cultures, is exactly useless. "Science and engineering produce 'know-how'; but 'know-how' is nothing by itself; it is a means without an end, a mere potentiality, an unfinished sentence. 'Know-how' is no more a culture than a piano is music." For education to finish the sentence, it would have to transmit ideas of value, of what to do with our lives. Science cannot produce the ideas by which we could live.

▶*Technology with a human face.* The modern world has been shaped by technology, so we should look at technology as a possible cause of the crises that beset it. What does technology really do for us? Its primary task is to lighten the burden of work. But, says Schumacher, "the type of work which modern technology is most successful in reducing or even eliminating is skillful, productive work of human hands, in touch with real materials of one kind or another." St. Thomas Aquinas defined man as a being with brains and hands, yet to be able to use both creatively has become the rarest of privileges in a modern society, a fact which may underlie the modern neurosis.

> We may say, therefore, that modern technology has deprived man of the kind of work he enjoys most, creative, useful work with hands and brains, and given him plenty of work of a fragmented kind, most of which he does not enjoy at all. . . . Taking stock, we can say that we possess a vast accumulation of new knowledge. . . . The use we have made of our knowledge is only one of its possible uses and, as is now becoming ever more apparent, often an unwise and destructive use.

The direction which modern technology has taken is the opposite of real progress, Schumacher argues. There must be a new orientation, which everybody must help decide, since it cannot be left to the experts. "Today, the main content of politics is economics, and the main content of economics is technology. If politics cannot be left to the experts, neither can economics and technology."

▶*Science and the Third World.* In many countries the poor are getting poorer, and the established processes of aid and development seem unable to reverse the trend, but rather promote it. What has gone wrong, in Schumacher's analysis, is that aid givers have established new industries, mostly in the cities, and largely in imitation of Western economies. But the common criterion of success—growth in GNP—is utterly misleading. It is more important that everybody should produce something than that a few people should produce a great deal. What should be done is to create cheap workplaces, located in the countryside and based on production technologies that use local materials and easily acquired skills.

Intermediate Technology

To such small-scale, labor-intensive, cheaply created forms of production, Schumacher gives the name "intermediate technology." In the belief that the best form of aid is knowledge, he founded the Intermediate Technology Development Group (ITDG) in 1966 to make Third World countries aware of the alternatives that exist to the high technologies touted

Geological Survey Lowers Its Sights

The U.S. Geological Survey has dramatically lowered its estimates of undiscovered, recoverable oil and gas resources in the United States, and the Survey's new estimates are already having an effect on national energy policy. In a document the Energy Research and Development Administration bills as a new "national plan" for energy R & D, ERDA says the Survey's reappraisal means that extending the life of U.S. oil and gas resources has become the nation's "first technological need."

In March 1974 the Survey estimated that between 200 billion and 400 billion barrels of oil and 1000 trillion to 2000 trillion cubic feet of natural gas remained to be found and produced by conventional technology on- and offshore in the United States. The Survey's latest estimates, which follow an extended controversy over the validity of the 1974 figures (*Science*, 28 February 1975), place undiscovered recoverable oil at 50 billion to 130 billion barrels and gas at 320 trillion to 655 trillion cubic feet. The lower figures are said to have a 95 percent probability of being correct and the higher figures, 5 percent.

Estimates of offshore oil and gas alone fell even more sharply than the overall figures. Whereas the USGS previously predicted 65 to 130 billion barrels of oil would be found on the continental shelves to a depth of 200 meters, the Survey now estimated 10 to 49 billion barrels, with the lower figure having a 75 percent chance of being right and the higher one a 25 percent chance.

According to ERDA's R & D plan, released on 28 June, the new estimates imply that current rates of oil and gas production will be "difficult to maintain" even after oil and gas begin flowing from the continental shelf and Alaska's North Slope. Without the application of enhanced recovery technology, the plan's 8-page summary declares, "the estimates indicate that production of domestic oil will drop rapidly in the mid-1980's, as will the production of domestic natural gas. It is unlikely that major new energy resources could be ready by that time."

Advanced recovery technology would, the plan continues, buy roughly 10 years of added time. This decade is said to be "crucially important," for it would effectively double the time available for developing major new sources of energy.

Oil industry analysts and some of the U.S. Geological Survey's own experts have long regarded the USGS estimates as far too high, but it was not until last summer, when the National Academy of Sciences' resource committee agreed to arbitrate the disagreement, that a resolution seemed in sight. Last February, the academy committee concluded that USGS had used some misleading math in its estimates and that something like 113 billion barrels of oil and 530 trillion cubic feet of gas remained to be found. This was close to most industry estimates and to those propounded for many years by M. King Hubbert, a senior geophysicist at USGS.

In the meantime, the Survey was working on its revised estimates using a more sophisticated approach that resembles those of major oil companies. Regional specialists analyzed more than 100 distinct petroleum provinces, plugged in what the Survey called "large quantities of new geologic and geophysical data" and, for the first time, assigned probability limits to the new estimates. All of this has been greeted with praise by Hubbert, one of the Survey's most persistent critics.

"It's revolutionary," Hubbert exulted in a recent conversation. "For the first time in 15 years the USGS has got down to dealing with facts, not fancy . . . they worked the hell out of all the information they could get."

As for the controversy that had clouded relations between the Survey and Hubbert, one of its more distinguished employees, Hubbert said, "The air has been cleared almost completely. This situation has come to an end."—R.G.