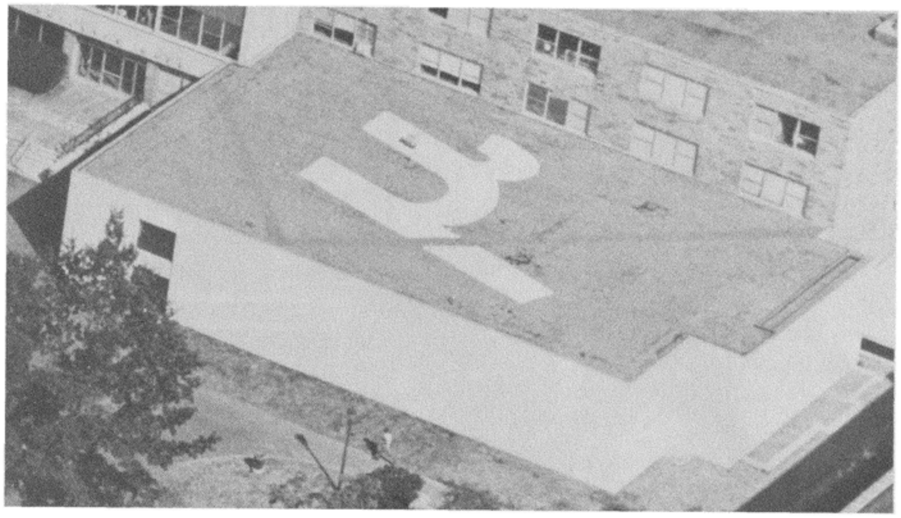
It's a Small World



Colored gravel produces the symbols for 'less than' and 'micron' on the roof of the Submicron Facility, a wing on Phillips Hall, above.

While the $15 billion-a-year microelectronics industry has provided the momentum for the development of submicron technology, the ability to make extremely small structures has inspired research in a number of other fields. Here are a few of the non-electronic projects under way at the Knight Laboratory:

- Prof. Aaron Lewis, a biophysicist, studies vision cells by attaching fluorescent tracers to enzymes in the cell. By observing the fluorescence through a 500-Angstrom hole made by the Submicron Facility, he'll be able to tell when two enzymes come close enough together to react. In effect, he'll be using a light microscope to observe an area one-tenth the size of the wavelength of light. Electron microscopes can resolve detail this fine, but not in a living cell.
- Prof. Robert Richardson of the Laboratory of Atomic and Solid State Physics is planning experiments on cubes of metal some 200 Angstroms across cooled to temperatures near absolute zero. In solids at low temperatures, energy is stored in rhythmic vibrations of atoms in the crystal lattice. Richardson wants to find out what happens to the energy when the lattice is shorter than the wavelength of the vibration.
- Prof. Myunghwan Kim, electrical engineering, is designing tiny probes to detect the electrical activity of nerve cells. The probes will be built directly into integrated circuits to amplify and process the signals they receive.
- In work that crosses the boundary between microelectronics and low temperature physics, Prof. Robert Buhrman, applied and engineering physics, is studying Josephson junctions, tiny, superfast superconducting switches. The smaller you make them, Buhrman says, the faster they will switch on and off. Faster switching means faster computers, and supercold operation at the temperature of liquid helium (about 4 degrees above absolute zero) means that more circuitry can be packed in a smaller space without overheating. Buhrman envisions computers the size of bowling balls with the power of today's room-sized mainframes.

Josephson junctions also make supersensitive magnetometers able to sense the magnetic fields generated by an eyeblink, which may find application in locating underground ore deposits or tracking submarines.

- Prof. Arthur L. Ruoff, director of the Materials Science and Engineering Department, has demonstrated that under incredibly high pressure between two diamond surfaces, xenon gas becomes a metal and conducts electricity. To test the conductivity of the material, he used tiny electrodes created on a diamond surface by photolithography and electron beam lithography. One goal of his research is to make metallic hydrogen, which might be used as a fuel for fusion reactors.
- Professors Joseph Ballantyne of electrical engineering and Martin Harwit of astronomy are making microscopic grids which serve as polarizers for X rays and far-ultraviolet light, permitting new observations of the Sun and other stars from outer space observatories. —WS

The Submicron Facility is housed in an annex to Phillips Hall that contains 7,500 square feet of "clean" laboratory and processing space and another 9,000 square feet of office and service space. The areas of the new building are clean in three important respects: Air, vibration, and electromagnetic interference.

- A system of air-lock doors exhausts slightly pressurized air to the outside whenever a person enters clean spaces. The air filtration system provides a Class 2000 working environment, meaning there are fewer than 2,000 particles (a half micron or larger) per cubic foot of laboratory air. Air inside laboratory hoods is filtered to a cleanliness of Class 10.
- Vibration-sensitive devices such as electron microscopes are installed in five rooms, each with separate 2½-foot-thick concrete floors (known as floating inertia slabs) which are mechanically isolated from the building by one-inch air gaps and are resting on compacted earth. Some instruments used in the facility are so sensitive to vibration that even the sound of the human voice can disrupt work in progress.
- To shield sensitive instruments from electromagnetic interference, electrical power is fed individually into each equipment room through a system of line voltage regulators and isolation transformers. Equipment is connected to a chemical ground rather than the more conventional building ground.

Other features of the new building:

A large glass wall between the processing area and the combination library-conference room permits visitors a panoramic view of laboratory activities without entering the clean areas. Personnel in the computer room also are separated from clean areas by glass.

Persons entering clean areas must first pass through a dressing room where the appropriate garments are donned to prevent contamination of the clean space.

The facility has five separate air conditioning systems, one each for the main laboratory (which receives about thirty air changes per hour), shop and office areas, and two for the computer-aided design areas.

De-ionized water for processing work is treated by resin exchange and reverse osmosis systems and with ultraviolet lamps to kill microorganisms, and is supplied to the laboratory through a recirculating system providing eighteen-megohm water.

Explosion-proof bunkers are used to store solvents and bottled gases.