitions in collaboration with the strategic partners (outside the periphery).
* Ambitions that address the research contributions (grey area).
* Excellent research (green area).
* Attractive for students (purple area).
* Socially intelligent solutions: technology to provide support for people (gray area).
* Accessible and attractive technology to remove obstacles to activity and encourage the adoption of healthy lifestyles (white area).
* Strongly related courses from different knowledge domains (purple area).
* Multidisciplinary research and experiments leading to new knowledge, applied in practice, and to new business models (gray area).
* People feel fit, recognise the importance of physical exercise and social activities and live longer independently (white area).
Core strategic ambition 1: Technology for healthy lifestyles

The human body is the focus of our research. We make a difference through our research by the integrative power of analysis (sensor technologies and data science) and synthesis (engineering solutions for personalised interventions).

**Ambitions for the research contribution of TU/e** (in the grey area)

- **Mine your own body**
  - Technology to increase vitality:
    - Sensor technology and data science to support people as they grow old while staying vital
    - Programmes like ‘augmented self’ and ‘mine your own body’
  
- **Evidence-based**
  - Proven results in increasing community vitality:
    - New measuring methodologies to verify the effect of physical exercise and healthy lifestyles (turning ‘soft’ aspects into ‘hard’ evidence)
    - Proving value through evidence-based interventions
    - Concrete targets and small projects to gain insight in what works and what doesn’t; scaling up successes

**TU/e-wide collaboration**

- Multidisciplinary research programmes:
  - Integrating the strengths of all departments in the area of health and vitality
  - Interdepartmental top institute for technology and vitality

**Core strategic ambition**

1. Technology for healthy lifestyles
   - The vital person
   - Evidence-based

2. Ambitions in collaboration with (strategic) partners (outside the grey area)
   - Health
     - Collaboration with the partners in the domain of health and well-being, as part of the ecosystem around the Strategic Area Health for research collaboration in technology supported health.
   - Smart City
     - Collaboration with the partners in the domain of healthy living environments, as part of the ecosystem around the Smart City Programme for collaboration in healthy urban living

3. Ambitions in collaboration with (strategic) partners (inside the grey area)
   - Health
     - Collaboration with the partners in the domain of health and well-being, as part of the ecosystem around the Strategic Area Health for research collaboration in technology supported health.
   - Smart City
     - Collaboration with the partners in the domain of healthy living environments, as part of the ecosystem around the Smart City Programme for collaboration in healthy urban living

4. Ambitions in collaboration with (strategic) partners (outside the grey area)
   - Health
     - Collaboration with the partners in the domain of health and well-being, as part of the ecosystem around the Strategic Area Health for research collaboration in technology supported health.
   - Smart City
     - Collaboration with the partners in the domain of healthy living environments, as part of the ecosystem around the Smart City Programme for collaboration in healthy urban living

5. Ambitions in collaboration with (strategic) partners (inside the grey area)
   - Health
     - Collaboration with the partners in the domain of health and well-being, as part of the ecosystem around the Strategic Area Health for research collaboration in technology supported health.
   - Smart City
     - Collaboration with the partners in the domain of healthy living environments, as part of the ecosystem around the Smart City Programme for collaboration in healthy urban living
Core strategic ambition 2: The vital person

**The vital person**
We approach vitality in a broad sense: physical, mental and emotional — and the impact of physical activity, exercise, food and sleep patterns. We research solutions that make preventive, personalised and proactive contributions to healthy lifestyles.

- **Systemic view of vitality**
  - Approaching vitality in a broad sense: physical, mental and emotional — and the impact of physical activity, exercise, food and sleep patterns.
  - We research solutions that make preventive, personalised and proactive contributions to healthy lifestyles.

- **Scientific cooperation**
  - Researching the effects of exercise, food, sleep, stress etc.
  - International recognised ‘vitality index’, tools and research data to support evidence-based longitudinal research.

- **Social context**
  - Addressing intrinsic motivation with achievable steps.
  - Coaching programs for behaviour change with the freedom to choose options that better fit individual needs and wishes.
  - Addressing intrinsic motivation with achievable steps

- **Personalised interventions**
  - Accessible and attractive technology to remove obstacles to activity and encourage the adoption of healthy lifestyles.
  - Socially intelligent solutions: technology to provide understanding and intrinsic motivation.

- **Social technology**
  - (Top) sports & human performance: applying mechanisms from sports to other situations and vice versa.
  - 'Food' for vitality: production and consumption of food.

- **Integral value of vitality**
  - The value of a vital community is recognised and translates into willingness to invest in new products and services.
  - People feel fit, recognise the importance of physical exercise and social activities and live longer independently.
  - The power of schools, (sports) clubs and associations to address the social cohesion of difficult target groups.

- **Collaboration in research domains related to vitality**
  - Scientific cooperation: Collaboration in research domains related to vitality.
  - (Top) sports & human performance: applying mechanisms from sports to other situations and vice versa.

- **Ambitions in collaboration with (strategic) partners (outside the grey area)**
  - Real impact on vitality of people in the region.
  - People feel fit, recognise the importance of physical exercise and social activities and live longer independently.
  - The value of a vital community is recognised and translates into willingness to invest in new products and services.

- **Social context**
  - Addressing the social context of people:
    - (permanent) infrastructure and create visibility.
    - The power of schools, (sports) clubs and associations to address the social cohesion of difficult target groups.
    - The value of a vital community is recognised and translates into willingness to invest in new products and services.
Core strategic ambition 3: In context and with partners

We conduct research in the real context of people and with partners. We play a key role in the collaboration in the area of human vitality and technology.

Strong reputation in ‘human vitality and technology’:
- Embedded in the ecosystem as source of knowledge
- Reliable partner for research
- Governance of all programmes and collaborations from a shared vision

Brainport vital technocity
Collaboration in and for the healthiest region:
- Combining a ‘Burgundian’ lifestyle and hospitality with health and vitality to contribute to local business and economy
- TU/e, Fontys, local government (cities, province and national) and partners such as Philips, ASML, PSV and SME’s and start-ups collaborating to prove impact of innovations

Ecosystems
Strong collaboration in the quadruple helix at regional, national and international levels:
- Strong coalition to gain (inter)national recognition as innovative region for technology and vitality
- Multidisciplinary research and experiments leading to new knowledge that is applied in practice and to new business
- Collaboration with national ecosystem based on clear added value and leadership

Brainport vital technocity
Collaboration in and for the healthiest region:
- Combining a ‘Burgundian’ lifestyle and hospitality with health and vitality to contribute to local business and economy
- TU/e, Fontys, local government (cities, province and national) and partners such as Philips, ASML, PSV and SME’s and start-ups collaborating to prove impact of innovations

In context and with partners

Ecosystems
Strong collaboration in the quadruple helix at regional, national and international levels:
- Strong coalition to gain (inter)national recognition as innovative region for technology and vitality
- Multidisciplinary research and experiments leading to new knowledge that is applied in practice and to new business
- Collaboration with national ecosystem based on clear added value and leadership

Living Labs
Research and innovation collaboration in real life contexts:
- Programmes with strong research lines and partner consortia
- Citizens benefit directly from innovations
- Building on the assets of partners (e.g. using the marketing power of PSV)
- Apply intelligent infrastructures in field labs and regional vitality areas with iconic value, like the Geenleper Parken area

Knowledge centre
Strong reputation in ‘human vitality and technology’:
- Embedded in the ecosystem as source of knowledge
- Reliable partner for research
- Governance of all programmes and collaborations from a shared vision
General ambitions related to the overall TU/e policy

**Excellent research**
International recognition through scientific contributions:
- Publications in top journals with societal impact
- Top 3 position in international research rankings
- Academic status with empirical research in Living Labs using real data

**International recognition**
Strong reputation in the 'technology and vitality' domain:
- Important international events taking place in Eindhoven
- Collaboration with national and international organisations
- Future-proof approach supported by well-founded visions and roadmaps for longer term aspirations

**Science for society**
Contributing to societal challenges — health:
- Reducing obesity — e.g., children enjoying physical activity
- Connecting vitality, technology and social domains
- Concrete innovations for physical activity, food etc., are available to all through schools, public space, clubs etc.

**Core strategic ambitions TU/e**

1. **Technology for healthy lifestyles**
   - Contributing to societal challenges — health:
     - Reducing obesity — e.g., children enjoying physical activity
     - Connecting vitality, technology and social domains
     - Concrete innovations for physical activity, food etc., are available to all through schools, public space, clubs etc.

2. **The vital person**
   - Contributing to societal challenges — health:
     - Reducing obesity — e.g., children enjoying physical activity
     - Connecting vitality, technology and social domains
     - Concrete innovations for physical activity, food etc., are available to all through schools, public space, clubs etc.

3. **International recognition**
   - Strong reputation in the 'technology and vitality' domain:
     - Important international events taking place in Eindhoven
     - Collaboration with national and international organisations
     - Future-proof approach supported by well-founded visions and roadmaps for longer term aspirations

**Attractive educational programme**
Curriculum around 'Technology and vitality of people':
- Strongly related courses from different knowledge domains (e.g., technology, design and psychology)
- Broad, integrated cross-departmental curriculum
- Attractive for students
Research programmes
Current programmes in the Strategic Area Health and various departments all recognise that researching vitality in a broad sense has significant potential. These programmes go beyond ‘vitality’ alone and cover the whole health spectrum. We have research that connects sports psychology theses with human performance to gain a deeper understanding of exercise and recovery on health and vitality. Saving and measuring technology is an asset which we already have a position, but could further develop towards integrated solutions for vitality.

Living Lab
The approach to research and experiment with innovative solutions in living labs is considered a strong asset. Various Living Labs for different purposes already exist in the region, e.g. the Life & Sports labs. Next to the labs, there is also a bottom-up approach in the urban sports culture: young people increasingly use public space for physical activities.

Human-centric approach
We are strong in technology, but with a human focus. We are able to combine strengths from sensor technology, data science, design and psychology. The combination of competences like sensing and behavioural research creates added value. Various psychological orientations are explored, extending from extrinsic to intrinsic motivation. Technology can play a role to motivate people with different lifestyles.

Role in the Top Team ‘Sports & Vitality’
The existence of the Top Team and the proposed focus for TU/e Ambition & Research Roadmap ‘Human Vitality and Technology’ reflects a strong focus on vitality. The role of Aarnout Brombacher in the team is regarded as important to gain a deeper understanding of exercise and recovery on health and vitality. Saving and measuring technology is an asset which we already have a position, but could further develop towards integrated solutions for vitality.

Collaboration in the region
The collaboration with Fontys has increased since 2013 and is an important asset for further collaborations. Within the region and the Province of North Brabant a large number of projects are running, with significant budgets. As well as vitality, these also cover sports. There is strong potential for further connecting opportunities to address vitality in a broader sense, also in collaboration with schools, (gym) facilities and companies. The Sports & Technology Foundation is an existing platform that enables further innovation in for labs with parties in the region. Various parties in the region recognise the importance of collaboration, and see opportunities (for example with the City of Eindhoven, Philips, P&G). Collaboration in the region is reciprocal, parties respect the contributions and strengths of others.

Sports
The research we do in the area of top sports is getting a lot of media attention. For example the collaboration with the Lotto-Jumbo team on aerodynamics, and with the City of Eindhoven, Philips, P&G. Collaboration in the region is reciprocal, parties respect the contributions and strengths of others.

Visibility
Although quite a lot of things are happening, they are not really visible (also TU/e initiatives). The problem that is often based on past performance, so visibility is crucial. Vitality is also a ‘softer’ topic than engineering; this means you have to prove more to get visibility. It is difficult to prove return on investment, also for investors.

Multidisciplinary collaboration
There is much focus on scientific research in ‘silos’, while vitality requires a broader view. Collaboration between fundamental research and application is needed but multidisciplinary research is more difficult. The facilities are available (like a collection of Field Labs), but how can we use all the separate ingredients to create a tasty meal? We need to strengthen TU/e internal collaboration (e.g. on ethical aspects) as well as collaboration with external partners (e.g. for legal aspects and projects).

Lack of a clear focus and goal
We do not have a clear goal: what do we want to achieve? Medals in sports? Economic activity in the region? Healthy citizens? Is the focus on sports, vitality or physical activity? Vital people, vital organisations, vital neighbourhoods? We need to choose a clear focus, communicate it clearly and stick to it.

One-of-a-kind
We do not get beyond one-of-a-kind projects. A lack of problem ownership makes it hard to scale-up from n=1 to n=100. It is also hard to find ‘vital’ business (partners to take up projects for continuity and on-going support).

Lack of coherent plan
Both internal and external parties recognise the large number of ad hoc initiatives. The multiple projects are not connected in a coherent programme. TU/e may have a lot to do related to vitality-related PhD’s but the chance that they will meet each other is low. There is also lack of a joint idea of where the region is heading in relation to sports and vitality.

Connections to other plans
Several other initiatives and plans are relevant to build up connection from the roadmap:

Scope
As well as the high lights and low lights, the interviews revealed the need to define the ‘scope of the vision and roadmap. Initially the project focused on ‘sports and vitality’. Sports were mentioned as not being the right subject: for many, this title referred to professional sports and only attracts already healthy people. Health also covers the full spectrum of people, from very healthy to ill people, as well as non-technical interventions. It was decided in the workshop to focus this project on human vitality and technology. This is in line with the strengths of the TU/e (people, sensors, measuring).

Connections to other plans
Several other initiatives and plans are relevant to build up connection from the roadmap:

• Top Team & Advanced Research Centre at national level
• Top Team & Advanced Research Centre at regional level
• Top & Advanced research centre with the quadruple helix
• Policy of the Province of North Brabant: ‘Brabant Beweegt’
• ‘Brabant & Technology’
• Eneco city policies and plans

High lights
Research programmes
Current programmes in the Strategic Area Health and various departments all recognise that researching vitality in a broad sense has significant potential. These programmes go beyond ‘vitality’ alone and cover the whole health spectrum. We have research that connects sports psychology theses with human performance to gain a deeper understanding of exercise and recovery on health and vitality. Saving and measuring technology is an asset which we already have a position, but could further develop towards integrated solutions for vitality.

Living Lab
The approach to research and experiment with innovative solutions in living labs is considered a strong asset. Various Living Labs for different purposes already exist in the region, e.g. the Life & Sports labs. Next to the labs, there is also a bottom-up approach in the urban sports culture: young people increasingly use public space for physical activities.

Human-centric approach
We are strong in technology, but with a human focus. We are able to combine strengths from sensor technology, data science, design and psychology. The combination of competences like sensing and behavioural research creates added value. Various psychological orientations are explored, extending from extrinsic to intrinsic motivation. Technology can play a role to motivate people with different lifestyles.

Role in the Top Team ‘Sports & Vitality’
The existence of the Top Team and the proposed focus for TU/e Ambition & Research Roadmap ‘Human Vitality and Technology’ reflects a strong focus on vitality. The role of Aarnout Brombacher in the team is regarded as important to gain a stronger position in future developments, such as an Advanced Research Centre and the research lines of the national science agenda.

Collaboration in the region
The collaboration with Fontys has increased since 2013 and is an important asset for further collaborations. Within the region and the Province of North Brabant a large number of projects are running, with significant budgets. As well as vitality, these also cover sports. There is strong potential for further connecting opportunities to address vitality in a broader sense, also in collaboration with schools, (gym) facilities and companies. The Sports & Technology Foundation is an existing platform that enables further innovation in for labs with parties in the region. Various parties in the region recognise the importance of collaboration, and see opportunities (for example with the City of Eindhoven, Philips, P&G). Collaboration in the region is reciprocal, parties respect the contributions and strengths of others.

Sports
The research we do in the area of top sports is getting a lot of media attention. For example the collaboration with the Lotto-Jumbo team on aerodynamics, and with the City of Eindhoven, Philips, P&G. Collaboration in the region is reciprocal, parties respect the contributions and strengths of others.

Visibility
Although quite a lot of things are happening, they are not really visible (also TU/e initiatives). The problem is that funding is often based on past performance, so visibility is crucial. Vitality is also a ‘softer’ topic than engineering; this means you have to prove more to get visibility. It is difficult to prove return on investment, also for investors.

Multidisciplinary collaboration
There is much focus on scientific research in ‘silos’, while vitality requires a broader view. Collaboration between fundamental research and application is needed but multidisciplinary research is more difficult. The facilities are available (like a collection of Field Labs), but how can we use all the separate ingredients to create a tasty meal? We need to strengthen TU/e internal collaboration (e.g. on ethical aspects) as well as collaboration with external partners (e.g. for legal aspects and projects).

Lack of a clear focus and goal
We do not have a clear goal: what do we want to achieve? Medals in sports? Economic activity in the region? Healthy citizens? Is the focus on sports, vitality or physical activity? Vital people, vital organisations, vital neighbourhoods? We need to choose a clear focus, communicate it clearly and stick to it.

One-of-a-kind
We do not get beyond one-of-a-kind projects. A lack of problem ownership makes it hard to scale-up from n=1 to n=100. It is also hard to find ‘vital’ business (partners to take up projects for continuity and on-going support).

Lack of coherent plan
Both internal and external parties recognise the large number of ad hoc initiatives. The multiple projects are not connected in a coherent programme. TU/e may have a lot to do related to vitality-related PhD’s but the chance that they will meet each other is low. There is also lack of a joint idea of where the region is heading in relation to sports and vitality.

Connections to other plans
Several other initiatives and plans are relevant to build up connection from the roadmap:

• Top Team & Advanced Research Centre at national level
• Top Team & Advanced Research Centre at regional level
• Top & Advanced research centre with the quadruple helix
• Policy of the Province of North Brabant: ‘Brabant Beweegt’
• ‘Brabant & Technology’
• Eneco city policies and plans

Low lights
Some ‘low lights’ were also mentioned in the ambition interviews. These present challenges or issues that are currently not sufficiently addressed. A summary of the low lights is given here.

The ambition interviews mentioned a long list of ‘high lights’. This shows that the topic of vitality is gaining traction in the research at the university. A summary of the high lights is given here.
LightHouse

Navigating to the knowledge of the TU/e

LightHouse is founded in 2012 to disclose the knowledge on smart lighting and smart cities of the Eindhoven University of Technology for Society. LightHouse is originally founded as part of the Intelligent Lighting Institute (ILI) and has close ties to the research programs related to smart urban lighting. LightHouse has expanded its scope to smart cities solutions with the foundation of the Data Science Centre Eindhoven (DSCe). LightHouse executes knowledge intensive projects starting from needs or questions from society and organisations as part of the valorisation activities of TU/e Innovation Lab, where it also holds office.

We co-create solutions with cities as well as multinationals and small companies and start-ups. We add value to the TU/e by bringing in best practices and societal needs to inspire new research and education programs.

LightHouse works with a network of partners, researchers and students in its projects.

About LightHouse & the TU/e Innovation Lab

TU/e Innovation Lab

Where science meets business

Today’s world demands an adaptive university that seeks and cultivates collaboration and cooperation with business, industry and government.

Because not only are research and education the work of the TU/e but also, and emphatically, innovation. TU/e Innovation Lab focuses on translating our scientific and technological results into solutions that make a contribution to the marketplace and society.

We are keen on close collaboration with our academics and scientists, staff and students, and with our external business partners. Because this is the kind of collaboration that generates new ideas, technological concepts and scientific breakthroughs. And it is this collaboration that can get the knowledge into products and services and into the marketplace and society. Effective knowledge valorisation gives the TU/e a position at the heart of the Dutch knowledge economy. And you are key part of our mission.

Authors of the Ambition and Research Roadmap Human Vitality and Technology:
This report is the result of a research project to define the ambition and research roadmap 'Human Vitality and Technology' for the Eindhoven University of Technology. For this purpose various interviews and workshops were held to gain deeper understanding of the strengths and competences of TU/e research groups and bundle them in a powerful collaboration network with partners in the Brainport region and at national and international levels.

This report describes the approach and results of the process to create a shared 'Human Vitality and Technology' ambition and research roadmap.

For more information: www.tue-lighthouse.nl/Vitality.html

Eindhoven, March 2017