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ANTIKYTHERA WHEEL

This largest surviving piece of the mechanism contains some of its internal workings, including one of the major gearwheels and several smaller gears that have been crushed underneath.

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MECHANICAL INSPIRATION

The ancient Greeks' vision of a geometrical Universe seemed to come out of nowhere. Could their inspiration have been the internal gearing of an ancient mechanism? ***By Jo Marchant***

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Two thousand years ago, a Greek mechanic set out to build a machine that would model the workings of the known Universe. The result was a complex clockwork mechanism that displayed the motions of the Sun, Moon and planets on precisely marked dials. By turning a handle, the creator could watch his tiny celestial bodies trace their undulating paths through the sky.

The mechanic's name is now lost. But his machine, dubbed the Antikythera mechanism, is by far the most technologically sophisticated artefact that survives from antiquity. Since a reconstruction of the device hit the headlines in 2006, it has revolutionized ideas about the technology of the ancient world, and has captured the public imagination as the apparent pinnacle of Greek scientific achievement.

Now, however, scientists delving into the astronomical theories encoded in this quintessentially Greek device have concluded that they are not Greek at all, but Babylonian — an empire predating this era by centuries. This finding is forcing historians to rethink a crucial period in the development of astronomy. It may well be that geared devices such as the Antikythera mechanism did not model the Greeks' geometric view of the cosmos after all. They inspired it.

The remains of the Antikythera mechanism were salvaged from a shipwreck in 1901 (see 'Celestial mirror from the deep') and are now held in the National Archaeological Museum in Athens. A series of ever more sophisticated radiographic studies of the gearwheels hidden inside the corroded mass culminated in proposed reconstructions of the device from a team led by astronomer Mike Edmunds of the University of Cardiff, UK, in 2006[1], and from London-based mechanic and curator Michael Wright in 2007[2].

The device, which dates from the second or early first century bc, was enclosed in a wooden box roughly 30 centimetres high by 20 centimetres wide, contained more than 30 bronze gearwheels and was covered with Greek inscriptions. On the front was a large circular dial with two concentric scales. One, inscribed with names of the months, was divided into the 365 days of the year; the other, divided into 360 degrees, was marked with the 12 signs of the zodiac.

Pointers moving around this dial were thought to show the date as well as the corresponding position of the Sun, Moon and probably the five planets known at the time. A revolving ball, painted half black and half silver, displayed the phase of the Moon, and letters marked on the zodiac scale acted as a kind of index, linking to inscriptions that described the appearances and disappearances of major stars at different times of the year.

On the back of the device were two spiral dials, one above the other. The top one showed a repeating 235-month calendar, popular because after 235 months or 19 years, the distribution of new Moons in the solar year is the same. The bottom spiral represented a 223-month repeating eclipse cycle. Symbols inscribed on its month divisions told the user when to expect eclipses, and gave information about the type and timing of each event.

The researchers who did the 2006 reconstruction noted that the 235- and 223-month cycles were originally derived by the Babylonians. That was to be expected: the empire's priest-astronomers, who saw astronomical events as powerful omens, had identified many such cycles over the centuries, and Greek astronomers of this period often made use of their results.

But this fact did not shake the researchers' central conclusion that the device embodied the Greeks' own geometrical models of the cosmos. These models, based on spheres or circles that described the motion of the planets in three-dimensional space, had originally been qualitative and philosophically pleasing rather than accurate. But by the time of the Antikythera mechanism's construction, scholars such as Hipparchus, who worked in Rhodes in the second century bc, had been inspired by the Babylonians' precision to put numbers into the Greek models, and to insist that they fit with actual observations. Modern experts were confident that the device's zodiac display — its centrepiece — reflected such state-of-the-art geometrical theories.

Supporting this idea were X-ray scans revealing that a mechanism hidden within the device's clockwork directly modelled the varying motion of the Moon. Because the Moon's orbit around Earth is elliptical rather than circular, it seems to travel faster at some points in its orbit than others. Greek philosophers believed that all heavenly orbits were perfect circles, so Hipparchus explained this variation in the Moon's motion by superimposing one circular orbit onto another that had a different centre — the 'eccentric' theory.

MISSING GEARS

The gearwork in the Antikythera mechanism seems to put this into practice perfectly, using a pin-and-slot mechanism that enabled one gearwheel to drive another around a slightly displaced axis. In their 2006 *Nature* paper[1], Edmunds and his colleagues described it as "a mechanical realization" of Hipparchus' lunar theory. The team and other scholars assumed that the maker of the Antikythera mechanism must have used similar techniques to model the path of the Sun and probably the planets, too. The relevant gearing is missing, but the assumption is plausible: Greek astronomers accounted for the movement of planets — which not only seem to speed up and slow down in the sky, but sometimes change direction — using a theory that was mathematically equivalent to the eccentric model. The basic idea, which would be refined and made famous by the Greek astronomer Ptolemy in the second century AD, was that each planet travelled in a small circle called an epicycle, whose centre was simultaneously moving in a larger loop around Earth.

To demonstrate how the Antikythera mechanism could have operated, Wright built a working model of it. His device incorporates small gear wheels riding on larger ones to model the epicycles of Mercury, Venus, Mars, Jupiter and Saturn, as well as the varying speed of the Sun. The Antikythera mechanism thus seemed to be a stunning demonstration of how the ancient Greeks had translated their most famous astronomical theory into physical wheels of bronze.

But now a new team has noticed a detail that could turn this view of the mechanism on its head. Historian of astronomy James Evans at the University of Puget Sound in Tacoma, Washington, and his colleagues knew that the 360 divisions on the zodiac scale should be spaced slightly farther apart than the 365 divisions on the calendar scale that encircled it. But when they used X-ray scans provided by Edmunds' team to precisely measure the division widths on the surviving part of the dial, which encompasses 88 degrees, they found that the zodiac marks are actually closer together[3]. The marks on the vanished parts of the scale must have compensated somehow with a wider spacing.

The researchers believe that this was done on purpose to represent the Sun's uneven progress through the sky. Instead of the device using epicyclic gearing to drive a pointer with varying speed as previously thought, Evans believes it is "extremely likely" that its maker used a pointer moving with constant speed around a circle split into two sections of equal overall size that were divided differently: a 'fast zone' in which the degree markings were closer together than normal, and a 'slow zone' in which they were farther apart. This scheme is identical to a theory of the Sun's movement used by the Babylonians, known as System A.

If correct, this interpretation suggests that the astronomy encoded in the mechanism's gearwork does not represent state-of-theart Greek theories after all. It is Babylonian through and through.

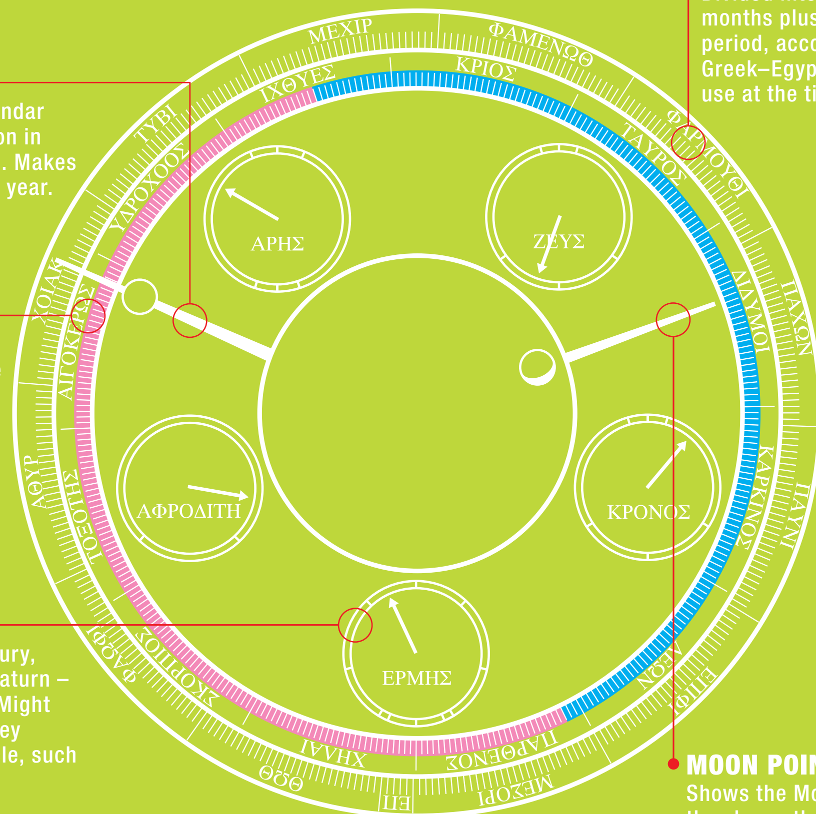
This is a tough assertion to prove. The uneven division of the zodiac scale could have been just the result of sloppy work by the machine's creator, and its similarity to the Babylonian scheme just a coincidence. Wright, who was the first to suggest that epicyclic gearing modelled the motions of the Sun and planets, says he is "very uncomfortable" with the idea that the device modelled the Moon's motion mechanically, yet used an abstract numerical scheme to do the same for the Sun.

But astronomy historian Alexander Jones of the Institute for the Study of the Ancient World in New York is taking the hypothesis seriously. He argues that Greek astronomers were more interested in convenience than consistency. Such an intimate mix of geometric and arithmetic approaches fits the spirit of the period, he says. "They were playing with different toolboxes at the same time."

A. THORNDIKE & J. EVANS

CROSS-CULTURAL COMPUTER

The latest reconstruction of the Antikythera mechanism suggests that its front display relied on Babylonian theories describing the Sun, Moon and planets.



CALENDAR SCALE
Represents a 365-day year. Divided into twelve 30-day months plus a 5-day extra period, according to Greek–Egyptian calendar in use at the time.

SUN POINTER
Shows the date on the calendar scale, and the Sun's position in the sky on the zodiac scale. Makes one complete turn for each year.

ZODIAC SCALE
360-degree dial divided into the twelve signs of the zodiac. Split into a 'fast' zone (red) with slightly narrower divisions and a 'slow' zone (blue) with slightly wider divisions to represent the varying apparent speed of the Sun.

PLANETARY DIALS
Five known planets – Mercury, Venus, Mars, Jupiter and Saturn – shown by individual dials. Might have shown the timing of key events in each planet's cycle, such as changes in direction.

MOON POINTER
Shows the Moon's position in the sky on the zodiac scale. The revolving black-and-white ball shows its phase.

KEY EVENTS

Evans's hypothesis forces a rethink of other parts of the mechanism, too. Previously, scholars assumed that the positions of the Sun, Moon and planets were all displayed around the same zodiac scale. But if the zodiac scale had been tweaked to accommodate the varying speed of the Sun, it would no longer be accurate for showing the positions of the other bodies.

Evans thinks that the five planets were instead displayed on individual smaller dials (see 'Cross-cultural computer'). He adds that these dials didn't necessarily have to show the planets' positions in the sky. He thinks the machine's maker would have been more interested in showing the timing of key events in each planet's cycle, such as changes of direction, or first and last appearance in the night sky. If so, the pointers on these dials could have been driven at constant speed by simple gear trains representing period relations derived by the Babylonians — no epicycles required.

Jones is more cautious about this suggestion, although he says it "makes sense in terms of how planetary motion was talked about at the time". Both he and Evans are hoping that more clues will come from inscriptions on the front cover of the mechanism. The surviving lettering is hidden inside the mechanism's battered and corroded remains, but it is being painstakingly reconstructed and translated from X-ray scans by Agamemnon Tselikas, director of the Centre for History and Palaeography in Athens, and Yanis Bitsakis, a physicist at the University of Athens. So far the two researchers have deciphered mentions of Mars, Mercury and Venus, along with several references to the 'stationary points' at which planets seem to change direction.

Evans argues that even the clearly epicyclic gearing of the Moon display may model Babylonian arithmetic, not Greek geometry. The amplitude of the variation encoded by the pin-and-slot mechanism is larger than that used by Hipparchus in his eccentric model, he points out, and is closer to the amplitude used in the lunar algorithms of the Babylonians. "Perhaps a mechanic tried to represent the variations in the Moon's speed according to the Babylonian theory using gears," he says — and hit upon an epicyclic arrangement.

In other words, epicycles were not a philosophical innovation but a mechanical one. Once Greek astronomers realized how well epicyclic gearing in devices such as the Antikythera mechanism replicated the cyclic variations of

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CELESTIAL MIRROR FROM THE DEEP

Where did the Antikythera mechanism come from?

In 1900, when a crew of Mediterranean sponge divers took shelter from a storm by the tiny island of Antikythera (see inset map), they found an ancient wreck full of statues, jewellery, weapons, furniture and other treasure — including an odd-looking clockwork device: the Antikythera mechanism.

Scholars have been trying to reconstruct its story ever since. Studies of the wreck suggest that the vessel was Roman and had sailed from the eastern Mediterranean around 70–60 BC (see main map). The Romans were fighting King Mithridates IV of Pontus in Asia Minor at the time, so the sunken ship may well have been carrying spoils from that war.

The Antikythera mechanism was initially thought to have been made on Rhodes, where the ship had almost certainly stopped, and where the Greek astronomer Hipparchus had worked. But the month names on the device are most closely related to those used in colonies established by the city-state of Corinth in northwest Greece and Sicily[4]. And a four-year dial on the device displays the timing of the Olympics and various other games — including 'Naa', a small athletic event of interest only near Dodona in northwestern Greece. This suggests an origin (or a customer) in that vicinity. Confirmation may yet come from Magdalini Anastasiou at the University of Thessaloniki, Greece, and her colleagues, who are using the order of events listed in the device's star calendar to work out the latitude at which it was intended to be used.

Wherever it originated, the mechanism ended up in the East. Historian Attilio Mastrocinque at the University of Verona, Italy, thinks it was looted from Mithridates' capital of Sinope on the southern shore of the Black Sea[5]. According to the ancient Greek geographer Strabo, he notes, the Roman general Lucullus seized a mysterious "Globe of Billarus" when he conquered Sinope in 72–71 BC. This globe was never heard of again. Mastrocinque believes that this is because it sank to the bottom of the sea at Antikythera. **J.M.**

celestial bodies, they could have incorporated the concept into their own geometrical models of the cosmos.

"It is a new possibility," says Jones. "I am quite attracted to it." There is little evidence for who came up with the idea of epicycles, although it is often ascribed to third-century-BC Greek geometer Apollonius of Perga. Intriguingly, gears and epicycles seem to have arisen at about the same time, with gears perhaps a little earlier. Also in the third century BC, Archimedes used simple gears to change the size of an applied force. Some two centuries later, the Roman politician and author Cicero wrote that Archimedes built a bronze astronomical device that might have been similar to the Antikythera mechanism.

"Maybe we need to rethink the connection between mechanics and astronomy," says Evans. "People think of it as purely one way, but maybe there was more of an interplay." In other words, when that Greek mechanic shaped the Antikythera mechanism's complex gear trains, he created more than a model made of bronze. He helped to forge a view of the Universe that would hold sway for nearly 2,000 years.

Jo Marchant *is a London-based writer and author of* Decoding the Heavens, *a book about the Antikythera mechanism.*

1. Freeth, T. *et al. Nature* **444**, 587–591 (2006).
2. Wright, M. T. *Interdiscipl. Sci. Rev.* **32,** 27–43 (2007).
3. Evans, J., Carman, C. C. & Thorndike, A. S. *J. Hist. Astron.* **41,** 1–39 (2010).
4. Freeth, T., Jones, A., Steele, J. M. & Bitsakis Y. *Nature* **454**, 614–617 (2008).
5. Højte, J. M. (ed.) *Mithridates VI and the Pontic Kingdom* 313–320 (Aarhus Univ. Press, 2009).

NEW DIMENSION OF CHROMATOGRAPHY: FASTER, MORE SENSITIVE

From infant care to sports to bioterrorism, Shimadzu Corporation's chromatography instruments are enabling scientists to meet the challenges faced in an increasingly complex world.

Counterterrorism experts, pediatricians, perfumers, and professional sports watchdogs might seem, at first glance, to share few professional concerns. But many within these fields face a common challenge: the need to analyze complex biochemical substances.

For example, pediatricians, caring for infants that cannot tolerate milk need to figure exactly which protein is to blame and find substitutes. Counterterrorist experts struggle to pinpoint the origin of biological agents, which requires a precise knowledge of the subtle features that separate one bacterial strain from another. Sports regulators must monitor the growing number of natural and synthetic doping agents used by athletes to enhance their performance. The most alluring, the most fragrant perfume will not sell unless perfumers can figure out how to root out the allergens inside, and a perfume cannot be produced if the main odor-active compounds are not identified and quantified.

Scientists recruited to aid in these wide-ranging endeavors face the twin challenge of finding separation techniques that are fast enough to be of practical use and sensitive enough to provide conclusive and reliable results. The more technological progress is made, the greater scientists' demands for even more sophisticated devices. They are often forced to do so by the increasing complexity of the subject matter. For example, the new range of designer steroids used by athletes is forcing a fundamental new approach to drug screening.

Kyoto-based Shimadzu Corporation has devoted itself to meeting this consistent demand for better performance measuring devices. It has succeeded in its mission by working directly with scientists who use them. Through such collaborations, Shimadzu Corporation engineers understand the problems and the needs from the inside, and have been able to build devices that can be finely tuned to each endeavor. The latest progress in its chromatography devices—and particularly its fast gas and liquid chromatography (GC and LC) and comprehensive two-dimensional gas, liquid or liquid-gas chromatography (GC×GC, LC×LC and LC×GC) instruments—are set to change the way we think about and approach these problems.

Collaboration born in innovation, innovation born from collaboration

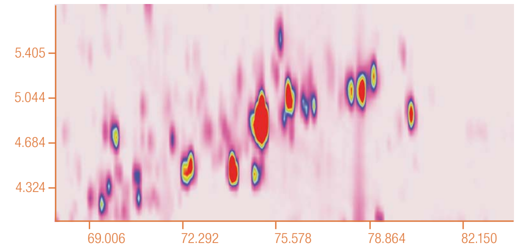
Luigi Mondello
Professor
Farmaco-chimico Department
School of Pharmacy
University of Messina

With more than 20 years of experience in the field, Luigi Mondello has become a leading light in the field of separation techniques. Aside from his hundreds of articles, in 2002, he authored a book on separation techniques, *Multidimensional Chromatography,* which has come to define the field, and another entitled *Comprehensive Chromatography Combined with Mass Spectrometry,* which will be printed in 2011. Thanks

GCxGC/qMS analysis with High-Speed Performance

GC×GC-MS System

GCxGC/qMS analysis of a fragrance extract



x-axis: retention times for first separation (in minutes)
y-axis: retention times for second separation (in seconds)

Courtesy of Prof. Luigi Mondello, University of Messina

to his rich publication record, he received the "HTC-Award for the most outstanding and innovative work in the field of hyphenated chromatographic techniques" in 2006 and the "Silver Jubilee Medal for his Considerable Contribution to the Development of Separation Sciences" given by The Chromatographic Society in 2008.

Funding agencies have recognized the importance of his work, and he now has a 1000-square-meter, multi-million Euro laboratory, fully stocked with devices that are almost exclusively from Shimadzu Corporation. "Without Shimadzu I could not have achieved all of this," says Mondello.

Mondello applies the instruments to the analysis of samples ranging from plant extracts, food products, petro-chemicals, pharmaceutical and cosmetic products to various environmental substances. "In particular, the development and introduction of multidimensional instrumentation, as well as innovative software, has contributed greatly toward revealing the unsuspected complexity of many real-world samples," he says.

For example, Mondello works with the petrol industry to separate fuels. Kerosene has frustratingly long analysis times. With the new chromatography devices, Mondello has reduced processes that took two hours to two or three minutes. He has also worked with some of the world's largest perfume designers to cut through the "forest of compounds" in their newest scents to find the allergens. Under the auspices of the North Atlantic Treaty Organization, his team created a 30-minute GC×GC-MS test to identify the bacteria present in a given sample by focusing on their unique fatty lipid profiles.

Mondello's team has also been analyzing donkey milk, which holds global potential as a substitute for bovine milk. In some 2% of children, bovine milk induces vomiting or allergic reactions. Donkey milk is much more similar in its protein and fat content to human milk, and Mondello's team provided the most detailed account yet of the triacylglycerols in it using LC×LC-MS. Based on these studies, clinical trials are now ongoing on the use of donkey milk as a substitute.

Mondello works closely with Shimadzu to develop these tools. He now focuses on ultra-fast gas chromatography that allows users to perform analyses in greatly reduced times without losing information. Fast gas chromatography units are often linked with mass spectrometers for further analysis. "This translates into the possibility of getting real time results. This is very useful when a high number of samples needs to be analyzed or immediate answers are needed," says Mondello.

Mondello and Shimadzu are also upgrading comprehensive two-dimensional and multidimensional gas chromatography. When a sample has hundreds, or even a thousand of components, conventional techniques do not have enough separation power. The two-dimensional devices automatically force the samples through two stage separation by linking two columns, each selecting for a different characteristic. The end result is another order of specificity.

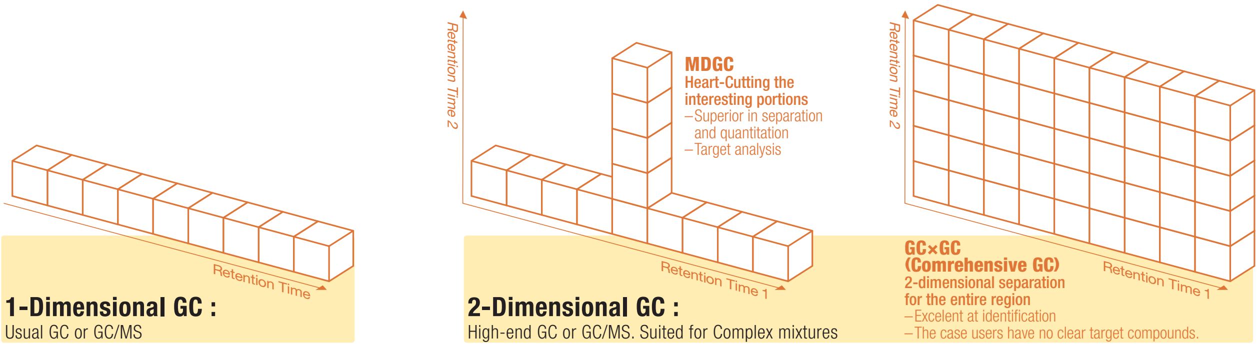
Mondello says he started working with Shimadzu because of the company's willingness to completely rethink technology. "In the last ten years Shimadzu has developed entirely new instrumentations. They did not just remake old instruments," he says, adding, "I also like the Japanese way of solving problems–slowly but with excellent results."

The working relationship developed into formal collaborations. Shimadzu provided instruments. Mondello's team developed software, modified the hardware, and sent back prototypes. Shimadzu then used those to make models for the market. "We tested, advised and validated these powerful devices for speed and selectivity. It has been a very nice and

Luigi Mondello with the Shimadzu LCMS-IT-TOF mass spectrometer at the University of Messina

GCxGC/qMS analysis with High-Speed Performance

Classification of Gas Chromatography



fruitful collaboration," says Mondello.

Thanks in large part to Shimadzu, both fast GC techniques have become routine over the past five to ten years. "When I first started my collaboration with Shimadzu, the use of fast GC and GC-MS was barely employed due to the lack of commercial instrumentation. Now, fast methods are routinely employed in many industrial and academic fields," says Mondello.

The same can be said for multidimensional chromatography methods. In fact, comprehensive two-dimensional gas, liquid and liquid-gas chromatography hardware and software have been developed and are now exploited by a great number of analysts across the world. GC×GC methods are making greater inroads in the analysis of fatty acid methyl esters in food and biological samples, of pesticides and petrochemicals, as well as flavours and fragrances, while LC×LC, linked with mass spectroscopy, is increasingly useful for a range of tests related to health, biology and nutrition, including proteomics, lipidomics, and food antioxidant analysis. LC×GC methods have a demonstrated effectiveness for food contaminant analysis (e.g., mineral oil in vegetable oils). "In short, analytical horizons have been extended," says Mondello.

Mondello is not one to stay complacent. He plans to continue developing instrumentation for fast GC, with attention focused on the injection system, and to develop more simple and effective modulators for comprehensive chromatography. He also plans to engage in the development of software for multidimensional chromatography and in MS spectra libraries, which will make compound identification a simpler and more reliable task. "Our main common goal, namely the evolution of chromatography-mass spectrometry technology, will be achieved within the context of our intense collaboration with Shimadzu," says Mondello.

The upshot will be far reaching. "Ten years from now, the comprehensive chromatography methods we are working with, such as LC×LC, GC×GC and LC×GC, will have a revolutionary effect on the chromatography community. If we succeed in making these powerful technologies more accessible, both in hardware and software terms, then the impact will be a great one," says Mondello.

Seeing the whole field

J. Thomas Brenna
Professor
Division of Nutritional Sciences
Cornell University

In a sporting world in which athletes are using ever more sophisticated illegal drugs to enhance their capabilities, how can a regulator keep up? The answer is by coming up with better screening techniques. Cornell University's J. Thomas Brenna has set himself on that task.

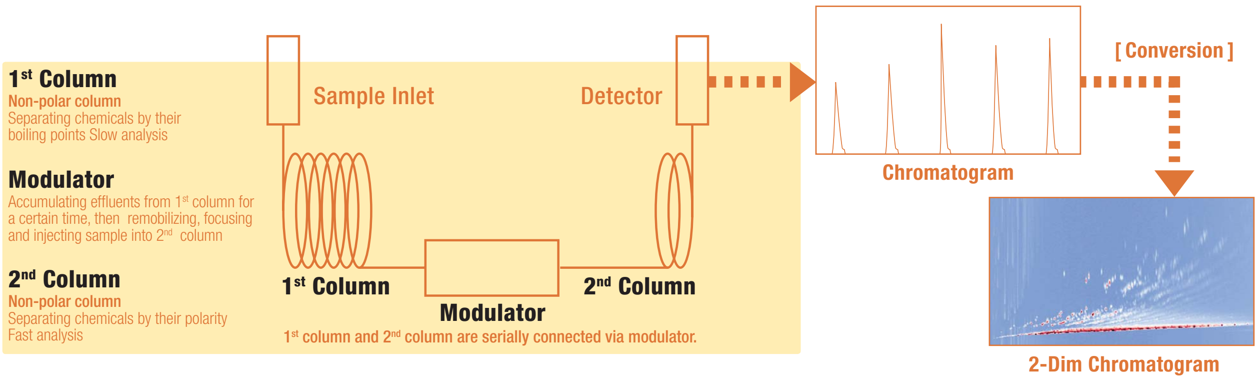
Brenna and his research group have been funded for two decades by the US National Institutes of Health and private sources for development of molecular, elemental, and isotopic mass spectrometry. His group has also been at the forefront of human polyunsaturated fatty acid nutrition and related lipid metabolism research. With that background, he and his colleagues are developing advanced techniques to help anti-doping laboratories detect use of illegal performance-enhancing substances.

Scientists have made major strides in distinguishing natural occurring testosterone from pharmaceutically derived versions. But the tests are pushed to the limits. Official doping control tests screen some 300 drugs and metabolites for each sample, and the number of necessary determinations is reaching impractically large numbers with the increasing number of samples that need to be tested and the increasing number of potential illicit drugs.

The major concern now for Brenna—and for sports regulators as well—is the threat of designer steroids which do not even have a naturally occurring counterpart. These are notoriously hard to find. Until now, the use of designer drugs was only discovered when a whistleblower turned in a syringe with the substance in it. Otherwise testers wouldn't know where to start to look.

GCxGC/qMS analysis with High-Speed Performance

Two different types of columns, modulator and special software for analysis are required for GCxGC system.



"The problem is that in a typical test, we develop a protocol, validate the protocol, and then add the test to a list. But you can't do that with a molecule you've never seen before. How do you develop tests to screen for molecules we don't suspect?" he asks.

Brenna's answer is a comprehensive screen that will match the test sample against all relevant, normally present steroids. "Imagine that steroids and other metabolites of an athlete's urine are dispersed by chromatography and by mass to make a multidimensional map with many peaks. They represent all the normally present urinary steroids and other metabolites. If you know what is supposed to be there, you can look for what's not supposed to be there. That is, we intend to establish not only where peaks are supposed to appear but also where they are not supposed to appear," says Brenna. "Then we can identify steroids or other drugs that have not been seen previously. That is what we're driving for."

But to achieve that kind of comprehensiveness and specificity, Brenna needs a powerful chromatographic device. He found it in Shimadzu's GCMS-QP2010 Plus and its GC×GC capabilities.

The device gives Brenna the separation space he needs. "Normal separation techniques work for a limited number of chemicals. Beyond a hundred or so, there is not enough space between peaks to resolve them all, let alone leave blank baseline where unusual compounds might appear. More real estate is needed along those baselines," he says.

When running a sample in Shimadzu's GC×GC technology, while the first column is running its normal 30 minute separation process, the secondary column continuously collects five-second to ten-second slices from the first and separates them again using a different chemistry. The result is much better separation even between substances that looked nearly the same from one vantage point. "Instead of two-dimensional profiles, the voluminous data appear like three-dimensional mountains," says Brenna.

The key to the speed is Shimadzu's patented quadrupole filtering device. "Their quadrupole can scan rapidly enough to keep up with the 200-millisecond-wide peaks as they emerge," he says.

The fast quadrupole provides several definitive advantages over competing technologies, such as time-of-flight (TOF) mass spectrometry. Brenna says Shimadzu's GC×GC in principle has the possibility to achieve similar sensitivity to TOF mass spectrometers at half the cost.

More importantly for scientists, the GCMS-QP2010 Plus has the capability for chemical ionization (CI), which is not available in TOFs. "We have already found that chemical ionization with specialized gases can produce sensitivity competitive with conventional electron impact ionization, but yielding far more structural specificity," says Brenna.

Brenna anxiously awaits the imminent arrival of the upgraded version, the GCMS-QP 2010 Ultra. "We'll anticipate even better data," he says.

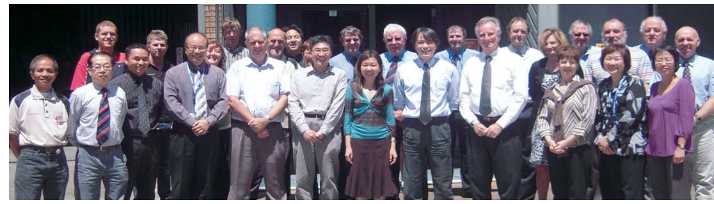
That won't be welcome news for those designing new illegal drugs. Brenna is already analyzing crude extracts of urine to quantify steroids, taking advantage of the very high separation space available with GC×GC-qMS. "We expect to be able to see many more steroids than previously possible and perhaps unexpected steroids," he says.

It won't be easy to find a way around this new test. Designing something with anabolic activity that would be undetectable will be difficult. "In principle, a rational strategy to defeat a doping test is to design a novel illegal substance with very similar separation properties to a normal, endogenous compound, which would thus be hidden from view. We hope to make that task much more difficult using the vastly greater separation space of GC×GC-qMS," says Brenna. He adds: "Shimadzu has given us a weapon that I didn't expect to have."

Despite this progress, chromatography has not reached its end. Mondello poses himself the question: how much more room is there for development both in the LC and GC hardware and software field? Have we reached the maximum level of separation power, selectivity, sensitivity and speed? "I have an answer to this, which is simply no. There's still plenty of room for development, before the 'perfect' GC or LC method is developed," he says. But with Shimadzu's ongoing efforts, that goal will always be coming closer.

Best Yet to Come for Shimadzu in Australasia

Shimadzu's sister subsidiaries Down Under are using leading edge technology to strengthen brand image and keep on top of their markets



Staff gathering outside Sydney headquarters

Staff of the Melbourne office

Shimadzu's subsidiaries in Australasia service a region stretching from Perth in Western Australia to as far away as New Zealand, and takes in the Pacific Islands such as Fiji along the way. That's a geographic sweep of some 5,300 kilometres, making it larger than any other territory covered by the Kyoto-based parent company Shimadzu Corp., including its USA and Europe markets. The organisation is made up of two subsidiaries: Shimadzu Scientific Instruments (Oceania) Pty Ltd. and Shimadzu Medical Systems (Oceania) Pty Ltd.

"Given the size of the region, we maintain offices in Sydney, Brisbane, Melbourne, Adelaide and Perth in Australia, and in Auckland and Palmerston North in New Zealand," says John Hewetson, director and general manager of Shimadzu Scientific. "We share a number of these offices with Shimadzu Medical to our mutual advantage."

Shimadzu Scientific sells and services analytical and measuring instrument such as gas and liquid chromatographs, spectroscopy equipment and various materials-testing instruments. "Roughly 60 percent of our business is with government-funded institutions such as universities and hospitals, the rest with private industry," says Hewetson. "Our market share in all major product areas has been over 25 percent for many years now."

Sister company Shimadzu Medical also provides sales and service support in all six Australian states, New Zealand and the Pacific Islands. Equipment segments for medical diagnosis and treatment cover angiography, fluoroscopy, mobile X-ray and radiography products.

"With the launch of our MobileArt mobile X-ray products in the Australian market, Shimadzu has been the market leader since 2000 with a share ranging between 60 to 90 percent," says Nick Mascoulis, general manager of the subsidiary. "And in the past decade we've also led in supplying general X-ray rooms, boasting a market share greater than 50 percent."

Major milestones for both companies were establishing direct sales, marketing and service operations: Shimadzu Scientific in Australia in 1991 and in New Zealand in 1995, well ahead of its competitors. "We have our own service engineers to cover directly all states in Australia, New Zealand and the Pacific Islands," says Hewetson. "In addition, we have specialists in chromatography and mass spectrometry providing close customer support." For its part, Shimadzu Medical set up its direct operations in 1996.

When Mascoulis was appointed general manager of Shimadzu Medical, he conducted a customer survey and found that although company products were rated highly for reliability and performance, marketing presence left something to be desired. "As one customer told me: 'Shimadzu is the world's best kept secret,'" says Mascoulis.

To improve brand image he has overseen the creation of a new web site (http://www.shimadzu.com.au) as well as launching an e-newsletter. And from 2011 all service engineers will wear a new Shimadzu uniform. The company is also turning product launches into media events, "to better inform our customers of Shimadzu's leading edge technology," explains Mascoulis. "We have already seen success from this with quick orders for our newly released Digital Radiographic products."

A good example of Shimadzu's technology edge is illustrated by the recently introduced LCMS-8030 Triple Quadrupole Mass Spectrometer. This ultra-high-speed user-friendly system can be used for a variety of analytical processes, from detection of drugs in biological specimens to environmental contaminants and pesticides in food.

"We've taken a different approach to our competitors by focusing on speed and sample throughput with this system," says Hewetson. "In fact, the LCMS-8030 is the fastest system of its kind in the world. So we believe it will improve the efficiency of analysis in high-throughput labs in the clinical, forensic, food and metabolomics industries."

By offering customers products that are more productive and reliable, the two companies have been able to withstand the effects of the global economic turndown and the strong yen, and still remain profitable. "The market is taking much more notice of us now," says Mascoulis. Our competitors are starting to copy our products and features. This is why I believe the best of Shimadzu is yet to come."

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LCMS-8030 Tandem Quadrupole LC/MS/MS System Permits Ultra Fast Quantitation of Trace Levels of Multiple Analytes

The LCMS-8030 is the ideal instrument for the quantitation of trace level analytes in complex matrices, such as the measurement of residual pesticides in foods, analysis of contaminants discharged into the environment, measurement of drug concentrations in blood, and the screening of drugs and toxic compounds. In the face of increasing numbers of target compounds and analytes, the LCMS-8030 offers ultra fast quantitation of a huge number of trace components and provides highly reliable data with excellent reproducibility.

LCMS-8030

GCMS-QP2010 Ultra is a Premium Model that Improves Laboratory Productivity and Reduces Environmental Impact

The GCMS-QP2010 Ultra boasts a novel mass spectrometer design to deliver the highest sensitivity and analysis speed in its class, making it the ideal instrument for Fast GC/MS or GC×GC/MS analysis. It not only significantly improves laboratory efficiency, but it also offers an industry-first Ecology Mode that cuts power consumption and carrier gas consumption to minimize its environmental impact.

GCMS-QP2010 Ultra

X-Ray Fluorescence Spectrometer Optimized for RoHS/ELV Screening

The EDX-LE offers all the features necessary to screen the elements regulated by the RoHS and ELV directives. This new product incorporates a detector that does not require liquid nitrogen to reduce operating costs and simplify maintenance, while enhancing ease-of-operation and improving the reliability of analysis results.

EDX-LE

Development of Transparent and High Barrier Thin Film Fabrication Technology for Encapsulation of Organic Light-Emitting Diode (OLED) Displays

Shimadzu has succeeded in obtaining transparent (absorption coefficient < 20 cm^{-1}) SiNx films with a water vapor transmission rate (WVTR) of less than $1x10^{-5}$ $g/m^2/d$ by using an improved microwave-excited surface wave plasma chemical vapor deposition (SWP-CVD) system. This transparent barrier film prepared under low temperature conditions, protects OLEDs from the invasion of oxygen and water moisture, which can cause them to easily deteriorate.This technology will enable applying a simple and low-cost encapsulation layer for next-generation large scale OLEDs. This study was partially supported by the New Energy and Industrial Technology Development Organization (NEDO).

Collaborative Research Contract Signed with Center for iPS Cell Research and Application (CiRA), Kyoto University

CiRA and Shimadzu will undertake joint research into the safety of iPS cells and to search for biomarker indicators for evaluating whether iPS cells grow according to a specific purpose, such as for heart, muscle or nerves. The joint project involves the proteomic analysis and identification of biomarkers of iPS cells established by CiRA, by using Shimadzu Advanced Mass Spectrometry System.

New R&D Center for Analytical and Measuring Instruments in Shanghai, China

In January this year, Shimadzu completed a new development center for analytical and measuring instruments in Shanghai, China. This center will be responsible for developing new chromatographs and new spectrophotometers instruments, core Shimadzu product categories, that are tailored to local requirements. It will provide new mid-priced products for the environmental and pharmaceuticals markets, which are expected to continue growing in the future.

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