Preface to Special Issue "Development of Advanced Core Technology"

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1. Introduction

Shimadzu's corporate philosophy is "Contributing to Society through Science and Technology" and its management principle is "Realizing Our Wishes for the Well-being of Mankind and the Earth." It can be taken for granted that leading-edge technological development is essential to achieving these objectives and to fulfilling Shimadzu's brand statement of "Excellence in Science." The development of advanced and innovative leading-edge technologies is an impressive-sounding pursuit, but in practice is an ongoing process of refining and elevating existing technologies to an advanced level. It is also a process of taking new technological concepts, refining these concepts, and developing them into leading-edge technologies for adoption by society. Essential to this process is a steadfast commitment to innovation and building on past advances. Another important aspect of this process is being able to recognize whether a given technology has a market, will have a positive impact, or solves a problem. Unfortunately, many projects do not find a market, are abandoned and never see the light of day.

This special issue of Shimadzu Review focuses on the development of advanced core technologies and presents a selection of recent leading-edge technological developments. The articles in this special issue cover technologies developed since the last special issue on advanced core technology (February 2019) and are grouped by sector or field.

2. Healthcare Sector (Testing and Diagnosis)

AutoAmp is a fully automated real-time PCR system designed with ease-of-use in mind that meets the needs of PCR testing at small and medium-sized clinics. Many AutoAmp systems are already installed and in operation at clinics throughout Japan. AutoAmp was developed within an unprecedented time frame by fully utilizing existing core technologies, and such a process can also be considered a leading-edge technology. Plasma amyloid β assays offer a simple blood test to estimate amyloid β buildup in patients with Alzheimer's disease (AD). These assays are expected to play a useful role in the management of dementia in an aging society by monitoring drug efficacy and aiding in the diagnosis of AD. Genetic testing has become extremely popular in recent years, and the EluNA nucleic acid extraction system offers rapid and simple extraction of nucleic acids from samples for genetic testing. The EluNA system not only improves analysis throughput, it also improves test result reliability by reducing operational errors and minimizing human involvement. The BresTome TOF-PET system, designed for head and breast PET, offers high-resolution PET images that aid in early diagnosis, improving diagnostic accuracy, and pathological research. When Shimadzu sought to design a user experience (UX) for a urine volume measurement device, a significant part of development was spent in the field identifying user issues and resolving those issues to create a urine volume measurement device that is the first of its kind.

3. Healthcare Sector (Cells and Therapeutics)

The Cell Pocket cell image analysis system is a web application that offers deep learning-based image analysis and data sharing, aggregation, and management features. The Cell Pocket system resolves practical issues faced during cell research and advances digital transformation (DX). Cells cultured by conventional methods have limited practical use as they offer limited useful qualities, but HYDROX novel 3D cell culture substrate can create three-dimensional cultures with organ-like qualities that could radically expand the range of applications for cultured

cells. Biopharmaceuticals are now an immensely popular area of research and development. Shimadzu's antibody drug analysis technology for advanced immunotherapy and MultiNA-based glycan analysis technology offer effective tools for the development and evaluation of biopharmaceuticals, particularly antibody drugs, and have the potential to transform the drug development process.

4. Infrastructure, Environment, and Energy

Transportable optical lattice clocks with 18 digits of precision are aiming to supplant conventional atomic clocks and become a next-generation time standard. These clocks can be deployed as a reference in high-speed communication networks or for ultra-precise elevation measurements based on relativistic effects for monitoring crustal deformation and to prepare for natural disasters. Xspecia-based chemical state analysis technology aids in the research and development of rechargeable batteries for the coming era of carbon neutrality. While infrastructure, environment, and energy are only covered by two articles in this special issue, these areas are as important as healthcare and are expected to become more active areas of research, development, and publication.

5. New Measurement and Analysis Technology

The HuME (human metrics explorer) multi-device biometric system offers an integrated analysis of multiple physiological signals that includes novel metrics based on sensory measurements. The HuME system quantifies and visualizes human subjectivity, offering innovative evaluation metrics that can transform the product evaluation process. A cavity ring-down spectrometer for radiocarbon (^{14}C) analysis allows users to detect extremely low levels of analytes without needing a large-scale synchrotron and is aimed at pharmacokinetic applications. The Multi-omics Analysis Package that aids data analysis and interpretation also resolves practical issues in omics-based research that uses mass spectrometers. Peakintelligence, a deep learning -based peak picking software for LC-MS/MS uses deep learning to pick chromatographic peaks and calculate peak areas. Peakintelligence not only saves on labor, but reduces operational mistakes and minimizes human involvement for more reliable results.

6. Conclusions

Almost all the developments presented in this special issue came to fruition thanks to collaboration with universities, companies, and public research institutions. Furthermore, some of the innovative technologies described in this special issue have yet to see deployment in society, and collaboration with external groups and open innovation are also essential to accelerating this process. We hope this special issue will help create new opportunities for external collaboration and open innovation.