The Production of Technologists and Robotization in Japan

Michio Morishima
London School of Economics and Political Science

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The Suntory Centre
Suntory and Toyota International Centres for
Economics and Related Disciplines
London School of Economics and Political Science
Houghton Street, London, WC2A 2AE, UK.
Tel. 020-7955 6698

Abstract

When Japan embarked upon her forced march to build a modern nation in 1868 the resource upon which she was most able to rely was her labour force. This was of a considerable size, and certainly not of a poor quality. According to Ronald Dore, at least 40% of Japanese males at that time had received a basic level of education. In international terms this was a very high figure for the time. Furthermore, the Japan of that time had already more or less fulfilled many of the preconditions enabling the appearance of modern companies and corporations and guaranteeing their domestic development. The language of Tokyo was already in essence the country's standard language, in common use, at least as the official language, almost everywhere throughout the country. Something else of considerable importance was that both samurai and merchants regarded it as a virtue not to break their word; hence it was easy to establish a contractual society. Furthermore, they were all well aware that it was not a good thing to get public and private mixed up.

Keywords: Japan, robotization, technologists, contractual society, education.

THE PRODUCTION OF TECHNOLOGISTS AND ROBOTIZATION IN JAPAN

Michio Morishima

1. When Japan embarked upon her forced march to build a modern nation in 1868 the resource upon which she was most able to rely was her labour force. This was of a considerable size, and certainly not of a poor quality. According to Ronald Dore at least 40% of Japanese males at that time had received a basic level of education. In international terms this was a very high figure for the time. Furthermore the Japan of that time had already more or less fulfilled many of the preconditions enabling the appearance of modern companies and corporations and guaranteeing their domestic development. The language of Tokyo was already in essence the county's standard language, in common use at least as the official language almost everywhere throughout the country. Something else of considerable importance was that both samurai and merchants regarded it as a virtue not to break their word, hence it was easy to establish a contractual society. Furthermore they were all well aware that it was not a good thing to get public and private mixed up.

One of the things regarded as most important by the Meiji government was the improvement of the quality of this labour force, namely the provision of education. Before the Meiji period, in the Tokugawa period, there had existed both temple schools, which provided education for the common people, and domain schools established by each feudal domain to educate the children of the warrior class. The Meiji government used the former of these two kinds of school to build up a system of elementary education, whilst using the latter as their starting point for a network of higher education. The domain schools had in fact during the Tokugawa period been places where officials were trained for local and central government, so this kind of character (that of training human resources for the purposes of the state) became a characteristic also of the institutions

of higher education of Meiji and post-Meiji Japan. As is made quite manifest in the first clause of the Imperial University Edict of 1886, which states 'The Imperial University shall have as its purpose instruction in the arts and sciences such as accords with the cardinal principles of the state and research into their deepest mysteries', Japanese higher education did not exist for the sake of the individual; the individual was educated for the state in accordance with the needs of the state.

In the Meiji period the key positions in the state were largely filled by those who originated from the old warrior class. Although the status system had been gradually breaking down during the course of the Tokugawa period, officially at least it continued to operate in all its rigidity right up to the end. While warriors were soldiers, they were at the same time administrators or economic bureaucrats in either central or local government; they amounted to no more than 5-6% of the total population. With the exception of the work they did on the orders of their lord they were forbidden to work in any of the spheres of agriculture, industry or commerce, and samurai themselves regarded such economic activity in pursuit of personal gain as being repugnant. When after the 1868 revolution the status system was abolished and a system of conscription was implemented, the former warriors could no longer automatically become professional soldiers, and were forced to seek work in new spheres.

In the 1908 edition of Jinji Kōshinroku (the longest standing Japanese Who's Who), of the 159 individuals who call themselves politicians (dietmen) 41% have samurai origins, and of the 1659 termed businessmen (excluding directors of small companies and those with minor posts in large companies) 35% are former samurai. By contrast 77% of the 279 administrators (bureaucrats) and statesmen, 77% of the 117 engineers in fields related to agriculture and engineering (working mainly for the

government or nationalised enterprises), 75% of the 102 scholars specializing in agriculture, science, engineering and medicine, and 64% of the 125 involved with law, social sciences or the humanities were designated as stemming from the old samurai class.

It is not surprising to find that former samurai monopolised the higher levels of the government bureaucracy, but what is remarkable is the wholesale advance of the warrior class into the spheres of business and industrial engineering, spheres hitherto the domain of the members of the artisan and merchant classes. The samurai, with their relatively low illiteracy rate, were without doubt at an advantage over the less educated people at large when it came to entering new fields, but what is noteworthy is how the warriors, effectively abolished as a class, should essentially take over the new fields which had sprung up - engineering, natural sciences - as well as accounting for over a third of the busines world, traditionally regarded as the province which is very much foreign to them. Moreover, if we divide the business world into consumer goods industries (including spinning and paper manufacturing) and other sectors of industry (this includes the sectors destined to play an indispensable role in the building of the new Japan - heavy industry, munitions, merchant marine, banking, insurance) and compare the two, we find that former samurai account for a far higher proportion in the latter than in the former. One additional fact that is worthy of special mention is that former samurai showed an interest in studies related to the natural sciences and formed the nucleus of Japan's army of technicians in the Meiji period. At a time when the Imperial University had yet to be established on any scale such men studied at universities abroad, in America, Britain, Germany and elsewhere, and brought back to Japan the technology and natural sciences of the West.

The nucleus of higher education was the imperial universities. At first there was only one of these, in Tokyo, an institution produced by amalgamating and modernizing the schools of the Tokugawa government. Later on, at the height of the Japanese Empire there were nine such universities, including two in the colonies, at Seoul and Taipei. At these imperial universities the study of technological systems - first agriculture, later engineering - was given considerable emphasis. By comparison basic learning was inevitably throughout given relatively little attention. The number of students in the science and humanities faculties was very small. In 1917, for example, science faculties accounted for only 5% of all imperial university students, and the percentage for humanities was the same. By contrast the students in engineering and agriculture together accounted for 35% of the total, graduates of faculties related to the social sciences 36% and medicine 18%. (For other years see Table 1). The imperial universities were essentially institutions to develop human resources for the new state.

2. The tendency to disregard basic knowledge at the expense of practical learning has continued in the postwar period. Of course the system of special privileges for the imperial universities was abolished after the war under pressure from the Occupation authorities, but the old imperial universities of Tokyo, Kyoto, Osaka and elsewhere even now continue to be the most prestigious universities in Japan. As shown in Table 1 a very large number of students are still concentrated in the engineering faculties. These universities, with the addition of the Tokyo Institute of Technology, are the main sources of supply of technologists in Japan.

The first of the imperial universities was established at Tokyo, and the second, third and fourth were branch shools of Tokyo University which

TABLE 1 : UNDERGRADUATES OF IMPERIAL UNIVERSITIES BY SUBJECT (AS % OF TOTAL)

	EDUCATION	SOCIAL SCIENCE	MEDICINE	ENGINEERING**	AGRICULTURE	LITERATURE	SCIENCE	TOTAL NO. OF STUDENTS
1911	-	37	18	13	20	8	3	7,094
1917	-	36	18	16	19	7	5	8,187
1921	-	37	18	20	13	5	6	8,036
1931	-	42	15	15	12	11	6	17,103
1933	-	39	23	15	9	9	6	17,558
Osaka (1974)	-	18	14	51	-	8	9	9,197
Kyoto (1978)	2	22	9	35	11	9	11	11,467
Tokyo (1980)	-	33	-	36	3	12	17	3,077*

Source: Japan Statistical Yearbook and others
(In Japanese)

*The total number of students at Tokyo University, unlike the figures for these of Kyoto and Osaka, is not the total number of students in the institution, but the number passing the entrance examination in 1980. The total number in the university will thus be around four times this figure. The distribution between faculty also shows only the distribution for entrants in 1980. The figure for medicine is 0, since entrance into the Faculty of Medicine cannot be made directly from school, but Tokyo does in fact have a large Medical Faculty.

** Including architecture.

then split off to become independent. Thus Tokyo University has the position of the main branch of the lineage of Japan's universities, and it can trace its origins back to the various colleges and institutes used by the Bakufu, which were then reorganized, amalgamated and modernized. Tokyo University is thus very different in character from places such as Oxford and Cambridge, which were established as church schools and which developed independently of the state, or, rather, in actual opposition to the state. The universities of China, too, were established by the state for the training of officials, and it was as a result of Chinese influence that the domain schools and various Bakufu schools of the Tokugawa period were set up with very much the same purpose in mind. Hence Tokyo University, the modern version of these schools, always played the role of a training institution for the central officialdom of the Meiji state.

Japan's universities were americanized after the war, but the distribution of students between faculties retained its existing Japanese character. The classification of universities into imperial universities and other universities ceased to exist, and universities were instead categorized as national universities and private universities. In view of the fact that the national universities included some which had grown out of normal schools and higher colleges, there were some national universities very poorly equipped in terms of facilities and staff, possessing, moreover, no thought out educational ideology. There were also many private universities, which had merely entered that sphere of activity with an eye to profit opportunities. It is thus difficult to reach a general comparison of the national universities and the private universities, but on the basis of such things as entrance examination results, it would appear that on average the students of the national universities are considerably more able than those at the private

universities. Recently this difference has been thought to be diminishing, but even though some of the private universities have been able to attract good quality students on the basis of their advantageous locations (many are concentrated in the big cities) it remains true that the better students are still concentrated in the national universities (where the fees are far lower than in the private institutions).

In the 1982 distribution of students show in Table 2 22% of the total of some 410 thousand undergraduates in national universities were in engineering faculties; the equivalent figure for private universities (totalling 1.3m. undergradutes) was 13%. By contrast the figure for science faculties was 6% in the national universities and only 2% in private universities. We can compare this with the United Kingdom, as shown in Table 3, where we can see that in Britain in the same year some 23% of those gaining first degrees graduated in science, and 14% graduated in engineering. This demonstrates the marked emphasis in the case of Japan on applied studies, and the relative lack of attention paid to the non-applied.

Table 3 also shows that in British universities the three main undergraduate disciplines are (1) social science (2) science and (3) language, literature and arts. Table 2 shows us in contrast to this that in Japan's national universities the three main sectors of learning are (1) engineering (2) education and (3) social science, while in the private universities it is (1) social science (2) language, literature and arts and (3) engineering. Education only became a university subject in response to pressure from the Occupation authorities at the time of the postwar educational reforms. The reason for the substantial position of the social sciences and language, literature and arts in the private university sector lies in the fact that students can be attracted cheaply to these sectors of

TABLE 2 : DISTRIBUTION OF STUDENTS BETWEEN COURSES IN HIGHER AND FURTHER EDUCATION IN JAPAN (AS % OF ALL STUDENTS)

	EDUCATION	HEALTH	ENGINEERING	AGRICULTURE	SCIENCE	ARCHITECTURE	SOCIAL SCIENCE	LANGUAGE HUMANITIES ARTS	HOME KEEPING ETC.	OTHER	TOTAL NO. OF STUDENTS (THOUSANDS)
Graduate School	5	15	27	8	11	5	11	17	1	1	58.6
Universities — National	22	11	22	7	6	4	18	9	1	1	414.1
Universities — Private	4	6	13	2	2	5	47	19	2	0	1302.9
Junior Colleges and Technological Colleges	21	4	13	1	0	3	8	26	24	0	416.3
Specialist and Miscellaneous Colleges	3	22	8	0	0	2	10	10	29	16	718.4

Source: Statistics Bureau, Prime Minister's Office, Japan Statistical Yearbook, 1983 pp.655-62.

learning, which require little capital outlay. What is remarkable is that even at the private universities engineering faculties account for 13% of the total number of 1.3 million students (18% if architecture and civil engineering are included). Not only that, but at the postgraduate level as well 27% of students (32% if those specialising in architecture and related subjects are included) are researching into engineering.

That apart, there are in Japan other institutions of higher education, namely the four year technological colleges which run in parallel to the three years of high school, and the two year courses at what are called junior colleges, entered by high school graduates. Students at the former consist largely of males who study engineering, architecture, navigation and industrial design, while the latter, although they do include some junior engineering colleges, cater largely for female students, teaching humanities, liberal arts, home economics, education, art, social sciences etc., and acting as the counterparts of Britain's finishing schools or secretarial colleges. Colleges of this kind accounted for around 416,000 students in 1982, of which 13% were specialising in engineering.

Finally there are specialist schools and miscellaneous schools. The total number of their students was in excess of 1 million, but if we exclude from this number schools preparing students for university entrance examinations, driving schools and schools for non-Japanese, the number falls to around 720,000 students. 29% of this 720,000 is studying such subjects as dressmaking (Western and Japanese), cookery, knitting, handicraft, tea ceremony, catering, beauty, while no more than 8% is engaged in the study of engineering. This 8% is concentrated in the fields of electricity and electronics, radio communication, computing and data processing.

TABLE 3 : NO. OF STUDENTS GAINING QUALIFICATIONS (DEGREE, CERTIFICATE, DIPLOMA) IN BRITAIN, 1982 (AS % OF TOTAL)

	EDUCATION	HEALTH	ENGINEERING	AGRICULTURE	SCIENCE	ARCHITECTURE ETC.	SOCIAL SCIENCE	LANGUAGE HUMANITIES ARTS	MODULAR COURSE & OTHERS	TOTAL[a] (THOUSANDS)
Graduate School Level[b]	29	6	11	2	16	7	22	9	–	34.1
Undergraduate Level[b]	7	7	14	1	19	3	26	22	1	108.6
Higher National Diploma[c]	0	3	57	2	8	5	24	0	0	27.0
Ordinary National Diploma[d]	0	0	46	3	4	4	41	1	0	72.1

Source : Department of Education and Science, and others : Education Statistics for the United Kingdom, 1984 Edition, London : Her Majesty's Stationary Office.

a) Excluding GCE, SCE, CSE
b) Including CNAA
c) Including Higher National Diploma, Higher National Certificate, TEC/SCOTEC higher certificate/diploma, BEC/SCOTBEC Higher Certificate/Diploma
d) Including Ordinary National Diploma, Ordinary National Certificate, TEC/SCOTEC Ordinary Certificatre/Diploma, BEC/SCOTBEC Ordinary Certificate/Diploma

3. Let us now see how we should evaluate the quality and quantity of these recipients of higher and further education by comparison with the United Kingdom. The first thing to which our attention must be drawn is that, whereas Table 2 shows the distribution of students in institutions of higher and further education in Japan, the figures for Britain shown in Table 3 show the subject distribution of those who have obtained degrees, diplomas or certificates on completing their studies in higher or further education. For that reason a straight comparison of the figures as they stand tells us nothing. However, since, for better or worse, those who have got into Japanese universities are able almost automatically to receive a degree after the prescribed number of years, if we divide the total number of students by the number of years necessary to complete the course, we will get something approximating to the moving averages of the number receiving degrees. (In the case of a Ph.D. certain courses at some universities in Japan have the bad habit of the senior professor not permitting the submission of a completed doctoral thesis where the candidate is considered to be too young. This may therefore lead to a certain discrepancy between my estimated figure calculated from the number of years and the actual number of people acquiring doctorates, but should this in fact be the case my own estimate is likely to reflect rather more closely the real situation regarding the results of graduate school education than are the actual figures.)

In Japan graduate schools offer a two year Master's course and a three year Ph.D. course. (The two courses are not parallel, entry to the latter being permitted only to those who have completed the former). If we divide the number of students on the Master's course by two, and the number on the doctoral course by three, then assuming that all those eligible for a degree actually obtain one, then the total number will be 26,200. (The

distribution of these recipients between the various subjects will be slightly different from the distribution of all students shown in Table 2. Recipients of degrees in fields related to education are 6% of all degree getters - in contrast registered students in these fields were 5% of all registered students - whereas the shares of health, engineering, home economics etc. and others are 12%, 29%, 0%, 0% respectively. In the other sectors the figure is the same as that for the share of all registered students.) Calculated in this way the numbers of recipients of postgraduate degrees in engineering (excluding civil engineering and architecture) and science faculties are 7,489 and 2,821 respectively.

The university undergraduate course is four years, junior college two years and technological schools four years. If we divide their numbers of students in each case by the appropriate number of years, we arrive at our estimates of the numbers of recipients of higher education qualifications for Japan in 1982. Of course all those students who enter these schools do not in actual fact obtain a qualification; some abandon the course before the end, others fail. Nevertheless in Japan very few do actually withdraw and since those who fail in later years are compensated for by those who come back having failed in earlier years, it can be assumed that the net failure rate is very low. Moreover, junior college graduates who have specialized in engineering for two years after leaving high school and technological school graduates who have specialised in engineering for one year after studying the subject for three years at the high school level as well can be regarded as having roughly the same level of knowledge of engineering. We thus get the first column in Table 4.

If we compare these figures with those for degree or diploma recipients in Britain (see column 2 of Table 4) we first have to consider how we are to assess the quality of thse Japanese 'degree recipients'. Of those who

are given in the Table, as completing graduate school some will certainly have completed course work as well as writing a thesis to qualify for the degree of Ph.D., but the figure also includes some who have only done course work. Hence the number of graduate students in Japan probably has to be somewhat discounted in order to be compared with that in the UK.

At the undergraduate level the lower level graduates of the national universities are probably worse in quality than British graduates, but it may be said that overall the quality of Japanese national university graduates is not substantially lower than that of British graduates. The quality of private university graduates, however, is inordinately difficult to assess. The top level private universities have many students comparable to those in the top national universities, but there are also some utterly irresponsible private universities. Moreover it is extraordinarily easy to graduate at Japanese universities. I don't know whether the average quality of undergraduates at private universities is comparable to that of Britsh students who have received an HND, or far lower. Likewise there is also no way of knowing whether the quality of junior college and technological school graduates can be equated to that of recipients of the ordinary national diploma.

We will assume below, however, that the graduate schools of each country are similar in quality, that Japanese national university undergraduates are of the same class as British undergraduates, that Japan's private university graduates are equivalent to recipients of an HND in Britain, and that Japanese junior college and technological school graduates are equivalent to holders of a British OND. On this basis we can try and reach a quantitative comparison on the basis of the figures in Table 4. The first thing that is clear is that as far as science faculties are concerned Japan is vastly inferior to Britain in terms of numbers. At

TABLE 4 : STUDENTS OBTAINING DEGREES IN BRITAIN AND JAPAN, 1982

	(1) JAPAN		(2) BRITAIN		(3)
Science	Graduate School	2,821	Higher Degree	5,520	10,322
	National Universities	6,024	First Degree	20,839	38,969
	Private Universities	7,773	Higher National Diploma	2,209	4,130
			Ordinary National Diploma	3,176	5,939
Engi-neering	Graduate School	7,489	Higher Degree	3,855	7,209
	National Universities	21,936	First Degree	15,350	28,704
	Private Universities	41,696	Higher National Diploma	15,471	28,931
	Junior Colleges and Technological Colleges	22,009	Ordinary National Diploma	33,475	62,598

Source: Japanese figures calculated from Statistics Bureau, Prime Minister's Office, Japan Statistical Yearbook, 1983. British figures in Department of Education and Science and Others, Education Statistics for the United Kingdom 1984 Edition.

postgraduate level the number of recipients of degrees in Japan is no more than 51% of the actual equivalent figure for the UK, and the total number of graduates of national universities is less than 30% of the number of first degree holders in Britain. It is true, of course, that the number of graduates of private universities is more than 1.4 times the total number of HND and OND recipients in Britain, but in science faculties it is far more important to have a small number of highly able people than a large number whose quality is low.

Compared with science faculties, Japan is far more substantial in terms of engineering faculties. Of course, in 1982 Japan only produced two thirds as many lower grade engineers (junior college and technological college graduates) as was the case in Britain (using OND recipients as the equivalent), but both at higher degree and at first degree levels Japan outstripped Britain, producing 41,000 private university first degree holders in engineering by comparison with the UK's 15,000 HND holders. There is no doubt that as far as the field of engineering is concerned Japan produces a far larger cohort of technologists in terms of numbers than does Britain.

4. However is the production of technologists in Japan of a scale sufficient to support Japan's manufacturing industry? According to the International Labour Office's Yearbook of Labour Statistics (Geneva, 1983), in 1980 the economically active population working in Japan's industrial sector in the broadest sense of the term (including, apart from manufacturing, mining and quarrying, electricity, gas, water, transport, storage and communication) was around 1.87 times the figure for the UK in the same year. Thus for Japan's industrial sector to be provided with the same ratio of technical experts as the UK their numbers would need to be equivalent to 1.87 times the figure in column (2) of Table 4. Numbers

computed on this basis are to be found in column (3) of Table 4.

If we then compare column (3) and column (1) certain things become clear. In the first place, what becomes immediately apparent is a shortfall in the absolute numbers of those taking science degrees. It is these people who are the ones who must make a contribution to the development of science later on, whether in universities, or in the research and development sections of enterprises, and the numerical paucity of human resources in the field of pure science is likely to act as a severe impediment to any Japanese contribution to scientific progress.

If we look next at the figures which relate to the field of engineering we see that the actual figures for Japan's higher grade technologists (holders of postgraduate degrees or equivalent, and those who have completed a four year course at the national universities) and for the lower grade technologists as well (graduates of private universities, of junior colleges or technological colleges) are more or less equal to, or lower than, those which would be necessary to achieve for Japan's engineering sector a similar distribution of technicians to that found in the UK (the figure in column (3)). In the case of lower grade technicians in particular the shortfall is a severe one. While the supply situation for such technicians is such that enterprises of the first rank and large enterprises are able to acquire as many technicians as they need, medium-sized and small enterprises will suffer from a shortage of technicians. This is likely to result in a considerable disparity in productivity between the large enterprises and the medium-small enterprise sector. Despite this shortfall, however, it must be acknowledged that the engineering sector is so much more developed than the field of pure science that there is really no comparison.

Apart from these there are also the engineering high schools. Students spend three years at these schools, so one-third of the total 460,000 students at such schools, i.e. around 150,000, can be regarded as graduating each year. Since these schools also teach English, Japanese and other general subjects they are not vocational schools in the true sense of having specialised solely in the acquisition of engineering skills. Moreover a very large number of graduates of these schools go on to study at universities or junior colleges, thus not all of these 150,000 graduates immediately join the labour force in the engineering sector.

It is true that some of these graduates go to make good in part the shortfall in lower grade technicians in the engineering sector. However, it is also the case that the level of education provided by the technical high schools (in particular the level of education in specialist engineering skills, leaving aside the education in more general subjects) is on average of a lower level than that attained by achievers of the ordinarly national diploma in the UK. In Britain those gaining the advanced national diploma are backed up by more than five times as many, around 83,000, engaged in advanced courses in higher education, and behind those gaining the ordinary national diploma are more than twelve times that number, around 402,000, pursuing non-advanced courses in further education. It is with these figures that we must compare the number of graduates of technical high schools. Bearing in mind the fact that at the time in question Japan's engineering sector was already 1.87 times the size of the British one, the number of graduates of technical high schools in Japan, too, must be regarded as inadequate.

It is strange that Japan, which apart from the US has a higher rate of university attendance than any western industrialized country, and which, moreover, have a very large percentage of its university students

concentrated in the field of engineering - especially in the universities regarded as being the most outstanding - should be less able to supply its industry with sufficient technologists than a nation such as Britain, where the rate of attendance in higher education is low, and where, moreover, engineering receives scant attention in the university sector. What is all the more strange, though, is the fact that despite this undoubted shortage of technologists Japan has managed to conceal this shortcoming, getting the better not only of Britain, but also of the other advanced industrial nations, in the sphere of international economic competition, and achieving a reputation as a country highly advanced in technological terms.

There is no doubt that compared with other late developers Japan possesses a labour force of a quite outstanding quality, receiving a higher level of education. Compared with the advanced industrial nations, however, there is no question of that part of the workforce in receipt of formal technical education being what might be termed abundant. It is a case in Japan of effective use of a limited workforce in the achievement of maximum, or near-maximum possible results. It is impossible to gain an understanding of Japan's development without unravelling the mysteries of Japan's effective use of her labour force.

5. It is frequently said that Japan is obliged to purchase foreign technology for her technologists to work in an effcient manner. This is the natural outcome of the fact that traditionally Japanese university pure science faculties have existed only on a very small scale. Certainly, this reluctance to put any effort into the basic fields of pure learning, such as science and literature is not a good thing as far as higher education is concerned. Furthermore, as long as basic knowledge continues to be ignored Japan will never be able to stand in the forefront of the competition for

technological advance.

However, if we take the view that the aim of higher education is to achieve victory in technological competition - and this qualification is one with which I myself do not agree - then the strategy of not insisting on the first place in the competition for technological advance, rather making do with the second place, of rejecting the field of pure science and possessing as large an engineering sector as possible, and of purchasing all new technology from abroad, is not necessarily a bad way of going about things. This is because if this policy is carried out skilfully it can produce behind the first ranking country a second ranking country guaranteed of a place just a very little way behind. This is the method of competition adopted by Japan in recent years. This strategy has provoked criticism of Japan both inside and outside the country on the grounds that with it Japan will never achieve the first rank and that Japan has merely utlized technology developed in other countries and is not of the type to develop her own; but as long as people do not feel the need for the special honour attached to achieving first place in the technological race, then there is in economic terms little difference between being in first place and being in a second place only just behind. For such a strategy as that adopted by Japan to work there exists the prerequisite that economic relations between Japan and other countries have to be sufficeintly friendly to allow of the sale of technology to Japan by other countries. Should the second rank threaten to achieve first rank and incur the displeasure of the first rank, or of others, leading those countries to become unwilling to sell their technology to Japan, then Japan would inevitably be faced with an acute crisis.

The second factor enabling Japan's efficient use of her scarce technological personnel is the dual structure of Japanese industry. All

sectors of Japanese society consist of a modern subsector and a pre-modern subsector. There are many people who say that the term 'pre-modern' is no longer appropriate, since the very subsectors referred to as 'pre-modern' are now at a highly developed level, but even so these sectors continue to be pre-modern as far as their relations with the so-called 'modern subsectors' are concerned. It is the modern subsectors which constitute the teams representing Japan in the international competition with the nations of the West, while the pre-modern subsectors know that they themselves must put up with discrimination and play the role of an Atlas, providing support so as to enable their own team to do well in international competition.

Thus those technologists who have graduated from the best universities mostly take up work in the modern subsectors (consisting mainly of large enterprises) of the industrial sector (including mining, gas, electricity, water, transport and communications). Hence no shortage of engineers can be found in the modern subsectors, the deficiency being shifted entirely onto the pre-modern subsectors. There are two methods of development, one the so-called 'balanced modernization' way of development, whereby the development of a country's economy is achieved by modernizing all the sectors of the economy uniformly with each other, the other the so-called 'expansion-of-the-core' way, which we find in the Japanese economy, where a totally modernized nucleus is created, and this nucleus is then expanded. The Japanese economy has consistently pursued development along the latter lines ever since the Meiji period. The dual structure is the inevitable outcome of this path of development, and thanks to it Japan has succeeded in building a far larger modern industrial sector than Britain's, though maybe not quite so large as 1.87 of Britain's. It goes without saying that this development according to the expansion of the core formula proves it

to be a highly effective formula in terms of economic development, but as a developmental formula it is bound to produce many problems from the viewpoint of equality and impartiality.

The dual system does not merely produce a division of each sector into two subsectors; the various subsectors operate according to totally different principles. The modern subsectors and the large enterprise sector are founded on the principle of loyalty, in which the system of lifetime employment plays a pivotal part. In the pre-modern subsectors and the medium sized and small enterprise sector it is the principle of competition which prevails. It is ironic that the large enterprises believed by Japanese to be comparable to their Western counterparts are managed very much in an idiosyncratic Japanese manner, and it is labour relations in the medium-small enterprises, regarded by Japanese as being very 'Japanese', which are the more western (at lest more so than those in the large enterprises).

Under the lifetime employment system a complete system of education at the workplace must be provided. Where a certain kind of engineer is surplus to requirements, under a non-lifetime system of employment such engineers must be made redundant and new enginers hired of the kind needed by the company. Under a lifetime employment system it is difficult to make surplus enginers redundant so they must be retrained as far as possible.

Furthermore, since under a system of lifetime employment engineers and workers trained by that company will not move to work for another company there is no need to fear that the results of that education will benefit not the company which provided the training, but another one. Moreover in a 'Confucian' society such as Japan older people feel a sense of obligation to instruct the younger ones, conversely the younger people are aware that they must learn from their elders, thus technological education can be

carried on on an informal and individual basis in every corner of the workplace, according to time and opportunity. There is no question but that the organized study and training existing in the large eneterprises, as well as the informal instruction in skills given by experienced older workers to their juniors, in large, medium and small enterprises, have very much increased the efficiency of Japanese technology.

6. It has been argued that there is no such thing as lifetime employment in Japanese enterprises, or at least that its existence is doubtful. For example, basing his statistics on Survey of Basic Statistics on the Structure of Wages, Koike Kazuo found that looking at blue collar employees (men only) the proportion in continuous employment for 10 years or more were 37.9% of all employees in Japan, 37.3% in West Germany, 34.8% in the UK and 30.8% in Italy. For white collar workers (men only) the figures were Japan 52.3%, West Germany 47.9%, UK 38.8%, Italy 38.3%. Koike's conclusion from this is that as far as blue collar workers are concerned there is no marked difference between Japan and other countries, but I myself feel that Koike's findings support rather than refute the assertions of those who argue that a lifetime system of employment exists in Japan.

To say something about the history of lifetime employment, this system began to prevail for white collar employees in large companies by the first half of the Taishō period (1912-1926). Before World War II it was extended to some of the blue collar employees of the large enterprises, and after the war its sphere of application was widened further[1]). It is thus to be expected that even today there should be considerable differences in the

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1. E.g. M. Morishima, Why Has Japan 'Succeeded'? CUP 1982

average length of employment of white collar and blue collar employees. This is made clear by Koike's figures given above. Koike also calculated the length of continuous employment according to the scale of the enterprise (number of employees), and finds that in large enterprises (1,000 or more employees) 46.8% blue collar employees and 62.4% white collar employees have been in employment for over 10 years. By contrast the figures for small enterprises (100 or less employees) are over 30.8% and 38.3% respectively. (In both cases for male employees only.) The figures for large enterprises are far higher than those for West Germany, the highest for the West, while the figures for small enterprises are about the same as Italy, the lowest on the Western side. Koike's figures are thus perfectly consistent with the view of those, including myself, who believe in the existence of a lifetime employment system as a concomitant of the existence of a dual structure.

And that is not all. There is one basis on which Koike's figures can be regarded as underestimating the true state of affairs. None of those who believe in the existence of a system of lifetime employment believe that such a system operates in Japan in the strictest sense (i.e,. once an individual has entered a company he or she continues to work in that company until retirement). Sometimes when a permanent employee gets older a company would prefer to dispense with that employee's services, and in such instances such an employee is transferred to a related company (subsidiary, subcontractor or one with whom they have dealings), by order of his own company, by instruction or by suggestion. This kind of transfer or leaving will appear in the statistics as a break in continuous employment. It must be seen, however, that there is no break in continuous employment for the group revolving round the large enterprise as a whole, a group which includes subsidiaries, subcontractors, affiliates and

customers. For an employee to change his company on the order of his company is surely evidence of lifetime employment, and can hardly be counted as counterevidence of the system.

This kind of transfer falls into two categories; that which stems from the desire of the individual and that which results from the personnel policy of the company itself. If we take these two categories separately we find considerable difference in the statistical result. In my own sampling survey (university graduate white collar employees, sample number 51) during the 14 years from 45 to 59 years of age 51% of the total number had changed the enterprise, government office, university etc. at which they were working once or more, but if one excludes changes of employment resulting from the orders of the company the percentage of those changing their place of employment once or more falls to only 18%. Around two thirds of those who changed their jobs were not rejecting the companies for which they had hitherto worked, but were respecting the wishes of the company, and moving to a company in the same group - probably a smaller one - to make a necessary contribution to their company. If we could exclude from Koike's figures such devoted employees who leave their companies for this reason then his percentage of those with ten years or more continuous service in Japanese companies (especially for white collar workers and for blue collar workers in large enterprises) would be far higher than the figures for the countries in the West.

With a lifetime employment system of this kind prevailing in the large enterprise sector, it is difficult for medium-sized and small enterprises to secure a sufficient number of workers and engineers. Moreover, as we have already seen, the supply of engineers is in any case inadequate. It is particularly rarely that medium and small enterprises have a chance of employing first rate engineers, and as long as a dual structure prevails in

the labour market, with medium and small enterprises continuing to be segregated and at a disadvantage, they will continue to operate at a low technological level and will be unable to escape its inevitable concomitant, low productivity. One thing which is likely to help the medium and small enterprises find a way out of this difficulty is robotization. Robots have the same ability whether they are operating in large, medium or small enterprises. Workers and graduate engineers can choose to go to large enterprises with considerable social status and a lifetime employment system, but robots are of more or less the same quality for the same price. The medium and small enterprises may thus be able to overcome their shortage of workers, especially of technologists, by means of robotization. Medium and small enterprises who have robotized their operations tend to secure improvements in productivity and there is no question that the disparity in productivity between large enterprises and smaller ones is narrowing considerably. The remaining small and medium enterprises are becoming worse off - at least in relative terms - so in that sense the disparity is growing, but as long as robotization continues to progress - as of 1982 Japan accounted for 66% of the world's total robots[2)] - the shortage of labour and of technologists is unlikely to act as a bottle neck sufficient to impede the rapid development of the Japanese economy.

7. It has been shown above that the number of well qualified workers and engineers produced by Japan's schools and universities is barely sufficient to continue to sustain Japan's economic development. Up to now, however,

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2. The US accounted for 13%, West Germany 9% and Italy, France and UK each 2%

this bare numerical sufficiency has been successfully covered up by means of improvement in the quality of both workers and technologists by training at the workplace. What is important is to carry out research which compares Japan and the West with regard to their methods of workplace training and the respective degrees to which such training brings about improvements in productivity. Unfortunately we have no space here to embark upon a consideration of this question. We will content ourselves with discussing below how far the neglect of basic knowledge, one possible bottle-neck in the Japanese economy of the future, exerts an influence on the Japanese ability for imaginative innovation.

If we compare Table 2 and Table 3 the difference between perceptions of higher education in Japan and Britain become clear. In Table 2 and Table 3 the various levels of education are placed in order of rank from high to low, with various subsectors of higher education reading from top to bottom. If we now assume that a high rating is given to any subject that takes a larger share in the overall distribution of students at the higher levels of higher education, and conversely, any field of learning which has a higher proportion of the total number of students at the lower level is a low-rated field of learning, then we find that according to Table 2 in Japan engineering, agriculture and pure science are typical high-rated fields, whereas languages, humanities and arts are, excluding education at postgraduate and specialist schools, low-rated ones. Moreover while engineering and science may both be high-rated fields, at the levels of national universities and above the scale of science faculties is only around one third of that of enginering faculties. By contrast Table 3 shows us that in the UK engineering and agriculture are low-rated subjects, whereas pure science, languages, humanities and the arts are all highly rated. Moreover these latter subjects are of a scale to consistute the

core subjects at British universities.

As long as this kind of neglect of basic learning continues we cannot expect major contributions to learning from Japan. It is extremely difficult to find any satisfactory way of estimating the contributions to learning of different countries and to make this sort of assessment must be virtually impossible, but Table 5 tries to give certain indications. This table shows the distribution by country of the Foreign Honorary Members of the American Academy of Arts and Sciences. Americans are thus automatically excluded. There are likely to be certain biases in the selection of members, of course. Nationals of non-English speaking countries suffer from a linguistic handicap in that it is very difficult for their achievements to be evaluated by Americans, while the number of honorary members from all countries researching into fields not highly esteemed in the US are also likely to be disproportionately few. The number of British members might therefore be expected to be great. In the natural sciences, however, the linguistic barriers are not really all that great, and in any case the total figures from the UK shown in Table 5 are clearly greater than the total for other countries (157) as well as being greater than the total for the five countries listed, France, Soviet Union, W. Germany, Japan and Italy (160). Britain has achieved considerable results in all fields, and compared with Japan is quite outstanding, especially when one takes into consideration the fact that Japan's population is twice that of the UK.

Facts such as these suggest that a British-type education system which emphasises basic learning, makes a major contribution to the advancement of knowledge. Japan's contribution to the new fields of science, such as her research into electronics and carcinogenicity, for example, will only be assessed in the future, and her 'score' may increase considerably, but there is little prospect of Japan's position in Table 5 showing a rapid

TABLE 5 : The American Academy of Arts and Sciences – International Distribution of Foreign Honorary Members (1985)

	Mathematical & Physical Sciences	Biological Sciences	Social Arts and Social Sciences	Humanities	Total
UK	39	50	39	54	182
France	18	10	14	17	59
Soviet Union	21	5	2	4	32
W. Germany	7	10	4	10	31
Japan	7	8	4	3	22
Italy	3	3	1	9	16
Others	41	44	41	31	157

improvement in the near future. Such facts lead many to believe that while Japan may be able to catch up any other country in the field of industrial production, she will never be able to overtake.

Nor is it likely, of course, that the epoch-making discoveries of the future will have their origins in Japan. However, this shortcoming does not necessarily mean that Japan is incapable of producing economically successful innovations. Many entrepreneurs are not themselves engineers. The majority of them have in any case not developed their own technology but borrowed it from elsewhere and modify it for industrial purposes, so the borrowing of technology, whether domestic or foreign, is not a great problem. It is true that where the price of borrowed technology is very high it cannot be used, but if the price is made so high it cannot be sold at all it is the seller who suffers, thus the price of technology, too, is likely to end up at an appropriate equilibrium value. As Japan's experience in electronics demonstrates, it is quite possible to carry out major industrial innovations by making sundry improvements in borrowed technology, so Japan's poverty in basic knowledge does not necessarily mean immediate lack of success in industrial innovation.

However, for Japan's economic success to rest on such a strategy is likely to call forth the "free ride in basic learning" argument, which claims that Japan is arguably not investing to an appropriate degree in basic scientific development, and to make Japan an object of Western criticism. Still Japan's "unrespected expansion" may continue as long as there is a steady expansion in foreign trade. Japan is then likely to become an object of disdain on the grounds that her prosperity is "unworthy of respect", a country whose status in the field of pure science is low, while she accumulates excessive profits for her economy. If this should happen Japan will be faced with having to reflect on the structure and

methods of a higher education sector which has developed in excessively close collusion with industry (and before the war with military priorities) and the need to recognize the importance of pure science.

The reality of capitalist countries today, both countries such as the UK and even more so countries like Japan, is that they are the products of compromise with various elements carried over from before their industrial revolutions. Thus it must be acknowledged that the concept of the dictatorship of capitalism, in the sense of capitalist principles dominating the smallest corner of the economy, breaches any respect of history and disregards any sort of "compromise". In the West, where learning was established well before the industrial revolution, learning and industry have kept an appropriate distance from each other; they have developed up to the present by cooperating with each other while maintaining opposition, throughout they have produced the requisite conflicts. In Britain people bemoan the inefficiency of this kind of relationship between industry and education. By contrast, in Japan, which imported science and technology specifically for the purpose of achieving an industrial revolution, industry has ended up by putting learning in a totally dependent position. For that reason the cooperation between industry and education in Japan is a highly effective one, but before long Japan herself will no doubt perceive that this kind of strategy makes her an object of criticism from the "free ride in science" lobby, and will come to devote her attention to the development of basic scientific research.