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How can Medical & Biological Engineering & Science (MBES) contribute to the development of the Humanistic Society (Society 5.0)?

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Human society: Its historical development:

Society 1.0: Hunter and gatherer society (begin: birth of human beings)

Society 2.0: Agrarian society (begin: 13.000 B.C.)

Society 3.0: Industrial society (begin: end of 18th century)

Society 4.0: Information society (begin: second half of 20th century)

Society 5.0: humanistic society (begin: 2016)

Transition of Societies

- Society does not describe a steady-state but an evolving system that can frequently be subdivided in so-called high-cultures, e.g. in Australia (Aborigines, 45.000 B.C.), China (Yangshao-culture, 5.000 B.C.) Mesopotamia (Sumerian culture, 4.000 B.C.), Egypt (pyramides, hieroglyphes, 3.050 B.C.), Central America (Majas, 3.000 B.C.), Mesopotamia (Babylonian culture, 1.800 B.C.), Austria (Hallstatt culture or Older Iron Age, culture of the Illyrians and Celts, 800 B.C.), Central America (Aztecs, 1.350 A.C.).
- The evolution of societies and their transition (or transformation) into the following society was supported by technical inventions and progress in technology, e.g. improved tools (for craft and for agricultural work), construction of houses, cities and vehicles, weapons, material (bones, bronze, iron), communication (printing tools).
- **Transition to the societies 3.0 and 4.0 has primarily been initiated by new technologies (e.g. by energy-driven machines, mass-production machines, plastics) and IT.**

Question: Can technology contribute also to the transition to Society 5.0?

The Society 5.0

- Its prinicipal concept was first presented in 2016 by the Japanese Government as a strategic part of the “Basic Policy on Economic and Fiscal Management and Reform 2016.”
- It is aiming for a human-centered society and hence covering more than the German concept of Industry 4.0 (published in 2011) that focuses on the general digitization of industrial production.
- It considers both the OECD “Innovation Strategy” (published in 2010) and the United Nations „2030 Agenda for Sustainable Development, with Sustainable Development Goals (SDGs)“ (adopted in 2015).

The Society 5.0

- will be a super-smart society with the goal to develop a society in which each individual can live in social harmony with the social community and can realize its own personal wishes leading to **self-actualization**.
- shall be based primarily on the relevant progress reached in the Society 4.0 (Information Society), i.e. Internet of Things (IoT), Artificial Intelligence (AI), big data handling, autonomous robots, 3D-bioprinting.
- shall be supported by better understanding of economy sharing and social life organisation.
- requires the general acceptance of **humanism**.

International Humanist and Ethical Union (IHEU, founded in 1952) defined in its Amsterdam Declaration:

Humanism is a democratic and ethical life stance, which affirms that human beings have the right and responsibility to give meaning and shape to their own lives. It stands for the building of a more humane society through an ethic based on human and other natural values in the spirit of reason and free inquiry through human capabilities. It is not theistic, and it does not accept supernatural views of reality.

Updated in the Amsterdam Declaration 2022:

We affirm the worth and dignity of the individual and the right of every human to the greatest possible freedom and fullest possible development compatible with the rights of others. To these ends we support peace, democracy, the rule of law, and the universal legal human rights.

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Humanism is

- emphasizing the individual and social potential of human beings.
- considering human beings as the starting point for moral, ethical and philosophical inquiry.
- based on human agency, i.e. on the capacity of human beings to make choices and decisions with understanding their unlimited responsibility for the consequences.
- typically represented by non-religious movements and aligned with secularism.
- looking to science and its application (utilization) for progress in human life and sustainability.

Society 5.0: The main technology-related goals shall be:

- to merge the cyberspace and the physical space.
- to be a knowledge-based and data-driven society.
- to transform information into inventions and finally into innovations.
- to utilize the unrevealed potential that may be included in block chain technology, cloud technology, quantum computer, intelligent robotics, new materials and production methods (e.g. nanotechnology), and in gaming.

Glossary

Invention: A unique or novel device, method, composition or process, or relevant parts of existing devices, methods, compositions or processes that render possible **new applications or provide higher or safer applications**.

Innovation: New ideas, products or methods which have not been used before. Innovations are based on the results of new technological developments and advanced scientific knowledge. Innovations respond to societal or economic needs and demands. They generate new products, services, production processes or business. They are **successfully introduced into an existing market or create new markets.**

Product innovation: The introduction of a new or a significantly improved good or service into the market.

Process innovation: The implementation of a new or significantly improved production process, distribution method or support activity for goods or service.

Humanistic Society 5.0 - a totally new concept

Confusion of the Humanistic Society with other social concepts should be avoided, especially with the

- Confucianism: This concept of a harmonic society proposed by Confucius (600 B.C. – 500 B.C.) contains remarkable ethical and moral elements. However it is primarily based on the acceptance of existing hierarchical structures and does not demand saecularism, i.e. the separation of religion from civic affairs and state affairs.
- Communism: The goal of this concept as proposed by Marx (1848) is to establish a classless society in which all property and wealth are communallyowned, instead of by individuals. However, it is not in accordance with the principles of humanism and does not provide the chance for unlimited selfactualization to everybody.

Humanistic society: Why is it needed?

It might be a unique problem solver for problems related with:

- the still growing world poulation
- ageing society with its effects on the healthcare system, the reduction in active working population and the social system with increasing demands for elderly people care.
- the changing scope of new diseases, unexpected (future) pandemies, and the increase of the number of people with disabilities and handicaps which may be physical, sensoric, mental, or intellectual.
- the complex challenges by nature protection, climate changes, depletion of natural resources, limitation of food production, and mass migration of peoples for different reasons.

The Humanistic Society is in agreement with the WHO definition of health:

„World Health Organization defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.“

Scientific approaches that explain the sequential phases of human social development and may be helpful for developing the Society 5.0 in collaboration with technology and other scientific developements

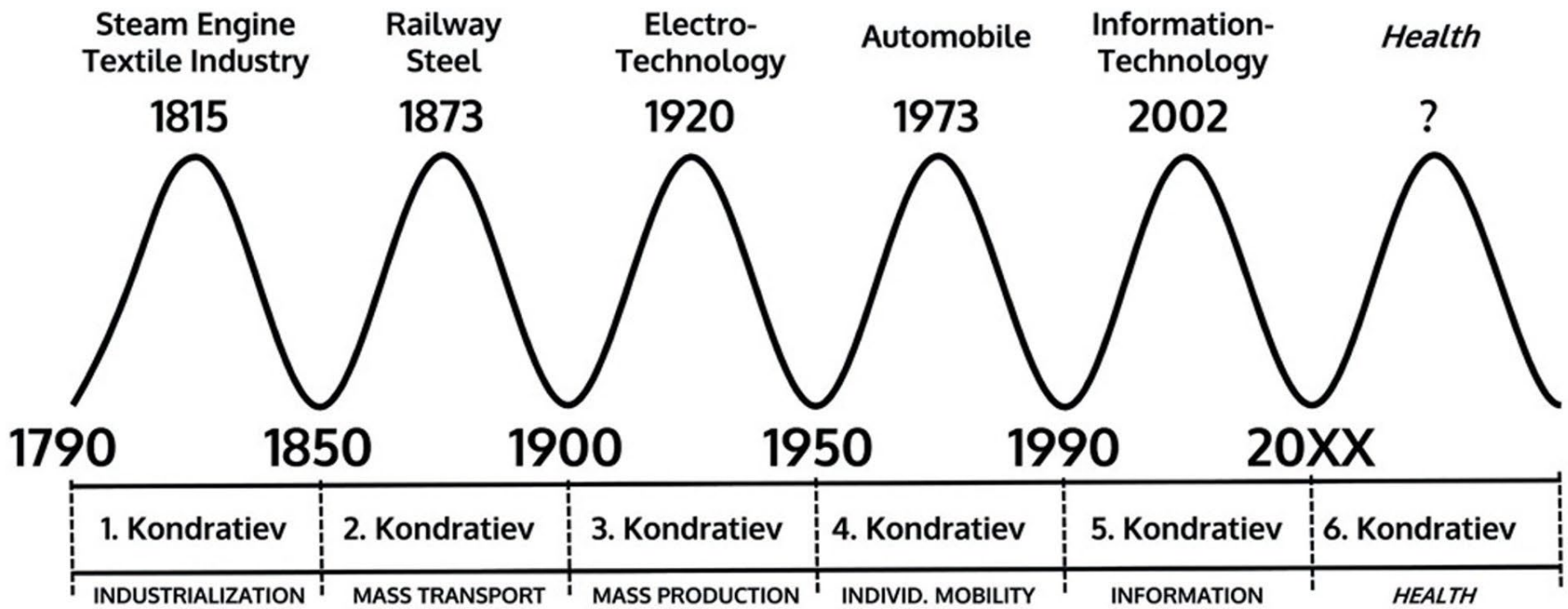
- **Ethnology** deals with the division of human beings into races and their origin, distribution, relations, and characteristics. It may be useful to understand and consider those differences for the development of the Society 5.0.
- **Anthropology** is the science of human beings; especially: the study of human beings and their ancestors through time and space and in relation to physical character, environmental and social relations, and culture. Subdisciplines are:
  - **Cultural anthropology:** focusing on the study of cultural variation among humans.
  - **Social anthropology:** the study of patterns of behaviour in human societies and cultures.
  - **Physical anthropology (or: biological anthropology):** focuses on the origin, evolution, and diversity of people, especially on the human and nonhuman primate evolution, human variation and its significance, and the biological bases of human behaviour.
  - Ling**uistic anthropology:** devoted to the study of how language influences social life.
- **Evolutionism** is based on a selection process comparable to what has been proposed by C. Darwin for biology, i.e. Darwin has seen **biological evolution** as the result of **natural selection**.

The Kondratiev-Cycles, i.e. a time grid approach taking into account the longterm cycles between economic booms and depressions phases (30 – 60 years)

- **1790 - 1850**: The first cycle was fueled by the invention of the steam engine and the growth of textile industry.
- **1850 – 1900**: The second cycle was triggered by the genesis of the steel industry and by the increasing railway transport that supported the mass transportation of both people and cargo,
- **1900 – 1950**: The third cycle was the first wave that was primarily triggered by the use of advanced science and technology. It was mainly based on the broad application of electrical power and basic innovations in the chemical industry which allowed the mass production of commodities, especially plastics.
- **1950 – 1990**: The fourth cycle was driven by the growth of the petrochemical industry that supported the growth of the auto market and the plastics industry.
- **1990 – 2020**: The fifth cycle was triggered by the computer-based information technology which became the main driver of economic growth. As a consequence, the industrial society began transitioning into an information society.
- **2020 - ?:** The sixth cycle may be the first cycle that is not primarily related with technological progress, but with health in combination with nature protection and climate changes, i.e. life sciences. Medical engineering and biotechnology may be key technologies.

The Kondratiev-Cycles

Up-and-down-cycles of the world economy



Will MBES be an enabler of the next Kondratiev Cycle 2020 – 20yy?

Science and technology contributing to the enhancement and extension of human capabilities:

- Period 1, beginning about 5.000 years ago: Enlargement of human physical power and motoric capabilities, e.g. by using levers, pulleys, wheel-equipped vehicles.
- Period 2, beginning about 500 years ago: Enablement of human beings to extent their sensoric capabilities beyond physical limits, e.g. by microscopes, thermistors, radioactivitiy sensors, electric and magnetic sensors,
- Period 3, beginning about 50 years ago: Enablement of human beings to enhance their intellectual capabilities, e.g. by computers, algorithmic-based reasoning, Artificial Intelligence.

Trendsetting contributions of science and technology to the development of the human society

- Digits (symbols), numbers and icons: first applications about 10.000 B.C.
- Hieroglyphs, letters (symbols) and characters: first applications about 5.000 B.C.
- Invention of the wheel for vehicles (transportation), for special machines, mills and other technical tools; about 3.500 B.C.
- Invention of explosives (10th century), application for work and war
- Printing art with single, movable letters (1480 by Gutenberg in Mainz)
- Programme-controlled machines, e.g. looms (1758 by Jacquard in France)
- First computer, i.e. machine for electronic data processing (1941 by Zuse in Germany)
- First transistor using semiconductor technology (1947 by Bardeen, Brattain, Shockley in USA)
- Biotechnology, i.e. the combination of natural sciences, especially microbiology, and engineering sciences in order to manipulate organisms, cells, parts thereof and biomolecules, computer-based production of vaccines (e.g. mRNA vaccines) and tools like the gene scissors CIRSPR technology

The „two-culture-discussion

Snow, C.P. an English novelist and physical chemist who also served in several important positions in the British Civil Service, delivered on May 1959, a Lecture „The Two Cultures“ which subsequently was published as „The Two Cultures and the Scientific Revolution“.

The thesis of Snow was that science and humanities which represented "the intellectual life of the whole of western society" had become split into "two cultures" and **that this division was a major hindrance to both in solving the world's problems**.

- London: Cambridge University Press. p. 3. ISBN 978-0-521-45730-9
- „The hundred most influential books since the war“. The Times (London, 30 December 2008)

Culture, Nature, Technology, Arts, Philosophy:

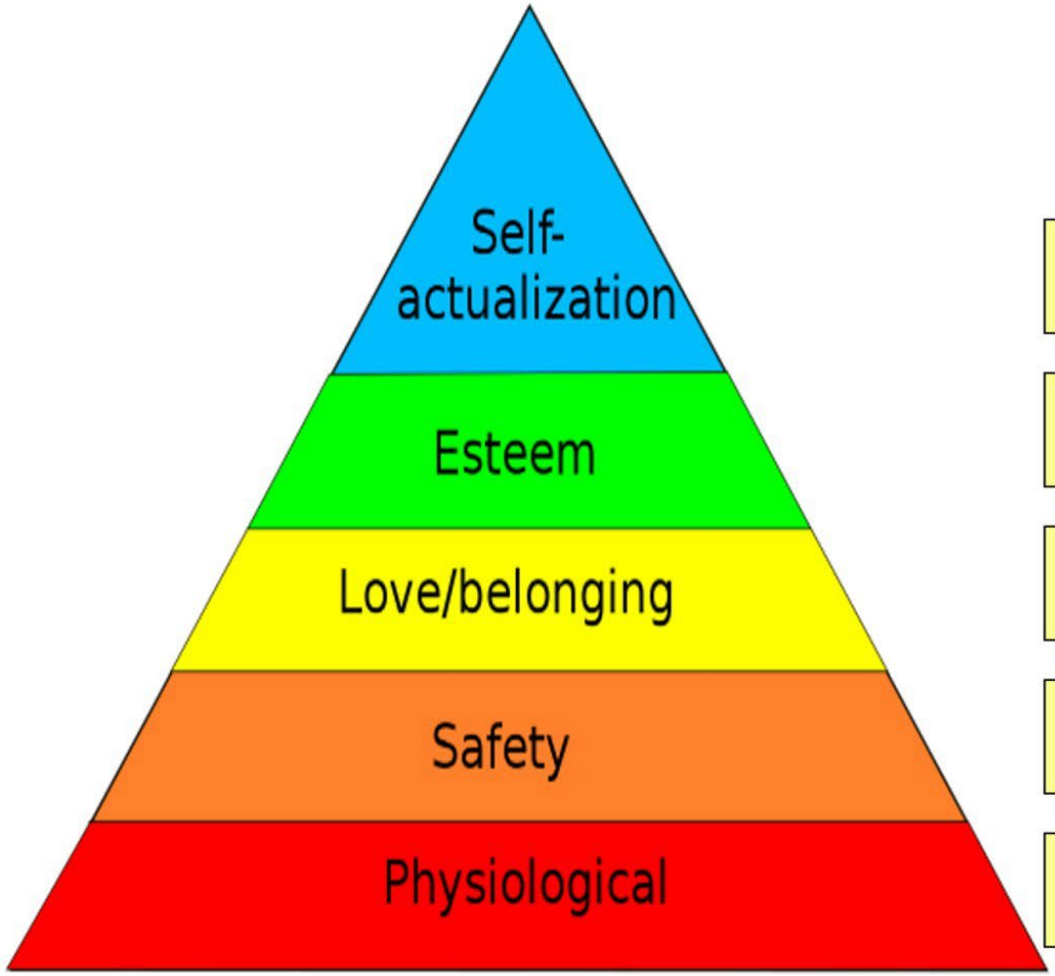
- **Culture** is accepted as being of the greatest value, importance and significance to humanity. Hence, it is the totality of all human activities in accordance with tradition and experience and guided by a catalogue of accepted (western?) values.
- **Nature** is a non-man made system and controlled by laws that are identified by man in the natural sciences and reveal what can be generated by man. Hence, it is the antonym to culture.
- **Technology** is the body of knowledge and methods that are employed by engineering for the generation of new products and production processes.
- **Arts** is the expression or application of human creative skill and imagination in fields like painting, sculpture, music, literature, theater and architecture.
- **Philosophy** is a way of thinking about certain subjects such as ethics, thought, existence, time, meaning and value.
- **Humanities are academic disciplines that study aspects of human society and culture.**

Summary: Culture is the umbrella that encompasses nature, technology, arts, philosophy and humanities. The frequently „misused difference“ between „the two cultures“ is not helpful for reaching the humanistic society.

Humanistic Society: Self-actualization, the fundament of Society 5.0

Maslow, Abraham: „A Theory of Human Motivitation“ (1943),

modified and adopted to demonstrate the contribution of MBES on the way and necessary steps to the top level , i.e. to the Society 5.0



Personal development Self-actualization	**?** **Challenge for MBES**
Inclusion , Acceptance Respectation	wheelchairs, prothesis, hearing aids, visual aids, speech aids, implantable drug infusion pumps, etc.
Rehabilitation, Ass. Living Social Needs	devices for physical, mental and neurological training, wearable monitoring systems, roboters, etc.
Diagnosis, Care Safety Needs	equipment for monitoring, imaging (X -ray, NMR, Ultrasound etc.), for laboratory diagnosis, etc.
Survival, Life saving Basic Needs	cardiac pacemaker, defibrillator, respirator, dialysing machine, infusion pumps, rescue packs, etc.

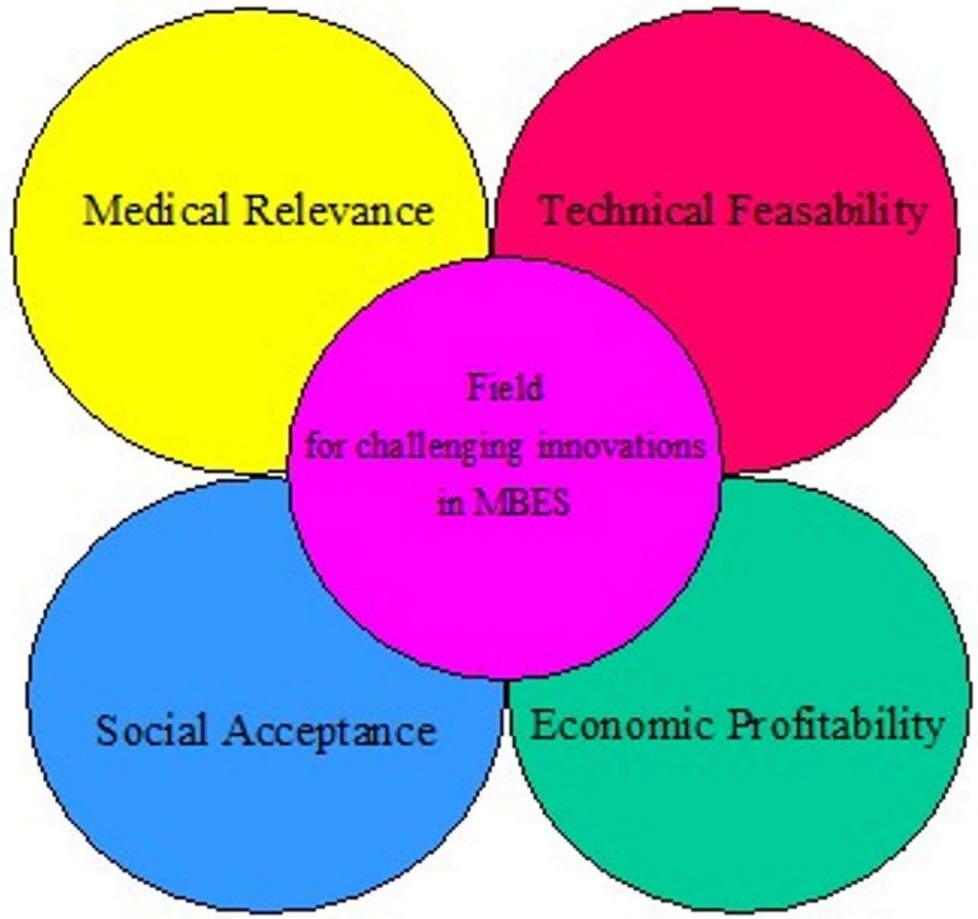
Self-actualization in Maslow’s hierarchy of needs means:

- It is the highest level of personal development, where the individual‘s potential is fully realized after basic bodily and ego needs have been fulfilled and the "actualization" of the full personal potential takes place.
- It is the realization or fulfillment of one’s full talents and potentialities.
- Self-actualizers are free from reliance on external authorities or other people. They tend to be resourceful and independent.
- The self-actualizers possess "Gemeinschaftsgefühl", which refers to "social interest, community feeling, or a sense of oneness with all humanity“.

Self-actualization

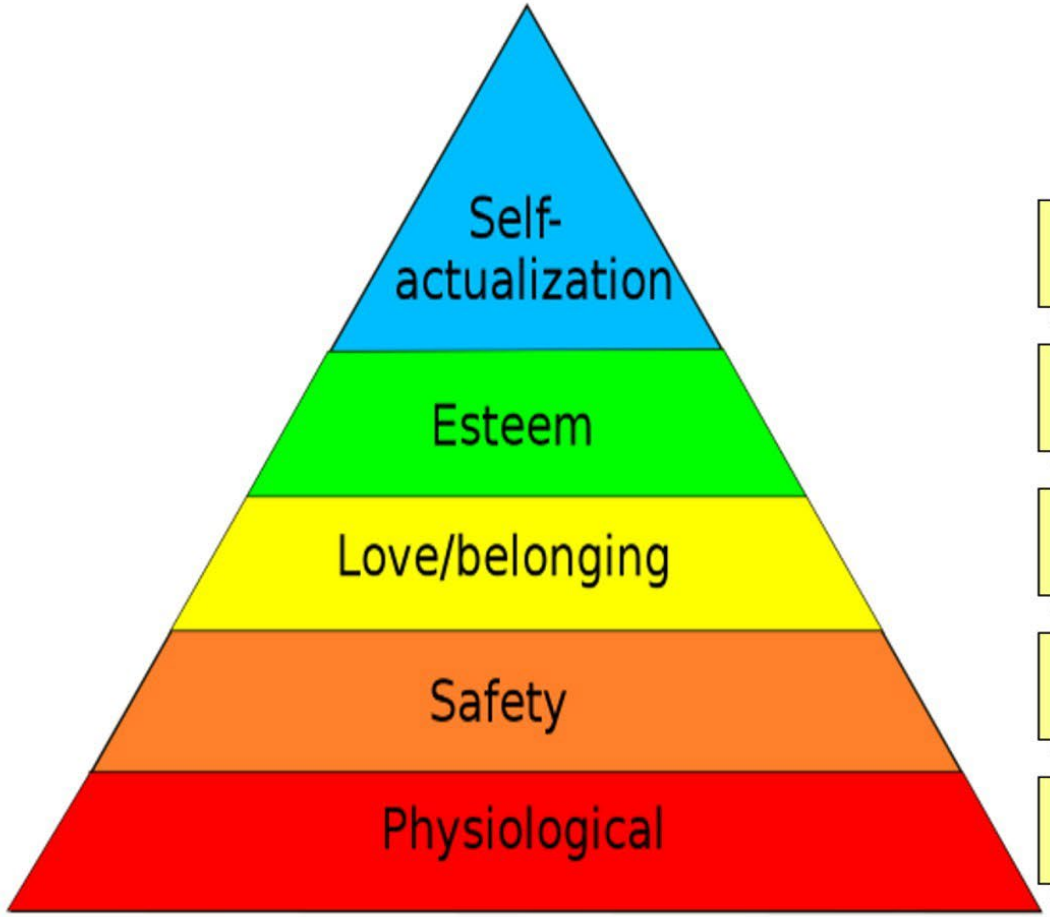
- requires active co-operation, willingness for that life mode, and acceptance of the provided aids by the concerned individual (i.e. nobody can be forced!).
- should not be confused with self-realization, development of personality, selfesteem etc.
- **means in relation with MBES** that an individual with disabilities or handicaps for physical, sensoric, mental or intellectual reasons should be enabled to lead a life like a comparable (e.g. in age) individual without any of those deficits (i.e. it shall be made clear that tools useful only for the compensation of certain deficits are not the ultimate goal!).

Challenging innovations in MBES are based on 4 pillars



Humanistic Society: Self-Actualization - Level 5 of the Hierarchy of Needs

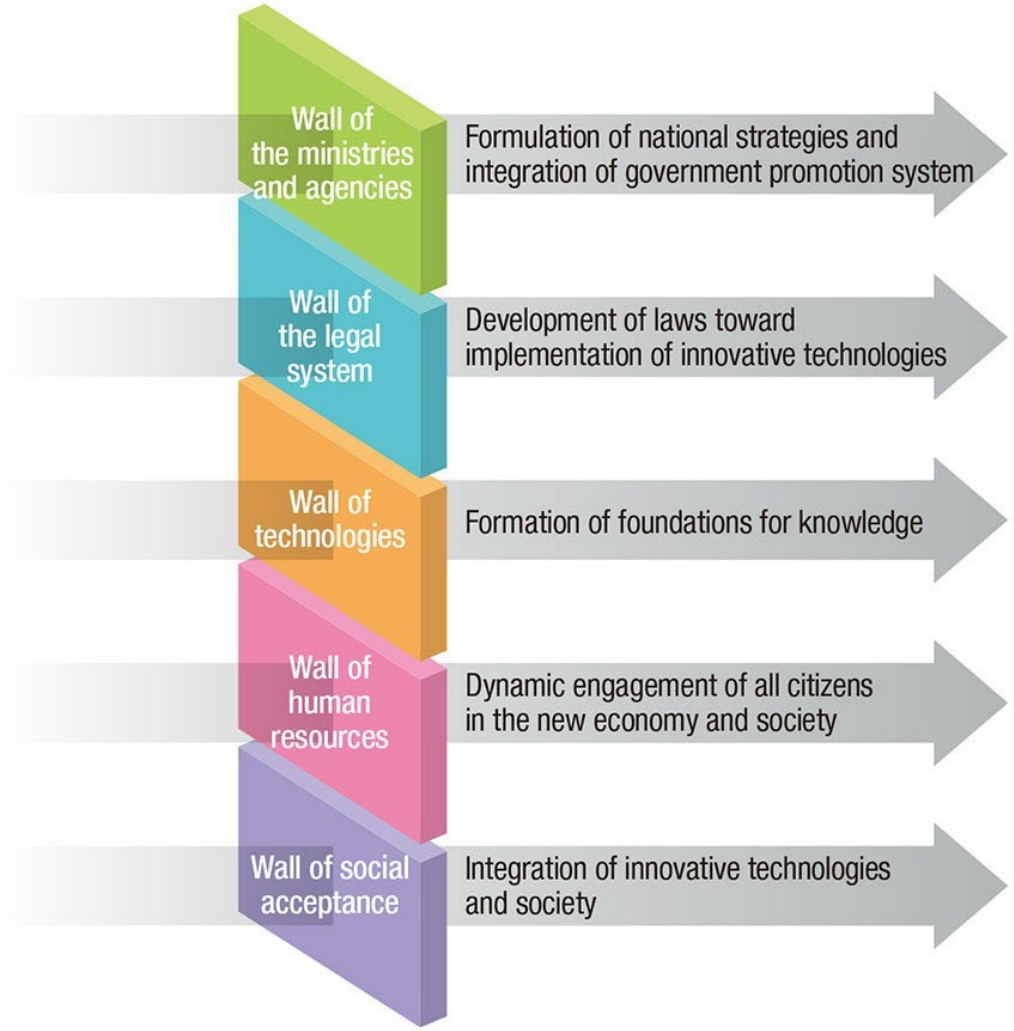
Maslow, Abraham: „A Theory of Human Motivitation“ (1943):
modified and adopted to demonstrate the contribution of MBES on the way and necessary steps to the top level , i.e. to the Society 5.0



Personal development **Self-actualization**	Technical aids for people with physical , sensoric, intellectual or emotionlal disbailities and handicaps
Inclusion , Acceptance **Respectation**	wheelchairs , prothesis , hearing aids , visual aids , speech aids , implantable drug infusion pumps , etc.
Rehabilitation, Ass. Living **Social Needs**	devices for physical, mental and neurological training, wearable monitoring systems, roboters, etc.
Diagnosis, Care **Safety Needs**	equipment for monitoring, imaging (X -ray, NMR, Ultrasound etc.), for laboratory diagnosis, etc.
Survival, Life saving **Basic Needs**	cardiac pacemaker, defibrillator, respirator, dialysing machine, infusion pumps, rescue packs, etc.

Walls against the development of the Humanistic Society, identified in the Hitachi Review 2017: Aiming for a New Human-centered Society 5.0

Japan's Science and Technology Policies for Addressing Global Social Challenges



Source: Prepared based on materials from the Japan Business Federation (Keidanren)

AAL: Ambient Assisted Living, later: Assisted Active Living

- AAL has been started by the EU in 2008 as a funding programme aiming to create better quality of life for older and for handicapped people, **to strengthen industrial opportunities in the field of healthy ageing technology and innovation**, and to develop assistive care services.
- AAL has been co-financed by the European Commission (through **Horizon 2020**) and 17 countries until 2020 for an approximate budget of €700 million.
- Although AAL has been a first and promising step in the direction towards the development of a society with enhanced recognition of concerned people, the results were not really convincing. The German „Bundesministerium fuer Bildung und Forschung“ concluded in 2016 „**that there are only few examples for successful application of new technologies for the increase of the life quality of elderly people. The necessary technologies, however, are available and their application is simple.“** („es gibt kaum erfolgreiche Beispiele für den Einsatz neuer Technologien zur Steigerung der Lebensqualitaet aelterer Menschen. Dabei sind die benoetigten Technologien bereits vorhanden und koennten relativ einfach angewendet werden.“)
- **The Humanistic Society approach must go beyond AAL. However, it may benefit from the body of AAL knowledge and may find support by the EU!**

Available technological prerequisites for the Humanistic Society:

- miniaturized, implantable and intelligent multisensor-actor-systems.
- multi-sensor-based, communicative wearables with body area networks (BAN, also referred to as a wireless body area network (WBAN) or a body sensor network (BSN) or a medical body area network (MBAN), i.e. a wireless network of wearable computing devices).
- autonomous healthcare devices and systems, e.g. equipped with antropomorphish automatons, i.e. human-like self-operating robots, that interact with humans.
- System-on-a-Chip Technology, i.e. an integrated circuit that integrates most functions of a powerful computer.
- big-data processing.
- Intelligent robotic systems, i.e. with human-like behaviour.
- Virtual and Augmented Reality technology.
- Cyborg-technology: cybernetic organism („cyborg“) is an organism with both biological and technological components for increased performance.
- Emerging biotechnologies and advanced molecular biotechnology, e.g . the CRISPR/Cas9 gene editing system and artificial gene synthesis.
- Gene technology(?), especially in non-human fields (ethical problems)

The Humanistic Society cannot be reached by only thinking in the category of traditional health care technology. More innovative technologies are required!

First ideas for MBES products towards Society 5.0 (I)

- Informative aids for blind and visually impaired people that deliver more information than the (still necessary) stick or guiding profiles in the ground, e.g. answers to questions like „Where can I find shadow or protection against rain“, „Will it rain within a few minutes“, „Who is the person speaking to me“, „Where is the next washroom“, help to find connection to public traffic systems, and especially for orientation by using GPS etc.
- Wearable „artificial kidney“ that works continously, i.e. more physiologically than the usual twopoint-control procedure, and does not require frequent and time-consuming visits in the dialyis center.
- Wheel-chairs that not only offer more user comfort, e.g. with regard to rain and cold, but enable the user to overcome hindrances like stairs, and are equipped with intelligent sensors and actors, e.g. position sensors and safety instrumentation.
- Mobilisation-Stimulators for people with ALS, Parkinson, paraplegia and other neurologic or muscular deficits.
- Complex communication aids enabling complete inclusion in all fields from education and learning to working and taking part in social life, e.g for people after removal of the vocal cords, or multi-sensoric handicapped people.

First ideas for MBES products and innovations towards Society 5.0 (II)

Instrumentation for comprehensive monitoring of the state of the Autonomous Nervous System (ANS) with regard to heart attacks, circulatory disturbances, migraine, epilepsy unclear headache and many other health failures before the attack occurs.

Virtual Reality and Augmented Reality (possibly assisted by gaming methods and/or gamification) are very promising

- for the training of people with
  - memory problems, e.g. with dementia,
  - complex mobility disturbances e.g. after brain stroke,
  - anxiety syndroms for different reasons: Anxiety disorders are a group of mental disorders characterized by significant feelings of anxiety and fear.
  - neurological or neurodegenerative disorders
- for the preconditioning and adaptation of oversensible people, i.e. people who are **extremely sensitive to influences from the external environment**
- for people suffering under psychological stress, i.e. emotional pain and pressure.

Tissue Engineering including 3D-bioprinting for the fabrication of tissues with desired features and complex organs.

Summary and Conclusions

1. There are urgent needs for the development of the Humanistic Society.
2. The Humanistic Society aims for enabling each individual to live in social harmony with the social community and to realize its own personal wishes leading to selfactualization without restrictions.
3. The Humanistic Society is in agreement with the OECD “Innovation Strategy” (published in 2010), the United Nations „2030 Agenda for Sustainable Development, with Sustainable Development Goals (SDGs)“ (adopted in 2015), and with the WHO definition of health.
4. Most of the required technologies are already available or will become available in the near future.
5. What is needed now for this challenge are creative and excellent heads which are willing to work for that transition.
6. Walls still to overcome are related with administration, strategy, social acceptance, funding programmes and educational curricula.

Some of you will think: The humanistic society is a dream. And you are right!

However:
The Engineer says:

If you have not tried to make a dream a reality, you cannot say that this is impossible!

Walt Disney said:

All your dreams can come true if you have the courage to pursue them!

Robert Kennedy said:

There are those who look at things the way they are, and I ask why . . . I dream of things that never were, and ask why not?

Thank you very much for your kind attention