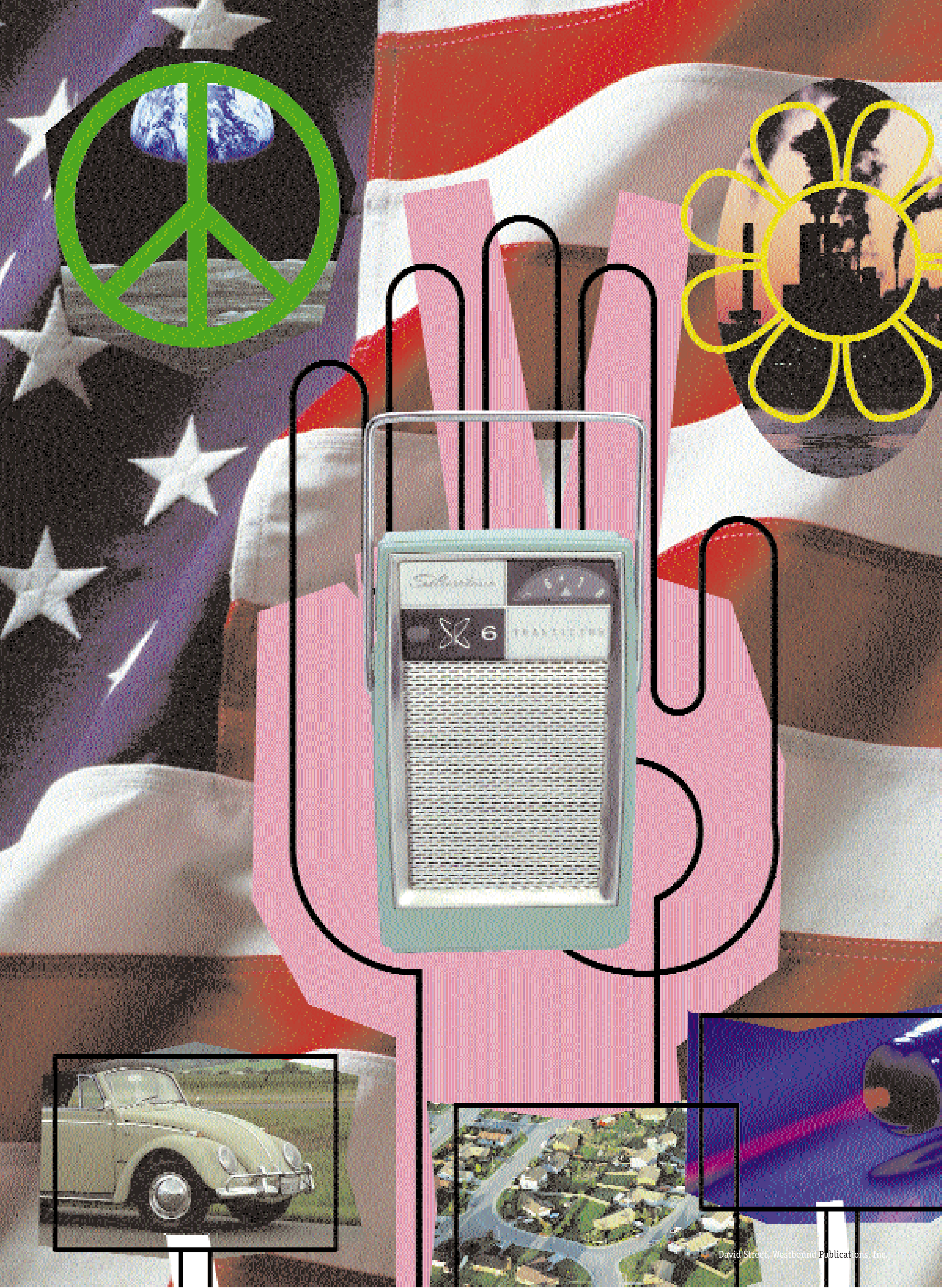


David Street, Westbound Publications, Inc.

'60s

Of Guns and Butter: Better Living through Chemistry?

Like it or not, the chemistry is going out of analytical chemistry.

— H. A. Liebhafsky, G.E. Research Laboratory, 1962

Mark S. Lesney

The effects of Sputnik and the Cold War would play out fully in the 1960s in the United States as an unparalleled prosperity met the unparalleled expectations of the Baby Boomers. The chemical industry was on the front pages of American life, from the plastics boom (ultimately satirized in the film *The Graduate*) to the role of rocket fuel and instrument technology in the race to the moon. But these positive motifs shared the stage with skeletons: Rachel Carson's *Reader's Digest*-promoted best-seller *Silent Spring* gained public recognition of the perils of air and water pollution from the bounties of chemical agriculture; the sexual revolution (born in large part from the chemistry of the Pill, first marketed early in the decade) was seen by the "silent majority" as a threat to family and society, as much as it was a liberation to others; the Cuban missile crisis in 1962 convinced a generation of youth that they could be blasted away in thermonuclear destruction at a moment's notice by the pressing of a button; and the use of napalm, munitions, and powerful new herbicides in Vietnam in the latter part of the decade resurrected the horrors of warfare that chemistry could provide. Such specters eroded the easy complacency and trust in science that had been one of the primary effects of WWII success.

A Changing Spectrum

Throughout the decade, the issue of civil rights for African Americans, women, and Native Americans would nearly tear the country apart. And by the end of the decade these struggles would extend to a new generation of Latino and Asian immigrants, and even to a gay American minority. Across the globe, anticolonial movements such as that in Vietnam and a host of African and Asian protectorates would become configured across Cold War alignments.

It was amidst this chaos and complexity that analytical instrumentation adapted further to a growing consumer economy, while expanding its military footing. Automation technology "came of age" in this era along with the first of the baby-boom generation. A host of new instrument companies formed to commercialize hitherto research lab technologies and to couple them to the developing computerization methods, making these technologies easier to use and spreading their influence from lab to factory to hospital. A wealth of consumer products in the West and the developing bounty from a chemically driven food system continued to provide pocketbook incentives to have faith in science for the typical American.

The continuing development of national television, packaging and refrigeration technology, advertising, and a national highway system created a unified national market in the United States and contributed further to massive urbanization, consumerism, and the quest for global markets. The success of postwar reconstruction through the Marshall Plan and other programs had finally achieved its desired result in the demand for American products from growing economies across the world. But on the other side of the coin, these same economies were capable of entering the race for markets themselves. Competition from Europe and Japan, foreseen and fretted over in the 1950s, became a daily reality. In *Analytical Chemistry*, foreign ads became commonplace, and on the streets the German Volkswagen became not only the first signaled threat to American automobile dominance, but a populist symbol of the new counterculture as well.

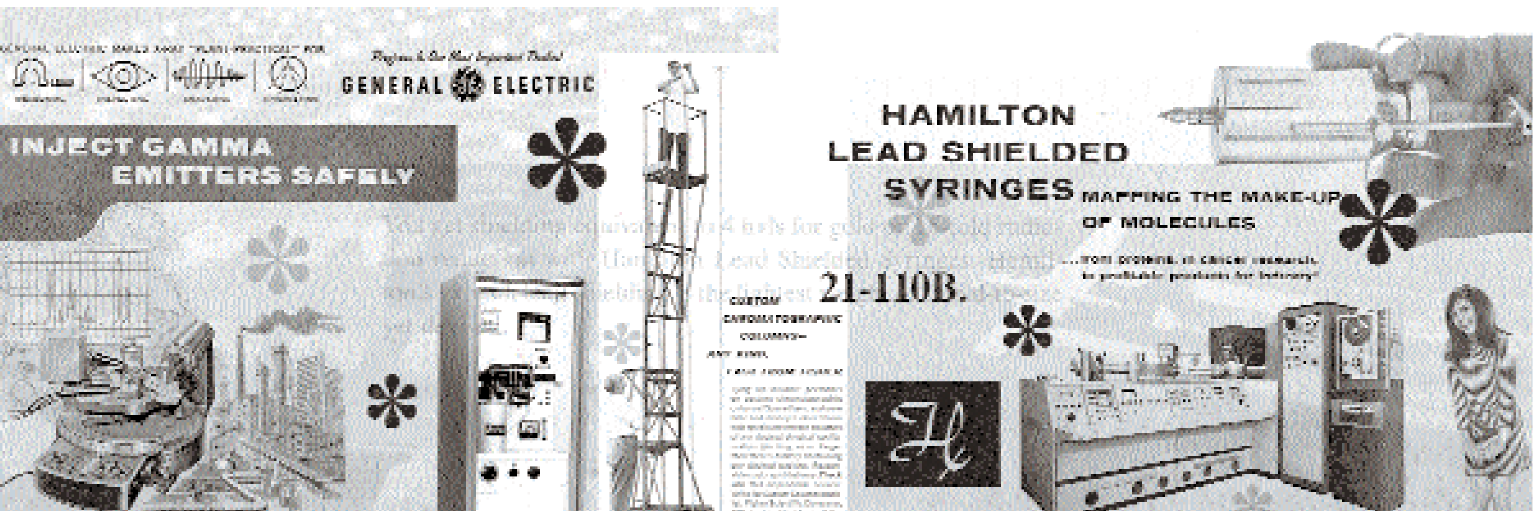
On the whole, across the world, the realities of the continuing Cold War forced the pull between military and civilian goals in both science and society, leading to a classic guns-or-butter conflict. In the United States, this resulted, on the one hand, in growing inflation and taxation; on the other it stretched Lyndon Johnson's Great Society ambitions to the breaking point. On the social front, perhaps, as one of the most telling symbols of the age, in their June 1960 cover story, *Time* magazine noted that one third of Americans lived in suburbia.

Instruments Adapt

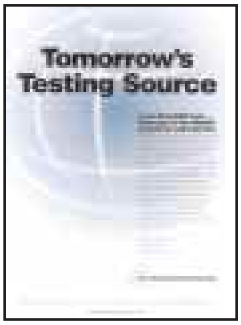
The start of the decade was highly eventful for both analytical instruments and society as a whole. In 1960, providing an unintentional Buck Rogers flourish to the developing space age, Theodore Maiman built the first laser. Lasers would come to have profound effects in the future of fiber-optic technology, medicine, and electronics. By 1962, Hughes Aircraft Co., Honeywell, Bell Telephone, and Perkin-Elmer would all begin marketing lasers. In the mid-1960s, new laser companies such as Coherent Laser, Inc. (1966) and Oriel—first a distributor (1965), then a producer (1968)—came into existence to market the new technology. But perhaps these companies' major impact on instrumentation in this period came because lasers made Raman spectroscopy not only more sensitive and efficient, but also significantly cheaper. By mid-decade, the Cary 81 Raman unit operated with a laser attachment and competed with the integrated Perkin-Elmer LR-1 and the Jarrell-Ash Raman system.

The decade heralded a host of other changes. In 1960, the Système International (SI) units were agreed upon and subsequently adopted by the National Bureau of Standards (NBS)[*Anal. Chem.* **1964,** *36(6)*]. Throughout the decade, the NBS continued to define the new standards for instrumentation in the United States, for example, moving the pH scale from an accuracy of +/- 0.01 to +/- 0.001. As a service in 1961, the NBS performed over 129,540 instrumental calibrations for both government and industry, and distributed 78,148 standard samples from a suite of 600 certified standard reference materials (SRM).

Standards and levels of sensitivity were tremendously important to the development and marketing of instrumentation in the 1960s as instruments rapidly matured. Pickler




SOLUTIONS.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Nuclear reported the "Thresholds of Measurabilty" then current in one of its ads: 1 ppb, 6A, 10^8 neutrons/s, 10^{-11}Torr, 10^{-10} curies, 1 μm^3, and $0.006°_{2\theta}$. It was typical of what would become a routine touting of increases in analytical sensitivity in instrument ads from that point on. By the end of the 1960s, for example, anodic stripping polarography and other techniques were heralded for their ability to allow detection of numerous elements at less than part-per-billion ranges routinely. In a further assault on "old" chemical techniques, the quest for better standards showed in 1961 that prior determinations of atomic weights contained a host of unsuspected errors, revealed only by the use of the new instruments.

New Demands, New Markets

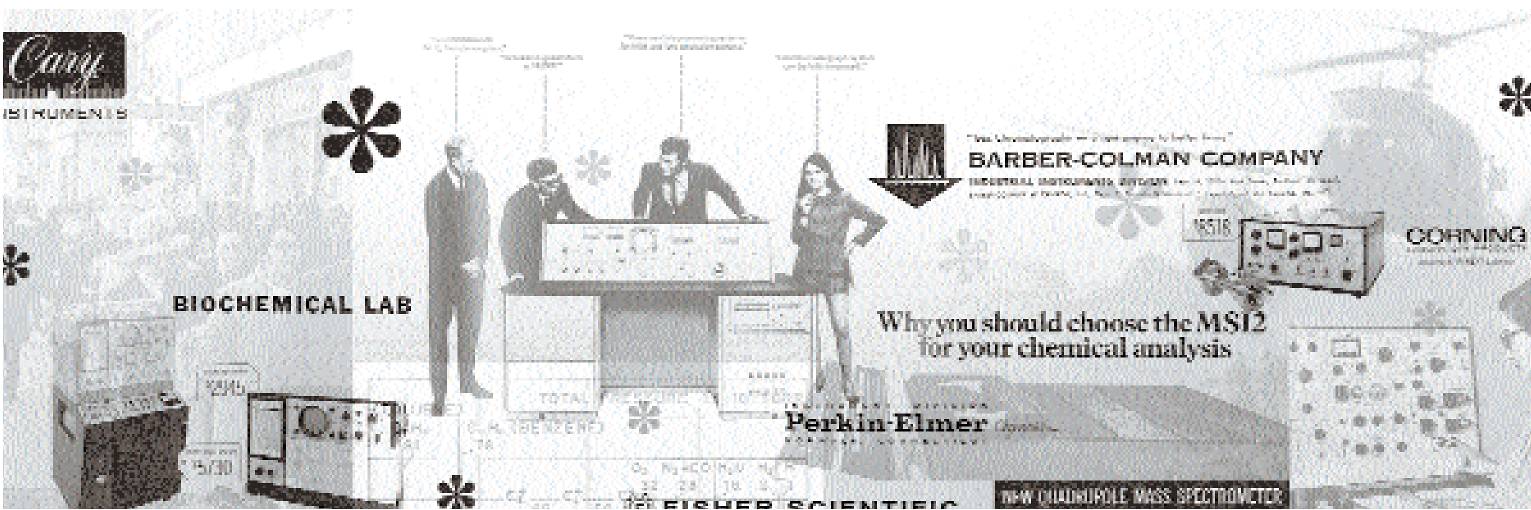
In one of the defining moments of the decade, in 1961, President Kennedy announced the race to land a man on the moon, a project that would provide a huge demand for new technologies and instruments. Also in 1961, further evidence of a growing alliance between analytical chemistry and biomedicine became obvious through a number of developments in instrumentation. Proton relaxation enhancement NMR, introduced by R. G. Shulman and co-workers, enabled NMR to be used to study macromolecules and thus the biochemistry of DNA and proteins. With the use of superconducting magnets, high-frequency/high-resolution proton spectrometers enhanced study of nucleic acids and proteins immensely. Researchers at Oak Ridge National Laboratory (ORNL), working with Jonas Salk, developed the process of ultracentrifugation for biomedical purposes. And, by 1961, the 11th National Institutes of Health Research Equipment Exhibit and Symposium was so crowded with medically related products that trailers were used to display the overflow of instruments. Cost in this period was becoming more and more of an issue, especially with increased domestic and foreign competition. In 1961 Varian Associates produced the A-60 NMR spectrometer to make the technique "within reach of the average chemical laboratories."

> **Perkin-Elmer is participating in the space age. The role embraces nearly all the company's capabilities and products…**
> —Perkin-Elmer annual report, 1959

The federal government continued its attempts to help industry through research, instructing ORNL in 1962 to establish an Office of Industrial Cooperation. In this period, a host of new companies such as DuPont (new, at least to this type of venture) and Milton Roy moved into the scientific instrument business. *Analytical Chemistry* suggested in 1963 that this move was primarily due to increased government spending, as well as to increased U.S. exports. (This export picture would rapidly change. Already Japanese companies such as Shimadzu and Hitachi routinely sold instruments in the U.S. market. By the mid-1960s the sales of West German, English, and Swedish instruments further eroded the American market while U.S. companies increased their global sales.)

But perhaps of most long-term significance from 1962: Rachel Carson published *Silent Spring*, whose revelations of the dangers of pesticides in the environment awakened an American environmental movement. The book was obliquely acknowledged by American Cyanamid in an article in *Analytical Chemistry* that reaffirmed "the important role played by chemical compounds in increasing food production." No mention of Carson was made in a pesticide review in April 1963 by a U.S. Department of Agriculture researcher, or anywhere obvious in the nonscience article pages of *Analytical Chemistry* that decade except for an ad that asks, "Have you read *Silent Spring*?" By the end of the decade, however, more and more pollution-related ads, especially concerning water and insecticides, would be apparent, as companies such as DuPont would sell "high-pressure" LC systems with special packing materials and pressures up to 3000 psi specifically for analyzing DDT and other sprays.

In 1962, FBI Director J. Edgar Hoover ratified the concept that chemistry was becoming more instrumental, as witnessed in his experiences with the FBI laboratory: "In 1942, a medium quartz spectrograph was the workhorse instrument for analyzing all types of small bits of evidence. Now, just 20 years later, the emission spectrograph is only one of many valuable instruments available and is used frequently as a supplemental guide." Incidentally, law enforcement influenced the language of instrumentation as well. Spectral "fingerprints" in text and ads were becoming the lingo, as genetic fingerprints are today.



Capitalizing on Chromatography

In 1963, a photo in *Analytical Chemistry* of a 25-ft LC column seemed almost a cry for the high-pressure liquid chromatography (HPLC) that would arrive in 1966 from the research of Csaba Horvàth at Yale and others, a technique that would blossom by the 1970s. The Waters LLC system in this period was a rough prelude to HPLC with its dedicated cabinet and equipment system. Once it was recognized that LC was a highly useful technique for labile compounds, especially those of medical interest, companies such as Barber-Colman marketed ionization detectors for LC such as those previously used for GC.

Another form of liquid chromatography, thin-layer chromatography (TLC), which had been perfected in the 1950s by G. Kirchner and co-workers at the U.S. Department of Agriculture's Fruit and Vegetable Laboratory in California, came into its own in the 1960s with a host of new coating/solvent mixtures, new chemical and physical detection techniques, and automatic readers, all but replacing the use of paper chromatography. TLC would also be turned to pesticide and pollution analysis, but its main, or at least most frequent, benefit would be to the life sciences and as a "fine-tuning" device for GC and LC in research and production laboratories.

By 1964, gas chromatography, in a maturing phase compared to liquid, was becoming increasingly influenced by capillary GC columns advertised under Golay patent 2920478. Other trends included the rush to data management, with more than 200 manufacturers making some 1000 recording devices for GC. Increasing use of computer technology allowed storage and automatic calculation of GC data, including peak integration and reduction of data using the new computer language, FORTRAN. Of tremendous significance, LKB (Sweden) provided the first practical helium separator interface, which allowed the linkage of a gas chromatograph to the vacuum-based mass spec (a magnetic sector MAT unit) and thus inaugurated GC-MS. By 1966 the LKB 9000 GC-MS systems were in production, and at Pittcon a symposium was held on the combined technique. And like every other piece of equipment, the new systems, including atomic absorption spectroscopy developed by Alan Walsh in Australia in 1964, produced ever more data, ever more information.

Computers in Chemistry

Information management thus became a critical issue as new analytical instruments generated tremendous amounts of data. Recorders were still the rage. Companies arose to maintain and compare huge numbers of spectra from AA to MS to NMR to IR. The growing proliferation of scientific papers caused angst in government, academic, and industry circles as to how they would be maintained, searched, and utilized. For the first time in 1965, Chemical Abstract Services offered its computerized searching system and biweekly tape delivery for use on an IBM 1401/1410 system. Wang advertised the LOCI-2, a programmable "desk-top computer with the capacity for making life easier for the chemist."

Transistors allowed this development of miniaturization in nearly all areas of scientific equipment. The issue of miniaturization was discussed in a review of instrumentation in a 1964 issue of *Analytical Chemistry*, which attributed both the drive for it and its success in part to the growing space program. One interesting facet of the computation/electronic revolution was the tendency to gratuitously open up the innards of equipment in ads to "prove" that they had transistors, circuits, and so forth. By the late 1960s, computer companies were working intimately with instrument companies IBM with Varian; DEC with GE, Siemens America, and Infotronics (all of which used DEC's PDP-8, or 88 system); and Olivetti-Underwood, which worked with Beckman to produce the Beckman Omega, a computerized liquid scintillation counter planned to be expandable to a host of electrochemical and spectrophotometric instruments. Foreign competitors such as Jeolco manufactured electronic computers specifically for chemistry. These trends were so ubiquitous that in reporting on both the 1968 and 1969 Pittcons, *Chemical & Engineering News* chose to highlight the role of computers at the show.

In 1965 DuPont's 900 Digital Thermal Analyzer was one example of the developing "plug-in" module mentality made possible by this new electronic world. One interesting rhetorical flourish to the new electronic controllers being routinely offered for all lab equipment: They were often personalized in ads as intelligent servants, lab techs, scientists, and researchers easily added to the laboratory staff, ones incapable of making a mistake. This trend was in keeping with Warner-Chilcott Laboratories' "Robot Chemist" advertised in 1966: a fully automated, programmable "wet" chemistry station.

Biology Meets Chemistry

In addition to replacing chemists with automation, instrument makers realized a change in the kind of workers using their products: not chemists, but doctors and biologists. In one ad, for example, they provided "an open question to Bioanalytical Gas Chromatographers: Do you want equipment specifications or guaranteed results?" The push to service the biomedical industry was also apparent with the F&M Series 402 Biomedical Gas Chromatograph introduced the

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year before and would continue with a host of other instruments both large and small from then on, including GCs such as MicroTek's MT 220 "specified for pesticide analysis." The combination of new users/markets and a great increase in instrument producers created these new products for specialty niche users. Interestingly enough, Varian ads for their table-top EPR claimed it was designed to bring it in the range of "*all* biologists, chemists, biochemists, and biophysicists." The motive force of the developing biological revolution was obvious even here.

The advantages of the new quadrupole GC/MS and the potential of computerizing the systems led to the development of companies such as Finnigan (1967), which introduced the first commercial quadrupole type, high mass range GC/MS in 1968 which immediately found favor in medical research at universities. Also by the late 1960s, a host of biomedical-serving instrument and component companies such as Bio-Tek (1968) had evolved. New medical technology and new applications would close out the decade as amino acid analyzers such as the Beckman Model 121 became able to run up to 72 samples automatically; peptide synthesis units, as well, were available from companies such as Becton-Dickinson. In 1966, Weston Anderson and Richard Ernst, who was at Varian, perfected Fourier Transform NMR (FT-NMR), which would come to improve sensitivity nearly a hundredfold.

A Social Revolution

All of this was not taking place in a social vacuum, although in the pages of *Analytical Chemistry* it might seem so. Among the poor and dispossessed in the United States from 1963 to 1968, rioting and burning in the cities would become the favored means of protest when placards failed to move the powers that be. The 1963 March on Washington led by Martin Luther King, Jr., would help to focus the nation on civil rights as never before. (As a brief sign of its effectiveness, in December 1963 the first African American appeared in an ad in *Analytical Chemistry*. There would be a lack of racial diversity, however, throughout instrument ads in the 1960s, although in May 1968, an African American male appears in a Union Carbide ad and another in a Beckman photo in 1969. White women continued to be depicted frequently, often as sex symbols wearing miniskirts with high heels or go-go boots.) In counterpoint, however, to the 1940s and 1950s, a significant number of ads would come to show a few of these women as obviously trained equipment users rather than the prettified "demonstrators" of the earlier era, perhaps as a response to the large increase of trained women in the workforce fresh from college, rather than any acknowledgment of the Women's Movement, which was just gathering force.

By 1964 with President Johnson's social programs such as the Great Society on the horizon, instrumentation found itself in a guns vs. butter mode. An editorial in *Analytical Chemistry* warned that with military demand down, instrument and chemical companies were switching to civilian application after 25 years of government largesse. This would change rapidly, however, as in 1965, probably the most significant event for American social and political life in the decade began with U.S. troop involvement in the war in Vietnam. The war would lead to tremendous social unrest and financial burden. It would become a major feature in the economic woes of the nation throughout the late 1960s and the 1970s. Because the new generation of Baby Boomers had grown up without a Depression or a major world war, and in the midst of new technologies, goods, and services, they had a series of different expectations and demands that changed their response to war from that of their parents. They were better educated, had more leisure and chance to act collectively, and attended college in record numbers, male and female, such that by the end of the decade college enrollment had tripled since 1945. It was these students who would form the core of protest.

In part it was communications technology and a glut of information (this time from the mass media) that drove the response both in the civil rights and the antiwar movement. Televising the war, racial protests, and the Watts and Detroit riots galvanized the population in a way that less visceral media might not have, according to many historians of the period.

Moon Rocks, Drugs, and War

Again, recognition of any of this social anarchy was not apparent in the pages of *Analytical Chemistry*, where the only appearance of the war was in ads for U.S. savings bonds that showed soldiers in rice paddies "defending American freedom." This was a far cry from the use that war and the military had been put to in the post-WWII era and the Korean conflict to enhance instrument sales. Perhaps this may be considered the ultimate cultural validation of the controversial nature of the Vietnam war: Advertisers refused to touch it.

Throughout the 1960s, the main acknowledgment of a developing counterculture in *Analytical Chemistry* would be the creeping in of a Peter Max–type art in some of the ads, the use of phrases such as "turn on," a bit more blatant

sexuality in copy and photos, and a heightened awareness of the instrumentation needs of drug enforcement personnel. Sure signs of the 1960s were apparent not just with the health and pollution-related inclusion of "Carcinogens" and "Carbamate Pesticides" which were determinable by the Coulson Detector from Tracor Analytical Instruments, for example, among a host of others, but with the somewhat standout categories of "Hallucinogens" and "Stimulants." By the early 1970s, GC/MS would be the tool of choice for determining illegal drug trafficking and use.

Despite the chaos and injustice, the decade would end on a unique and celebratory high note. In 1969 the Apollo 11 moon landing would represent the triumph of American technology (even to the Perkin-Elmer-coated visors of the Apollo 11 astronauts whose reflective surface so dominated their photographs, and P-E's optics for the laser retroreflectors). Raytheon fiber-optics system had been used for NASA quality control. But the moon landing would, also, unfortunately, provide a forcible counterpoint to the nation's social problems. As Ralph H. Müller, whose Instrumentation column had graced the pages of *Analytical Chemistry* for more than 20 years, noted on the occasion, "Those who want no more space exploration but an immediate solution to urban renewal, abatement of pollution, and perfect race relations ignore one fundamental fact. We have the technology but not the total collective will and determination to do so."

Part of the story, though, of the 1970s would be technology's attempt through new instruments and new industries to solve the problems anyway.

Sources

See source list on page 96.