OECD/J. J. Salomon

Dr. Hornig (center) and members of the U.S. delegation at an OECD Paris session on the technology gap.

anything about closing an array of technology gaps.

"There are all kinds of gaps," Presidential Science Adviser Donald F. Hornig, head of the U.S. delegation, quipped during the Paris meeting of science ministers, "including the gap between the advanced shipbuilding nations like Japan and the Soviet Union and lagging nations like the United States."

Out of the massive review has come a new identification of the reasons for the dominance of many markets by U.S. research-based industry, and a new determination in Europe to deal with its own archaic and tradition-bound research structures in an effort to improve:

- The mobility of researchers among European nations.
- Internationalization of research on the European continent as well as unification of now fractional European markets for the fruits of research.
- Levels of interdisciplinary research, now restricted by hidebound and archaic domination of university research centers by traditional designations.

"The range and content of these disciplines," concluded Prof. Joseph Ben-David, in an OECD study on "Fundamental Research and the Universities," "reflected the state of science about the beginning of the 19th century."

Even after German breakthroughs in research organization more than a century ago, says Prof. Ben-David, professor of sociology at Hebrew University of Jerusalem and a specialist in the evolution of European universities, "The new research institutes in Germany were carefully subordinated in prestige and, in the case of university institutes, also in power, to the corporation of university professors representing the traditional disciplines.

"Since only the universities possessed autonomy, this arrangement eventually constricted scientific enterprise and has probably had an adverse effect on creativity too."

Major differences between Europe and the United States, Prof. Ben-David suggests, along with Dr. Hornig and, now, many of the European science ministers themselves, were less in quality of the scientists than the management of science and the place of utilization in its orientation.

In the communique following the Paris meeting, the science ministers noted that, for their nations, "There is thus a need to relate science policy to the general economic and other policies of governments. This implies a new relationship between governments and industry in making use of science for social and economic progress."

This implies as well a massive reshuffling of institutions and relationships which have refused to change in generations.

Steps are already being taken and progress is being made in France, Italy and elsewhere.

France is spending research money in adjacent countries, and, internally, its organizationally modern nuclear research center at Grenoble, where Franco-German cooperation is developing, is already the equal in physics of the more traditional University of Paris.

In Italy, an international graduate school in molecular biology is developing at Naples on an independent footing, with U.S. encouragement and assistance and the support of the Italian Government; it is expected to become a model for others. Along with such institutional changes, the European science ministers endorsed an international matching fund for support of four-or-five-year, pilot interdisciplinary research programs, as well as establishment of reserve funds in each participating nation for projects approved by international committees.

Also being sought now is an accelerated program of patent harmonization among nations and a massive program aimed at increasing the flow of scientific and technical information across national boundaries, beginning with an organization similar to that within the U.S. Office of Science and Technology.

Elsewhere, U.S. and European negotiators are wrestling with nontariff barriers to international trade. These include such questions as differences among patent systems and the lack of uniformity among technical and industrial measurements and standards.

MAGNETOOPTICS

A technique to fingerprint solids

When an engineer sets out in search of a specific material to do a job no material has yet successfully done, it would be helpful if he could characterize the materials he meets.

Gases today can be rather neatly catalogued, but the engineer is usually in search of a solid. He knows what he wants to find—or create—but recognizing its complete signature has been a built-in problem.

By combining supercold, extreme magnetic fields, laser light and extremely pure crystals into a technique called quantum magnetooptics, researchers can now achieve such identification.

They may even turn materials engineering into an exact science.

Up to now, at least, a problem has been the difficulty of applying to solids investigative techniques that work in gases.

An electron in a free atom of a gas has certain set energy levels that it is allowed to occupy. When it changes from one level to another, the electron emits or absorbs light in bursts called photons or quanta. The frequency of the light is proportional to the difference in the energy of the two levels, and therefore when the spectrum of a gas is examined it shows patterns of bright sharp lines.

In a solid, however, the atoms are closely bound to each other; as one result of this the energy levels of the electrons are smeared into overlapping bands within which an electron can have virtually any energy. The spectra reflect the situation by appearing in bands instead of lines.

An important key to the electronic structure of a solid would be the ability to see detail within these bands. This has not proved easy, but with quantum magnetooptics it becomes possible, according to Dr. Benjamin Lax of the Francis Bitter National Magnet Laboratory in Cambridge, Mass. Dr. Lax reported on progress in the field to the Optical Society of America at its spring meeting in Washington, D.C. *(See p. 314).*

Magnetic fields interact with electrons by way of the magnetic fields the electrons themselves generate. An electron in an atom, for example, generates a small magnetic field by going around in its orbit.

If a fairly weak external magnetic field is imposed on a sample of gas, the phenomenon known as Zeeman effect results. The external field exerts force on the electron fields, trying to bring them into line with itself. The orbital motion of the electron opposes the disturbance and the result is compromise—a rotation of the electrons' fields around the external field at an angle determined by the specific conditions of each situation. Since those conditions have discrete values, only certain discrete angles can result.

Each possible angle has a slightly different energy, so that each original nonmagnetized energy level is now split into several closely spaced ones.

The electrons now have several possibilities for energy transitions where only one existed before, and this shows up in the spectra by the splitting of previously single lines into several closely spaced ones.

The high magnetic fields of quantum magnetooptics, Dr. Lax reports, provide a solid-state analogue of the Zeeman effect. As he puts it, the high fields have an effect on the broad solid-state bands similar to that of the weaker fields on the gas spectral lines.

What happens when a very pure crystal is placed in a high magnetic field (and cooled to liquid nitrogen temperatures to minimize noise produced by thermal vibrations), is that peaks and valleys appear in its spectrum.

The effect of this requantification is to permit resonant absorption, that is the selective absorption by solids of quanta with certain precise frequencies. Resonant absorption is characteristic of gases because of their sharply defined energy levels and is one of the most important means of detailing their atomic structure. In solids it should yield detailed quantative information about the interactions of electrons with each other and with the ion lattice that forms the foundation of the crystal.

An example of the sort of solid-state prescriptions that may become possible is a search for a thermoelectric converter being conducted by Dr. Lax and his colleagues. In principle a system that converts heat directly to electricity can be competitive with other means of power generation. The practical trick is finding a substance that will do the job with proper efficiency.

None is yet known, but the investigators have found that they need a material with the electronic properties of lead telluride, but not its crystal structure, and the thermal properties of germanium. "In the end we may have to invent it," says Dr. Lax.

IEEE

Accenting the nontechnical

For the 65,000 engineers who swarmed into New York last week for the annual meeting of the Institute of Electrical and Electronic Engineers, reports on research and development, as represented by technical seminars, were apparently of marginal interest.

In the first place, a field so closely connected to commercial production doesn't usually announce many technical discoveries until they are packaged in walnut with a price tag attached. Second, with an organization so large, and including so many diverse specialties, a narrow technological report could appeal to only a tiny fraction of those attending.

Recognizing the problem, the IEEE this year instituted a more general aim in its technical sessions, tying engineering into other areas in an attempt to find subjects that would appeal to a cross-section of the membership.

Discussion groups were held on, among other subjects, the role of electronics in transportation systems, proposed changes in the patent laws and problems raised by electronic eavesdropping devices.

Even where technical subjects were discussed, the papers presented were more of the wrap-up, where-are-we-now kind than reports of specific technical progress.

An example was the seminar on solid state technology in which four engineers brought a large audience up to date on the prospects for semiconductors, magnetic devices, piezoelectric systems, and superconductive applications. The conclusion seemed to be that cryogenics, in which metals are lowered in temperature to the point where they have practically no electrical resistance, has the most promise in the future.

"I suggest we all go out and buy helium mines," concluded session chairman S. K. Ghandhi of the Rensselaer Polytechnic Institute.

Despite the new policy on session topics—which seems to be successful, since the sessions were well attended—the technical program was small for such a large meeting. Only 49 sessions were held in the four-day meeting, far fewer than the less populous but more technically oriented meetings of other professional groups. Probably only a tenth of those at the convention attended technical meetings.

A bigger drawing card was the technical exhibition.

This year saw a decrease in the big splashy displays—several companies, reflecting poor business last quarter, cut down on exhibition space. The result was that a lot of smaller companies moved into the available space, and were represented for the first time.

The large-company disenchantment with the show reflected the hard fact that few sales are ever made there. Display booths are more a form of advertising, say the exhibitors, but worth watching to find out what the competition is coming up with.

Another popular activity in New York last week was job hunting. Although frowned on by the IEEE management, the annual gathering of talent inevitably becomes an opportunity for recruiting, to the point that some small companies are reluctant to send good men to the meeting for fear they will be snapped up.

Unlike some professional societies, which set up placement bureaus at their annual meetings, the IEEE prohibited recruiting at the headquarters hotel, the New York Hilton, and at the Coliseum where the exhibit was held. But most companies set up recruiting suites in nearby hotels.

Demand for engineers was strong and salaries were about four percent higher than last year, but recruiters seemed pleased with the prospects they saw.

New draft rules for graduate students introduced an uneasiness among prospective employers, but the draft's real impact will show up next year.

(Science News will carry the meeting's technical highlights next week.)