Executive Summary

The digital world

The digitisation of everyday life, as well as the realms of business and industry, is well advanced. It is being driven even further by ever increasing capacity and speed in data processing and data transmission. The present Technology Outlook bears witness to this trend: half of its articles deal with future aspects of the digital world.

Interconnectedness and industry 4.0: Today's already ubiquitous digital networks, which enable electronic data collection and digital control of machines, appliances and systems, provide the ideal basis for growing interconnectedness. The term industry 4.0 (or fourth industrial revolution) covers the interlinking of industrial production with cutting-edge information and communication technologies: people, machines, systems and products communicate with and among one another. With the Internet of Things, the digital and the physical worlds merge into products and services. In this new hybrid world, Swiss businesses have a lot of catching up to do in almost all sectors. Sensor manufacturers must succeed in combining three key competences: sensor technology, smart data processing in close proximity to the sensor (smart sensors), as well as data aggregation and hosting in the cloud. Notwithstanding standardised basis technology for hardware and software, it is evident that industry 4.0 solutions must be task-specific, and that normed uniform solutions fall short of requirements. Extensive practical knowledge in this field is already available in Switzerland, as pressure on prices forced many businesses to initiate a thorough digitisation of their operations years ago, and numerous small and medium-sized businesses have been integrated as subcontractors in the networked production of large firms. However, the development of cyber-physical production systems also requires digital mastery and control of all involved processes.

Artificial intelligence: Algorithms, infrastructures, computing power and storage facilities are already advanced enough for artificial intelligence and machine learning to be put into practice. The development of networks consisting of artificial neurons based on biological models (neural networks) is revolutionising machine learning: over the past three years, enormous progress has been made especially in the field of image and speech recognition. The range of potential applications is wide: satellite imagery analysis, drones, medical imaging techniques, robotics, driverless cars… Switzerland looks back on a long tradition in the services industry. Its banks, insurance companies and touristic offers remain highly recognised for their quality and their reliability; nonetheless, these sectors will also have to contend with new digital business models.

Robotics: In order to work precisely, traditional robotic systems (industrial robots) are operated in a rigid manner and preset for a specific position. This requires closed environments, as such systems react only insufficiently to unstructured situations. Today, however, developers are coming up with flexible and smart robots, which present no safety hazard to humans and are able to work hand in hand with them – in industry, in the medical field or in the personal sphere. Service robots assist individuals at work or at home. Flying robots are proving themselves in agriculture and in search and rescue missions. These new robots must be able to perceive and understand their environment in its full complexity. Switzerland possesses the research and industrial competences required to play a leading role in this field – as witnessed by the many start-ups created in the context of its federal institutes of technology (ETH Zürich and EPFL Lausanne).

Manufacturing processes

Pulsed lasers offer new possibilities for the precision surface treatment of metal, ceramics and plastic. So far, the use of high-performance lasers for the precision machining of surfaces in the submicrometre range and for 3D printing has met with only partial success. Challenges encountered in these fields can be remedied by using novel, highly integrated systems developed based on extremely short-pulse lasers and using multiple-wavelength interferometres as measuring devices.

The continuous development of new materials and the tendency, displayed especially in the automotive and aviation industries, to replace screws and rivets with adhesives, call for new joining techniques and ***multifunctional adhesives***. Additive manufacturing is an innovative manufacturing technology that fundamentally reconfigures the entire value chain, from design to finished product. The Swiss machinery industry still operates at the worldwide cutting edge when it comes to precision mechanics – additive manufacturing is now presenting it with the opportunity to strengthen its leading position. ***Process analytical technology*** serves to analyse, control and optimise manufacturing processes in the chemical industry. It aims to improve product quality by means of standardised controls and a documentation of critical values during production.

Other technologies

Photonics combines two fields of physics: optics and electronics. Photonics originally developed out of optical communications engineering – glass fibres serving as transmission medium and laser diodes as adjustable light sources. The continued exploration of optical principles and development of optoelectronic components (photodetectors, LEDs and laser diodes) have greatly widened photonics' scope of application. Both in terms of academic research and industry applications, Switzerland holds a strong position in this field.

Biotechnology: CRISPR/Cas 9 is a disruptive molecular biological method – a form of genetic scalpel. Over the past four years, it has taken genetic engineering by storm, for it opens new possibilities in the fight against AIDS, cancer and a wide range of hereditary diseases, as well as in the cultivation of plants and the breeding of animals. However, its use in diagnostics and therapy, in agronomics, in food technology and in other fields will raise numerous technical and ethical issues.

Medical technology: The commodification of many medtech products and the growing pressure on prices have significantly hampered the attractiveness of medical technology in Switzerland. Small and medium-sized medtech companies are finding it more and more difficult to gain access to hospital procurement departments or to win large tenders. Healthcare providers are reacting to these shifts in the market with new models and services. Given its manageable size, the Swiss medtech sector should prove nimble enough to take advantage of arising opportunities.

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