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EVERY BITE YOU TAKE

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SHIMADZU'S STATE-OF-THE-ART ANALYZERS ENSURE GLOBAL FOOD SAFETY

As a worldwide leader in the manufacture of analytical instruments, Shimadzu provides 'total support' solutions for the food safety community.

- Innovation and flexible design keeps Kratos Analytical ahead of rivals
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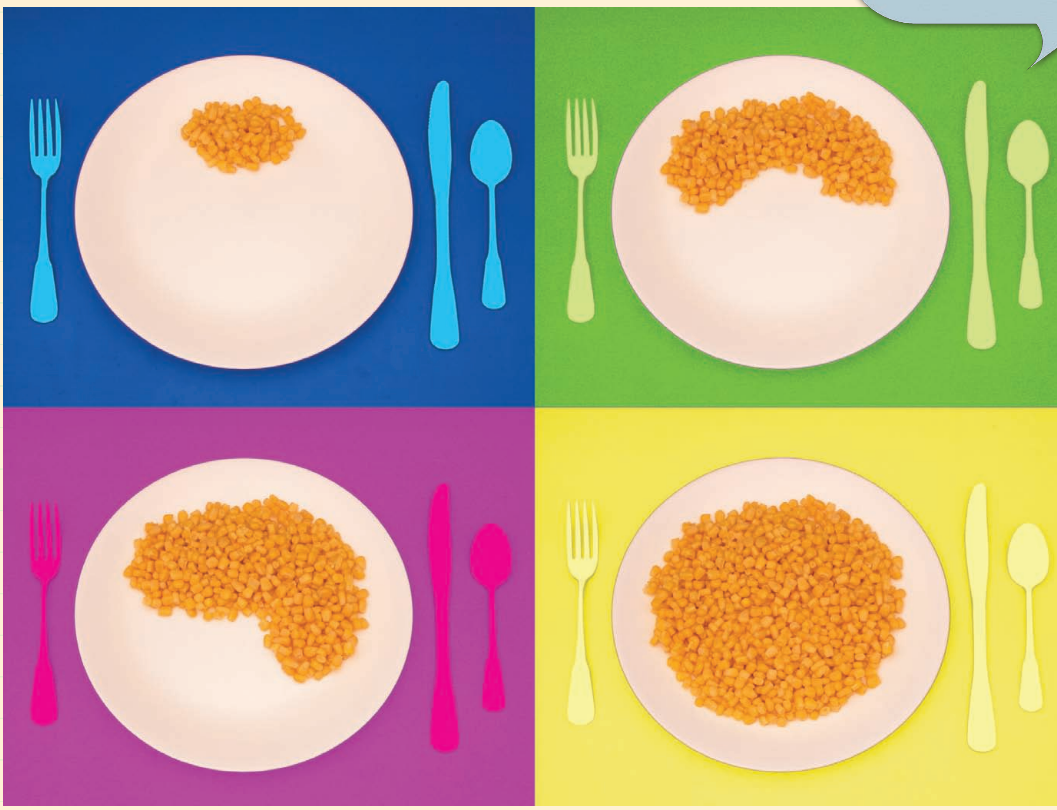

Portion truths: photos help people recall what they ate.

N. ISLAM/H. DADABHOY/BAYLOR COLLEGE OF MEDICINE

EVERY BITE YOU TAKE

If a camera snaps everything you eat, you can't lie about it later. That's why scientists are building high-tech gadgets to measure the human 'exposome'.

BY BRENDAN BORRELL

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A decade ago, as part of a study on diet, psychologist Tom Baranowski was asked to recall everything he had eaten the previous day. A chicken dinner, he said confidently, remembering that he had prepared it for himself and his wife Janice. The thing was, he hadn't made chicken that night. It was only later that he realized he'd treated himself to a hamburger.

If Baranowski, who studies children's diets at Baylor College of Medicine in Houston, Texas, was an unlikely candidate for making such a mistake, consider how abysmal the dietary memories of everyone else must be. By observing his study subjects one day and following up the next, Baranowski has found that children routinely forget about 15% of the foods they have eaten, and more than 30% of the foods they do recall turn out to be figments of their imagination. Adults show similar patterns. "The errors of dietary assessment are overwhelming," says Baranowski.

These mistakes are more than a reminder of the human memory's fallibility: they threaten to undermine the foundations of modern medical epidemiology. In this field, researchers make associations between past events and experiences, and later ones such as the emergence of cancer or other diseases. But if the initial records are inaccurate, these associations can be weak, misleading or plain wrong. Although the problem is most jarring in studies of diet, it also infects investigations of exercise, stress, pollution or smoking — basically, anything that relies on people reporting their own exposures through interviews or questionnaires. "This is the weak part of epidemiology," says Paolo Vineis, an environmental epidemiologist at Imperial College London.

Baranowski and Vineis are at the forefront of a movement among health researchers to develop measurements of environmental exposures that are more precise and objective than questionnaires. Some are working to develop personalized exposure profiles using blood–based tests. Others want their study subjects to trot around town with sensors dangling off their bodies capturing their movements, snapping photos of their lunch and taking samples of the air they breathe. "We are getting to the point where you can conceive of doing a study with 500,000 people and giving them a cellphone- sized device that they put in a charger every night," says David Balshaw, the exposurebiology programme manager at the National Institute for Environmental Health Sciences in Research Triangle Park, North Carolina.

Some researchers foresee a day when they will keep track of the entire spectrum of environmental exposures for a single individual, dubbed the 'exposome' (see 'How to measure everything'). That's a long way off. In the meantime, *Nature* takes a look at efforts to measure three key elements of the exposome: air pollutants, physical activity and diet. Each of these is bringing the exposome one step closer to reality — and the questionnaire, with all its flaws, a step closer to extinction.

BREATH BY BREATH

The contraption fitted snugly inside a child's backpack. The tangle of green plastic tubes, filters, pumps, circuit boards and a hefty battery weighed about 3 kilograms and made a low hum when it was switched on and began sucking in air. Tiny filters were designed to collect continuous records of all the grit and grime a child in the Bronx would be exposed to during their pilgrimage from their apartment, through the New York City subway system to school and back again.

For geochemist Steven Chillrud, whose team built the device in 2004, it represented the future of exposure biology. In the United States, environmental scientists have traditionally estimated human exposure to airborne pollutants by analysing data from building–mounted sensors. But the shortcomings of this approach became clear in a landmark study[1] published in 2005, in which researchers showed that levels of many hazardous compounds were higher inside homes than out. The findings made sense to Chillrud, who had already been thinking about the exposures of people living in New York City. "People do not live on buildings," he says.

To the New York City Police Department (NYPD), though, Chillrud's contraption was a potential terrorist threat. After four terrorists detonated bombs on London's public transport system on 7 July 2005, the NYPD had been conducting random searches on the subway system. When Chillrud stopped by the local police precinct to alert them to his planned study, officers were aghast, and even Chillrud admits his device looked intimidating. "We put a lot of effort into it," Chillrud says now, as he hoists it onto his desk at Columbia University's Lamont–Doherty Earth Observatory in Palisades, New York. "Then, the police shut us down." But they also offered the team a way forwards. "If we could shrink it to the size of a Walkman, we'd be back in business."

Last November, after several iterations with his collaborators, the first of Chillrud's Walkman-sized environmental sensors finally arrived. When participants in the study leave the vicinity of a 'home' beacon, the device switches between two filters, making it possible for Chillrud to distinguish between exposures at home and elsewhere; a Global Positioning System (GPS) device helps to differentiate exposures during the commute from those during the school or work day. After several days of use, the filters can be chemically analysed to identify different sources of black carbon and other chemicals. And the NYPD will be pleased: the pared-down version slips neatly into a special vest with an air inlet near the collar.

The first health studies with the contraption will be

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How to measure everything

In the 1998 film *The Truman Show*, the central character Truman Burbank gradually discovers that his entire life since conception has been broadcast through thousands of cameras hidden throughout a giant film set. Add to that surreal vision the chemical analyses of Burbank's air, food and water, samples of his gut flora, and blood tests for endocrine-disrupting chemicals, heavy metals and metabolic products, and you have some idea of the overwhelming nature of the 'exposome' — the full catalogue of a person's environmental exposures throughout their life.

The ability to draw up this catalogue could reveal which exposures contribute to developing disease in the future. But it is as technically difficult as it is conceptually overwhelming. "People may think it's so complex that it's not achievable," says Christopher Wild, head of the International Agency for Research on Cancer in Paris, a branch of the World Health Organization, who coined the term exposome in 2005.

Sensors worn on the body can record some aspects of the 'external' exposome. But "those devices are not going to contribute more than a few per cent to our understanding", says Stephen Rappaport, an environmental-health biologist at the University of California, Berkeley. That's why he and others are working on ways to record the 'internal' exposome, profiles of biological molecules that reveal the effects of diet, toxins and other exposures. Metabolites from the pesticide DDT, for instance, can be detected in blood 20–30 years after exposure. But researchers are many years from a unified approach that could profile tens of thousands of compounds and extract from this a full history of life's onslaughts. Part of the problem is that one person's metabolic response to a change in diet, say, can be completely different from another's.

For now, some investigators are combing existing exposure data for associations with specific diseases. Since 1999, for example, the Centers for Disease Control and Prevention in Atlanta, Georgia, has conducted the National Health and Nutrition Examination Survey, which includes interviews, medical examinations and biomonitoring of hundreds of chemicals in the blood. Last year, Atul Butte, a bioinformatician and paediatrician at the Stanford School of Medicine, California, used these data in an environment-wide association study to hunt for correlations between type 2 diabetes and 266 environmental factors. The biggest surprise came from the discovery that a form of vitamin E increased the risk of diabetes[5]. **B.B.**

aimed at more accurately measuring passive contact with tobacco smoke. Chillrud will be studying 50 adults and a handful of children using portable sensors and a method developed by Avrum Spira, a pulmonary specialist at the Boston University School of Medicine in Massachusetts, which uses changes in gene expression in cells brushed from the nostril to assay smoke exposure[2]. Spira believes that a more precise measure of cumulative smoke exposure can pin down the reasons why some smokers — but not all — develop lung cancer and conditions such as chronic obstructive pulmonary disease. "We are not measuring just exposure, but how you are responding to exposure," Spira says.

STEP BY STEP

Another aspect of daily exposure is charted in Kevin Patrick's maps of San Diego, California. They take a few minutes to understand. The blue Pacific lapping against the shore on the left is immediately recognizable, as is the city itself, a false-colour patchwork of highways, buildings and parkland. Finally, you begin to notice the green, yellow, orange and red dots, and it all starts to come together. The dots show an individual's heart rate at different points in time: widely spaced green dots represent the sedentary drive to work; a day at the office generates green dots layered on top of each other; and finally, a jog or bike ride along the bluffs appears as a string of heart-thumping orange and red (see 'Every step you make').

Patrick, a director of the Center for Wireless and Population Health Systems at the University of California, San Diego (UCSD), says that these maps measure physical activity more accurately than the pedometers and questionnaires he and other researchers used for years. "We realized we needed to know not only how active someone is, but where that activity occurs," he says. Such monitoring can help the researchers understand how the layout of a city — with its parks, hills and smog traps — influences physical activity and, ultimately, public health.

Patrick launched the mapping project in 2007. Called the Physical Activity Location Measurement System, or PALMS, it combines heart-rate monitors, a GPS device and acceleration sensors to record body movements in detail. More than 1,500 people have already worn the US$60 devices, after which they sit down to explain what they were doing at different points during the day. Working with computer scientists, Patrick hopes to develop a pattern recognition system to automatically distinguish different activities.

The first proposed health application of PALMS will measure physical activity among San Diego-based participants in the Hispanic Community Health Study/Study of Latinos, run by the US National Heart, Lung, and Blood Institute among other bodies. He also has plans to measure the effects of interventions, such as campaigns encouraging people to spend more time in parks than city streets.

Patrick works on another project, CitiSense, led by software engineer William Griswold, also at UCSD. This aims to measure physical activity and airborne pollutants with gadgets similar to Chillrud's. In one planned study, Patrick will give these devices to San Diego cyclists, providing them with real-time feedback on the quality of the air they breathe during bike rides. Patrick says he looks forward to the day when researchers can link up the data that he is collecting with those on social networks, psychology and genetics to understand how these factors in combination contribute to disease. "I don't think it's going to be very long before that happens," he says.

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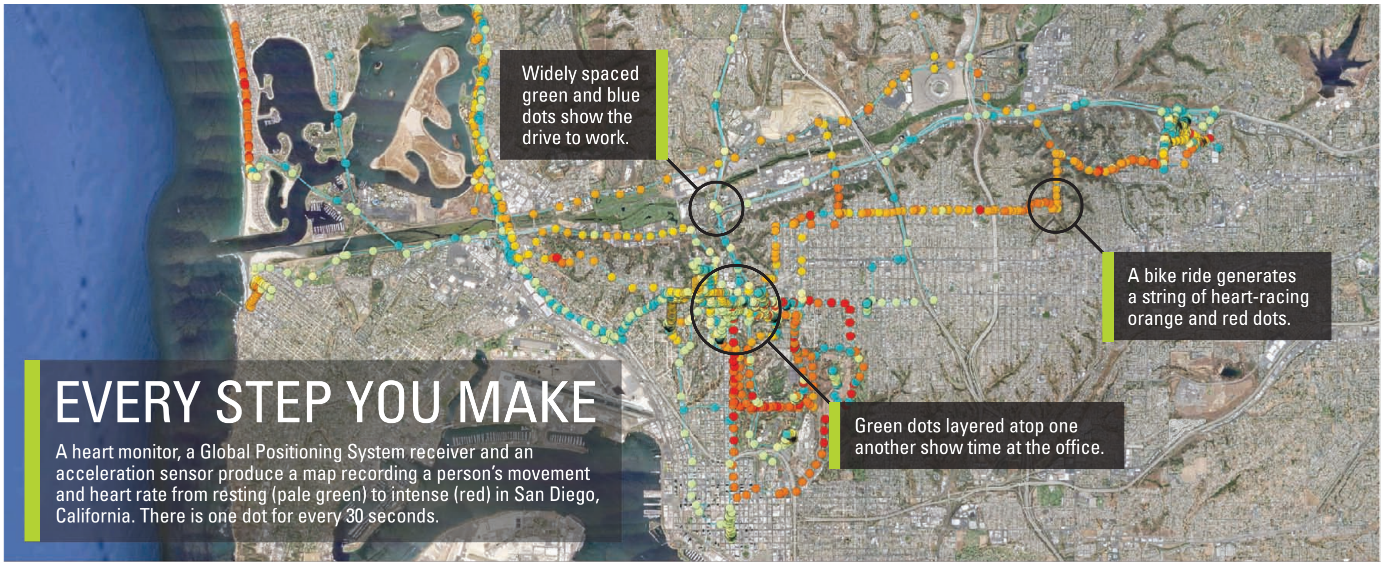

EVERY STEP YOU MAKE

A heart monitor, a Global Positioning System receiver and an acceleration sensor produce a map recording a person's movement and heart rate from resting (pale green) to intense (red) in San Diego, California. There is one dot for every 30 seconds.

GULP BY GULP

No study of human exposure will be complete without examining food. That's why, on a rainy afternoon in December, Baranowski was looking closely at a dinner plate of maize (corn) on a flat-screen monitor. In fact, it was one of eight plates of maize, identically positioned on a blue table, differing only in their portion sizes from a few spoonfuls to a few cups. "The kids' job," Baranowski says, "is to pick which size comes closest to the portion they consumed."

Over the past few years, Tom and Janice Baranowski have taken serial pictures of foods prepared in the 'metabolic' kitchen on the third floor of the Children's Nutrition Research Center, ranging from breakfast cereal to chicken nuggets to grapes, amassing some 15,000 photographs altogether. The photos are part of an effort funded by the US National Cancer Institute to improve the Baranowskis' food intake recording software, called Automated Self-Administered 24-hour Dietary Recall (ASA24), and adapt it for use by children. During trials, the photo-prompts help children estimate portion sizes of meals they ate with about 60% accuracy, Baranowski says. The goal is to build a web-based tool that other researchers can use in place of food diaries to, for instance, link up dietary habits, genetic signatures and risk of disease.

Electrical engineer Mingui Sun of the University of Pittsburgh, Philadelphia, is trying to circumvent self-reporting entirely. He has built an all-purpose exposure-biology device that hangs around the neck and contains 5–8 sensors including a GPS device, an audio recorder, accelerometer and a digital camera programmed to take 2–5 pictures a second over the course of a week[3]. Image-processing software can automatically recognize dinner plates or a glass of milk, segmenting the video stream so that meals and cooking procedures can later be reviewed by dieticians. Sun says the devices will soon be used in a pilot study estimating the caloric intake and physical activity levels of people who are obese.

Vineis, though, has taken a very different tack to measuring the dietary component of the exposome, as part of his work on the tencountry European Prospective Investigation into Cancer and Nutrition cohort. In November, his group published a proof-of-principle paper[4], in which they compared blood-plasma analyses and dietary assessments of 24 people who went on to develop colon cancer over a seven-year period, compared with 23 healthy controls. They found one biomarker — a derivative of benzoic acid produced by fibre-digesting gut bacteria — that correlated with dietary fibre intake and a reduced colon cancer risk. Vineis calls this the "meet-in-the-middle approach" to discovering biomarkers that measure exposure at the same time as showing how the exposure might foreshadow disease.

But fibre is just one of the known and unknown environmental exposures to which a human body is subjected, and colon cancer just one of its many downfalls. A comprehensive exposome is many years off — so for now, Vineis is just hoping for a better way to measure one exposure at a time. "I don't think we'll completely give up on questionnaires," he says.

Brendan Borrell *is a freelance writer based in New York.*

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ENSURE GLOBAL FOOD SAFETY

SHIMADZU'S STATE-OF-THE-ART ANALYZERS

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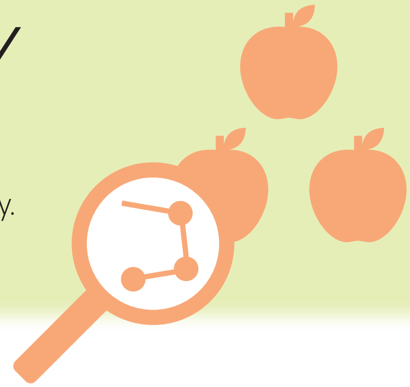

Speakers at the Shimadzu Global Technology Forum on Food Safety 2011

With the increasing demand by consumers for higher standards of food safety and quality, new technologies are rapidly being developed to improve food monitoring and analysis. These demands have prompted the introduction of increasingly strict standards worldwide from bodies such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO) of the United Nations, as well as local regulatory authorities. To meet these new standards, there is a corresponding demand for accurate analytical equipment that ensures the safety of food products.

In recognition of the need to enhance innovation and awareness of food safety issues, Shimadzu hosted the ‘Global Technology Forum on Food Safety 2011’ in Singapore on 9–11 November 2011. Focusing on the theme of ‘Strategies for Effective Regulation in Food Safety’, this event not only presented the latest cutting-edge research in food safety, but also promoted international collaboration and networking opportunities between researchers, corporations and governmental organizations. In this collection, key representatives and opinion leaders at the Forum share their knowledge about the latest trends and developments in food safety.

Prerequisite program: Traceability and advancement in automated analysis generate interest in the field of food safety

Goichiro Yukawa

Head
Department of Technical Services
Japan Food Research Laboratories

Goichiro Yukawa heads the Department of Technical Services at Japan Food Research Laboratories, one of the country’s premier food analysis laboratories. The major activities undertaken by the Department of Technical Services include consultancy on hazard analysis and critical control points (HACCP) and food labeling, as well as examining international standards for food production and safety, which include standards set by the International Organization for Standardization (ISO). According to Yukawa, current emerging trends in food safety management include the increasing attention to prerequisite programs, traceability issues and IT-food labeling practices.

[1] Prerequisite programs

Prerequisite programs provide a foundation for sound manufacturing practices which, in the case of the food industry, include hand-washing, cleaning, sterilization and disinfection of the workspace. Guidelines for prerequisite programs have been drawn up by the Codex Alimentarius Commission,

Top-class equipment that ensures food safety and protects consumer health

Shimadzu has developed a suite of state-of-the-art equipment that assures the best standards of food safety and quality. The Shimadzu range of first-rate products feature incredible accuracy, analytical speed, and have the ability to assess a vast number of ingredients, and are leading the world in cutting-edge food safety technology. Equipped with diverse applications, Shimadzu products can be used in the analysis of residual pesticides, food additives, toxic metals, fungal toxins, antimicrobials for meat, and animal drugs such as antibiotics and hormone preparations for the testing of foreign substances; the prevention of packaging defects, and genetic testing to detect the misrepresentation of the region of origin. Shimadzu is proud of its world-class range of products which provide effective solutions to a wide variety of customers.

Launched in 2010 and made in Japan, the LC-MS/MS system is Shimadzu's flagship product. In 2011, company collaborated with the world's leading amino acid manufacturer in Japan and launched a high-throughput amino-acid analyzer system, the UF-Amino Station, which holds a unique position in the market. Shimadzu is looking to expand its line-up of food safety products in the future.

Shimadzu is also making active efforts to apply its long-accumulated technology and experience in industrial physical property testing to analyze texture, including hardness that determines palatability and crunchiness.

Shimadzu now aims to be a key provider of food engineering solutions, with a focus on the functionality of food products, and plans to explore enhanced functionality through the altering of the taste and smell of food products, and tailoring food requirements for specific consumers, such as foods which elderly people can eat safely. With consumer health in mind, Shimadzu aspires to expand its products into the research fields of biology and medicine.

LCMS-8030 Triple Quadrupole Mass Spectrometer

established jointly by the FAO and WHO. In Japan, food companies and other food-related companies are required to comply with these guidelines under the *Food Sanitation Act*.

In 2009, the prerequisite program drew additional attention after the ISO published a technical specification, ISO 22002-1:2009 'Prerequisite programs on food safety — Part 1: Food manufacturing'. The new specification was designed to complement ISO 22000:2005 'Food safety management systems — requirements for any organization in the food chain', an international standard for food safety management systems issued in 2005.

Yukawa explains: "Food safety textbooks of the 1970s only listed and described individual hazards, such as pesticides, heavy metals, additives and microbes. The '80s saw the spread of the concept of process management, which was designed to ensure safety through the management of various processes in food manufacturing. Then, in the '90s, HACCP-based management became popular, with the prerequisite program treated as incidental to HACCP. However, in the 2000s, the ISO not only standardized HACCP in ISO22000, but also issued ISO 22002-1 for the prerequisite program. With these new standards, people finally began to understand that food safety would be achieved only if the prerequisite program was properly implemented. Analytical laboratories are responding to these new developments by simplifying and speeding up those tests that are used to validate bacteriological testing and other systems."

[2] Traceability

Traceability — the ability to track and trace food from the raw materials stage to production and distribution — has become an important means of identifying genetically modified foods and organic produce since the 1990s. In the aftermath of the accident at the Fukushima nuclear power plant in March 2011, traceability became an urgent issue due to the heightened concerns about possible contamination by radioactive substances. "Countermeasures for reducing radioactive contamination are a matter of great concern not only for regulatory authorities but also for the food distribution industry in Japan and abroad," says Yukawa. "Now, we also need traceability of agricultural production materials, including compost and fertilizer." Under new safety standards that will take effect in Japan in April 2012, general food products will be allowed to contain a maximum of 100 becquerels of cesium per kilogram (Bq/kg), both infant food and milk will have an upper limit of 50 Bq/kg, and drinking water a maximum of 10 Bq/kg. Efforts are underway to establish methods of reliably detecting low-level radioactive materials and ways of ensuring traceability up to the raw material production stage.

[3] IT-linked food labeling

Some observers suggest that the items in food labeling tend to increase in number as food-safety standards intensify and the need for traceability becomes increasingly important. However, food labeling is becoming harder to read because of excessive information on the label. Yukawa notes: "Now, the Japanese Consumer Affairs Agency is discussing to radically revamp the current food labeling program. And the issues being discussed include reorganization of diverse food labeling items and new information services for consumers via the Internet and by other means not relying on directly displaying information on the label. For example, a combination of a smart phone and a barcode reading app could provide information to consumers at anytime, anywhere. Discussion is also

The Shimadzu High-Speed HPLC Prominence UFLC
at Japan Food Research Laboratories Tama Laboratory

underway for mandatory nutrition information labeling."

In response to the above developments, analytical laboratories for food ingredients are feeling a need to provide accurate information as promptly as possible more keener than ever before.

Rapid analysis is the key to better food safety testing

Jose M. Rodriguez

Director, Petroleum Products Division
Director, Chemical Regulatory Division
Assistant Research Professor
Adjunct Chemistry Professor

Mississippi State University
Mississippi State Chemical Lab

In recent years, the most significant change to take place in the field of food safety testing in the US is the way in which scientists have become proactive rather than reactive. Faced with such rising challenges as bioterrorism and the expanding use of drugs in animal feeds, scientists need to think ahead. "Scientists can no longer wait for threats or accidents to happen before they get involved," says Jose Rodriguez, Director of Mississippi State Chemical Laboratory. "And with the ongoing globalization of the food chain, the work of protecting consumers is becoming ever more challenging."

In addition, Rodriguez lists other areas of concern including residual pesticides and herbicides in agricultural produce; the range of additives used in foods such as sweeteners, colorings, antioxidants and preservatives; the effects on humans of antibiotics injected into animals to enhance productivity; and the need to quickly detect the source of harmful bacteria, like salmonella, that are responsible for outbreaks of food poisoning. Rodriguez points out that despite these mounting concerns, only 2 percent of foods imported into the US are currently inspected, while just 15 percent of home-grown foods are analyzed.

Threats to food safety can also arise from human error. In April 2010, the Deepwater Horizon oil spill in the Gulf of Mexico turned into the largest accidental marine oil spill in history. The resulting oil slick covered 2,500 square miles and had a devastating impact on the Mississippi marine life that supports a seafood industry contributing $450 million to the state's economy. Rodriguez and his colleagues were called on to test fish, shrimp and oysters for contamination from harmful oil compounds and chemical dispersants. "We conducted extensive research to make sure these seafoods were fit for human consumption," says Rodriguez. "It helped that we were able to use the Shimadzu GCxGC-MS gas chromatograph with its fast scanning mass-spectrometer. It is like having two gas chromatographs in one because it enables two-dimensional separation of compounds, which makes for a very quick analytical technique."

In using this equipment, Rodriguez estimates sample analysis time has typically been reduced from a day to about one hour. He adds that they will likely continue using the equipment to monitor the situation in the gulf for the next two years. But given fewer samples require testing as the threat of oil and surfactant contamination recedes, he says they have begun looking at ways to extend the use of the GCxGC-MS by developing methods to analyze foods for other kinds of contaminants.

"The key to being proactive is to be able to analyze foods fast," says Rodriquez. "So we're working closely with instrument manufacturers like Shimadzu to quickly figure out more efficient ways to better analyze contaminants in food."

Cutting-edge liquid chromatography equipment underpins food safety

Naoki Mochizuki

Senior Officer
General Manager
Research Laboratories
for Food Safety Chemistry
Asahi Group Holdings, Ltd.

The Research Laboratories for Food Safety Chemistry of Asahi Group Holdings, Ltd. is one of Japan's leading food safety laboratories encompassing food safety for its entire group operations, including Asahi Beer and Asahi Soft Drinks. "These laboratories was established to fulfill the need for one organization responsible for food safety research covering an entire series of processes from raw materials to final products, and came about in response to heightened consumer interest in food safety and a tightening up of global food safety standards," explains Mochizuki, head of the Research Laboratories. His laboratories are different from the business units in charge of quality assurance which are usually set up within leading food manufacturers. Mochizuki's laboratories instead independently carry out research activities while collaborating with the quality assurance department of each group operation. The key research areas of the laboratories include the development of chemical analysis methods for trace amounts of risk substances in food, including residual pesticides, and residual animal drug and fungal toxins. "Beer brewing companies employ many experts in microbiology and fermentation technology. In our laboratory, we have a group of researchers with diverse scientific backgrounds, including pharmacology, chemistry and engineering," Mochizuki explains.

"Development of a new analytical method is a thrilling part of our research. We are trying to develop more efficient analytical methods that take into consideration any anticipated change in relevant standards. For example, we have developed an analytical system capable of testing 300 different ingredients of pesticide at once in order to ensure compliance with the positive list system for residual pesticides, in which the number of covered ingredients is increasing every year. If there are new concerns such as an accident, we will be required to promptly build a new analytical system and carry out a fact-finding survey."

Another important role of the laboratories is to enable the Asahi group companies to deal proactively with manufacturers and trading companies within Japan and from abroad by testing their submitted raw materials, and performing sampling inspections. Mochizuki's laboratories will also answer internal enquiries concerning safety standards and monitor safety control management in the production process.

The Asahi research laboratories are cultivating an international profile in food safety issues through submissions to international journals and overseas conference presentations. "Through these activities, we can attract the attention of the global market and collect information. Moreover, we are now having active technical discussions with government-affiliated research institutions, and we have more opportunities to take part in the establishment of official methods. These activities are effectively linked with increasing the motivation of our researchers who, as they accumulate experience, become part of our growing roster of 'pilots' who are able to use our newest equipment to manage various situations," explains Mochizuki.

"We initiated the high-performance liquid chromatograph-mass spectrometer (LC-MS/MS system) in the late 1990s, in response to the finding of trace substances in food, including carcinogens, residual pesticides and endocrine-disrupting chemicals generated by food processing, which came into the spotlight in the late 1990s. The LC-MS/MS system was introduced to quickly address this risk, and at that time we required a unit of analytical measurement equipment with the highest possible sensitivity. The LC-MS/MS system was both highly selective and highly sensitive, and it was capable of increasing the limit of detection. After the introduction of the system, we were able to more rapidly check the safety of our products at high levels." Currently, 10 units of the LC-MS/MS system are in operation.

"We are using Shimadzu's Ultra High-Performance Liquid Chromatograph (UHPLC) Nexera, which is capable of performing high-throughput analysis at a speed 10 times the previous method by applying pressure to the HPLC column at about five times the normal level. The chromatograph shows a high degree of separation and is easy to use. Because development of a new measurement method requires repeated trials, the shorter analysis time achieved by Nexera is very helpful. Nexera not only increases the speed of routine analysis, but also accelerates the study of analytical conditions in the event of a food risk incident that needs to be dealt with quickly," Mochizuki says.

'Carry-over' is the phenomenon of detecting trace amounts of any component left behind after the previous analysis, and is likely to occur in the analysis of ultratrace components. Mochizuki also appreciates Nexera's ability to enable accurate analysis while preventing carryover due to its installed washing equipment and the inner-surface treatment of materials within the equipment.

The Research Laboratories for Food Safety Chemistry and Shimadzu often collaborate in the development of new analytical applications. "In a growing number of recent research projects, we have investigated changes in at-risk food ingredients during the manufacturing process from raw material to finished product. In such research, we need to be able to perform more advanced analyses, and Shimadzu product has been a big help to us in this respect," Mochizuki says.

Innovation and flexible design keeps Kratos Analytical ahead of rivals

Vertically integrated UK enterprise is unique among Shimadzu group companies.

When asked to account for Kratos Analytical's consistent leadership in the high-performance analytical instrument market over the years, Kozo Shimazu, the company's managing director, points to the strong foundation of integrated design, manufacturing and marketing operations Kratos is built on. Outside of Japan, this makes the wholly owned Manchester, UK-based enterprise special among all of Shimadzu Corporation's 44 group companies, he notes.

Kratos supplies two major lines of scientific analytical equipment. X-ray photoelectron spectrometers (XPS) are used in the chemical analysis of the surfaces of a broad range of materials. This nano-analysis can lead to the production of new products such as non-iron fabrics, self-cleaning glass and organic photovoltaic materials employed in the construction of solar cells. Kratos launched one of the first commercial XPS systems in 1969, soon after Kai Manne Borje Siegbahn developed this method of spectroscopy. Since then Kratos has been at the forefront of XPS innovation and its application in various fields. Siegbahn was awarded the Nobel Prize for developing the technology in 1981, following in the footsteps of his father, Karl Manne Georg Siegbahn, who was also awarded the Nobel Prize for his research and discoveries in the field of X-ray spectroscopy in 1924. The second business division produces matrix-assisted laser desorption/ionization or MALDI mass spectrometers used in the analysis of biological macromolecules such as proteins, and glycan are widely used in such fields as the biotech industry. This technology is based on work conducted in the late 1980s by Shimadzu researcher Koichi Tanaka, for which he received the Nobel Prize for Chemistry in 2002. Between 1992 and 2002, Tanaka spent a total of 6 years in the UK working with Kratos to help develop some of the company's MALDI products.

To maintain its leading position in the market, Kratos devotes around 25 percent of the company's manpower to research and development of XPS and MALDI products. "At any one time we have several major instrumentation developments in progress," says Simon Page, R&D manager of surface analysis technology.

Emphasis on R&D has helped Kratos earn a reputation as a technology innovator. "We were the first company to introduce XPS equipment employing magnetic lenses and automated charged compensation systems," says Chris Blomfield, business manager of the surface analysis group. "Our latest AXIS-ULTRA DLD model uses a spherical mirror analyzer, which enables high energy and spatial resolution parallel imaging, a unique capability that enhances performance."

Such advanced features explain why the AXIS-ULTRA system has captured around 50 percent of the worldwide market in the imaging and small spot XPS segment over the last six years and has sold over 250 units, says Blomfield. In particular, he attributes this success to the system's high degree of analytical sensitivity and imaging resolution, as well as the flexibility inherent in the design. "It's this flexibility," he emphasises, "that allows customers in research environments to customize the system to meet their exact needs."

The current best selling product in the MALDI division is the AXIMA Assurance (also adapted and commercialized by bioMérieux as the VITEK®-MS). "This product currently has around 60 percent of new installs in the MALDI market for microbial identification," says Ian Brookhouse, the MALDI business manager for Kratos. "Customers especially appreciate its simple operation." He points out that much of the data acquisition and analysis is automated by the system, and this can result in identification of a microbe in a culture sample, for instance, in as little as ten minutes, rather than the 24 hours required using traditional techniques.

Despite the ongoing global economic downturn most regions are experiencing, sales of Kratos equipment is increasing, particularly in the BRIC economies, including China and Brazil. "Thanks to the unique features and high specs of our XPS and MALDI instruments, sales are climbing, says Shimazu."

Shimazu notes that since Shimadzu Corporation acquired Kratos in 1989, the two companies have formed a strong bond. Kratos has contributed much to the parent company's biotech unit established in 2001, while Shimadzu Corp. has helped improve manufacturing at Kratos by introducing such Japanese knowhow as the kanban scheduling system that tells Kratos what and when to produce and how much to produce.

"I've also introduced a company slogan, Speed with Accuracy," says Shimazu. "This is working on a number of levels, and we're seeing more efficient research and development and an improvement in production and reduction in manufacturing lead time. Looking ahead, then, the future appears bright indeed."

Kozo Shimazu
Managing Director

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News & Topics from Shimadzu

Release of X-Ray Diagnostic System Equipped with a Large Portable Flat Panel Detector (FPD) for Improved Operational Efficiency and Extensive Dose Exposure Reduction Features

The new FLEXAVISION F3 system features a large portable FPD unit. The vertical and horizontal orientation of this FPD can be changed prior to radiography, making it possible to accommodate a wide range of examinations, including esophagus, thoracic, orthopedic, and urinary organ exams, all with a single system. In addition, a variety of features have been added to reduce dose exposure, an important concern in the pediatric and gynecological fields.

Release of the TOC-4200 On-line Total Organic Carbon Analyzer, the Ideal Instrument for Monitoring Water Quality, Such as Upstream Factory Effluent Tap Water, and Environmental Water

The new TOC-4200 can be connected to remote monitoring network systems via the Modbus communications protocol. By adding options, the TOC-4200 can have further functions, including a web-based monitoring feature that enables monitoring the instrument remotely from a computer in a separate location. It can also measure a wide range of samples, including recovered pure water for semiconductor manufacture, tap water, and underground water, and can even accommodate non-TOC measurement methods.

The BRANSIST alexa features a flat panel detector(FPD) with a field of view able to cover the entire body to support cardiovascular and angiographic procedures, including examinations of the lower extremities

Realtime high-speed image processing ensures excellent image quality, while reducing the exposure dose to the patient. The total system design eliminates stress on the staff performing interventions. The BRANSIST alexa is the optimal multipurpose system that meets all today's requirements to provide total support for advanced catheterization procedures.

System to Optimize Searching for and Reviewing Analytical Conditions for Liquid Chromatograph

The Nexera Method Scouting System automatically switches between various analytical columns and mobile phase solvents to enable identifying the optimal combination for analytical objectives. This system makes it possible to reduce the time required to repeatedly examine analytical conditions, particularly for the separation of impurities in pharmaceuticals, to about 1/9th that of conventional methods.

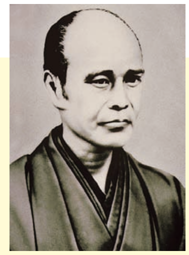
Establishment of an Analytical & Measuring Instrument Sales Company in the Republic of South Africa

As part of its efforts to promote globalization and to enhance the sales and service structure in southern African markets, Shimadzu Corporation established a sales subsidiary, Shimadzu South Africa (Pty) Limited, on October 1, 2011 in the Republic of South Africa, which boasts Africa's largest economy.

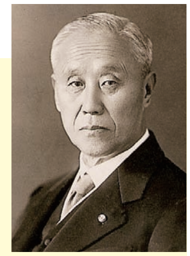
Joint Research Agreement Signed with Shimane University for Neonatal Mass Screening

To increase the number of diseases being discovered by neonatal mass screening, Shimadzu has signed a joint research agreement with Shimane University in Japan regarding tandem mass spectrometry, which is currently the focus of world attention as a new examination method for hereditary metabolic disorders. Using its mass spectrometry technology, Shimadzu will contribute to the development of methods and application software that enable the rapid and accurate examination of large-scale samples (on the order of tens of thousands), without burdening researchers.

Genzo Shimadzu, Sr. and Genzo Shimadzu, Jr. founders of Shimadzu Corporation were selected by the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy (Pittcon) and the Chemical Heritage Foundation (CHF) to receive the 2012 Pittcon Heritage Award.



Genzo Shimadzu, Sr.
(1839 – 1894)



Genzo Shimadzu, Jr.
(1869 – 1951)

2012 Winners: Genzo Shimadzu, Sr. and Genzo Shimadzu, Jr.

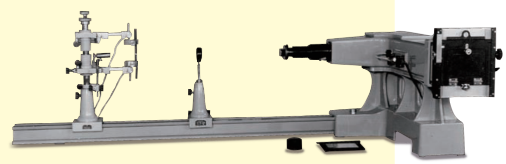
[About the Awardees]

Japan's rapid modernization in the second half of the nineteenth century was made possible by such people of vision such as Genzo Shimadzu, Sr. and Genzo Shimadzu, Jr. Genzo Shimadzu, Sr., began his career as a maker of Buddhist altars, but Japan's growing interest in Western technology after 1868 opened his eyes to new opportunities. Through the Physics and Chemistry Research Institute in Kyoto, Shimadzu eagerly and quickly absorbed knowledge about new technologies. In 1875 he began to manufacture scientific equipment such as distillation devices, evacuation apparatus, Atwood's machines, and even medical equipment — supplying them to Japanese schools. As his business grew, so did his reputation. In time he was invited to teach in the metal-working department of the Kyoto Prefecture Normal School.

Genzo Shimadzu, Jr., had grown up in the business his father created. (With his younger brothers, Genkichi and Tsunesaburo, he took the Shimadzu business into new areas.) In 1895 he created a department for science specimens. In 1897 the company launched the manufacture of storage batteries, a technology of particular importance for Japan. Shimadzu made a number of contributions in this area: most notably, he developed a revolutionary method for manufacturing high-quality reactive lead powder, an essential ingredient for storage batteries.

In 1909 Shimadzu Corporation built its first medical X-ray machine, which was also the first produced in Japan. The power source was a Shimadzu storage battery.

He continued to develop new devices throughout his life. By his death in 1951 he had registered about 180 inventions in twelve countries. During his lifetime Shimadzu Corporation became an innovative force, providing researchers with many tools for discovery, ranging from balances to spectrographs to industrial X-ray equipment.



Japan's First Glass Spectrograph (1934)

Educational
X-Ray Apparatus

[About the Pittcon Heritage Award]

The Pittcon Heritage Award is jointly sponsored by the Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy (Pittcon) and the Chemical Heritage Foundation (CHF). This award recognizes outstanding individuals whose entrepreneurial careers shaped the instrumentation and laboratory supplies community, inspired achievement, promoted public understanding of the modern instrumentation sciences, and highlighted the role of analytical chemistry in world economies.

Learn more

http://www.shimadzu.com/an

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