perature dependence of the correlation length is marginally better described by the form predicted by the dislocation melting theory, $\kappa \propto \exp[-B(T - T_M)^{-\bar{\nu}}]$, than by the conventional power law singularity of the form $\kappa \propto (T - T_c)^{\nu}$. Of course, the most notable observation is that the correlation length grows increasingly rapidly as T_M is approached from the fluid side to a length scale far in excess of those seen in any three-dimensional liquid and greater than the size of any two-dimensional computer-simulated system. These data thus provide very convincing evidence for a higher order transition.

While many experiments need to be done to make a conclusive case for dislocation-mediated two-dimensional melting, the results of the experiments described here look extremely encouraging in a number of cases.

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Critical Care at Tianjin's First Central Hospital and the Fourth Modernization

Renée C. Fox and Judith P. Swazey

The Chinese refer appreciatively to what they call a "window-picture": a dynamic view of a landscape, framed by a window in such a way that it is not only esthetically pleasing but also humanly interesting and intellectually and morally edifying. The Critical Care Unit (CCU) of the Tianjin First Central Hospital constituted such a window-picture for us (*1*). It provided us with a concrete, focused perspective on the application of China's current policy of the four modernizations (agriculture, industry, national defense, and science and technology) to the field of medicine. On this unit, the fourth modernization (*2*)—science and technology—is continuously brought to bear on the cases of critically ill patients who are sent to the hospital from the cities and the countryside of the province in which it is located. The CCU is part of a prominent, urban, "upper middle level hospital" that is known for its leadership in nursing and its competence in medicine and surgery, particularly the treatment of emergency and critical conditions. The hospital is committed to serving the patient by progressively "scaling the heights" of modern medicine through advanced scientific and technologically sophisticated care, scientific research, scientific management and quality control, and the effective teaching and implementation of "medical morality."

In striving to realize these goals, the CCU epitomizes the complex processes of what the Chinese call "walking on two legs" (*3*). A chain of dualities is involved: an intricate balancing of modern Western and traditional Chinese medicine, community public health and individual patient care, central control and institutional autonomy, preventive and curative medicine, primary and tertiary care, acute and chronic illness, rural and urban needs, mental and manual labor, being "Red" and being "expert," proletarianism and elitism, the old and the new, and the balancing of ideas and resources imported from abroad and "made in China."

A series of dilemmas that ramify beyond the walls of the First Central Hospital and its CCU are contained in these dualities. Societal precepts constantly shift concerning how the dilemmas ideally should be resolved, and what combinations of binary elements and states of equilibrium between them this implies. Proper "two-leggedness" in the medical as in all other spheres of Chinese society is not only defined and monitored but repeatedly altered by the flow of minor and major national policy directives that

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emanate from the political leadership in Beijing. In part, these fluctuations in policy are transforming consequences of the interaction between still another set of basic dualities: the canons of Communist Party doctrine and the dictates of Chinese pragmatism.

Summary. This case study of the Critical Care Unit at Tianjin's First Central Hospital, its physician-director, and one of its patients provides a portrait of how the policy of the four modernizations is being applied to the field of medicine in the People's Republic of China. On this unit of an urban hospital the "fourth modernization," science and technology, is systematically brought to bear on the problems of critically ill patients. The Chinese dualities and dilemmas that this "scaling the heights" policy entails are continually played out on the Critical Care Unit. An intricate balancing is involved between modern Western and traditional Chinese medicine, and between rural public health programs and primary and tertiary care services, within a medical morality framework that combines present-day political ideology with age-old ethical precepts. At this juncture the overall balance seems to be moving in the direction of modern, city-based, curative medicine.

The 4 weeks that we spent doing fieldwork in the hospital in June 1981 gave us a firsthand opportunity to see how some of these aspects of China's modernizations are played out in a medical setting whose rationale and very existence depend on the availability and application of advanced science and technology. Through our involvement in the daily round of the unit, our close contact with its medical director, Dr. Wang Chin-ta, and through following the case of "Small Boy," who was admitted to the CCU as a patient the same day that we made our initial visit to the unit, we gradually developed our window-picture view.

The "Pacer of the Road"

Dr. Wang Chin-ta is the ebullient founder-director of the CCU. To his staff, Dr. Wang is "the pacer of the road," the individual who developed China's first independent critical care unit, and a man "whose hard work and spirit of self-sacrifice mean much to the people of Tianjin and other parts of China."

Born in Beijing in 1925, Dr. Wang was influenced by his mother "to become a physician and save lives." He admits that at first he did not like either the idea or the fact of being a doctor but gradually began to feel "great satisfaction [with medicine], especially when a patient recovered." To this day, he finds his supreme pleasure in "seeing a patient cured. . . . A fully recovered patient is our Nobel Prize!" he exuberantly declares.

Wang Chin-ta attended Peking University Medical College, from which he graduated in 1944. During his undergraduate years he considered choosing public health as his special field. He still believes that "public health problems are the most serious and important ones in China," and that "in order to raise the health level of the people, the best method is preventive—particularly in a country that is not wealthy, like China."

Nevertheless, Dr. Wang opted for a career in critical care medicine because, as he explained:

> One of the major responsibilities of doctors is to prevent disease; the other is to reduce the mortality rate. . . . How to care for the acute patient? How to reduce their mortality rate? If even one [such] patient dies, there is a lot of trouble. If he is the pillar of the family, for example, there are a lot of economic troubles . . . troubles with the education of the children, and so on. . . . To reduce the mortality rate is more complicated [than to prevent disease]. By my personality . . . but not out of pride . . . or arrogance, I hope, . . . I chose to do the more difficult job . . . [to take] the not very smooth road . . . of critical care work . . . a new and necessary branch of medicine.

By the time he started his house officer training at the Christian Hospital in Beijing, Dr. Wang had decided on a career in critical care and had married a physician, a former classmate at Peking University Medical School.

In 1949, soon after the People's Republic of China was established, Dr. Wang went to Tianjin for postgraduate training. Accompanied by excellent personal recommendations from a senior physician in Beijing, he became an assistant to a highly regarded doctor in the Sky Harmony Hospital. Thirty-three years later, he is still living in the same city and working in essentially the same hospital. (In 1956, the Sky Harmony Hospital was amalgamated with the Postal and the Textile hospitals to form Tianjin's First Central Hospital.)

When the decade of the Cultural Revolution (1966 to 1976) arrived, Dr. Wang was established as a respected physician at First Central Hospital. All around him, Dr. Wang saw fine medical traditions being "smashed." Medical schools stopped functioning. Older doctors could not teach, train, or correct younger doctors. Many were sent to the countryside to work. Scientific research and publication ceased. Contact with medical ideas and colleagues from abroad was choked off. Colleagues no longer felt that it was safe to talk freely with one another, even about professional matters. Patient charts, clinical records, x-ray films, slides, specimens, teaching materials, medical journals, textbooks, and the hospital library were physically destroyed.

By 1971 conditions had improved somewhat, and many physicians who had been prohibited from practicing their profession were permitted to resume seeing patients. Dr. Wang was selected to become the Director of Internal Medicine at First Central Hospital in 1972. In 1974 the CCU was officially established by the Party Committee of the First Central Hospital, and Dr. Wang was appointed co-director along with an obstetrician. Initially, four beds of a medical ward were allocated to the unit, but by 1976 it had expanded to a total of 48 beds and had become a separate, freestanding unit. Now, to make way for new equipment, the 48 beds have been reduced to 33. Dr. Wang became sole director of the CCU in 1975.

"Scaling the Heights"

Reflecting the national priority attached to the development of science and technology, Dr. Wang and other leading physicians and nurses refer to the importance of "scaling the heights of medical technology" in their efforts to advance the level of medical care in the People's Republic.

Today, the CCU is staffed by 59 persons, including 18 physicians, 3 doctors of traditional Chinese medicine, 20 nurses, and 5 technicians, who deal with an array of complex, life-threatening medical problems. These include shock, sepsis, drug poisoning, refractory cardiac arrhythmias, congestive heart failure, severe disseminated intramuscular coagulation, acute respiratory distress, and acute renal failure.

As one first tours the CCU, observing its physical layout, organization, and the care of its patients, the sights and sounds are strikingly different from the intensive care settings of American hospitals.

Above all, one is struck by the silence—nurses, doctors, and other staff move noiselessly and purposefully about the unit; patients lie quietly in their plain beds in simply furnished, shabby, but immaculate, rooms; there is little audible conversation and no sounds of bells, beepers, monitors, or phones.

In addition to its large general recovery wards, conference rooms, and small offices, the unit has six other rooms that are the focus of its intensive care efforts. The acutely ill patients are usually treated for 3 to 5 days in a five-bed monitoring room with 24-hour coverage by physicians and nurses. Adjacent to the monitoring room, somewhat less critically ill patients are cared for in a six-bed recovery room. A short distance down the hall a small room is filled with one examining table and an array of equipment used primarily for hemodynamic monitoring. Equipment for other types of tests, such as for blood gas analysis and determination of blood coagulation factors and osmolarity, are available in two small laboratories. Finally, at the end of the CCU corridor, an airy room that looks as though it once served as a sun porch has been converted into the acute hemodialysis room, where some 40 to 50 patients are treated a year.

The equipment with which these rooms are filled, each piece neatly inside a fitted, light blue cotton slipcover to protect it from the dust and soot of Tianjin when not in use, represents an international assortment of medical technology. Touring the unit, one notes electrocardiograph and oxygen monitoring equipment from West Germany, a CO_2 analyzer and cardiac output computer from the United States and United Kingdom, multifunction monitoring equipment from Japan, Holland, and East Germany, ventilators from Sweden and East Germany, Japanese, Chinese, and Swedish dialysis equipment, an American osmometer and photometer, and a Danish blood gas analyzer. The selection of this equipment, Dr. Wang said, is predicated on cost, utility, and serviceability. By and large, he commented, American equipment is too expensive, while an advantage of Japanese equipment is that their engineers can visit the hospital annually to check and service it.

On one of our last visits to the CCU, Dr. Wang proudly showed us the unit's newest piece of equipment that had just been unpacked and installed in one of the laboratory rooms: a Danish *p*H analyzer, with a computerized video display screen, the first such fully automated machine the unit had obtained. Visible over Dr. Wang's shoulder, as he seated himself at the machine's console to show us how it worked, was a large bell jar on the windowsill. The jar contained a horseshoe crab, employed for testing patients' endotoxin levels and determining the dosage of traditional Chinese medicine that is used to treat endotoxemia. This juxtaposition of *p*H analyzer and horseshoe crab was a visible expression of the ways that Chinese medicine, in an area such as critical care, is seeking to integrate its drive to "scale the heights" through advanced science and technology with its centuries-old indigenous medical knowledge.

"Medical Morality": The Ethos of the CCU

For Dr. Wang, the mandate to move ahead with critical care medicine carries with it the moral obligation to work harder than ever. The "day and night" work to which he feels committed, as a pioneer and promoter of critical care medicine, involves the dual task of repairing the scientific, technical, and moral damage done to medicine by the Cultural Revolution, and progressively improving and transforming it, so that in all these respects Chinese medicine will meet the highest criteria and most advanced goals of the four modernizations.

It is primarily through his role as Teacher, in the full Chinese sense of the term, that Dr. Wang grapples with these problems and challenges. In his effort to raise the competence of the doctors and nurses on his CCU staff, he attaches great importance to the cultivation of "medical morality," as well as to the transmission of medical knowledge and skills. His emphasis on moral character and excellence, on rectitude, and on good attitudes and thought is not only expressive of current political ideology; it is central to the age-old moral precepts of the Chinese world view. Within this ethical framework, at once ancient and modern, the medical virtues that Dr. Wang continually stresses in his teaching include a scientific spirit, a high degree of responsibility, a spirit of self-sacrifice, a good sense of discipline, hard work, alertness, clarity, coherence, patience, self-control, modesty, honesty, the capacity to be frank about one's own limitations, shortcomings, and mistakes, as well as those of colleagues, and the willingness to be helpful to colleagues, to share knowledge with them, and to be fair to them.

Not only in his teaching, but also in his executive functions as organizer and director of the CCU, Dr. Wang is highly interested in the content and quality of relations between all medical and nursing professionals participating in critical care. His preoccupation with proper and harmonious relationships is as fundamentally and traditionally Chinese as the primacy that he accords to moral attributes and the perfecting of character. In the CCU situation, there are two sorts of relations that especially concern him.

To the first of these—"transprofessional" (interdisciplinary) relations—Dr. Wang makes frequent, explicit reference. "Many tasks must be combined in CCU work," he affirms, "because many body systems are involved. Achieving transprofessionalism, he concedes, is difficult. "If in a hospital, the heart department is authority, the lung department is authority, and the kidney department is authority, and they are all equal, [the doctors involved] won't listen to each other." In his view, doctor-nurse as well as doctor-doctor relations are also integral to transprofessionalism.

The second aspect of relationships on the CCU to which Dr. Wang is continually attentive is more delicate and latent. He rarely speaks of the problems involved, and never directly. These are the deep and subtle ways in which the experiences that the physicians and nurses of the CCU lived out in the time of the Cultural Revolution affect their current working relations with one another. During the Cultural Revolution, some of the men and women now on the CCU staff were sent to the countryside, and some were not. The form of "egalitarianism" that was imposed not only abolished all previously established status distinctions between different grades of physicians and between doctors and nurses, but also turned the status hierarchy upside down, so that in many instances younger, more junior colleagues had dominion over older, more senior colleagues. But now, irrespective of what happened to them and between them in the course of the Cultural Revolution, these physicians and nurses must work together in what is essentially a lifetime employment system on a medical service that requires an unusually high level of coordination and reciprocity, civility, and unity.

Small Boy

We most clearly saw the technological capabilities, ethos, and work of the CCU by following the case of a patient whom Dr. Wang and his staff affectionately called "Small Boy." During our first visit to the CCU, we heard Dr. Wang and his colleagues briefly discussing the im-

pending admission of a dying child, a boy of 13 who was being sent to the CCU from a rural hospital. The next morning we saw the boy, an oxygen mask covering his face, lying motionless in a screened-off bed that had been placed in the corridor because all the unit's regular beds were filled. Soon, Dr. Wang and some 18 of his staff gathered in the hall around the boy's bed for morning teaching rounds (Fig. 1).

The CCU staff was told that the boy had been taken to his local rural hospital with severe stomach pain and that appendicitis had not been diagnosed until 24 hours later, by which time the appendix had ruptured. Thirty-six hours after a too-late appendectomy, the boy had been transferred to First Central Hospital's CCU. He had a high temperature, a rapid pulse and respiration, disseminating peritonitis, complete renal failure, and possibly acute respiratory distress and disseminated intravascular coagulation. "His prognosis," Dr. Wang said later in the conference room, "is not good. The boy's family will come tonight during the hospital's visiting hours, and, because he is so ill, a family member will be allowed to spend the night with him."

For some 30 minutes, standing over the boy, Dr. Wang questioned, taught, and when necessary criticized his staff. He was displeased with the quality of the history that a resident and staff doctor had taken. "A history," he said, "must be illuminating like the sunrise, not like the sunset. You need a clear history of the boy to develop treatment plans. You doctors should make your own description, not rely on others." He also chastised his staff for having prescribed the wrong combination of antibiotics (penicillin and ampicillin) instructing them "not to give two drugs from the same family."

On the basis of an endotoxin test, it was decided that the boy would receive oral doses of a traditional herbal medicine to combat sepsis, and that an atrioventricular fistula would be made so that he could undergo renal dialysis.

Diffuse peritonitis like Small Boy's, we were told, is rarely seen in city hospitals, but is more common in the country. Sometimes such complications occur because parents delay seeking care of a sick child, or because the facilities and equipment in a local hospital are insufficient; sometimes they are due to diagnostic or treatment errors, or poor surgical technique by physicians who were inadequately trained during the years of the Cultural Revolution. (The unit treats many cases of septic shock, referred for care from both within and without the hospital. With the CCU staff's increasing knowledge and skill, the hospital's mortality rate from septic shock decreased from more than 30 percent in 1974 to about 10 percent in 1981.)

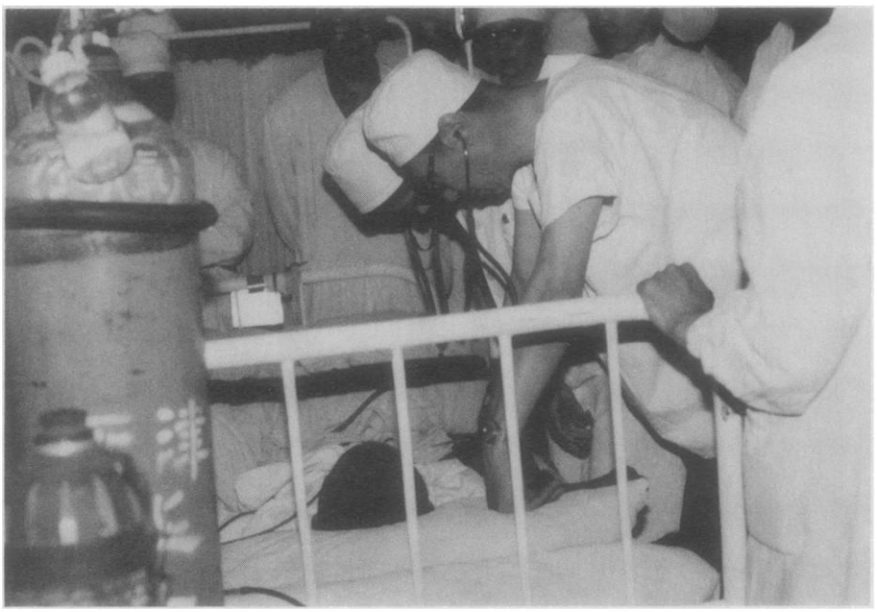

Fig. 1. Dr. Wang and his staff gathered around Small Boy's bed for the morning teaching rounds.

The following day, when we were escorted to the dialysis room, the boy was being placed on the artificial kidney for his first treatment. Dr. Wang reported that, with the use of antibiotics and traditional Chinese medicine, his patient's blood pressure had stabilized, his temperature was lower, he had put out 1500 milliliters of urine, and his intestinal peristalsis was returning. The boy's mental condition also was better; although still lethargic, he could answer the doctor's questions. Dr. Wang commented that the country hospital doctors who had initially taken care of the boy already knew their mistake—that they had delayed operating for 24 hours. In cases where the doctors did not realize their mistake, it was his practice to give them a report by phone or in writing, and sometimes to ask them to come and see the patient at the CCU.

The next day Small Boy was moved to an available bed in the men's recovery ward. His father and another relative had taken turns staying with him during the night. During morning care, two nurses patiently fed the boy spoonfuls of a watery-looking orange juice. He stared at them, and us, somberly, but his face lit up when he saw Dr. Wang.

Several days later, outside the hospital we met Small Boy's mother, a petite young-looking woman who had arrived from their home in the countryside to join the other family members in their vigil. Small Boy, we learned, is an only child; he had a sister who died. Beaming with joy, she shook our hands and expressed her thanks "for the society of medical workers who save so many children."

The boy was much better but continuing to show the effects of renal failure and suppurative peritonitis. He was still receiving dialysis, traditional Chinese medicine, and antibiotics.

On our last visit to Small Boy, near the end of June, he became ambulatory. We were on hand to photograph this happy event in his life and the unit's. After shaking our hands and saying hello, he was helped out of bed and took his first slow, wobbly steps in over 3 weeks. His nurses had dressed him in a new white T-shirt and white shorts, that hung baggily on his now very thin body. Like mother hens, they arranged and rearranged his outfit, straightened his corner of the ward, and posed him several times for "the picture" (Fig. 2).

Medicine and the Fourth Modernization

There were numerous indications that the CCU, its director, and the more general development of critical care medicine in China, are officially well regarded in relation to the country's current policy goal of achieving rapid modernization. The impressive amount of imported technology that is being delivered to the CCU has all been considered and approved consecutively by the president and the planning committee of the hospital, and by members of the local

Fig. 2. Dressed by his nurses in a new white T-shirt and shorts, Small Boy prepares to take his first steps in over 3 weeks.

Health Bureau who process applications for equipment. When an application is approved, Dr. Wang simply fills out the requisite purchase order for the import-export company through which the largely foreign equipment is obtained. He has been permitted to spend more than $300,000 for the critical care technology on his unit. These purchases have been favored and facilitated by the political leadership and the party.

Critical care medicine was accorded official status in 1978, as an integral part of the government's 8-year plan for the modernization of China's science and technology. Dr. Wang is a high-ranking senior physician. In 1978, at the National Science Conference held in Beijing's Great Hall of the People (*4*), Dr. Wang reported on the work of First Central Hospital's CCU which, after 4 years of existence, had treated 360 patients with an overall drop in the mortality rate from 40 to 20 percent. The CCU's work on multiple organ failure was identified at the conference as one of 108 key research projects in the country.

In this same year, physicians interested in critical care medicine met for the first time to plan and organize a national Critical Care Unit Association. Dr. Wang was named chairman of this association, and four national meetings have been held—several of them in Tianjin—on such topics as circulatory, respiratory, and renal failure. The association is still awaiting official approval by the State Scientific and Technological Commission. Since the National Science Conference was held, so many new scientific associations and centers have been established that the commission has felt it wise to slow the process down while some specific policy guidelines and more orderly planning procedures are developed.

To date, within the microcosm of modernization that the CCU represents, Dr. Wang's efforts have been largely directed toward the mobilization, deployment, and improvement of the scientific, technological, and human resources that the functioning of this sort of advanced medical unit requires. Although he says he realizes that health cannot surpass the economic level of the country, or medicine the scientific level, he is strongly committed to obtaining resources for the CCU. He would like to expand and reorganize the unit into a center made up of distinct but interdependent cardiac, renal, and respiratory subunits, with a good research laboratory as well as excellent clinical facilities. He realizes, however, that with all the patients who are sent to this unit from hospitals and health stations throughout the province, along with those who are transferred to the CCU from services within First Central Hospital itself, "even 100 beds would not be enough to meet our critical care needs." In an attempt to respond to this problem, Dr. Wang regularly sends physicians on his staff to upgrade the training of medical workers in the province's hospitals and of barefoot doctors in the countryside. This will increase the ability of these workers to care for some of the patients who are now transported to the CCU, and it will also enhance their ability to recognize when their knowledge and skill are too limited to handle a case and may result in their referring more patients to the CCU or other urban hospitals.

The problems associated with the allocation of resources that now confront Dr. Wang and the CCU are concrete instances of a more general set of problems that the national policy emphasis on medical modernization has incipiently created. While the provision of funds, facilities, equipment, personnel, and training to promote modern medicine can enhance the sophistication and quality of medical care in China, it also raises questions about how much should be committed to this type of medicine, how it should be distributed geographically and between medical institutions, and about who should be the recipients of such care.

The dramatic results of the massive public health program launched in the 1950's have radically altered morbidity and mortality patterns in China, so that its medical care needs now resemble those seen in more industrialized nations such as the United States. To meet these needs, in accord with the post-Mao ethos of the four modernizations, there are many signs pointing to China's development of a personal health system very different in costs, orientation, and organization from the public health system implemented under Chairman Mao to meet the medical problems of his country's predominantly rural population.

The First Central Hospital's CCU is emblematic of these new trends in China's medical care, as are several other medical settings that we observed in Tianjin and Beijing during our 6-week stay in China. Bioengineering research, including the development of an absorbent artificial kidney, acute renal dialysis capabilities, and organ transplantation programs, as well as the imminent opening of the country's first chronic dialysis unit at Tianjin's Teaching Hospital Number Two, the still primitive neonatal intensive care facilities, and the beginning excursions into clinical genetics, are signs of China's burgeoning adaptation of advanced medical technology, the type of medical care in which it is embedded, and its confrontation with the economic, political, ideological, and moral issues it poses.

Although the official legitimation that now exists for promoting more advanced medical care has reduced some of the tension to which medical professionals such as Dr. Wang were subject during the period of the Cultural Revolution, it creates still other tensions. Foremost among these is the allocation of scarce resources dilemma that the medical pro-

fession and the country as a whole now face (*5*). In a society as poor as China, which has entered the era of the four modernizations, what kind of balance should ideally be struck between supporting the predominantly rural public health programs and primary care services created by Chairman Mao, and fostering the development of greater competence to apply the knowledge and skills of modern medicine to the treatment of patients in medical institutions, staffed by highly trained professionals, that will probably have to be located largely in cities?

At this juncture, the overall balance seems to be swinging in the direction of the latter alternative and the favoring of medical settings like the CCU of Tianjin's First Central Hospital.

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Alternative Energy Futures: The Case for Electricity

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Summary. The energy trends of the past and their likely evolution in the next 50 years have been analyzed in the light of technological progress. It is concluded that society will tend to become less centralized than in the past and that it is possible to have future per capita values of energy consumption at the world level similar to those at present, with a substantial redistribution to allow for economic growth of the less developed countries. A condition for this is increasing penetration of electricity. The rationale for the suggested scenario is described, and prospects for electricity for both the industrialized and developing countries are discussed.

Current estimates of the size of the energy systems required to carry the world's population through the next century differ by at least an order of magnitude. High-energy futures explored by Haefele and co-workers at the International Institute for Applied Systems Analysis (IIASA) involve a three- to fourfold increase in world primary energy consumption over the next 50 years (*1, 2*). Analysis of low-energy futures by Lovins and co-workers (*3, 4*) indicate that it will be possible to survive comfortably, and even with an improved standard of living 50 years hence, on as little as half of the energy consumed in the world today, notwithstanding a doubling of the population in the same period.

Both these visions of the future are possible and they may be considered internally consistent in all their major static equilibrium features. In real life, however, social and economic systems are highly dynamic and consist of independent decision-making elements aimed at different objectives, frequently unrelated to energy as such. Social, economic, and political factors, rather than enlightened choice, eventually dominate the actual course taken by nations in their quest for fulfillment of their basic needs.

Both the hard approach of Haefele and the soft approach of Lovins remind us that what is required is not energy itself, but the services that require energy. Lovins makes it clear that a great deal of energy is wasted today, while technologies are, or will soon be, available to substantially improve energy efficiency in end uses. The hard approach emphasizes the importance of functional efficiency of the energy systems to be favored in the future. The two approaches, taken together, indicate that energy is not necessarily required in large quantities, but needs to be available in forms with increasingly high quality.

It is safe to assume that the most likely future course of the world energy system will lie somewhere between the hard and soft extremes, which may be considered as boundary cases. Colombo and Bernardini (*5, 6*) have suggested a different, more pragmatic approach to the study of energy futures; they predict in 50 years a doubling of the world population and energy consumption, and they assume a substantial redistribution of per capita energy consumption in the industrialized and developing countries.

Our scenario is based on a study of the energy trends of the past and an analysis of their likely evolution in the next 50 years, considering the progress of technology and the availability of capital for investment, and discarding unrealistic hypotheses concerning the structure of political power, and requiring tight coordination worldwide.

We do not assume that urbanization is inevitable. In the past, urbanization was favored by population pressure; the availability of centralized energy systems, which were far cheaper in urban areas than the decentralized energy systems they displaced; and the development of large-scale technologies, which have dominated the world scene. Prospects for the future appear quite different. In industrialized countries population is practically stationary and potentially declining; population pressure still exists in developing countries, but the context of energy and technology is quite different. The diseconomies of the very large scale—due to its excessive rigidity, environmental impacts, and other factors—need not be discussed in detail.

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