leaving the Intersecting Storage Rings untouched because the ISR is a unique instrument.

When, in 1970, Laboratory I promised to cut its budget by 210 million Swiss francs over an eight-year period, they instituted a three-stage program. (By 1978 the budget for the Synchrocyclotron, Proton Synchrotron and ISR programs will be half of what it was last year.) First, they made savings on things that were planned but had not been implemented. For example, instead of using the ISR for 4000 hours, it is to be used 3000 hours. The beams in the West area were not extended, the full increase in intensity of the Proton Synchrotron to be achieved by use of the Booster was delayed, and the computer was not extended. In the second stage, the growth of the administration was stopped completely, even though the work load had increased appreciably. The third stage, now being carried out, is to cut out segments of the existing operating program. Weisskopf told us, "These restrictions are worrisome, although in many respects the restrictions are certainly not worse than the cutbacks in the US."

Despite the cutbacks, the Proton Synchrotron itself has to live for another 20 years so that it can feed the SPS. So, for example, CERN is building a new 50-MeV linac injector because the old one is wearing out. If the current and pulse length on the old linac were extended any further, it would be expected to be very unreliable, not necessarily breaking down, but jittering. The old machine, which will remain in place alongside the new one, will be a standby in the running-in period. Furthermore its building may be used for other purposes, for example, the use of deuterons in the ISR, or heavy ions, or polarized protons. —GBL

Research frontiers in materials science

Selected quotations from the COSMAT study

Interatomic forces, chemical bonding, lattice stability "[The fundamental challenge is] to relate the properties of individual atoms to those of a crystalline solid composed of such atoms, particularly the imperfect solid."

Microscopic understanding of phase transitions ". . . we still lack the fundamental knowledge to predict the changes in crystal structure that occur with variations in temperature, pressure, or composition."

Amorphous, disordered state "A fully developed conceptual framework for amorphous materials is lacking and close collaboration between experimentalists and theorists . . . is a prerequisite for major progress to occur."

Impurity effects in solids ". . . we lack a general theory of the effect of impurities on materials properties at the microscopic level. The dilute limit while theoretically simplest, is experimentally difficult, while the converse is true for high concentrations . . ."

Surfaces "There is much ignorance regarding the effects of surface stress, defect structure and nonequilibrium conditions on the reactivity of metal surfaces . . ."

One- and two-dimensional systems "While some magnetic transitions have been studied in this context, virtually nothing has been done on structural, order–disorder, or ferroelectric transitions in less than three dimensions. [Further understanding] of two-dimensional systems is also essential to the eventual understanding of catalysis."

Physical properties of polymeric materials ". . . to put the structure/property relationship of polymeric materials on a firm, fundamental, and quantitative basis remains a prime challenge . . . greater in complexity than the parallel challenge posed by amorphous inorganic materials."

Collective behavior "Extensions of the concept should prove valuable in at least two directions: (a) nonlinearities and interactions among elementary excitations; and (b) elementary excitations in systems lacking long-range order."

Nonequilibrium systems "[the understanding] of materials under equilibrium conditions is far ahead of that for nonequilibrium systems . . . Recent progress in clarifying the transient and threshold behavior has illuminated analogies with equilibrium higher-order phase transitions. It is intriguing to consider more general instabilities such as hydrodynamic, magnetohydrodynamic and plasma phenomena from this point of view."

Materials science

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MAT questionaire. The generic problems in applied-materials research often cited as having high priority include investigation into five classes of properties (chemical, biological, mechanical, defects and microstructure, and electrical), four materials (composites, thin films, high-performance materials and plastics) and three processes (testing, joining and polymer processing).

Highest priority for basic research, the questionnaire revealed, was work in biological, chemical (particularly surfaces) and mechanical properties, and research into materials structurally more complex than single crystals including ceramics, composites, plastics, prosthetics, glass and amorphous materials. The subtle ways that the interaction of radiation with matter can reveal useful information about the properties and performance of materials underlines the importance of basic research on this topic.

Recommendations for action. The 24 recommendations included in the COSMAT study fall into five categories: technical, governmental, industrial, academic and professional. Technical recommendations deal with issues of energy technology, environmental considerations, recyclability and the use of renewable resources. Other technological recommendations include support for goal-oriented research, generic applied research and research into the fundamental properties of materials.

Governmental action cited by COSMAT as necessary includes taking advantage of federal laboratories, promoting of international cooperation in materials research and establishing of federal materials policy.

Industry, the committee contends, can play several key roles including the integration of materials knowledge into product design and manufacture and the promotion of civilian R&D in materials. COSMAT also proposes the formation of specialized research centers where collaboration among industry, universities and government can take place.

Universities are encouraged toward having more interdisciplinary programs and greater flexibility to allow more materials education at the undergraduate level. Block funding to materials research centers on campuses is also supported. This type of funding is "particularly appropriate for interdisciplinary programs," said Chynoweth. "It gives more local flexibility. With good, responsible administration on the campus or materials-science center, they may be able to use their funds in ways which are quite a bit more imaginative than the traditional individual funding approach."

COSMAT encourages participation of professionals to act as advisers to the government, by coordinating the information-distribution and other activities of professional societies and by obtaining manpower statistics. More flexibility in the interchange of personnel among university, industrial and governmental labs is also advocated.

The next step? The COSMAT

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