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Scientific Choice in Japan
II: Imported Technology Versus
Domestic Research

27 Lugard Road,
Hong Kong.

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Mr. R.H. Nolte,
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Dear Mr. Nolte,

No other scientific issue touches on so many aspects of Japanese life as the controversy over whether the government should restrict imports of foreign technology in order to stimulate domestic research. Not only in Japan is this a burning question, India's top science policy makers were doing a lot of soul searching on this issue when I was in Delhi a few months ago. But in Japan the problem is more advanced and the contributing factors appear in sharper relief.

To understand the issue it is necessary to go back to the Meiji restoration of 1868 and to one of the most momentous science policy decisons that any nation has ever made. This was the decision to modernize Japan by importing modern science and technology from the Western countries. Once this decision was made, the policy was implemented with such thoroughness that the present day efforts of the newly developing countries to do the same thing pale by comparison. Japan selected some of her brightest young men and sent them to the leading centers of science and technology in Europe to learn and bring back the new knowledge. (As, with the same zeal, she had once sent her young scholars to China centuries before in the T'ang Dynasty.) Experts were brought in from abroad, paid twenty times the salaries of their local counterparts, and four times the salaries of the Japanese ministers of the day. In fact a Japanese economist recently computed that in the 1880's and 90's, 3% of the Japanese national budget was allocated to the salaries of Western experts. (Newly developing countries throughout the world might take heed of this, it was science and engineering that the Japanese went abroad to acquire, not economics, law and the humanities which more than half of the foreign students now in the United States are studying.)

Japan imported modern science and technology but she kept them separate. It is true that in the 1870's and 80's science and technology were separate entities in the West, but one of the major differences between the Western world and Japan has been the marriage of science and technology in the former* and the continued separation in the latter. The offspring of the marriage in the West has been

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So close is the relation between science and technology now, that Lord Fleck, a noted British Industrialist, recently defined technology as science + time + quantity, and gave this example: To know how to make sulphuric acid is science, but to know how to make 1,000 tons of

the so-called scientific revolution, with new technologies and new industries burgeoning forth at an exponential rate. The implication for Japan of the separation of science and technology is that the basic ideas for new technology have been lacking. She has needed to continue to import new technologies in order to stay competitive in the world market. This has been especially true in the years since the second world war when the number of cases of imported technology rose from 30 in 1950 to 325 in 1960.

Just how successful Japan has been in using these imports is shown in her astounding economic growth over the past decade. A recent White Paper published by the Japanese Ministry of International Trade and Industry (MITI) said that the most important reason for this high growth rate is the technical reform in industry, due largely to imported techniques. It has resulted in new industries (for example the petrochemical industry, started in 1956); increased productivity (between 1955 and 1960 productivity in the manufacturing industry increased by 45%); an improved foreign trade position (new technologies have meant less dependence on imported raw materials and new products for export); and has promoted the national welfare (many more consumer goods are available at lower prices, and the average life span of the Japanese has increased by a decade in the past 12 years).

Many Japanese want to continue importing technology. But others, particularly those in government, say that for the good of the country, imports should be curtailed and domestic research encouraged. Both groups put up a strong case.

To the industrialist it makes good sense to buy just that particular technology which he needs. He believes it is cheaper to pay for licences and patent rights than to do his own research, which may or may not be a success. Sometimes it also enables him to evade Japanese patent infringements. Even when Japanese technology is available, some industrialists still prefer to import because of better quality or occasionally even cheaper price. At the same time the industrialist stops short of advocating unlimited imports. He realizes government must exert some control, otherwise the vicious competition might lead to a "disruption of industrial order".

Government officials who keep control over the number of licences issued, take a different and wider view. In the first instance they are concerned about the unfavourable balance of payments: 41,639 million yen were paid out in foreign currency for licence fees and patent rights in 1961, against 1,021 million yen received from the sale abroad of Japanese technology. Then they note that more than half of all the agreements have an export restriction clause which forbids the export from Japan of any goods made as a result of the imported technology -- an obvious drawback for a country which depends so heavily on exports for its livelihood. Also as more and more firms compete for the same new technology the company which gets the technology is usually the one which has settled for the terms least advantageous for Japan.

But the factor which worried the government officials most was the relatively neglected state of Japanese science and technology

due partially, they argued, to the import of foreign technology and consequent lack of incentive for domestic research. The officials implied that this state of affairs might be satisfactory for an underdeveloped country, but a major power must have a strong scientific base. There is little doubt in my mind that it is that latter, nationalistic, argument which is the main motive power behind the government's determination to build up domestic research -- at the expense, if necessary, of the freedom of the individual to import whatever technology he wants. In fact there was genuine fear on the part of several Japanese I talked to, that the government emphasis on research was a preliminary to rearmament.

In the same way as the industrialists stopped short of wanting unlimited opportunities for import, so the government officials stop short of banning all imports. They fully realize that a judicious choice of imports is very beneficial for Japan. They do, however, want a better balance between imports and exports. In fact both sides appreciate that it is not an either/or proposition, but one of degree.

The third factor in the debate is the scientists themselves. Do they exist in sufficient numbers to be able to do the research that is needed? And are those which do exist, sufficiently creative to be able to do research well? To find an answer to these questions we must look at the universities. The number of graduate scientists produced is low, only 2,000 a year (compared with 9,000 a year in Britain). There are more engineers, about 22,000 a year, but the ratio of combined scientists and engineers to total university population is only 1:4, very low compared with, say, Britain or the United States.

In the past there has been very little co-operation between university scientists and industry. The Japanese science professor has maintained an ivory towered outlook and had almost no contact with industry. At government universities (national, prefecture or municipal) the professor owes his allegiance to the State, he would feel compromised if he accepted money from an outside source. Not only that but, as one professor explained, his students would resent him doing consulting work, they would feel he was not paying full attention to his real job, and they would make certain these feelings were known. Also this same professor, one of Japan's most distinguished scientists, said that many university science faculties are reluctant to accept money from industry for research grants. The reason he gave was that the Japanese are a suspicious and jealous people, they trust no-one and suspect ulterior motives for every action. He believed that money from industry would somehow impinge on academic freedom, even if there appeared to be no strings attached. The engineers are not so fastidious and I gathered that industry gives substantial support for engineering research.

The question of creativity and research ability is more difficult to answer. The uninformed foreigner is inclined to think that the Japanese are only good at copying and are not creative. This is nonsense. At the other extreme there are those who argue that there is no innate difference in intelligence between

racial groups and that therefore the Japanese are as good at creative research as anyone else. I believe this is equally fallacious. It is possible to accept the evidence for comparable intelligence and still question comparable ability to do research, since the latter depends on other things, such as background, philosophical approach, and training. The real question is, does the Japanese education system produce good research scientists. The consensus opinion was that it has produced some excellent theoreticians but very few really top experimental scientists.

I talked about this at length with an American professor who had just spent nine months at the University of Tokyo. It was his first visit to the Orient and he had become fascinated by what to him signified one of the biggest differences between East and West. This was the question of "losing face". I had grown accustomed to, and come to accept, this explanation for what to me were irrational actions on the part of Chinese acquaintances, but the American was disturbed about its significance on the training of scientists. Why? In the first place it contributes to the misconception of teacher infallibility. The teacher never admits to making an error because he would lose face. The research worker is not so willing to take a gamble and get out on a limb because if he did it might fail and he would lose face. A Japanese scientist seems a little more reluctant to give up a particular stand in the face of mounting evidence against his work, than his Western counterpart, again because he is afraid of losing face.

One evening in Tokyo I had dinner with the American professor and his Japanese counterpart. The three of us have known each other for many years, and are good friends. The two professors are both in their late fifties and are at the top of their professions. The conversation turned to a discussion of losing face, and the American mentioned that occasionally when working through complex problems on the blackboard with his students he would make a mistake. He was always delighted when his students spotted the error and pointed it out, but said he had got the impression that most Japanese professors would never admit to having made a mistake, nor would their students point one out. The Japanese professor's face turned blank, "Oh really," he said, "for myself, if I ever made a mistake I would certainly admit it to my students, but of course I never have made a mistake."

Many Japanese are concerned about the shortcomings in their science education program and are taking steps to improve it. Dr. Mukaibo, Professor of Engineering at the University of Tokyo, and previously Science Attaché in Washington, has been a leader in this campaign. He was chairman of the education sub-committee of the Council for Industrial Planning. After much study and research the committee published a book called Emancipation of Creative Talent which is a blueprint for the "education of the gifted in science and technology". This book has had considerable impact on Japanese educators, and the government is setting up a model institute along the lines of the committee's recommendations.

I have digressed somewhat from the main theme, but creativity and research ability are relevent. There is some evidence that in the past the Japanese education system and the

philosophical background of Japanese students have not been as conducive to producing good research scientists as they might, but this is a complex subject and requires further study.

These three factors: the viewpoint of government officials; the viewpoint of most industrialists; and the supply and quality of scientific manpower, have been interwoven to form a complex pattern of events which have taken place in Japan since the issue of imported technology versus domestic research was first raised in the late 1950's.

One of the first public indications of the government's concern about this issue is shown in a report published in October, 1960, by the Science and Technology Council. The report emphasized the relative neglect of Japanese basic science and called for a much closer link between basic research and industrial utilization. It criticised the excessive dependence on foreign research. At about the same time the government committee which considers applications for importing technology, began to make it more difficult to obtain import licences. Almost simultaneously the larger industrial firms took the plunge and invested heavily in research. Overnight it became the fashion to build research laboratories, but many industrialists admitted that the laboratories were built without much thought as to what they would do, "Our rivals were building labs.," they said, "and we didn't want to get left behind".

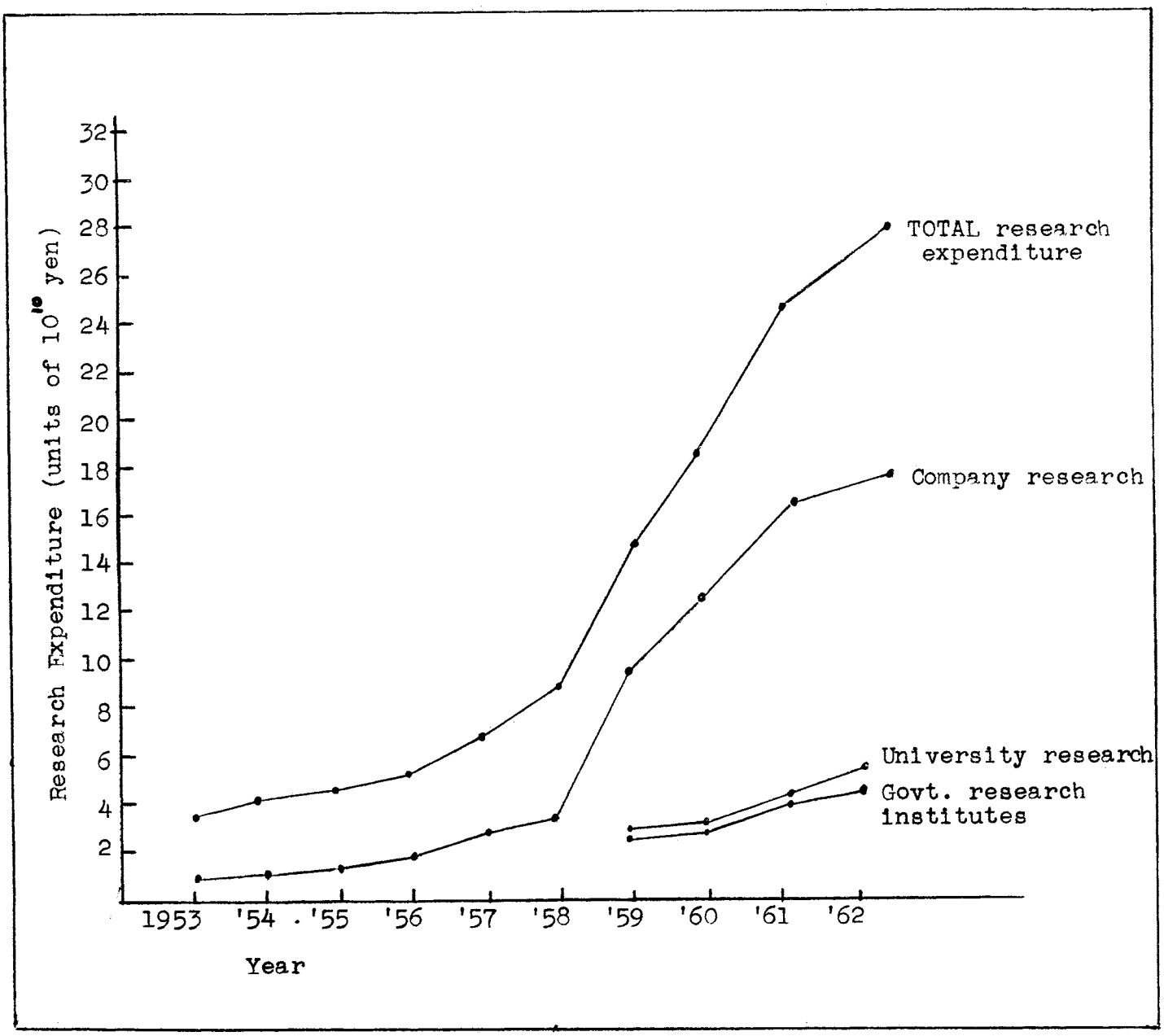
I tried without success to discover other specific factors which prompted the companies to embark so suddenly on a program of industrial research. Was it pressure from the government? Difficulties and delays in getting permission to purchase foreign technology? Tax incentives? A sudden realization that research is a good thing? Or what? My main hope for getting an answer to these questions was from Mr. Tashiro, President of Toyo Rayon Comapny, and a member of the Science and Technology Council. An interview was arranged but he was taken ill shortly before my visit and no-one else was able to give satisfactory answers.

The best explanation that I got for the tripling of industrial research expenditures which took place in 1958 (see Figure I) was that in that year new definitions of research expenditure were used by the Science and Technology Agency, which had compiled the figures. Thus the sudden jump in that year was largely illusory. Even allowing for this the increase in industrial research expenditure over the past four or five years has been astounding. Ten years ago the nation's research expenditures were divided pretty equally between industry, government, and universities, and the total amounted to 0.6% of the national income. Now industry accounts for two-thirds of all research expenditures and the total has risen to almost 2% of the national income. The increase in expenditure has slackened off during the past year as the initial phase of capital investment in buildings and equipment draws to a close.

The trend to domestic industrial research has had repurcussions for both the universities and the government research

Figure I

JAPANESE RESEARCH EXPENDITURES



laboratories. Suddenly, scientists are at a premium and private companies are willing to pay high salaries* to attract good men. This is having the effect of disrupting the old traditional paternalistic employment system. Now, scientists are changing jobs in mid-career, a phenomenon almost unheard of in Japanese society a few years ago. At one government research laboratory which I visited in Osaka, 8 of their senior scientists (out of a total of 140) had left for jobs in industry last year alone. Several were getting salaries which were 100% higher than what government were paying. One Japanese geophysics professor, who until he retired recently had been Dean of Science at the University of Tokyo, and who had proudly told me that both his father and grandfather had been professors, ruefully went on to explain that his own son, also a scientist, had eschewed a university career and had joined an industrial firm.

A recent technical manpower survey showed that although the annual production of scientists and engineers is now about 25,000, in fact 40,000 a year are required. A crash program to increase the number of university graduates in the sciences is under way, and the cautionary cries of those scientists who fear too much haste will mean a lowering of academic standards are drowned in the rush to expand. New concepts in curricula, such as the Dr. Mukaido program mentioned earlier, are being tried. Everywhere one hears the slogan, "San Gaku Kyodo" -- University: Industry Co-operation, although no-one seemed to know quite what it meant or specifically how universities and industry were supposed to co-operate. New organizations such as the Japanese Science Foundation, have sprung up to foster the growth of science and promote university: industry co-operation, in fact there seemed a plethora of organizations all with the same worthy objectives. Several companies work full time producing science films for educational television. (I had lunch with one lady who is in charge of science programs for a Tokyo television station. She said one of the most popular programs, featured every afternoon, was "Science for Housewives".)

Now that industry has finally got off the mark and is doing its own research there is less need for several of the government research laboratories, many of which were set up early in this century. As a result there has been a switch in emphasis. The government laboratories will now concentrate on: helping small and medium size industries; doing more basic research in those subjects which could have value to specific industries, such as chemicals; doing research on problems of national welfare, such as water and air pollution, natural disasters, etc.; and research and surveys for natural resources. I gathered that some of the changes had already been made and others are planned.

Finally it remains to question the success and value of this burst of enthusiasm for domestic research. When I was in Tokyo, MITI released statistics which showed that Japan still spends

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* It must be admitted that "high salaries" is a relative term. Japan does not give adequate financial reward to its intellectuals. The salary for a full professor at the top government universities starts at approximately U.S.$150 a month.

far less of the proceeds of manufactured goods on research than either Britain or America. The value of research investment as a percentage of proceeds was only 1% in Japan (compared with 3.5% in the U.K., and 4.3% in the U.S.A.). Also of the total money spent in acquiring new techniques (1.4% of total sales), one-third was spent on importing new technology and two-thirds on domestic research. I got the impression that MITI still considers this too much invested in foreign technology. The battle is not over yet.

I asked two foreigners stationed in Japan, whose jobs involve keeping an eye on Japanese science and technology, for their assessment of the pay-off from the industrial research. It is of course, too early for any final judgement, but the first said that although fine laboratories had been built, most enterprises were short of good scientists and lacked good research programs. He was not impressed with what he had seen. The other man held the opposite view, and gave his presence in Japan as proof -- he is employed by the Standard Oil Company of New Jersey to purchase new Japanese technology for export to the United States. It is a full-time job.

Yours sincerely,

C.H.G. Oldham

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