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UNIVERSITY OF VAASA

# *Feasibility of additive manufacturing for drone applications – University of Vaasa's activities: Dr. Rayko Toshev and team*

HEIDI KUUSNIEMI, DIGITAL ECONOMY  
UNIVERSITY OF VAASA

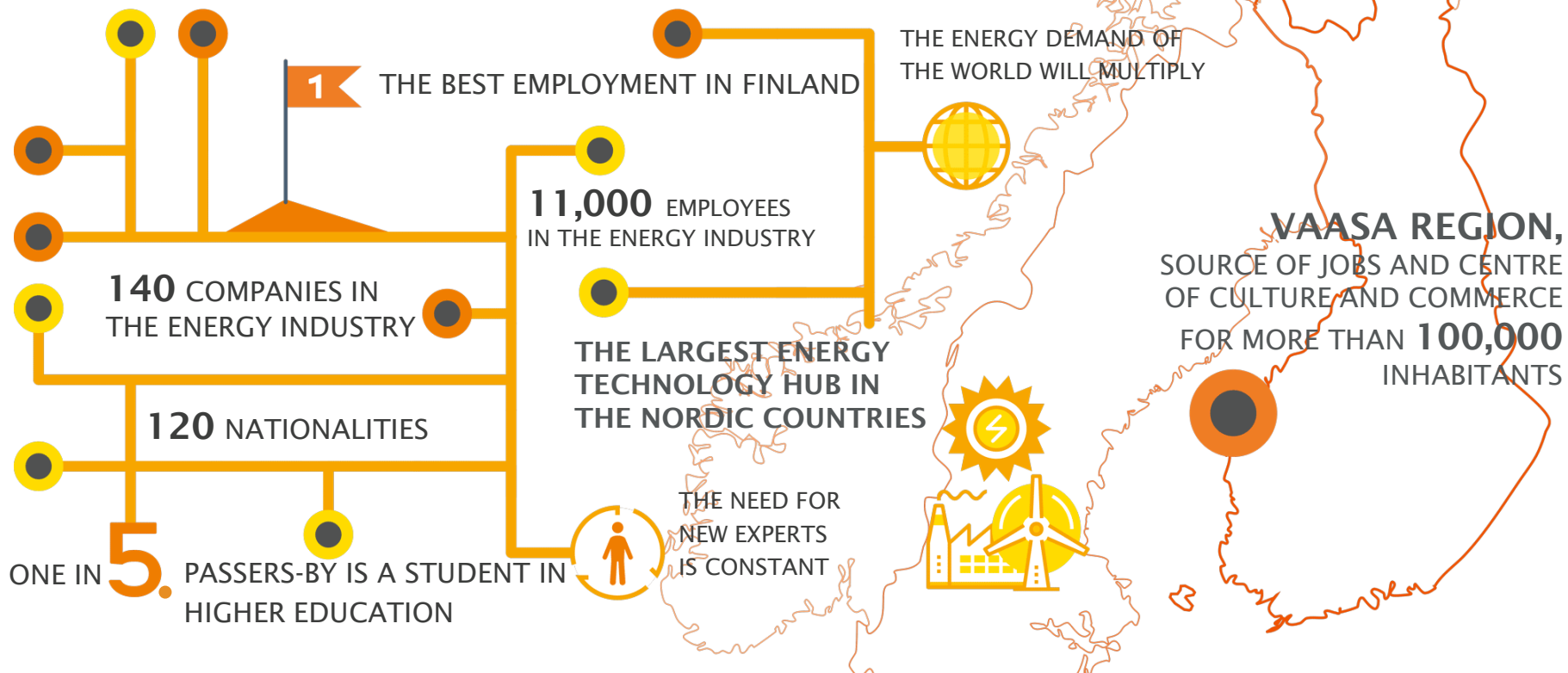
WORKSHOP ON AUTONOMOUS AERIAL VEHICLES  
BY NORDIC INSTITUTE OF NAVIGATION  
THURSDAY 15 NOVEMBER 2018  
NTNU, TRONDHEIM, NORWAY





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# Vaasa, Energy Capital of Finland



# University of Vaasa – maritime campus



# Key figures

- 1968
  - Established as a public university
- 5250
  - Students: undergraduate, graduate and doctoral
  - Business school represents about half of our educational activities
- 470
  - University staff
- 40 million Euros
  - University budget





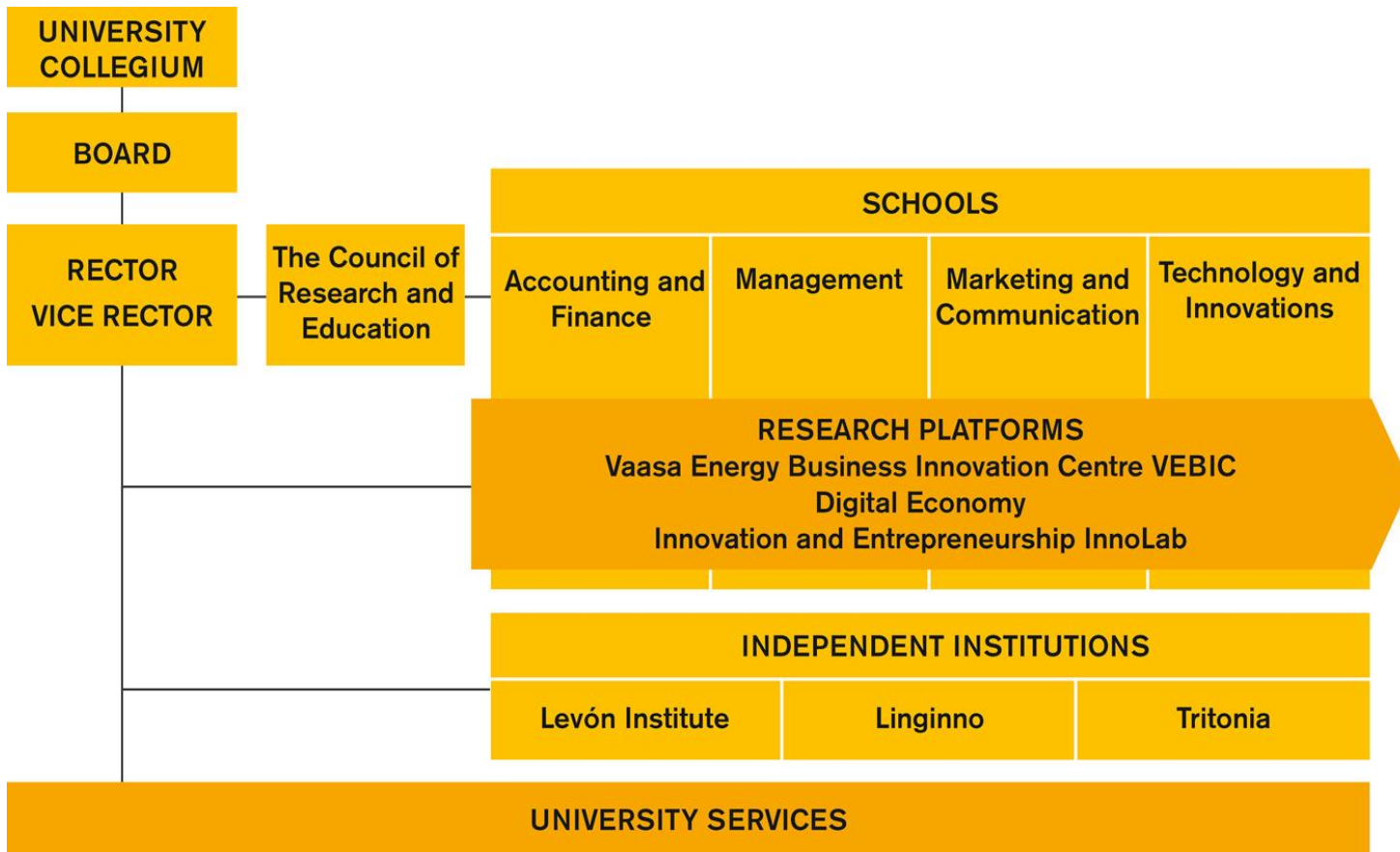
# University of Vaasa

- We specialise in
  - Technology
  - Business
  - Public policy
  - Communication
- Strategic areas of research
  - Management and change
  - Energy and sustainable development
  - Financing and economic decision making
- Four academic units (schools) and three multi-disciplinary research platforms





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# TECHNOBOTHNIA

## Technobotnia (1)

- The major research infrastructure at the university is found in the Technobotnia Education and Research Centre co-owned by all higher education operators in the region





## Technobotnia (2)

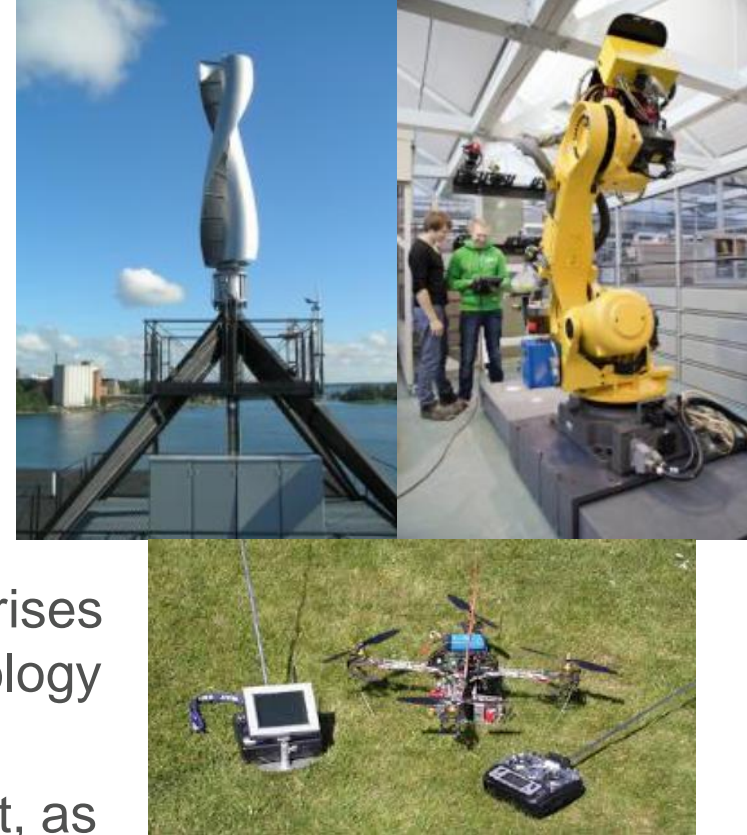
- Technobotnia's information technology lab is equipped with the latest in computer technology and ICT
  - Real-time simulators & multi-vendor environment
  - Digital manufacturing lab
  - Virtual factory lab
  - Drone lab
- Technobotnia also hosts a research laboratory for research within energy technology and the environment, parallel to the Vaasa Energy Business Innovation Centre VEBIC





# Technobotnia (3)

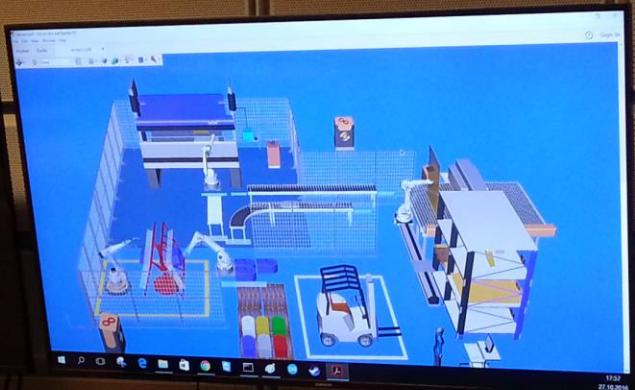
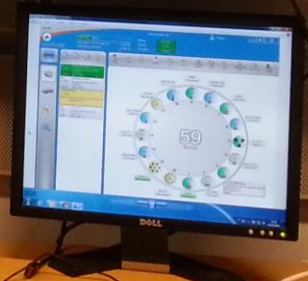
- Technobothnia's mission statement
  - provide a framework for high-standard education and research in the field of technology
  - serve as a channel of cooperation between educational institutions, enterprises and other research institutes and technology centres
  - offer research, and product development, as well as education, measurement and testing services to the private and the public sector





# Virtual factory lab

No Signal  
HDMI1  
(1) Check the cable connections and the settings of your source device.  
(2) Press Source on your remote control to select the connected source device.

A software interface showing a table of data. The table has columns for 'Production line name', 'Machine name', 'Machine type', 'Machine status', 'Machine location', 'Machine speed', 'Machine direction', 'Machine color', 'Machine size', 'Machine weight', 'Machine value', 'Machine cost', 'Machine price', 'Machine profit', 'Machine loss', 'Machine gain', 'Machine risk', 'Machine chance', 'Machine probability', 'Machine frequency', 'Machine period', 'Machine cycle', 'Machine time', 'Machine date', 'Machine time', 'Machine date', 'Machine time', 'Machine date'. The table contains multiple rows of data.



# Technobothnia's drone lab

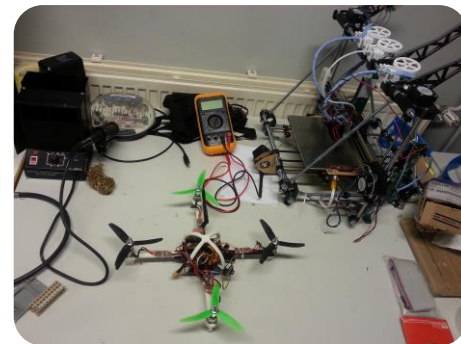
## Hardware

Octocopter 2,5 kg payload  
Quadcopters with gimbal  
Mini and nanocopters-3Dprinted  
Base-station  
First Person View goggles and monitor  
HD cameras  
RGB and Infrared cameras  
Near Infrared spectrometer  
3D printers&scanners

## Software

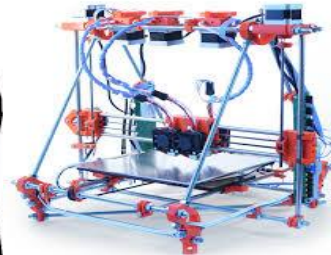
Drone flight simulators AeroSIM RC  
Ardupilot & Mission planner  
Photogrammetry-terrain buildings etc. 3D modelling from pictures

[www.technobothnia.fi](http://www.technobothnia.fi)



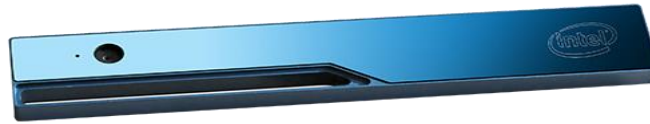
# Technobothnia additive manufacturing equipment:

- FDM (Fused Deposition Modeling) machines, multi-extruders
- SLA (stereolithography)
- DLP (Digital Light Processing)
- Material jetting
- Powder based



# 3D Scanning Hardware

Useful when adding new components



(a) Microsoft Kinect v1



(b) Microsoft Kinect v2



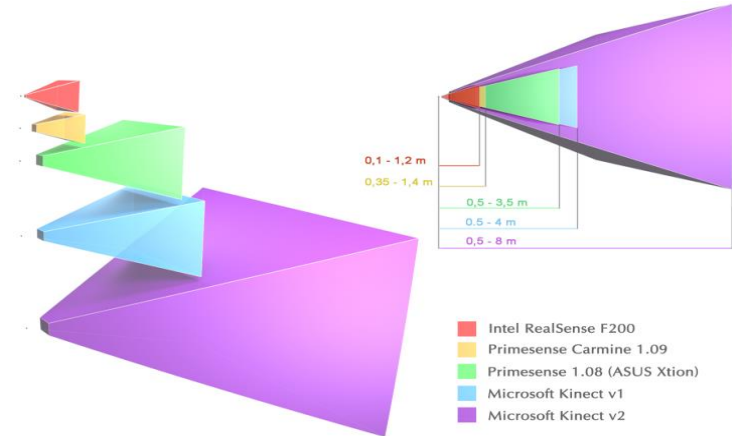
(c) ASUS Xtion (Primesense Carmine)



(d) Intel RealSense 3D camera by Creative (F200)



(e) Laptop featuring Intel RealSense 3D camera



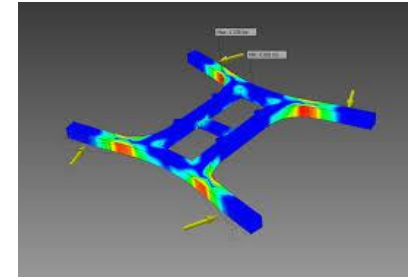
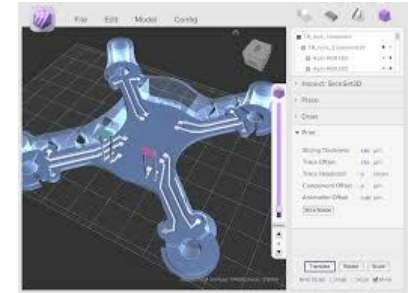
# VR & AR wearables

Useful in training or first-person view/  
video piloting



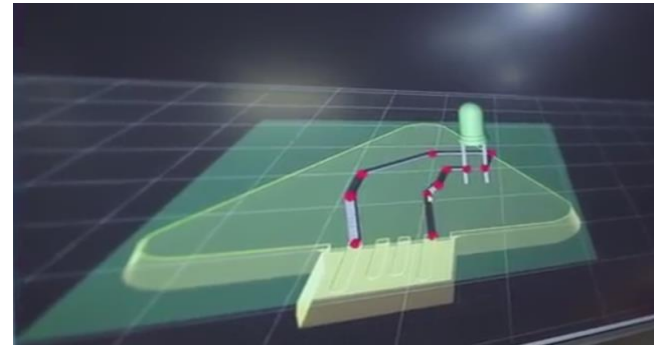
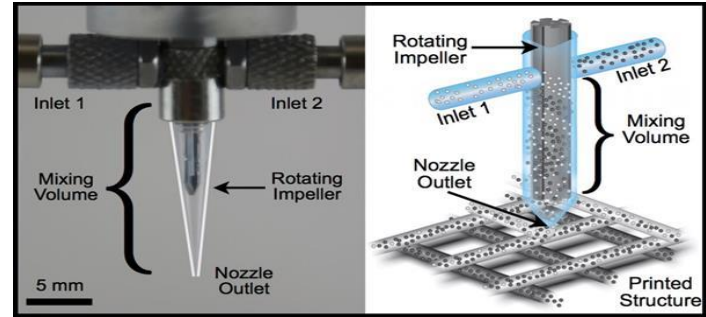
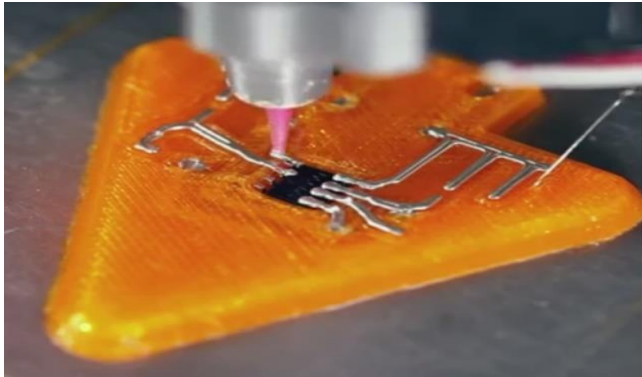
# 3D printed parts for drones

- Prototypes and functional parts, gimbals etc.
  - Fixture for motors
  - Smaller copter frames
- Electronics and sensor cases and shieldings
  - Housing for electronics
- Composite plastics
- Nylon & carbon fibre
- Conductive Thermoplastic Filament

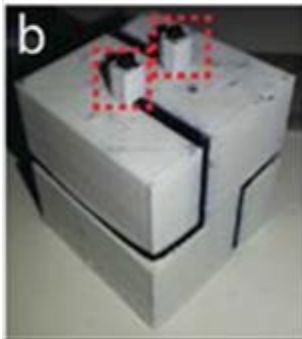
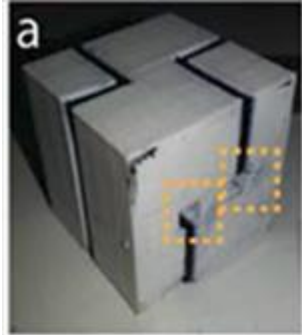


# Multi-material printing, tools

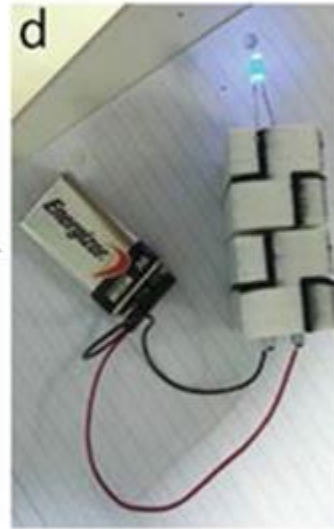
Multi-material printing



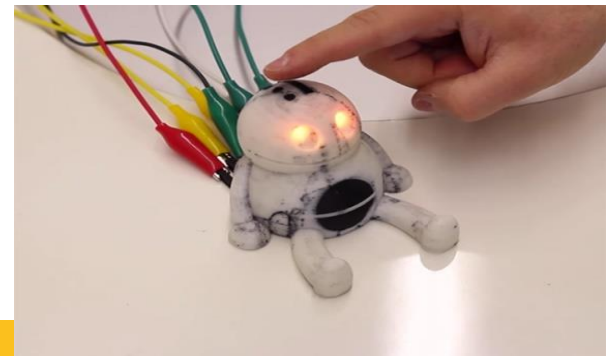
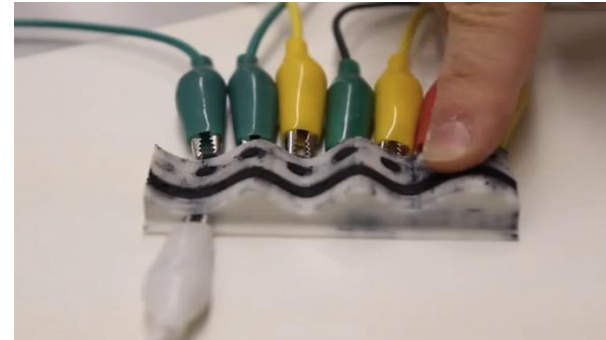
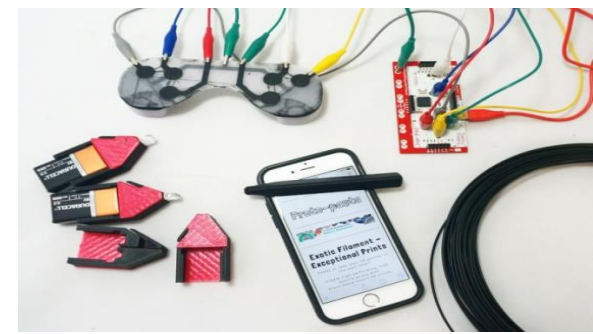
# Conductive Termoplastic Filament



2x  
→



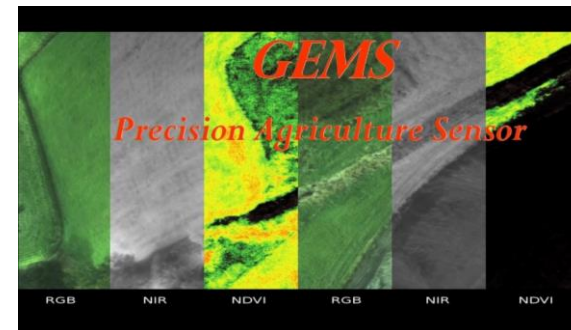
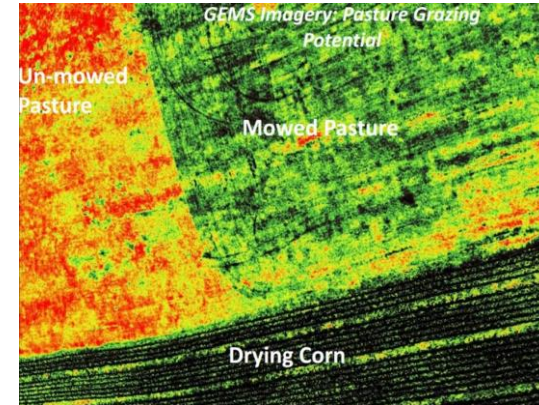
Potential for printing sensors  
and to replace cables





# Drones - commercial and civilian applications

- Public safety Emergency & Disaster Response – flooding, wild fire, accident scene investigation, wild life monitoring
- Precision Agriculture – precipitation, measure and identify plant disease, nutrient, and water pressure to improve yields and lower costs
- Energy – electric wires, oil and gas pipe inspection
- Surveying and Mapping - GIS (Geographical Information System) solutions
- Transportation and delivery for healthcare etc.

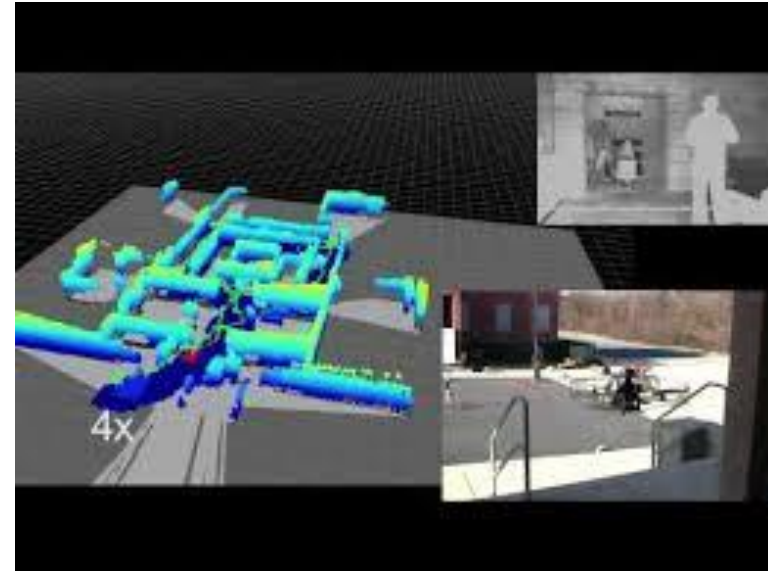


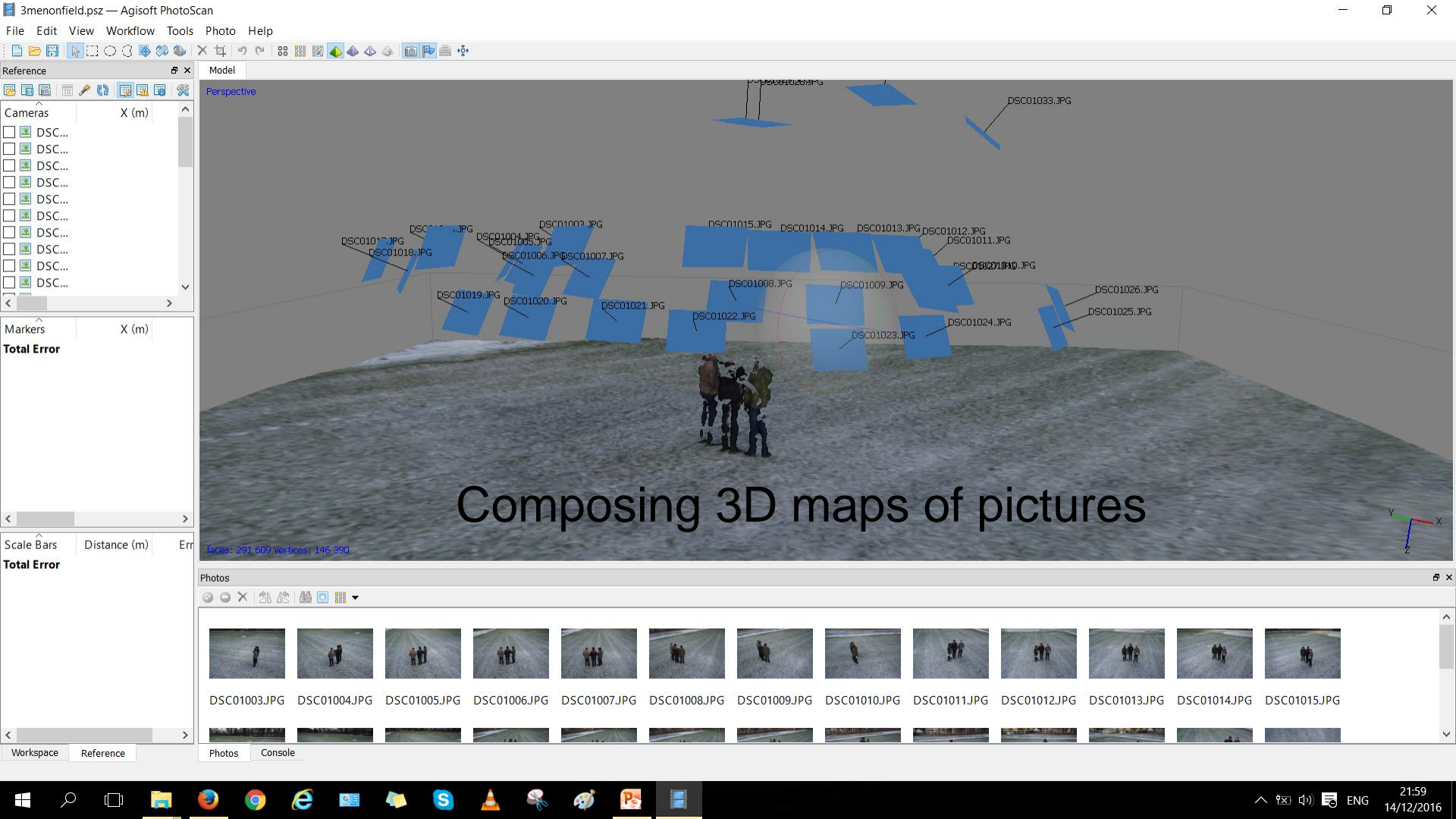
# Applications in Vaasa region

Drones with printed parts - goals:

- Taking images and combining into 3D maps
- Mapping the terrain: city planning together with the city of Vaasa
- Rain flow drainage modelling; city of Vaasa
- Nordic telemedicine (GeoDrone X4L multicopter by VideoDrone Finland Oy for eHealth – imaging and sensor node dropper)

[www.nordictelemedicinecenter.eu](http://www.nordictelemedicinecenter.eu)





Composing 3D maps of pictures

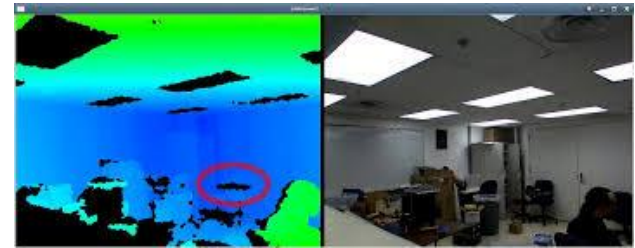
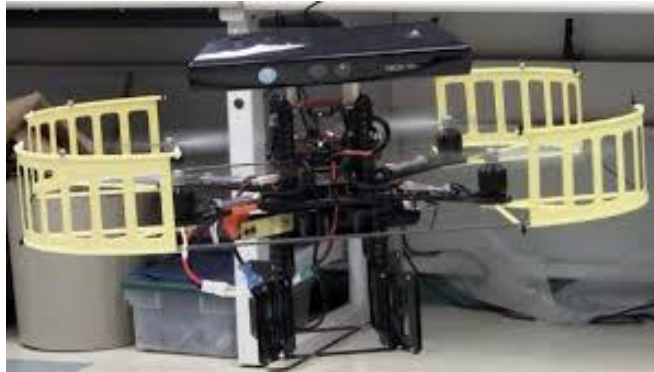


# Flooding terrain simulation in Blender (open source 3D graphics software)





# Data analysis, photogrammetry, machine vision, infrared 3D scanner for autonomous indoor path planning



# Drone pilot school - simulators



Training package activities at Technobotnia	Time
Introductory lesson, ground school with theory study manuals	2 days
Sensors and cameras for drones and robots, Radio communication procedures.	2 days
Drone flight simulator training, scenarios + practice aerial photography, video taking, first person view (FPV) mode, practice on many different models	4 days
Drones loading & performance, batteries and sensors handling	2 days
Ardupilot and mission planner tutorials, Pre-flight assessment check	1 days
Practical flight assessment + pilot checklists, indoor and outdoor flights with real data collection and live data streaming	6 days
Drones maintenance & inspection, Additive manufacturing/3D printing spare and customized drone parts	4 days
<b>Total work days</b>	21 days

Course in planning

# Thank you!



[@KuusniemiHeidi](https://twitter.com/KuusniemiHeidi)



[heidi.kuusniemi@uva.fi](mailto:heidi.kuusniemi@uva.fi)

