Theme's 4TU.Call 'High Tech for a sustainable future'

1 High tech to feed the world

We are facing one of the greatest social challenges of this century: over the next forty years the global food demand will be equivalent to the total amount of food produced over the past 8,000 years. Applying high-tech systems and materials and new ICT possibilities will support the agrarian and food sectors to meet these major social challenges. Moreover, the competitive position of these sectors in the Netherlands will improve and there will be opportunities to export new systems using these applications. Conversely, high-tech sectors will be challenged to find solutions to the problems that have stood in the way of such applications until now, such as non-uniform products, the circumstances in which systems have to function and limited economic scope for innovation. It is essential that the sectors concerned work together intensively on these opportunities.

2 Sensing Science and Technology

Smarter, cheaper, and more reliable sensors are required in various application domains such as smart industry, health, environment and agro-food. They are needed to develop advanced robots. We are at the forefront of developing the next generation of innovative sensing platforms and accelerating their introduction into the growing sensor market. Platforms will often be (wirelessly) networked, forming the basis for the next generation of the Internet of Things and the foundation for many smart society agendas. Development of innovative sensing platforms requires a cross-disciplinary approach, uniting scientific disciplines in developing new sensing functionalities, design and engineering of sensing systems/devices, communication networks, product design and development (including manufacturability), data management, interaction, and societal, ethical and governance aspects.

3 Robotics

Robotics offers new solutions to societal challenges ranging from ageing to health, security, energy and the environment. The potential of robotics extends far beyond the factory. Service robots for professional or domestic use represent an emerging market with strong growth potential as robots become mainstream appliances and systems in many walks of life (work, home appliances, security, leisure, assistive technologies for physically disabled, medical equipment, etc.). Robots increasingly have learning and adaptive capabilities that will have a broad impact on all future ICT systems in a wide range of products and services. It is essential to advance current robot capabilities in terms of robustness, flexibility and autonomy so that they can achieve useful tasks in an efficient manner while operating in real-world, often unknown, unstructured and highly unpredictable environments. Typical technology clusters within Robotics are: Systems Development (better systems and tools), Human-Robot interaction, Perception, Navigation, Mechatronics, and Cognition.

4 Health & vitality

Researching vitality in a broad sense has significant potential. These types of programmes go beyond 'vitality' alone and cover the whole health spectrum. One of the major challenges is the accurate measurement of an individual's health and well-being and then to intervene for the purpose of positively influencing this person's state. We need to develop more systematically an integrated and more complete approach to (remotely) measure, monitor, and act upon an individual's health and well-being, for example by:

- connecting sport-psychology theories with human performance to gain a deeper understanding of exercise and recovery on health and vitality
- sensing and measuring technology to develop further integrated solutions for vitality
- experimenting with innovative solutions in Living Labs
- combining strengths from sensor technology, data science, design and psychology.

The combination of competences such as sensing and behavioural research can create added value. Various psychological orientations could be explored, extending from extrinsic to intrinsic motivation. Technology can play a role in motivating people with different lifestyles.

5 Resilience

In today's complex and hyper-connected world, we face many huge challenges – from climate change to water and energy security, from securing complex food chains to creating liveable cities with increased IT penetration. We cannot deal with these challenges in the traditional way – by ex ante planning, by linear decision-making or by simply anticipating these challenges. Resilience will have to become a key component of strategies and designs to deal with these challenges and to achieve the UN Sustainable Development Goals.

6 Advanced materials

We are on the eve of an extremely important development which will equip us with the tools to create customised new materials. Materials scientists are in an ideal position to implement solutions for the major challenges known to humankind in the fields of energy, raw materials, health and prosperity. They are able to develop new materials and achieve breakthroughs in the areas of:
- climate: completely sustainable energy from the sun
- sustainability: a closed circuit for the usage of materials
- health: artificial tissues and medical sensors for an ageing population
- economy: a new manufacturing industry that makes smart products – made in Holland.

Research into these advanced materials could focus on the development of new classes of materials using nanotechnology or self-assembly. Gaining insight into the atomic and macroscopic behaviour of materials with new theoretical and spectroscopic techniques also falls within this main research area. Other challenges being addressed in this area include the development of advanced biodegradable and bio-based materials with specific properties and research that increases the understanding and control of complex forms of matter. Interactions between entities (molecules, cells) of complex organic, inorganic and hybrid systems lead to new features through self-organisation on a larger scale in space and/or time. Research within this research line includes physical chemistry, polymer chemistry, solid state chemistry and materials science, parts of organic chemistry, spectroscopy and theoretical chemistry, as well as soft condensed matter science.

7 Energy conversion & storage

Energy conversion: This is in general the transformation of forms of energy provided by nature to forms that can be stored, transported and used by humans. Research into new converters is needed.

Energy storage technologies are valuable components in most energy systems and could be an important tool in achieving a low-carbon future. These technologies enable the decoupling of energy supply and demand, in essence providing a valuable resource to system operators. There are many cases where energy storage deployment is competitive or near-competitive in today's energy systems. R&D work is currently underway with the primary goals of realising technology cost reductions and improving the performance of existing, new and emerging storage technology. Furthermore, many government and industry stakeholders are identifying and attempting to address non-technical barriers to deployment. Looking forward, the most important drivers for increasing the use of energy storage will be:
- improving energy system resource use efficiency
- increasing use of variable renewable resources
- rising self-consumption and self-production of energy (electricity, heat/cold)
- increasing energy access (e.g. via off-grid electrification using solar photovoltaic (PV) technologies)
- growing emphasis on electricity grid stability, reliability and resilience
- increasing end-use sector electrification (e.g. electrification of the transport sector).