


Well-being Enhancing Technology (WET)  
DSc Sari Merilampi, WET research group leader

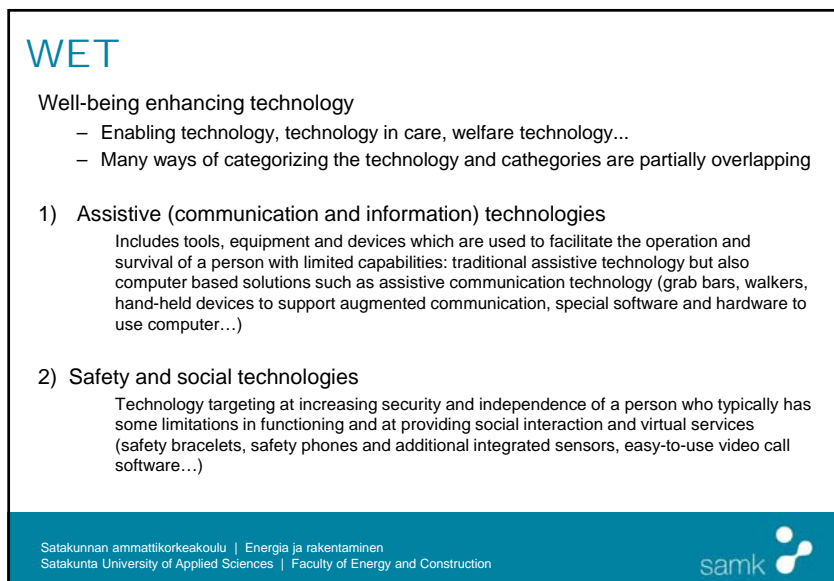
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Content

- What is WET?
- WET research group: aim, activities and philosophy
- Examples of novel technology solutions in our research projects
- Service design – making technology valuable service

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WET

Well-being enhancing technology

- Enabling technology, technology in care, welfare technology...
- Many ways of categorizing the technology and categories are partially overlapping

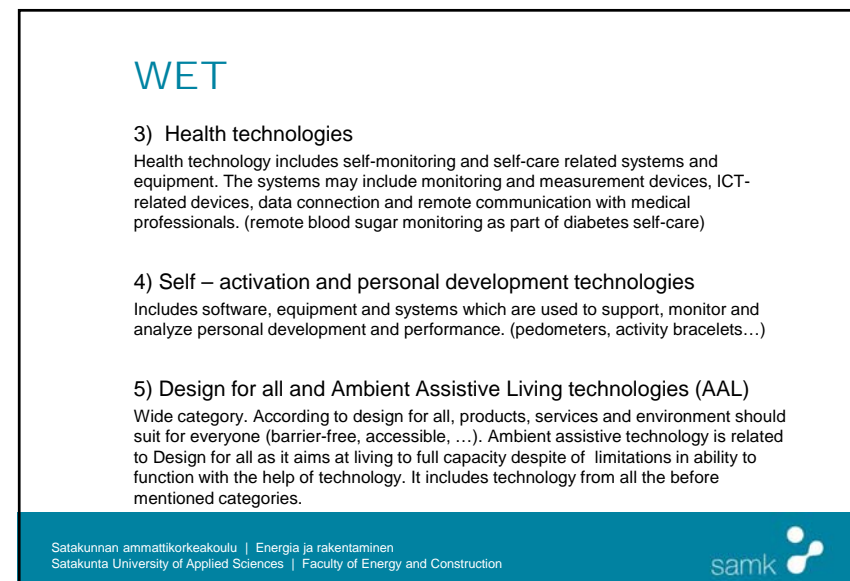
1) Assistive (communication and information) technologies

Includes tools, equipment and devices which are used to facilitate the operation and survival of a person with limited capabilities: traditional assistive technology but also computer based solutions such as assistive communication technology (grab bars, walkers, hand-held devices to support augmented communication, special software and hardware to use computer...)

2) Safety and social technologies

Technology targeting at increasing security and independence of a person who typically has some limitations in functioning and at providing social interaction and virtual services (safety bracelets, safety phones and additional integrated sensors, easy-to-use video call software...)

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3) Health technologies

Health technology includes self-monitoring and self-care related systems and equipment. The systems may include monitoring and measurement devices, ICT-related devices, data connection and remote communication with medical professionals. (remote blood sugar monitoring as part of diabetes self-care)

4) Self – activation and personal development technologies

Includes software, equipment and systems which are used to support, monitor and analyze personal development and performance. (pedometers, activity bracelets...)

5) Design for all and Ambient Assistive Living technologies (AAL)

Wide category. According to design for all, products, services and environment should suit for everyone (barrier-free, accessible, ...). Ambient assistive technology is related to Design for all as it aims at living to full capacity despite of limitations in ability to function with the help of technology. It includes technology from all the before mentioned categories.

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## WET

### 6) Gerontechnology

Also wide category. Includes technology from all the above discussed categories. The goal of gerontechnology is to develop age friendly technology as well as help older adults to use existing technology.

### 7) Hospital technologies and electronic health records systems

Includes hospital data and information systems such as electronic health record - digital version of the traditional patient paper chart but which also combines traditional patient information (medical and treatment information) into other information used in health and social care.

### 8) Medical technology (is this WET??)

Includes equipment such as Medical devices used for treatment and diagnostics...

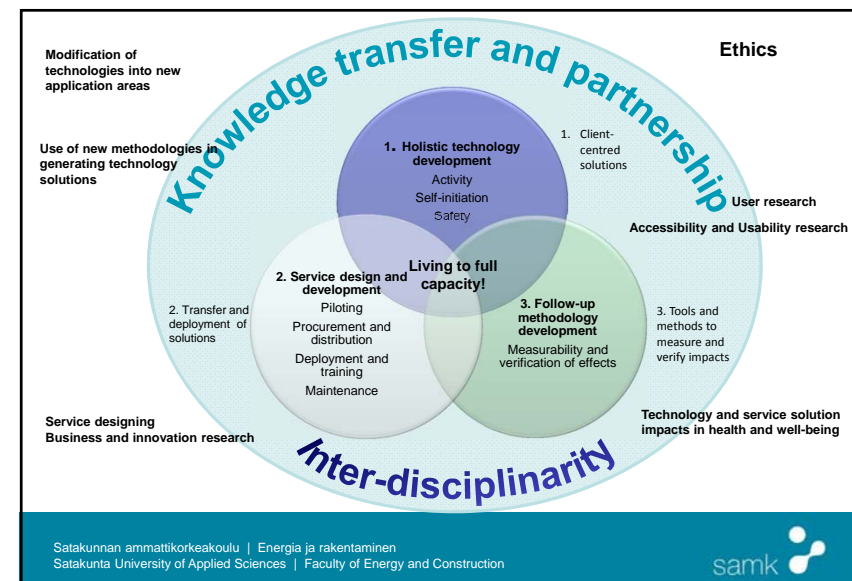
## Well-being Enhancing Technology Research Group

- The mission is to search and develop usable and accessible technology solutions to enhance individual well-being
- Multidisciplinary research team (technology, care, business...)
  - Acts as an intermediary between individuals and service providers both in the design and testing of technology supported solutions
  - Acts as an intermediary between different fields of business (for example technology and health)
- Focus on "people with special needs" such as the older adults, people with cognitive impairment or physical limitations, people with learning disabilities etc. -> Design for SOMEBODY

## Design for Somebody



- Person is at the center of the development process
- Most of the development work is performed to go very deep into user needs (narrow target group, even individuals)
- Technology and Services are designed for this individual need
- Most technology and services are already there (95% work already done) -> modifications are required to meet personal needs and make them accessible for people with special needs (5% of work to make the technology accessible and to serve real needs, including service design: how much and which services are required alongside with the technology)
- Iterative development and constant usability / user experience research



## Key technologies

- Mobile and wearable technologies
- Game technologies
- Automation technologies
  - Identification technologies (RFID, NFC)
  - Machine vision technologies
  - Sensor technologies
  - Systems (i.e. control-, follow-up-, alarm-, data- and computerised prediction systems)

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## Some examples of our technology solutions and projects

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## GaMeR – Gaming in Memory Rehabilitation



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## GaMeR – Gaming in Memory Rehabilitation

- Aim was to develop mobile games for memory rehabilitation (to help in diagnostics and to offer cognitive stimuli independent on rehabilitation resources, time and place)
- Two cognitively stimulating games were developed with memory rehabilitation professionals and the target group
- Test period (3 month)

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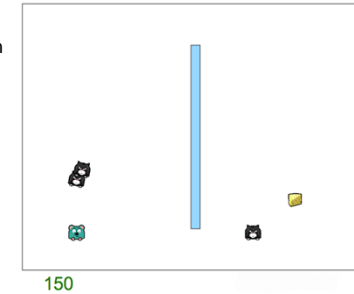
## TMT -game

- Electronic game version (traditional memory test: Trail Making Test)
- Numbers 1,2,3 ...(TMT A ) or numbers and letter: 1.A, 2, B, 3, C ... (TMT B) are tapped in right order as quickly as possible
- The more severe the memory impairment the longer it takes to finish the test
- Menu for selecting difficulty level (how many elements) and test type



## Cat vs Mouse

- Cognitively stimulating game which requires
  - coordination
  - reaction and attention skills
- Mouse collects as many cheese as possible in given time
- Cat (opponent) appears after having certain amount of cheese, cat follows the mouse
- Cat gets quicker and another cat appears depending on the progress in the game (similarly with the third cat)
- Obstacle(s) in the game are unpenetrable
- Game controls by tilting the device (mobile phone/tablet)



## GaMeR – Gaming in Memory Rehabilitation

- Main findings were:
  - Some improvement in game scores were found
  - User experiences extremely positive
  - > Huge need for self-initiated rehabilitation tools and positive attitudes-> business opportunities for customer-centered gaming services

## Wireless Welfare and WTAL (Wireless Technologies in assisting autonomous living) projects



Ulla Tuominen Foundation

## WTAL, Wireless Welfare

- Aim of WTAL was to introduce and search new possibilities of mobile games, identification and machine vision technologies in health and well-being
- Aim of Wireless Welfare was to further develop the above mentioned technologies and to make parallel trials in different context (different country and culture)
- Both projects targeted also for networking and partnership building

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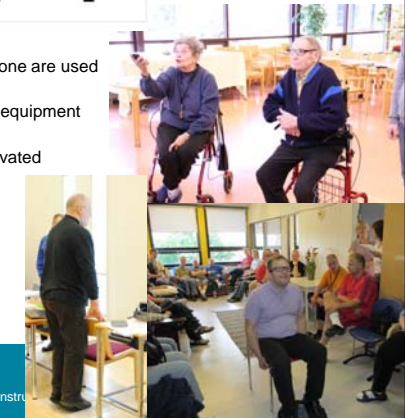


## Wireless Welfare and WTAL: Gaming and physical exercise

Target groups:

- Older adults
- People with learning disabilities

- Integrated acceleration sensors of a mobile phone are used to control a game
- Mobile phone can be integrated into exercising equipment such as balance board
- Movement of different parts of body can be activated
- Games are played with tv-screen or monitor
- Easy-to-use
- Multiple players



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## Combining arts and technology to enhance well-being

- People with serious physical limitations (mobile device/ balance board painting)



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## User centered game design



MobileGamevideo

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## Dundalk Institute of Technology – 3 student projects, 3 games:

- “*Evoke*” is a third-person sandbox adventure aimed at people affected by mood related conditions such as SAD (**Seasonal Affective Disorder**).
- “*Nyx*” is an open world puzzle adventure for people suffering from **physical impairment such as MS (Multiple Sclerosis) or MD (Muscular Dystrophy)**. Controls by Leap motion controller.
- “*Babel*” (Figure 3) is an on-line co-operative exploration platformer game, which explores the use of NVC (non-verbal communication) and gestures to support gameplay particularly for **people who suffer from social anxiety**.



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## HYVÄKSI (Commonweal) – Innovation Network for Well-being Enhancing Technology



Euroopan unioni  
Euroopan aluekehitysrahasto

Vipuvoimaa

EU:lta  
2014–2020

SATAKUNTALIITTO

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## HYVÄKSI (Commonweal) – Innovation network for well-being enhancing technology

- Main goal is to form an innovation network (users, developers, educators, associations, other stakeholders)
- Tools for joint development of technology and services
- Technology and service development cases and technology testings (living lab)

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## Orientation game

- To encourage and motivate for outdoor physical activities
- Target group: people with learning disabilities (lack of motivation for being active, game suitable also for all physically inactive user groups)
- Mini games which depend on place (reading through mobile device), may also contain physical exercise
- Game advances according to progress in mini games

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## Eye / head movement controlled technology

- For people with serious physical limitations
- Alternative methods for controlling different devices
- First app: reading news from screen by use of head movement

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## 3D printing for WET applications

- State of art technique: use of 3d imaged and printed head to calibrate novel magnetic treatment equipment, + for education purposes (learning how to use the equipment without real humans)
- Printing of other organs for similar purposes



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## Interactive calendar on mobile device or on large touch screen



- First version for care home for people with learning disabilities
- to help the clients to keep track on the daily living and for care staff to plan activities
- Calendar has special features: figures, speech (some of them cannot read), adjustable view (hours, day, week...)
- UI design according to users (separate view for care staff)
- Second version for rehabilitation center clients: include group activities...
- Suitable for larger groups and for social interaction (city?)



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## Mobile sensors for body movement detection

- Wearable device for limb movement analysis in air and under water
- Mobile app
- Applications
  - physiotherapy
  - water therapy applications
  - self-initiated rehabilitation



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## Wheeleri (developed before HYVÄKSI project)



- “Wheeleri” device is targeted for measuring the range and the speed of a Wheelchair or a Walker / Walking aid
- → motivating the user to move more and thereby promote personal health and well-being
  - Wheeler:
    - registers the special characteristics of a wheelchair or a walker due to data reliability,
    - saves all the data of the range, speed and time of the motion periods in a day → data to be checked in a separate display

## MakesSense! – project

## MakesSense! – project

- Aim was to develop and analyze possibilities of Radio frequency identification (RFID), near field communication (NFC) and machine vision for sensing perspiration and other bodily functions
- Another aim was to enhance collaboration with MIUN, Sweden

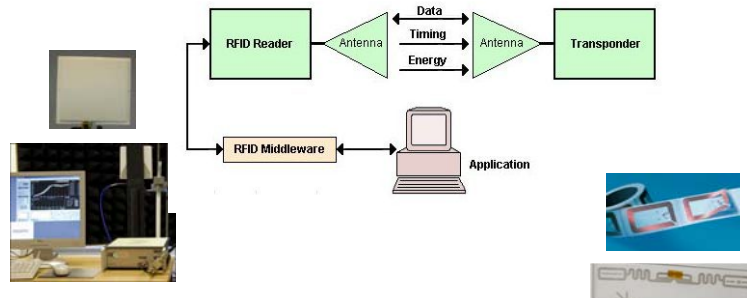
## RFID -technology

- RFID (Radio Frequency Identification) is a method for automatic identification of objects.
- Other automatic identification technologies
  - Machine vision
  - Bar codes, QR codes
  - Biometric identifiers (finger print, retina, voice...)
- The goal is unique identification of objects and the use of ID for different purposes (tracking assets, sorting, opening doors, warehouse management, to provide additional information of the object...)





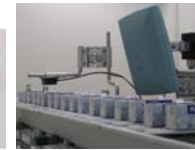
- The main difference of RFID and other automatic identification technologies is that RFID systems use electromagnetic radio frequency fields and waves for coupling and communication -> no visual contact is needed, remote reading possible, reading through some materials is possible
- All RFID systems consist of the same basic components according to which the systems can be further categorized.



## RFID in Healthcare



- Access control
- Tracking objects (surgery equipment etc.) and people
- Identifying patients and preventing adverse effects (wrong medications etc.)
- Identifying medication (anti-counterfeiting, tracking)
- Sensing
- Other



## Sensing perspiration - UHF RFID tags (seizure detection, sports: hydration levels...)

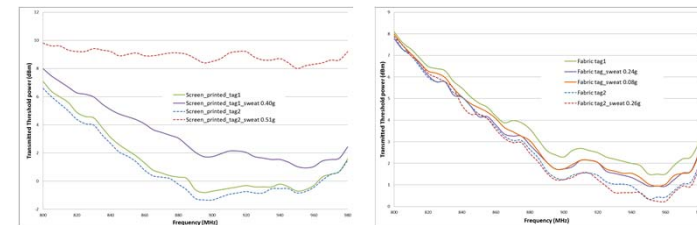
- The aim of the experiment was to analyze, if textile UHF RFID tags will be affected due to sweat which is absorbed into the tags
- Two textile tag models were used in experiment (antenna length 100 mm):
  - Type 1 tag antennas were manufactured from silver plated stretchable fabric made of nylon (76%) and elastic fibers (24%).
  - Type 2 tags were manufactured by screen printing polymer thick film (PTF) silver ink on stretchable fabric substrate.



- We measured the transmitted threshold power of the tags (power that is required to activate the tag using query command) as they were dry and as real human sweat was applied on them.



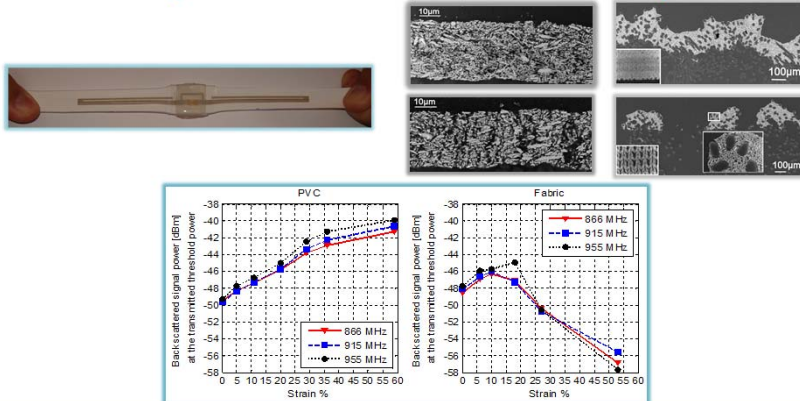
## Sensing perspiration - UHF RFID tags



Screen printed tags seem more severely affected by sweat than conductive fabric tags.

- This is mostly caused by impedance matching which is differently affected
  - In conductive fabric tags the sweat is absorbed only in the conductive antenna pattern (may even improve the conductivity) whereas in screen printed tags there is fabric in the t-mach structure and under the antenna -> changed material parameters of fabric due absorbed sweat -> significantly changed antenna impedance
  - Optimal operation frequency is slightly lower with screen printed tags (in Europe and USA its preferable; fabric tags are tuned to Asian frequencies)
- Based on these tentative trials UHF tag-based sweat sensing is possible at used UHF RFID frequencies)

## Strechable RFID tags as wearable strain sensors (limb movement detection)

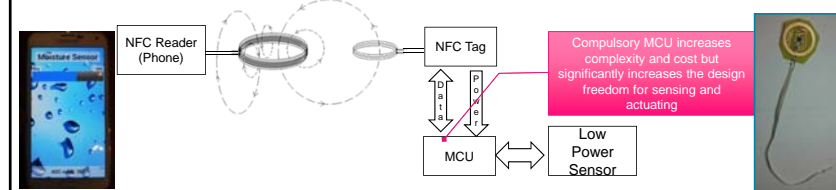


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## Sensing moisture with NFC readout (Mid-Sweden University) -> bandage tags, diaper tags

- NFC - a short range RFID system, reader integrated into mobile devices
  - Consumer applications without additional reader devices
  - NFC - tags also modifiable for (wearable) sensor use
- Newly developed NFC sensor tags that should be suitable for measuring perspiration
- The tags are technically more complex than the previous versions as they demand both an NFC chip and a microcontroller, but has lower production cost
- The functionality has been fully evaluated with water along a sensing strip and tests with perspiration are ongoing



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## Machine Vision – Intelligent seeing

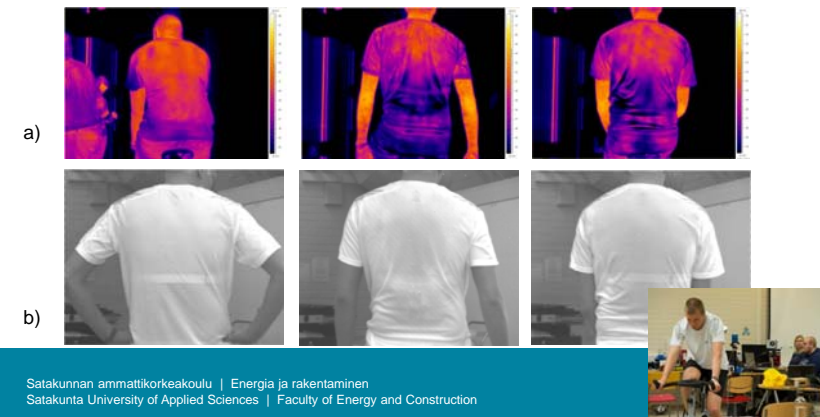
- Infrared technology** in its various forms, machine vision applications, and image analyzing in these fields have been focuses for research in Satakunta University of Applied Sciences (SAMK) for over a decade
- During the past eight years the infrastructure for IR technology and machine vision has been developed by acquiring modern **spectral imaging equipment**, IR imaging, **smart cameras and 3D imaging**



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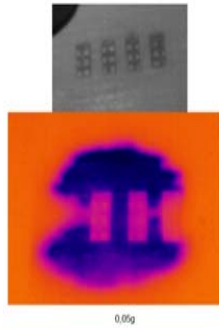
## Sensing perspiration in cloths and on skin during exercise with machine vision a) infrared (IR) and b) near infrared (NIR) imaging



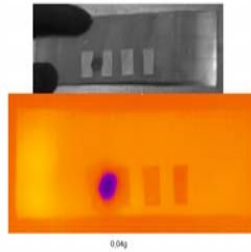
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## Water in different fabrics

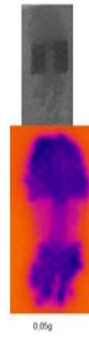
Sample 5 "hospital sheet"



Sample 7 "artificial skin"



Sample 8 "technical fabric"



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## NIRS research at the Satakunta University of Applied Sciences

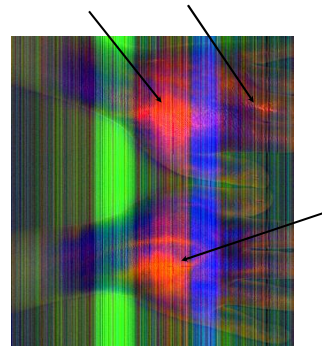
- NIRS imaging for the use in diagnostics
- The potential to **verify for example blood flow changes below human skin, inflammations and skin grafts** were tested in cooperation with Satakunta Hospital District



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## NIRS research: Case Example - Inflammation



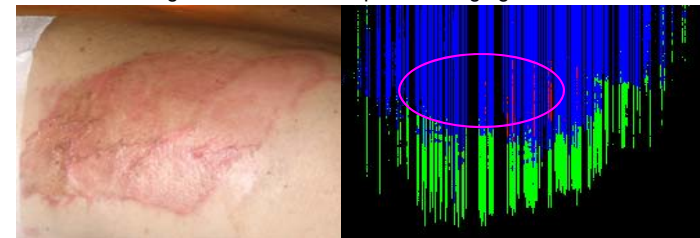
- Worst parts of the septic hand and bruise in the healthy hand can be seen as red spots with the help of NIRS imaging and hyper spectral data analysis

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## NIRS research: Case Example - Skin Graft

- Recognizing healing of the skin graft with the help of NIRS imaging and hyper spectral data analysis
- Part of the skin graft seems to be healthy or actually the blood flow seems to be similar to the healthy skin according to the spectrum
- Could the healing be seen with NIR spectral imaging?



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## Application examples – Machine Vision



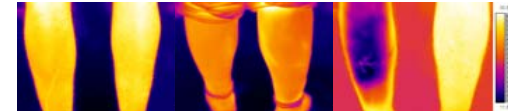
Tablet identification

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## Future challenges in enhancing well-being with machine vision

- Research area in welfare technology: How can machine vision be used in recognizing human body movements (e.g. during physical exercise to verify correct movements)?
- New **3D imaging technologies offer a huge range of possibilities to recognise human body movements** and thereby e.g. controlling different devices
- **Thermal imaging and near infrared imaging** used e.g. in **observing human body reactions** (like perspiration, muscle warming or cooling down)



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## MeWeT- project - combining various technologies, system integration and multidiscipline knowledge transfer



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Building automation:  
smart, adjustable  
and comfortable  
house

MeWeT

Well-being enhancing  
technology and remote  
care to assist in  
autonomous living

Construction work:  
Accessible and barrier  
free environment



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## MeWeT – Multifunctional environment fo Well-being enhancing Technology

- Aim of the project is to develop **environment for education and research** related to well-being enhancing technology (Erasmus+ for development of educational contents)
  - **Nursing and home care** -> demonstrating the technology, basic use and possibilities, possibility to affect the development of the systems and technology (feedback and person centeredness)
  - **Building automation**-> how to take into account well-being?
  - **(Repair)construction work** (accessibility and effect on construction work and construction planning)
  - **Technology development** (1) How and what technology to develop and implement the technology: What are we missing?-> Development of new technology and modifying the existing technology, usability and user experience research  
(2) How to get seamless, scalable and person centered systems for real needs: system integration!!!)
  - **Collaboration between different educational levels!!** How to educate skills which are essential and up-to date in working life.

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## Service design

Some definitions from the Internet...

Wikipedia says:

Service design is a form of conceptual design which involves the activity of **planning and organizing people, infrastructure, communication and material components of a service in order to improve its quality and the interaction between service provider and customers**. The purpose of service design methodologies is to design back and front office of services **according to the needs of customers** and the competences/capabilities of service providers, so that the service is user-friendly, competitive and relevant to the customers, while being sustainable for the service provider. For this purpose service design uses methods and tools derived from different disciplines, from ethnography (Segelström et al., Ylirisku and Buur, 2007, Buur, Binder et al. 2000; Buur and Soendergaard 2000) to information and management science (Morelli, 2006), and interaction design (Holmlid, 2007, Parker and Heapy, 2006). Service design concepts and ideas that are typically portrayed visually, using different representation techniques according to the culture, skills and level of understanding of the stakeholders involved in the service processes (Krucken and Meroni, 2006, Morelli and Tollestrup, 2007). Service design may inform **changes to an existing service or creation of new services**.

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## Service design

<http://www.service-design-network.org/intro/> says:

Service design is the activity of planning and organizing people, infrastructure, communication and material components of a service in **order to improve its quality and the interaction between service provider and customers**. The purpose of service design methodologies is to design according to the needs of customers or participants, so that the service is user-friendly, competitive and relevant to the customers.

Within Service Design, Service Interfaces are designed for intangible products that are, from the customer's point of view, useful, profitable and desirable, while they are effective, efficient and different for the provider. Service Designers **visualize, formulate and choreograph solutions that are not yet available**. They watch and **interpret needs and behaviours and transform them into potential future services**. In the process, exploring, generating and evaluating approaches are used similarly and a **redesign of existing services** is just as much a challenge as the **development of new innovative services**.

See more at: <http://www.service-design-network.org/intro/#sthash.cb18nNbnDpuif>

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## Service design for WET

- In case of WET, think and describe for example:
  - How would the technology solutions become service?
  - How would the solution become accessible and user centered by service design?
  - Are there any other application possibilities or user groups for the technology?
  - What kinds of services are needed to implement the technology?
  - What actually makes the most value for the customer?
  - Who could be the service provider and the customer?
- Customer journey map is a useful service design tool
  - customer touch points **before** (what they do before they need you, where they find you...), **during** (what they get from you) and **after** (what they do after your service, where they go) they come to you

VIDEO:

<http://uxmastery.com/how-to-create-a-customer-journey-map/>

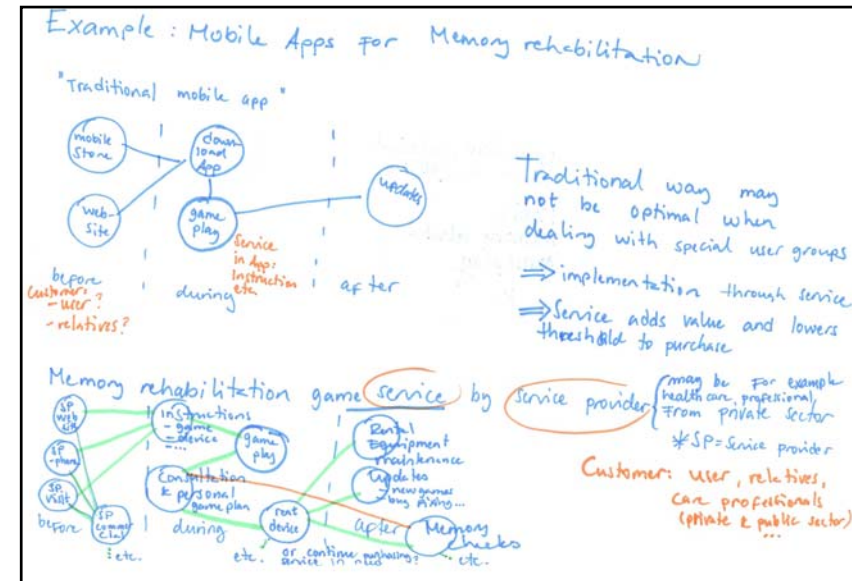
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## Example – How mobile rehabilitation games becomes service?

- Traditional mobile app
  - users, healthcare professionals or relatives download app from mobile store
- Add value and help implement the app through service (important in this context: interactions with real people)
  - Service provider provides the technology in form of service (more accessible, lower threshold to purchase)



## Home work: Service design for WET

- Select three technology solutions and describe
  - How would the before introduced technology solutions become service?
  - How would they become accessible and user centered by service design?
  - Are there any other application possibilities for the solution in elderly care?
  - Are there alternative user groups for the technology?
  - How to add value by service?
- DL in 2 weeks (e-mail)

## Time for demos

- Games
- 3d head
- Interactive calendar
- Tags



Thank you!

Questions and comments:

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