Chinese Science after Mao

Communist China's detonation of a 20-kiloton nuclear device on October 16, 1964, gave many Westerners the impression that Chinese science had entered the modern age. In fact, it had not. Overlooked was Beijing's reliance on Soviet and other foreign technology and expertise. And it was not only in *nuclear* science that China lagged behind other world powers. Chinese culture, it seems, was the chief culprit. Since 1978, China's post-Mao leadership has committed itself to the "modernization" of science. Here Richard Baum discusses a number of strong traditions that still stand in the way of success.

by Richard Baum

Speaking at China's National Science Conference in March 1978, Vice-Premier Fang Yi boldly proclaimed that China was "entering a new stage of flourishing growth" in science and technology.

"The dark clouds [of the Cultural Revolution] have been dispelled," he averred, "and the way has been cleared. A bright future lies ahead of us."

Fang Yi's pronouncements were not simply official rhetoric. Science and technology in China have undergone a significant renaissance since 1978. Thanks largely to reforms enacted under the "Four Modernizations,"* budgets for basic scientific research have been boosted, and more than 100 professional, science-related societies have been founded or revived. Beijing's new political leaders have allowed scientists rather than party cadres to head scientific institutes, and the work of research units is increasingly geared to China's developmental needs rather than to broad, politically motivated (and frequently unrealistic) programs.

In addition to a general improvement of wages and working conditions, thousands of research scientists have been sent abroad for training. In 1982, for example, more than 10,000 Chinese were studying in Western countries, including about 6,000 in the United States.

These reforms have without question provided a more rational structure for the pursuit of China's scientific and technological goals. They have also improved the status of China's 600,000 research specialists, many of whom suffered severe persecution during the Cultural Revolution's "decade of destruction" (1966–76).

Yet, despite signs of progress, the

*Modernizations of industry, agriculture, science and technology, and defense.

Chinese remain their own worst enemies when it comes to modernizing science and technology.

Chauvinism and fear of change are two qualities that have distinguished Chinese civilization for millenia. Unlike the Japanese, who for complicated historical reasons (e.g., internal group rivalries and power struggles) have been open to outside influences, the people of the "Middle Kingdom" have tended to look on anything from abroad as suspect and potentially dangerous, if not downright inferior.

Even with the passing of the traditional Confucian order, a process that began in the late 19th century and culminated with the Communist victory in 1949, certain distinctive styles of thinking and acting survived. They survived, moreover, because they were largely compatible with Chinese Marxism.

Several of these traditions impede China's development of modern science and technology. One of the most powerful is "cognitive formalism," an intellectual tradition with roots in the pseudoscience of classical Chinese philosophy.

According to Joseph Needham, the noted historian of Chinese science, cognitive formalism can be traced to the early (sixth century B.C.) Taoist theories of the "five elements"

Posters announcing scientific and technological progress are transported on bicycle wheels in this 1958 parade in Beijing. The greatest advances made under Mao were infrastructural—transportation and dam construction.

(wood, fire, earth, water, and metal) and the "two forces" (yin and yang).

In Taoist philosophy (as subsequently expanded by the Confucians to include human relationships), the "five elements" were assumed to lie behind every natural substance and process. Indeed, everything in the universe susceptible of numerical categorization was associated or correlated with the "five elements" (or permutations thereof). To this view of nature was added an element of limited dynamism with the incorporation of the yin/yang theory of cyclical flux.

This theory explained change as the interplay of two powerful cosmic forces, one negative, passive, and weak (yin), the other positive, active, and strong (yang).

Both Taoism and Confucianism embodied what Needham has called "associative thinking."

> It is a system that works by association and intuition, and it has its own laws of cause and effect. . . . It differs from the type of thinking characteristic of modern science, where the emphasis is on external causes. It does not classify its ideas in a series of ranks but side by side in a pattern. . . .
>
> Things behaved in particular ways not necessarily because of the prior actions of other things, but primarily because their position in the ever-changing cyclical universe was such that they were endowed with intrinsic natures which made such behavior natural for them.

In Needham's view, the dominant features of Chinese associative thinking—as manifested, for example, in the metaphysical classic, the *I Ching*—are its emphases on *organicity*, *order* and *pattern*.

Many observers have connected China's slow scientific development in the 19th and 20th centuries with the classical Chinese philosophical tendency to seek order and harmony by dividing the human and physical worlds into a number of intuitively fixed categories.

Irritating Mao

According to Derk Bodde, a leading authority on classical Chinese civilization, formalistic "categorical thinking" failed "to produce a true physical science because, being based upon man-made analogies, [it] . . . distorted and forced natural phenomena into an artificial pattern."

Categorical thinking did not die with the imperial order. In an essay written in 1942, "Oppose Stereotyped Party Writing," Mao Zedong criticized his fellow party cadres for "not using their brains to think over problems and probe into the essence of things." Too many comrades, he argued, "are satisfied merely to list phenomena in ABCD order." Mao likened such thinking to the schematic layout of the traditional Chinese pharmacy, where individual herbal tonics were neatly arranged "in cabinets with numerous drawers, each bearing the name of a (particular) drug."

Such schematic classification, complained Mao, "takes a conglom-

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eration of concepts that are not internally related and arranges them . . . simply according to the external features of things." Characterizing the pharmacy approach as the "most crude, infantile and philistine of all," Mao dismissed it as being "devoid of real content."

Although it is undoubtedly true, as the late historian Joseph Levenson once pointed out, that "the categories of Chinese communist thought are not traditional," and that "Confucian harmony is not Marxist struggle," many of the same qualities attributed by Needham to "associative thinking," by Bodde to "categorical thinking," and by Mao to "stereotyped formalism" continue to find expression in contemporary communist China.

Pseudoscience

The Chinese communists' penchant for neatly categorizing and labeling "correct" and "incorrect" ideas is one familiar example. Another is the tendency to believe in the reality of such abstract concepts as the "basic economic law of socialism," the "four fundamental principles," or the "10 major relationships."

Even in the origins and early development of the recent Four Modernizations campaign, one can find evidence of the formalistic approach.

When erstwhile Chinese Premier and party chairman Hua Guofeng first outlined the Four Modernizations in 1978, he identified the success of the campaign with the completion of 120 key industrial projects, including mines, steel mills, power plants, and harbors. What he failed to consider adequately was the enormous financial cost and critical shortages of skilled labor, energy, and transportation.

A crowd gathers outside a popular 19th-century Peking pharmacy.

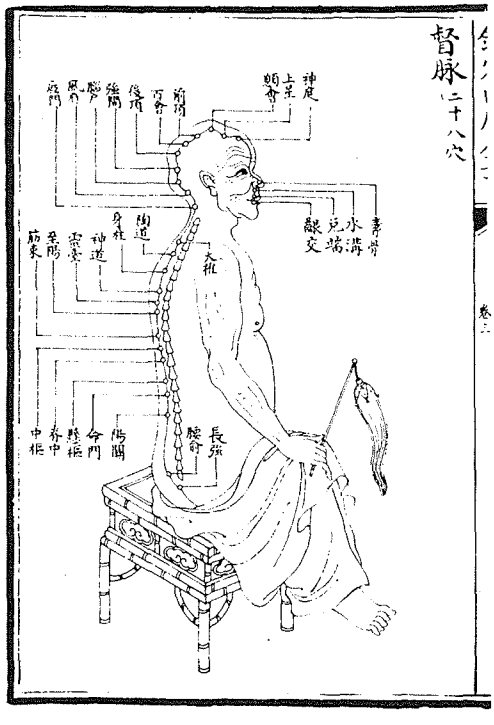
Hua's analytical weakness was sorely evident in the case of the Baoshan Iron and Steel complex. Intended to be the showcase of his grandiose modernization plan, it was launched in 1978 without feasibility or economic cost-benefit studies. The result, not surprisingly, was a multibillion-dollar boondoggle.

When Hua's plan for quick-fix modernization proved unworkable, his economic thinking was officially derided as "unscientific." He was sternly rebuked by his party colleagues for having concentrated, in formalistic fashion, on the one-sided pursuit of the modern *(xiandai)* to the virtual neglect of the all-important process *(hua)* by which modernity was to be achieved.

Thus, the formalism that characterized classical Chinese thought is very much alive in the People's Republic of China—if not among Chinese scientists and technical intellectuals themselves (many of whom have grasped more sophisticated analytical methods), then at least among the nation's political leaders, who set the goals and priorities for the research and development sector, appoint administrators, allocate budgets, and oversee operations.

Another obstacle to China's scientific development—and one which *seems* to contradict the first—is a tradition of narrow empiricism. Because classical Chinese philosophy relied so heavily on the metaphysical theories of the "five elements" and the "two forces," a sizable gap developed between theoretical *concepts* and empirically perceived *data*. The concepts were often primitive and unsophisticated, reflecting the crude formalism of associative thinking, while the data were frequently rich in detail and often led to techniques of great practical utility.

A good example of this curious combination is the Chinese medical science of acupuncture, which has, over a period of many centuries, acquired great practical and technical precision. Yet these refinements were made in conjunction with a highly metaphysical theory of biological functions (which holds that all illnesses result from an imbalance of the "body's forces"), without benefit of scientific knowl-



A 17th-century diagram of one of the 36 acupuncture tracts. The points depicted on this chart are used to regulate the flow of yang—the active force.

edge of either viruses or bacteria, and without a viable neurological theory.

Demonstrably effective both as an anesthetic and as a therapeutic technique in the treatment of muscle strains, intestinal disorders, and other ailments, Chinese acupuncture is nonetheless theoretically primitive and pseudoscientific.

Fighting Cancer

Similarly, in the field of seismology Chinese scientists have perhaps gathered and analyzed more data on the precursors of earthquakes and catalogued more detailed seismographic information than have scientists of any other nation. Indeed, the Chinese have met with some initial success in predicting imminent tremors, as in 1975, when early detection saved most residents of the northeastern city of Haicheng from the effects of a major earthquake.

Yet, again, all this has been accomplished on the basis of raw observation, without benefit of a workable scientific theory of seismic activity, resulting in what one knowledgeable Western observer has called "an inability to evaluate and sort out the validity of precursors on a scientific basis."

Even in the field of cancer research, where Chinese public health specialists have reportedly made enormous strides in recent years, work has been marked more by an emphasis on epidemiological data-gathering and clinical observation than by controlled laboratory experimentation or systematic analysis. Although Chinese scientists have painstakingly mapped differential cancer mortality rates in their own country, their approach to carcinogen research has been generally descriptive and unsystematic.

This is not to belittle Chinese science but only to point out that its main strengths, past and present, have been in the areas of observation rather than conceptualization, concrete thinking rather than abstract theoretical speculation, deduction rather than induction.

Since the early 1900s, Chinese students have gravitated toward the empirical and applied sciences—engineering, medicine, and applied mathematics, for example—rather than toward the more abstract and speculative disciplines. While such proclivities are not inimical to the overall scientific enterprise (indeed, they are essential to it), they are not in themselves sufficient to produce a *qualitative* scientific revolution.

A third obstacle to scientific progress in China has been the propensity to idealize science, to universalize its precepts, and thereby to elevate it from a method of inquiry to a dogma. This tendency, known in the West as "scientism," has produced in China orientations and attitudes strikingly different from those of Western science.

Skeptics Beware

As a consequence of the post-Galilean, post-Baconian scientific upheaval in Europe, Western science continuously moved in the direction of mathematical hypotheses, controlled experiment, and inductive theory-building.

The key element in this evolutionary process—and perhaps the most important single by-product of the scientific revolution—was the cultivation of a skeptical outlook. This ingrained skepticism led Western scientists to question, as a matter of course, the validity of any and all a priori assumptions, dogmas, and received theories.

The virtual absence of such an intellectual ethos, along with the absence of a native tradition of inductive logic, must be reckoned as a major source of China's prolonged scientific backwardness in the modern era.

Historians have traced the rise of scientism in modern China to the widespread sense of cultural despair and disillusionment that accompanied the collapse of China's traditional Confucian order in the late 19th and early 20th centuries.

The spiritual vacuum following the collapse was initially filled by a utopian faith in what modernization enthusiasts of the time called "Mr. Science." And it was but a short step, ideologically, from the uncritical embrace of "Mr. Science" to the equally uncritical embrace of the scientistic doctrines of Karl Marx's "dialectical materialism."

Yin and Yang

Classical Chinese formalism and contemporary Chinese scientism share a number of traits. The one assumes an underlying patterned organic unity in nature; the other posits dialectical laws of motion governing historical and even physical change. The one employs the yin/yang theory to explain cyclical flux; the other employs the theory of contradictions to explain struggle and progression. In each case, all of reality is held to be governed by immutable "laws," intuitively derived and categorically affirmed.

Another trait shared by classical Chinese formalism and contemporary Chinese scientism is their overriding concern with preserving doctrinal orthodoxy—and hence the political legitimacy of ruling elites. Just as Shi Huang Di (247–221 B.C.) and Emperor Wu (502–49 A.D.) strove to eliminate heretical thought by burning the books and banning the ideas of dissident scholars in ancient times, so too have China's modern political leaders, like those of other communist countries,* periodically imposed strict and often arbitrary limitations on the scope of scientific inquiry.

Noting the tendency to lump together political and academic issues, the eminent Chinese historian of science Xu Liangying observed in 1957 that "some areas in the scientific domain are arbitrarily designated as 'restricted areas', and some research aims are regarded as taboo."

Mao's Thought

Professor Xu also criticized the widespread phenomenon of political labeling in intellectual debates: "Seeking to demonstrate their own correct thinking and firm stand," Xu wrote, "some people indiscriminately use political jargon in issues of academic debate ... improperly labeling their opponents as 'reactionary', 'anti-people', 'feudalist', 'capitalist' and so on." Xu learned how truly destructive this practice is; he was condemned as a "rightist" during Mao's crackdown on dissident intellectuals that followed the brief "Hundred Flowers" liberalization movement in 1957.

Another feature of dogmatic scientism is the practice of obsessively quoting "authoritative" works to legitimize one's actions. This practice reached its peak during the Cultural Revolution, when the "thought of Mao Zedong" was endlessly cited to justify all manner of partisan behavior. Mao's thought was also credited with having inspired a variety of scientific and technical

*Notably Stalin, who prohibited scientific theories that ran counter to his own teachings.

achievements, from the surgical reattachment of a severed human limb to the chemical synthesis of insulin.

Such ritualistic obeisance was also very much in evidence at China's 1978 National Science Conference, where a leading official in China's fledgling satellite research program publicly attributed the success of that program to the "brilliant thesis" put forward by Mao Zedong in his 1936 essay, "On Practice."

Chinese intellectuals themselves have recognized the union of Confucian formalism and Maoist dogmatism as a major source of China's continued backwardness. In recent years, many have openly called for the unconditional establishment of freedom of inquiry in scientific research. One scientist, writing in 1980, argued that the "first important condition for creative labor is to let scientific researchers dare to think and dare to act."

The author went on to assert that for "science there can be no forbidden zones, no sacred cows, nothing which cannot be touched. Rigidity in thinking is the most formidable enemy of science."

A woman alchemist. Her craft dates from the fourth century B.C.

Science and Freedom

Since 1978, China's political leaders have made a number of gestures —some symbolic, some substantive—in the direction of loosening the restrictions on academic debate and criticism. The spirit of these gestures is embodied in the widely publicized twin slogans, "Seek truth from facts" and "Practice is the sole criterion of truth," promulgated in the spring of 1978. Since that time, thousands of intellectuals (including Xu Liangying) have been cleared of charges of "rightism," and the practice of political labeling has been officially discontinued with the revival of the Hundred Flowers policy.

In similar fashion, the thought of Mao Zedong has been at least partially demythologized, and the ritualistic quoting of Mao's works has been criticized as an "obsession" interfering with the scientific pursuit of knowledge.

Reacting to these developments, Xu Liangying, writing in early February 1980, enthusiastically proclaimed that the "march on science has again become a heart-stirring call." Perhaps. But within days of Xu's penning these words, the Central Committee of the Chinese Communist Party (CCP) formally proposed the abolition of those parts of the 1978 State Constitution guaranteeing Chinese citizens "the right to speak out freely, air their

views fully, hold great debates and write big-character posters." At the same time, party leaders began to reassert the political and ideological primacy of the "four fundamental principles"* governing the tolerable limits of free speech, criticism and inquiry.

Sky Labs?

The dogmatic scientism of the Chinese is reinforced by another ancient Chinese tradition—"feudal bureaucratism." Unlike bureaucra*cy*, which is a structural property of complex formal organizations, bureaucra*tism* has to do with pathological patterns of informal human behavior within organizations. Unfortunately, the Chinese language makes no clear distinction between these two concepts, both of which are rendered as *guanliao zhuyi*.

Since 1979, the Chinese mass media have begun to criticize such "feudal remnants" in organizational behavior as patriarchy, nepotism, and factionalism. Nevertheless, in typically patriarchal fashion, many leading cadres still treat their areas of command as their own private spheres of influence. The patriarchal style of leadership and policymaking comes out as well in the case of China's 1978 adoption of an eight-point charter for science and technology modernization. Giving high priority to such exotic scientific fields as high-energy physics, sky labs, and space probes, the eight points were selected not by seeking a broad consensus on national priorities within China's scientific community but rather by administrative fiat on the part of a small handful of senior officials in the science and technology establishment, many of whom were political confidants of China's top party leaders. As one outside analyst noted, the eight points reflected "an arbitrary exercise of the prerogative of the elite."

As a consequence, China's 1978 goals in science and technology were noteworthy more for their glamour than for their feasibility or their relevance to China's immediate needs.

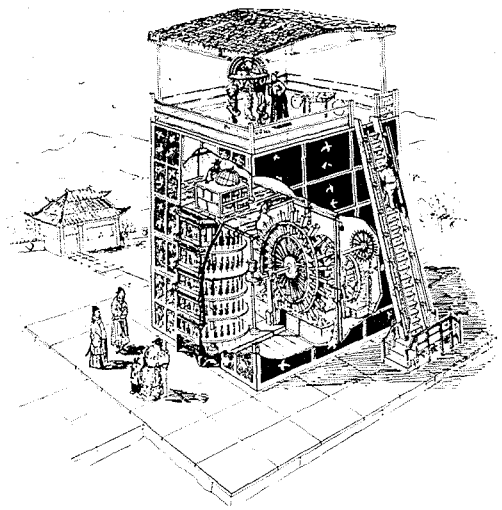
Reviewing the eight-point plan, Nicholas Bloembergen, a Harvard physicist with extensive knowledge of Chinese science and technology, noted that the choice of high-energy physics as a high priority item "is remarkable because it does not further the people's material welfare." Rather its selection was ostensibly based "on philosophical grounds—for example, [on] Mao's principle that matter is infinitely divisible."

Down with Copenhagen

Bloembergen also found it puzzling that a disproportionately large share of resources was being devoted to the development of superconductor technology, a field whose "promise for [practical] applications in electrical engineering is not close to realization, even in Western economies." And, finally, he concluded that the extreme weakness of current Chinese research efforts in such important areas as fiber optics, infrared photodetection, solar cells, nonlinear spectroscopy and basic atomic mechanisms reveals a "serious imbalance of effort" which was "probably determined by somewhat arbitrary initial choices."

Leading cadres who legitimize their actions by appealing to the pre-

*The "four fundamental principles" enjoin all Chinese citizens to uphold and promote party leadership, socialism, the people's democratic dictatorship, and Marxist-Leninist-Mao Zedong thought.



This astronomical clock-tower (11th century A.D.) was driven by a water-wheel and was extremely accurate. The clock did not appear in the West until the 14th century.

vailing political "line" sustain a feudal practice that is at least as stifling as patriarchalism. An anecdote related by Xu Liangying illustrates the problem: "Some young comrades . . . on hearing that certain [high-ranking] people had severely criticized the Copenhagen school [of physics], followed suit even before they could figure out whether Copenhagen was the name of a person or a place."

Because science has been so highly politicized and because the party line has frequently—and sometimes precipitously—changed, most organizational leaders are afraid to take the initiative. When black can become white virtually overnight, personal responsibility, initiative, and risk-taking—three characteristics generally deemed essential to innovation and creativity in science—are severely inhibited, to say the least.

Another harmful consequence of compulsive party line behavior in Chinese organizations is intense political and factional conflict.

The practice of labeling—a major weapon in such conflict—was widespread during the Cultural Revolution, when thousands of scientists and scholars were indiscriminately persecuted as members of the "stinking ninth category."

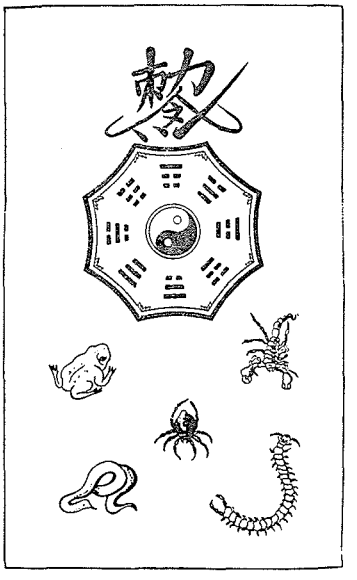
Labeling has been officially discontinued since 1979, and amends have been made to the victims of persecution. But the compulsion to politicize academic controversy remains an essential element both of the Marxist-Maoist world view of dialectical struggle and of a 2000-year-old Chinese cultural tradition emphasizing moral rectitude, ritualized obeisance to authority, and the avoidance of risk through the establishment of mutually protective interpersonal relationships (*guanxi*).

Another deeply embedded feature of Chinese culture, and the last we shall consider, is its highly ritualized system of behavior. Ritual displays of emotion, loyalty, and moral affirmation can of course be found in all

societies and cultures. What sets China apart, though, is the pervasiveness of its ritualized behavior.

The roots of this elaborate ritualism extend to the political needs of orderly imperial administration. Historically, the Chinese state lacked large standing armies to enforce imperial tax levies, tributes, and labor-service requirements; it similarly lacked a specialized, professional public administration to manage the affairs of a vast agrarian empire. Hence, adherence to the moral dictates of *li* (propriety) rather than *fa* (law) became the essential guarantee of public order. The secret of effective imperial governance was, as historian Ray Huang explains, "to induce the younger generation to venerate the old, the women to obey their menfolk, and the illiterate to follow the examples set by the emperor's court. To accomplish this, in turn, there was no substitute for ritualistic proceedings."

The maintenance of social harmony and order thus became largely a matter of everyone's perceiving—and responding to—the requirements of his or her particular role. To do otherwise was to risk losing face, to violate the expectations of others, and thereby to invite disorder and chaos *(luan)* into personal relations. One tried, furthermore, to avoid as much as possible all ambiguous or indeterminate obligations.



The Five Poisons, the Eight Diagrams, the Yin/Yang symbol appear on this charm.

Against the Grain

Like the other cultural obstacles to scientific progress, ritualism is by no means limited to pre-communist China. The ritualized process of small-group "criticism and self-criticism" and the tendency among Chinese communists to classify and label political objects and events in terms of moral stereotypes (the "great, glorious and correct CCP," or the "heinous crimes of the 'Gang of Four' ") preserve in modern idiom the conformist styles of traditional Chinese society.

The dialectical method itself, which the Chinese communists seem to have adopted more comfortably than has any other contemporary Marxist-Leninist regime, appears to be wholly compatible with the ritualism of traditional Chinese culture. Thus, for example, Mao Zedong's well-known obsession with "dividing one into two" (i.e., sharply distinguishing between the positive and negative elements in a given "contradiction") appears to perpetuate the traditional Chinese reliance on unambivalent moral categories.

This obsession was fundamental to

the Maoist perception of an irreconcilable "struggle between two roads" in the post-Great Leap era (1960–65); it similarly underlay Mao's dogmatic insistence, on the eve of the Cultural Revolution, that the portrayal of morally ambivalent "middle characters" in Chinese art and literature was destructive of socialist morality because it blurred the distinction between heroes and villains, positive and negative role models.

Science cannot flourish in a culture which strongly emphasizes formal propriety, individual dependency, and the denial of ambivalence and doubt. Ritualism is a mask used to obscure reality, to avoid uncertainty, and to resolve ambiguity. But modern science takes uncertainty and ambiguity as givens, and strives to penetrate the mask of the apparent in order to ascertain the nature of the real.

As Levenson insisted, Chinese communism is not merely "Confucianism with another name and another skin." Nevertheless, beneath the violent waves of revolutionary change that have swept over China during the past century, certain underlying cultural currents continue to flow. And while these cultural traditions have taken on new political forms, they remain, in many crucial respects, identifiably Chinese.

The recent, post-Mao institutional reforms in Chinese science and technology are significant because they cut directly against the grain of traditional (Confucian and communist) ways of thinking and acting. For precisely this reason, it is still highly uncertain whether the reforms will sustain even a modest advance toward modern science.

Despite official reassurances that science is henceforth to be protected as a vital and productive force, there are already disturbing signs: grumblings in the press over the "elitism" of the new scientific establishment, particularly the prestigious Chinese Academy of Sciences; charges that scientists are pursuing goals that have little relevance to the immediate economic needs of the People's Republic.

To an extent, the accusations are just. And, indeed, they echo one of Joseph Needham's most convincing explanations of China's arrested scientific development: that Chinese scientists, unlike their Western counterparts, have never bridged the gap between theory and technique.

Under Mao and then under the Gang of Four, China attempted to bridge this gap through a campaign of ideological purification, a campaign inevitably accompanied by political intimidation and persecution. The results were dismal. China will have made some headway in the 1980s if its rulers remember this time that such traditional "purifying" solutions are, at least for science and technology, no solution at all.