Biotechnology goes automated

Processes that previously required pipetting, analysis and production to be carried out manually are increasingly now controlled by automated systems. However, this has not necessarily involved a complete reinvention of the wheel, instead automation systems used in the systems and mechanical engineering sectors are being adapted and optimised for application in the life sciences.

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Fundamentally, the biotechnology sector is just like any other sector: as far as possible, manufacturing processes are automated to produce successful products as quickly as possible, in large quantities and at the lowest possible cost. This is in line with the trend towards standardisation, i.e. the process of developing and implementing technical standards for increasing commonality of goods, processes and services. In the field of biotechnology, as elsewhere, clients attach great importance to products of consistently high quality. Product manufacturers or service providers have implemented quality management processes and certification to demonstrate compliance with relevant standards. Compliance is a legal requirement, whether a company works in accordance with GMP guidelines or DIN and ISO standards. The implementation of automation and standardisation in biotechnological research, and this is particularly the case when dealing with living cells and tissues, is more complex than for products made of inanimate matter. Although traditional automation processes are an excellent basis for biotechnological research, they need to be adapted and expanded to life sciences requirements.

Automation in the life sciences is always associated with interdisciplinary cooperation: experts from the most diverse disciplines need to maintain a constant dialogue to be able to work together successfully – engineers and technicians from the fields of systems and mechanical engineering with life sciences experts, and if the particular product under development requires, medical professionals can also become involved. Life sciences experts and medical professionals bring in the know-how on how to deal correctly with biomaterials and living systems. An example relating to the bioproduction of fine chemicals clearly shows how important this sharing of knowledge and cooperation between experts is. Large-scale industrial production can only become competitive through the implementation of automated production processes, which is however only possible with organisms that can be adapted to large-scale production. This in turn requires experts with highly specialised knowledge about the metabolism of the production organisms used and the tools that allow processes to be adapted to the industrial scale.

Understanding life sciences products

The trend towards automation affects not only the bioproduction of medicinal products and materials, but also laboratory work and analysis methods used in the field, in a GP’s practice and at the patient’s bedside. Automation has also gained ground in research laboratories, which usually deal with relatively small amounts of sample material. Modern research laboratories are increasingly making use of automated technologies, including pipetting robots and high-throughput processes for screening biologically active substances, which enable new and improved processes. To this end, automated processes are usually associated with miniaturisation. This is also the case in the field of diagnostics, where the combination of automated and miniaturised systems enables the simultaneous analysis of a broad range of different parameters with minimal consumption of materials (e.g. body liquids). Lab-on-a-chip technology has also contributed to miniaturisation and automation of test systems. Proteins, peptides and nucleic acids are immobilised in regular arrays on carriers that are barely larger than a fingernail. This makes them well suited to automated reactions and analyses.

The drug discovery process in the pharmaceutical industry, at Boehringer Ingelheim to name but one example, demonstrates the huge progress that can be achieved with automated high-throughput technologies. Prior to the high-throughput screening (HTS) era, companies were happy if they were able to analyse 100 substances per day. Modern HTS systems have a throughput of at least 10,000 samples per day; ultra HTS systems even achieve a throughput of over 100,000 samples a day, and this throughput is constantly increasing.

Despite such developments, the life sciences sector is nevertheless lagging behind the automotive sector, to name but one example. According to the German Engineering Federation (VDMA), fewer than 50 robots per 10,000 personnel are used in the medical, pharmaceutical and cosmetics industries compared to several hundred robots per 10,000 personnel in the automotive industry. There is still plenty of potential to be exploited.

ELSA shows that automation brings industry sectors together

Semi-automated processes have already become an integral part of many bioscientific research institutions and biotech companies.

In the STERN BioRegion, the "Engineering – Life Sciences – Automation" (ELSA) cluster initiative specifically promotes the cooperation between automation/mechanical/systems engineering companies and life sciences companies. ELSA therefore specifically advances automation in the life sciences. A series of events and activities have been designed to trigger cross-industry cooperation projects, including a study entitled "Biotech meets Autotech", which provides insights into the current status of cooperation and the potential of closer cooperation. The results of the study show that the two sectors – although they appear very different at first sight – have similar intentions. Both sectors cite the same factors that they believe lead to success in collaborative work: clear responsibilities, sufficient resources and common objectives. It can therefore be concluded that networks are of great importance for both sectors.

The study clearly shows that both sectors have realised the potential opportunities that could arise from jointly tapping new fields of business, and are willing to use them specifically through strategic alliances and R&D partnerships. The study has identified analytics, diagnostics and the material sciences as the top three fields in which engineering and automation companies are already working with life sciences companies. This will not change much in the near future, but will eventually be extended to biopharmaceuticals, cell- and tissue technologies and nanotechnology. The automated dosing system i-DoT developed by the Stuttgart-based Fraunhofer Institute for Production Technology and Automation IPA is an excellent example of cooperation in the field of nanotechnology.

System solutions for the biological diversity

The time factor plays a major role in the field of biotechnology: materials need to be processed and analysed within a specific time slot; intermediary and final products of a biological nature cannot be stored like metal and plastics parts. In the meantime, technical progress has led to the development of processes that enable the storage of biological material without refrigeration, to name but one example. An increasing number of platform solutions are being developed as a response to the broad range of requirements in the life sciences. Flexible solutions based on a standard infrastructure are now being developed. This standard infrastructure generally includes the basic technical equipment, IT and communication technology as well as complete control and analysis modules.

Automation has a two-fold benefit. On the one hand, processes can be made more efficient, while also being more objective. This means that the processes are qualitatively and quantitatively always the same and can therefore be assessed more easily in terms of quality management. This is a considerable advantage in cases when laboratory work has to be carried out in conformance with GMP (good manufacturing practice) standards.

On the other hand, automation affects the people who design and those who use automated processes. In the field of biotechnology, all activities require expert knowledge and hence well-trained personnel. In research and development it remains current practice that scientists not only conceive the work but also carry out the experiments themselves. This ties up physical and mental time and energy. Automation releases this time and energy for other purposes.

What is automation?

From a historical perspective, automation followed the mechanisation of work and production processes that were considerably modernised by the industrial revolution. Automation goes far beyond mechanisation as it involves not just the pure execution of tasks but also the control and regulation being taken over by artificial systems.

Inspired by the word "automatic", the term automation was coined in 1936 by D. S. Harder from General Motors. Harder defined the term as the "automatic handling of parts between each production process". It refers to the entire process that involves the use of machines, control systems etc. in order to optimise production processes in the production of goods. Modern automation systems used in biotechnology consist of made-to-measure, highly precise hardware and software components. They are employed throughout, from single steps to complete processes, including management, regulation and control. Because of the good cost-performance ratio and the flexibility, platform solutions that can be adapted to certain requirements by both manufacturer and user have become very popular.

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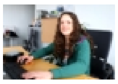

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