Science in Colorado: The Second Century Begins

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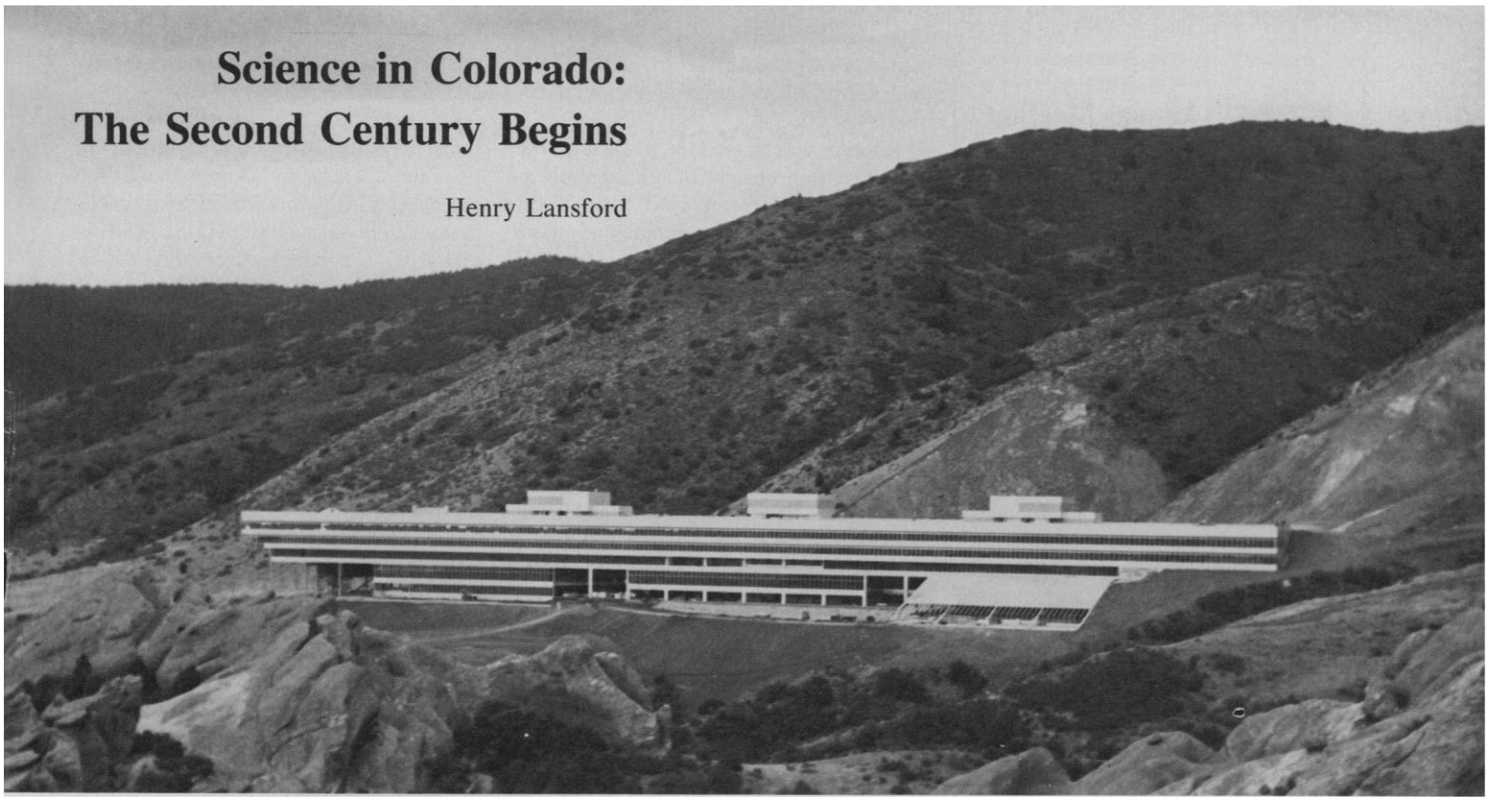

The Johns-Manville Corporation's world headquarters, in the foothills of the Colorado Rockies southwest of Denver.

For those with a historic bent, there are some interesting contrasts between the sites of last year's AAAS Annual Meeting and this year's. In 1848, the year that the AAAS was founded, Boston was a mature urban center of scientific, academic, and cultural affairs—"the cradle of American Science," as it was called in the 1976 Annual Meeting program. Harvard University was more than 200 years old in 1848, and the Massachusetts Institute of Technology would open its doors within the year.

But in 1848 there was no Denver; there was not even a Colorado. The plains around the confluence of Cherry Creek and the South Platte River in the western part of the Kansas Territory, where the Mile-High City now stands, were the hunting grounds of the Cheyenne and Arapahoe. The Spanish settlement of San Luis, now considered the oldest town in Colorado, would not be established until 1851.

In the summer of 1858, as the AAAS marked its tenth birthday, a party of nine prospectors led by a Georgian named William Green Russell took several hundred dollars' worth of gold from the sandy bed of a dry creek along the South Platte. Before winter set in, a gold rush had started and Denver City was growing up on the banks of Cherry Creek. The next year the "Fifty-Niners" started swarming in, drawn by the promise of instant wealth in the goldfields. "Pike's Peak or Bust" was their slogan, and many of them were busted and on their way back East within a matter of weeks, although a few found themselves very rich very suddenly.

Eighteen years later, as the nation celebrated its centennial, the new state of Colorado, with Denver as its capital, was admitted to the Union. Born in the get-rich-quick hustle of a gold rush, Colorado soon developed a broader economic base. Mining and railroading, ranching and farming, and various mercantile and commercial activities provided occupations for most Coloradans. But in addition to a sober majority of industrious citizens, Colorado also produced some flamboyant folk heroes and heroines—colorful *nouveaux riches* like Molly Brown and H. A. W. Tabor and his Baby Doe who cut broad swaths through Colorado society and history with their easy-come, easy-go silver fortunes.

The spirit of this lively era was not conducive to the emergence of a social and intellectual Brahmin class in Colorado, but respect for learning was more prevalent than might be expected, even in those rowdy early days. A year before Colorado was granted statehood, the cornerstone had been laid on a bare, windswept hillside in Boulder for a substantial stone building, now known as "Old Main," that would accommodate the first matriculants and faculty members of the University of Colorado.

Now, 100 years later, as Colorado begins its second century and the nation its third, there is at least one striking similarity between sedate old Boston and brash young Denver: both are national focal points of scientific research. Along with the multitude of research institutions and activities along Boston's Route 128, any comprehensive inventory of the nation's centers of scientific research must include the urban strip along the eastern foot of the Colorado Rockies, stretching northward and southward from Denver, Usually called the Colorado Front Range, for the mountains that form its western backdrop, this narrow strip contains a remarkably diversified and vigorous mix of government scientific facil-

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ities, university research activities, industrial research and development laboratories, and high-technology industry. Although the Front Range scientific complex includes work in a variety of scientific disciplines, including outstanding biomedical research at the University of Colorado Medical School and a variety of other solid efforts in the social and life sciences, the area is probably best known, internationally as well as nationally, for geophysical and environmental research.

Like the state itself, the Colorado scientific community grew rapidly from a modest beginning, attaining its present stature in a mere 25 years or so. But its roots go back further. Walter Orr Roberts, AAAS past president and a resident of the state for more than 35 years, has a unique view of the growth of Colorado science during that period. He first came to the state in 1940 as a Harvard graduate student in astronomy, and has maintained his home base here ever since, pursuing his own scientific interests in solar and atmospheric research and engaging in a variety of national and international scientific activities.

Roberts came to Colorado to set up a solar observing station on the continental divide, near the little mining company town of Climax. His mentor at Harvard was Donald Menzel, a Colorado native who grew up in the little mountain towns of Florence and Leadville and was graduated from the University of Denver in 1921. Opportunities for scientific careers were practically nonexistent in this part of the country then, and young Menzel, who wanted to be a scientist, went east to earn a doctorate at Princeton and to join the staff of the Harvard College Observatory.

By the time Walt Roberts was ready to begin his dissertation, Menzel had decided that Harvard should establish an observing station in the Colorado Rockies and equip it with the Western Hemisphere's first coronagraph. The coronagraph, which had been developed in France a few years before, uses occulting disks to create an artificial eclipse and permit observation of the solar corona.

Roberts was persuaded to take on the job of setting up and operating the Climax station. He departed from Cambridge with his bride, Janet, and some key components of the coronagraph in a secondhand Graham-Paige automobile that had been offered in lieu of a train ticket by Harlow Shapley, the observatory director. The trip was marked by a memorable series of mechanical breakdowns that began in Rochester, New York, and culminated in Hastings, Nebraska, where Roberts had to wire back to Harvard for a loan to enable him to make it the rest of the way to Colorado.

Although Colorado was not a complete scientific desert when Walt Roberts arrived here in 1940, the total effort in the state can only be described as modest. The University of Denver had established its high-altitude laboratories on Mount Evans and the University of Colorado had some good scientists on its faculty, according to Roberts, but he could count them on both hands.

"Science at the University of Colorado was typical of university research at that time," Roberts says, "It was done by faculty members who taught full time and did a little research on the side. They had to build all of their equipment, and it was usually held together with friction tape and baling wire."

Roberts recalls the case of James Broxon of the CU Physics Department, who built a chamber to measure cosmic rays and used it to discover the connection between sunspots and cosmic-ray activity. Where was this important piece of basic research performed? In the basement of the CU Auditorium, Roberts says, in a little workroom that Broxon had managed to take over from the university's plumbers.

World War II brought some major research facilities to other parts of the west, such as Los Alamos and Berkeley, but the wartime research effort did not have much impact on Colorado science. It was after the war, when federal research support was being redirected from military to peacetime concerns, that significant changes began to come to the Colorado scientific community.

Walt Roberts came down from the continental divide to head the High Altitude Observatory, a new research institution built on the work that had been done at Climax and based at the University of Colorado. In 1950, a major federal scientific facility came to Colorado—the Boulder Laboratories of the National Bureau of Standards (NBS), where research in the fields of radio propagation and cryogenics would be done.

Over the next two decades, other national laboratories came to Boulder. The National Center for Atmospheric Research (NCAR), supported by the National Science Foundation (NSF) and operated by a consortium of universities, was established in 1960, with the High Altitude Observatory as its nucleus and Walter Orr Roberts as its director. In 1965, Boulder was chosen as the headquarters for the research laboratories of the new Environmental Science Services Administration (ESSA), which included the Weather Bureau and some of the Boulder-based activities of the Bureau of Standards. When ESSA was absorbed in 1970 by another new agency, the National Oceanic and Atmospheric Administration (NOAA), the NOAA Environmental Research Laboratories remained in Boulder.

During the 1950's and 1960's, as support for research at universities became available through grants and contracts from NSF, NASA, and other federal agencies, research programs at Colorado's universities grew. The principal academic research centers were the University of Colorado at Boulder and Colorado State University at Fort Collins, both state institutions, as well as the private University of Denver, whose chancellor, Maurice Mitchell, is a co-chairman of the Denver AAAS meeting advisory committee.

The growing Colorado scientific and technological complex also attracted industry. Martin Marietta Corporation moved its aerospace division to Denver in the early 1950's, and IBM built a major facility northeast of Boulder in the mid-1960's. Boulder also had Ball Brothers Research Corporation, established by the Ball Corporation of Muncie, Indiana, around the nucleus of a small company that had spun off from a research group at the University of Colorado.

In the mid-1970's, the Johns-Manville Corporation decided to move its world headquarters and research and development center to Denver. Explaining Johns-Manville's decision to move to Denver, W. R. Goodwin, who was president of the corporation at the time of the move, cited "outstanding educational, cultural, and recreational opportunities" in the Front Range area. He said that in the corporation's site-selection evaluation, the area received a "superior" rating for its telecommunications, air service and access, higher educational facilities, economic growth pattern, and scientific and technological foundation. Presumably these factors are similar to

The Mesa Laboratory of the National Center for Atmospheric Research.

the ones that have brought other industrial organizations to the Front Range. Johns-Manville's current president, John McKinney, is serving as co-chairman of the 1977 AAAS meeting advisory committee.

Colorado industry has played an important and highly visible role in the U.S. space program in the 1970's. When the Skylab manned orbiting laboratory was launched in 1973, it carried six solar observing instruments on its Apollo Telescope Mount. Of these six, four were engineered and built by Ball Brothers in Boulder—two for the Naval Research Laboratory, one for Harvard, and one for NCAR's High Altitude Observatory in Boulder. Ball Brothers also built NASA's first seven Orbiting Solar Observatory (OSO) unmanned spacecraft, orbited in the late 1960's.

Martin Marietta Aerospace in Denver developed and built the two Viking spacecraft for the 1976 Mars landings, and the camera that sent back the first pictures of the Martian landscape also came from Colorado—it was designed and built by Ball Brothers engineers.

In recent years, the Colorado state government has been faced with a horde of problems that call for heavy infusions of scientific knowledge into the public-policy decision-making process if sound solutions are to be developed. Many of these problems grow from one of two causes: population pressure and national energy demands. New residents have poured into Colorado over the last few years, and many of them have settled in the Front Range area, creating many problems of transportation, air and water pollution, and all the other impacts of rapid population growth. The less densely populated and developed western part of the state, usually called the "Western Slope" by Coloradans, contains rich energy resources—coal, oil shale, and uranium. Many Coloradans, including Governor Richard Lamm, fear that the state could become an "energy colony" for the rest of the nation, with strip mining and other technologies for extracting energy resources applied irresponsibly in ways that could have devastating environmental and societal impacts.

Even with the abundant scientific talent and facilities found along the Front Range, Colorado has not been particularly successful in bringing those resources into the public-policy decision-making process by linking them with key decision-makers such as the governor, members of the state legislature, and top-level state administrators. Efforts to establish an effective scientific advisory mechanism for state government have surfaced intermittently over the last several years without achieving any real momentum or continuity.

But now there are signs that such an effort may be about to achieve critical mass. Frank Hersman, who holds a law degree as well as a doctorate in chemistry, has been loaned to Governor Lamm for 2 years as a science and technology advisor by NSF, where Hersman headed the intergovernmental relations program. Hersman is also executive director of a 50-member Governor's Science and Technology Council, which is chaired jointly by Floyd Mann, an organizational psychologist from the University of Colorado, and R. C. Mercure, Jr., a physicist who is president of Ball Brothers Research Corporation.

Hersman has been on the job for only 7 months of his planned 2-year tour of duty with the state of Colorado, and the scientific advisory council held its first working meeting last November, so it is too early to judge the effectiveness of the new apparatus in linking Colorado's scientific resources to its policy decision-making. Hersman is guardedly optimistic about the future of the effort, but sees it as "a substantial commitment that rates high on a national basis."

As Colorado begins its second century, science and technology seem certain to play a major role in the future of the state. Research development, and high-technology industry will continue to be an important part of the state's economic base, and scientific inputs will almost certainly take on increasing importance in policy decision-making at the state government level.