Releasing the Bottlenecks of Talent Shortage in Taiwan

*Yun-Peng Chu**
*Chin-Lung Chen**

I. Introduction

The overall path of Taiwan's industrial development in the past revealed the successful transformation in accordance with dynamic comparative advantage. However, past performance does not guarantee future success, which depends largely on how Taiwan responds to ongoing challenges. Taking into consideration the consensus of several national conventions, the Ministry of Economic Affairs, Executive Yuan, finally has a blueprint of the directions of Taiwan's future industrial development. In essence, it calls for the development of a manufacturing center of high value-added, high-tech products, as well as a regional center of innovation and R&D activities. Nevertheless, how far is Taiwan away from the realization of such ideal development mode?

Table 1 shows the sources of increases in value-added of manufacturing industries. As seen in the statistics from 1992-1999, two-thirds of the increase can be attributed to the output effects, while the remaining one-third is contributed by the value-added ratio effects. Dividing the eight years into two periods, we can see a prominent falling trend. The value-added ratio effect has dropped sharply from 40.62% in the first period (1992-1995) to 14.41% in the second period (1997-1999). In other words, the income or profit generated by Taiwan's outputs has suffered a severe decline, indicating that she is still a long way from the ideal high value-added

* Research Fellow and Professor, Institute for Social Sciences and Philosophy, Academia Sinica, and National Central University
*Assistant Research Fellow Technology & Economy Division, National Policy Foundation

industrial development.

The key factor in facilitating the transformation of Taiwan's high-tech industrial development is the availability of talents. Everywhere in the world, there is an excess demand for professionals. The United States is no exception. The director of the nano-technology laboratory of HP Labs had stated that "Everyone over the age of 45 in my lab was born in the United States. No one under the age of 45 in my lab is from the United States." In Taiwan, the gap between demand and supply is widening, too, whether in terms of high-level or mid-level human resources. The pace of development toward high-tech industrial productions cannot be met by the corresponding adjustment of personnel training in the rigid advanced education system. In addition, the lack of academics-industry collaboration results in a discrepancy between the needs of the industrial sector and the qualities or skills with which graduates are equipped. Thus, university graduates had difficulty finding suitable jobs, while industries also had problem hiring the right staff. According to the statistics from the DGBAS in May 2001, the national industrial and servicing sectors had 90,000 vacancies for engineers, specialists, technicians, and professional assistants. The knowledge fields required included electronic engineering, electrical engineering, mechanical engineering, biochemical engineering, industrial design, as well as quality control and management. The greatest demand was for electronic engineers, with 10,000 vacancies available. Moreover, the Council for Economic Planning and Development (CEPD) has forecasted that there will be an annual deficiency of 44,000 technology and management personnel in this decade, with around 60% being staff with technological expertise. All these indicate a severe shortage of talents at a time when Taiwan ventures into two ends of the "value chain curve". On the upstream side, industries need to develop their capabilities in R&D,

design, and the manufacturing of key components; while on the downstream side, they need to develop their capabilities in logistics, management, and marketing. This paper discusses the causes of talent bottlenecks and suggests policy recommendations to remedy the shortage. Only by releasing the bottlenecks of both talent shortage and institutional rigidity can Taiwan achieve industrial upgrade, transforming from the mode of large-scale manufacturing of standardized products to that with greater emphasis on R&D, design, and high value-added production.

II. Causes of Bottlenecks

1. Deteriorating quality of advanced education

In the past decade, the government allowed many new colleges/universities to be established or existing colleges to be upgraded to universities. The number of advanced education institutions has increased from 123 in 1991 to 150 in 2000, with 29 now in preparation. As a result, there is a large increase in the number of students receiving higher-level education. In 2000, college/university students account for 68% of the total student population, surpassing that of Japan, England and Germany. By 2011, the percentage will rise to 84%, making Taiwan one of the leading countries with the highest college/university student ratio.

Although the number of students receiving college or higher education has increased substantially, it remains doubtful whether the quality of such education, especially that of the education provided by the elite universities, has been maintained. Between 1991 and 1999, the teacher-student ratio in universities has increased from less than 1:15 to more than 1:18. Besides human resources, financial constraints have also cast a shadow on the quality of higher-level education. The increase in government education budget did not keep pace with the increase in students. In addition, a larger share has been re-allocated from the public to private universities. As a result, the public universities, which have been the main base of elite education in Taiwan, are facing mounting challenges of budget shortages. Among the countries of the Organization of Economic Co-operation and Development (OECD), the government expenditure on education is on average around 5% of the country's GDP, while that of Taiwan is only 4%. Worse still, the amount of budget per student is on the decrease, dropping from NTD 600,000 per student in 1991 to NTD 200,000 in 2001. Figure 1 displays the educational expenditure per student among various universities in Asia. As can be seen, the amount of expenditure per student at top public universities in Taiwan seriously lags behind that of their counterparts in Japan (NTD1,800,000), Hong Kong (NTD 900,000), South Korea (NTD 360,000), and is only slightly better than that of Beijing University (NTD 150,000) and Tsing Hua University (NTD 150,000) in Mainland China.

The tightening of the government education budget has brought adverse effects on the quality of advanced education. Owing to the lack of budget and regulatory restrictions, the universities are short of technicians and administrative staff. Their work is then shared by professors and students alike. This takes away the time and energy that could otherwise be devoted to teaching/learning or research. Other effects include a reduction in the subscription of journals, a decrease in the time allotted to each student for the use of facilities, and longer delay in acquisition of new equipment and software. The zeal of teaching among college professors and the enthusiasm of learning among university students are thus severely dampened. Under such circumstances, the quality of graduates further deteriorates. How can these poorly equipped graduates meet the challenging needs of the rapid advancing industries?

2. Gap between academic interests and industrial needs

Most university research is oriented toward paper publication and contribution to academic knowledge. As a result, there is substantial distance between research findings and their applications. Results of academic research have not been transferred to industries, not to mention meeting the needs of industrial development. In fact, the incentive system established in Taiwan encourages researchers merely to seek publications in international journals. Table 2 displays the number of engineering papers in EI per million people. As can be seen, in 1998 Taiwan ranked third among the nations, following the United States and the United Kingdom, and even surpassing Japan. By 2001, Taiwan has climbed to the top rank. Similarly, as shown in Table 3, the number of papers published by Taiwanese scholars in the engineering areas of SCI has become the highest in the world in 2000. Nevertheless, when judging from the cross-national comparison SCI citation impact per paper, shown in Figure 2, Taiwan no longer is and has never been the leader but lags behind the United States, South Korea, Germany and Japan. This is another evidence indicating that quantity does not equate quality.

The above phenomenon can be attributed to the emphasis on the number of published papers as a criterion for promotion. In order to be promoted and to obtain funding from the National Science Council, university professors seek to increase the number of publications by breaking up a research report into several shorter papers. Moreover, in order to increase the possibility of the submitted paper to be accepted and to speed up the time for publications to be made, the focus of research tends to be hot topics of interest to overseas academics. There seems to be a lack of relationship between research efforts and technologies actually and potentially needed by the local industries. This wide gap between academic interests and industrial needs further aggravates the problem of talent shortage. As a result, some companies have to undertake the R&D themselves.

3. Dwindling number of talents returning from overseas and low interflow of talents

The return of talents from abroad has made significant contribution to the economic development of Taiwan. They bring back novel technologies, new management methods as well as an international perspective. As of August 2002, among the 332 high-tech companies in the Science Park, Hsinchu, 122 were established by scholars who returned from overseas. However, as seen in Figure 3, the tide of overseas graduates returning from the United States is slowly ebbing. The number began to climb in 1991 from 2800 graduates, reached its peak of 5700 graduates in 1994 and started to decline. Not only is the number of returned scholars decreasing, many local graduates also choose not to study abroad for higher degrees. There are two reasons accounting for this. First, the attraction from high-tech industries has drawn many fresh graduates who hope to begin their careers in the 'star' industries fast. Second, the availability of scholarships or grants for overseas studies is becoming less, with most of them awarded to applicants from underdeveloped or developing countries. Figure 4 shows the number of Taiwanese students studying in the United States. As can be seen, the number soared to the highest of 37,580 students and decreased to 31,043 in 1999. This evidences the dwindling resources of graduates returned from overseas, who have been a major force behind the development of high-tech industries. Such decline further exacerbates the shortage of talents.

In view of the wide gap between the local demand and supply of talent, measures have been taken to attract overseas talents. However, such have proved to be disappointing. Table 4 displays the results of government programs undertaken by major institutions for attracting talents in 1999. As can be seen, the programs implemented by the Academia Sinica, the Youth Development Commission and the National Science Council have drawn few talents, a far cry from the need for Taiwan's high-tech industrial development. Particularly scarce are the R&D professionals from Mainland China on short visit or participating in research. Although efforts have been made to make it easier for enterprises to employ professionals from overseas including Mainland China, the business sector still complained that there are remaining barriers to be removed. Despite deregulation of the interflow of talents between public and private institutions, obstacles remain intact. These reveal that government-initiated programs fail to alleviate the shortage or release the bottleneck.

III Policy recommendations

In view of the severity of the talent shortage problem, the government has implemented the following measures to strengthen the training of personnel for high-tech industries and to enhance the mobility and interflow of talents.

1. Increase the enrolment of master and doctoral students in the fields of electrical and electronic engineering; plan and introduce new courses related to frontier sciences; and promote better cooperation and closer ties between the academics and the industry.
2. Combine the resources of the government, educational institutions, private enterprises, research institutes and vocational training centers to strengthen the training of personnel required by high-tech industries.
3. Create a favorable environment to facilitate and attract foreign high-tech professionals.

4. Lay down the regulations for the government and private enterprises concerning the procurement and management of well-known senior high-tech professionals in the international arena; and provide one-stop information service to facilitate the procurement of these personnel.
5. Evaluate the existing mechanism for employing professionals from Mainland China; and further de-regulate the restrictions imposed on the possible activities in which Mainland professionals can be engaged.
6. Increase the quota for postgraduate males to be relieved of doing the two-year military service but be engaged in research; and establish the system for males graduated with higher degrees overseas to participat in the national defense industry reserved officer (sergeants) selection.
7. De-regulate the restrictions imposed on faculty members at universities, allowing them to be on leave to work for industries, thus enhancing the interflow of talents among the government, educational and research institutions, as well as the industrial sector.

Among the above measures, the government has already laid down the guidelines for the procurement of overseas talents, in particular, professionals from the Mainland with no language barriers with their local counterparts. In addition, the quota for postgraduate males with technological expertise to be relieved of military service has also been fully utilized. However, there is still room for improvement with respect to equipping better the university graduates, enhancing the quality of advanced education, and promoting closer academics-industry collaboration. The following recommendations are thus suggested.

1. Increase education budget and enhance quality of students

Although universities should try to raise more funds on their own, the government should devote a large enough budget to elite universities to ensure that the resources they can command is at an internationally competitive level. In the long run, the funding should be steadily on the increase. With sufficient financial support, faculty members can devote more time and energy to teaching and research, which in turn, would enhance the quality of graduates. In addition, due to regulatory restrictions, there is only an annual increase of 85 students enrolled in information science, electrical and electronic engineering, opto-electronics and telecommunications. Nevertheless, such increase cannot keep pace with the demand for talents due to the rapid advances in high-tech industries. Steps should be taken to release the limits imposed upon the opening of the above-mentioned courses as well as the annual enrolment quota in order to make up for the talent shortage.

2. Enhance interflow of talents between education institutions and private enterprises

The government should further de-regulate the restrictions imposed on teaching staff of public schools and faculty members of research institutes. They should be allowed to participate in research projects of the industrial sector or undertake R&D work offered by emerging industries with no limit on the amount of time and the maximum remuneration. Closer academics-industry collaboration would, on one hand, enable researchers to obtain practical experience; and on the other hand, allow personnel in high-tech industries to acquire knowledge. All these would contribute to enhance the quality of human resources in Taiwan.

3. Introduce new instructional approach

For industries to shift from import-substituting production mode to one that emphasizes innovations and R&D, the key factor lies in the availability of creative talents. The traditional instructional strategy of spoon-feeding and rote-learning has to give way to new approaches that stress creativity, individual characteristics and independent thinking. Despite the educational reforms implemented aiming to replace the traditional exam-oriented system, there is still much room for improvement with respect to fostering creativity among students. More active measures and re-engineering should be introduced to encourage students to think freely, independently and creatively.

Table 1 Sources of Increases in Value-Added of Private Manufacturing

	1992-1999		1992-1995		1997-1999	
	NT $ million at 1996 prices	%	NT $ million at 1996 prices	%	NT $ million at 1996 prices	%
Total Change	848,186.47	100%	488,391.48	100%	499,921.93	100%
Value-added Ratio Effects	261,884.27	30.88%	198,367.55	40.62%	72,017.52	14.41%
Share Effects	5,537.72	0.65%	-2,113.82	-0.43%	-12,083.03	-2.42%
Output Effect	575,033.57	67.80%	294,525.60	60.31%	442,717.05	88.56%
Non-linearity Residual	5,730.91	0.67%	-2,387.85	-0.50%	-2,729.61	-0.55%

Source: Computed by another, using data from the DGBAS and MOEA, Taiwan.

Figure 1 Education expenditure per student（ ten thousand dollars ）

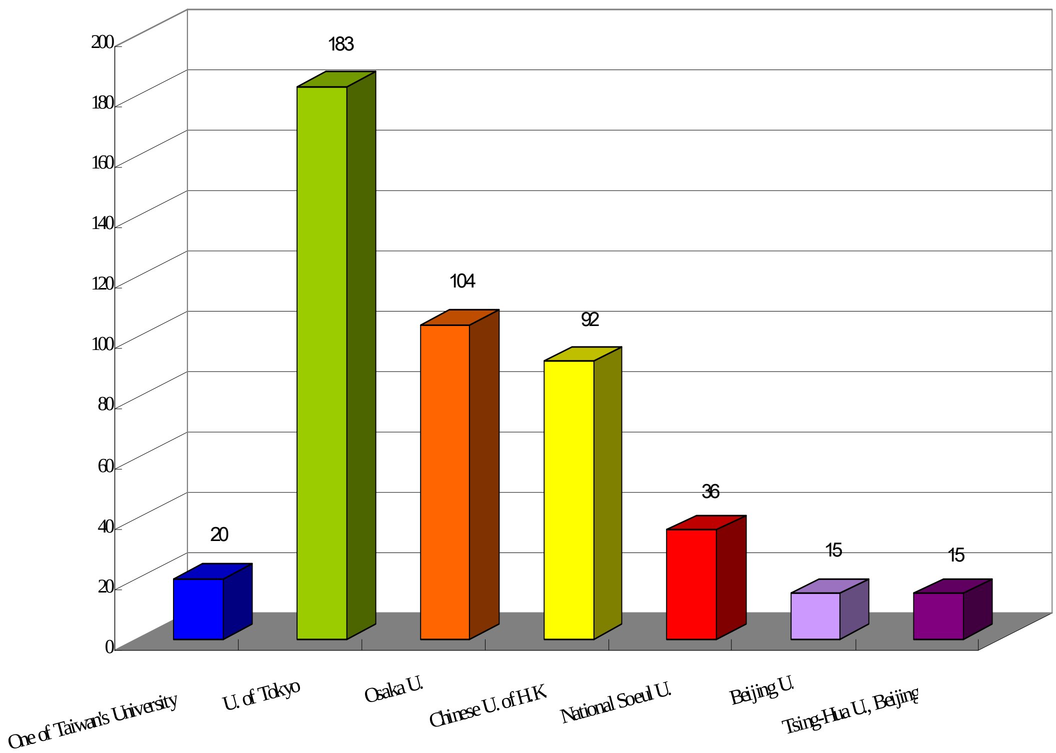


Table 2 Number of engineering papers in EI per million people

	1998	1999	2000	2001
Taiwan	187.9	213	222.7	218.1
PRC	10.4	9.4	10.8	13.1
Japan	157.5	181.9	183.3	169.6
Korea	81.9	112.7	127.7	131.4
U.S.	198.2	205.4	188.3	208.3
U.K.	194.9	196.7	208.6	213.3
Germany	123	139.2	147.4	155.2
Nether	166.9	178.5	183.3	190

Source：National Science Council, Taiwan

Table 3 Number of engineering papers in SCI per million people

	1998	1999	2000	2001
Taiwan	97.9	96.6	106.6	113.4
PRC	2.1	2.4	3.4	4.3
Japan	58.7	61.6	60.1	63.4
Korea	47.1	53.5	58.7	72.7
U.S.	87.9	84.4	86.1	83.3
U.K.	99.9	103.8	105.9	102.7
Germany	55	55.5	54.8	60.7
Nether	86	88.3	91.5	95

Source：National Science Council, Taiwan

Figure2 Cross-National Comparison of SCI Citation Impact

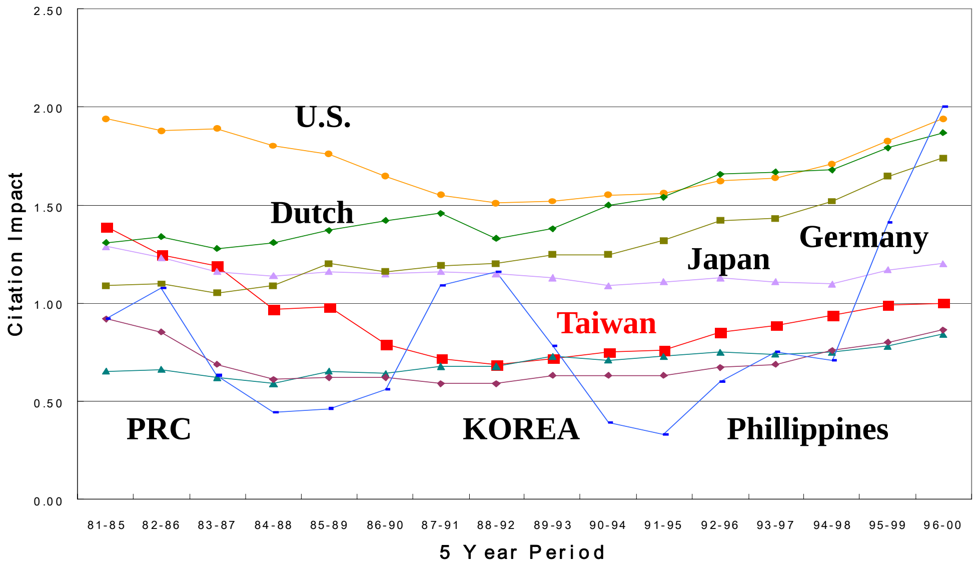
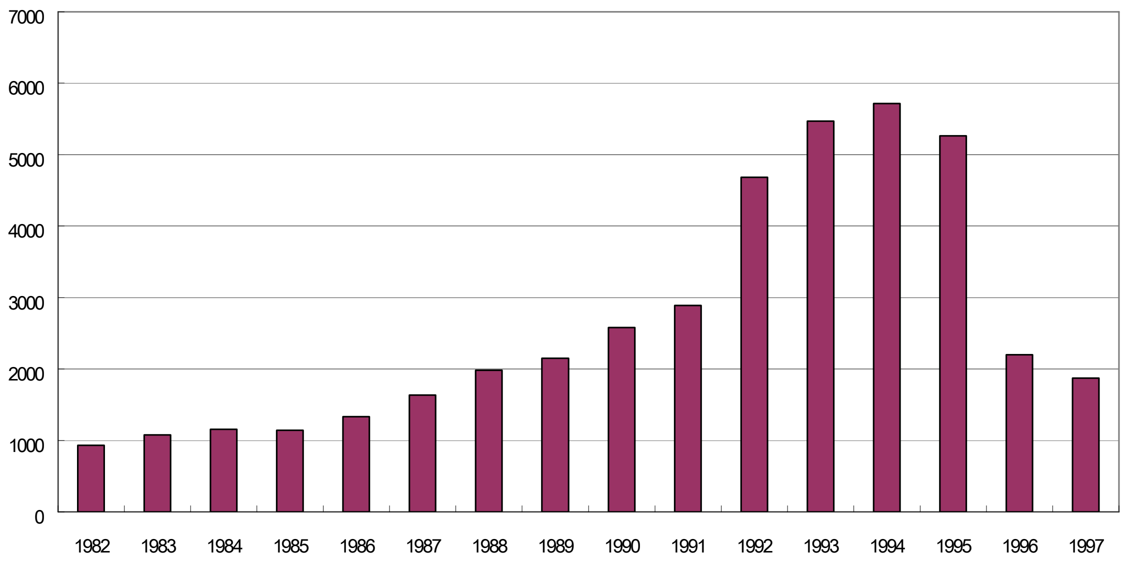
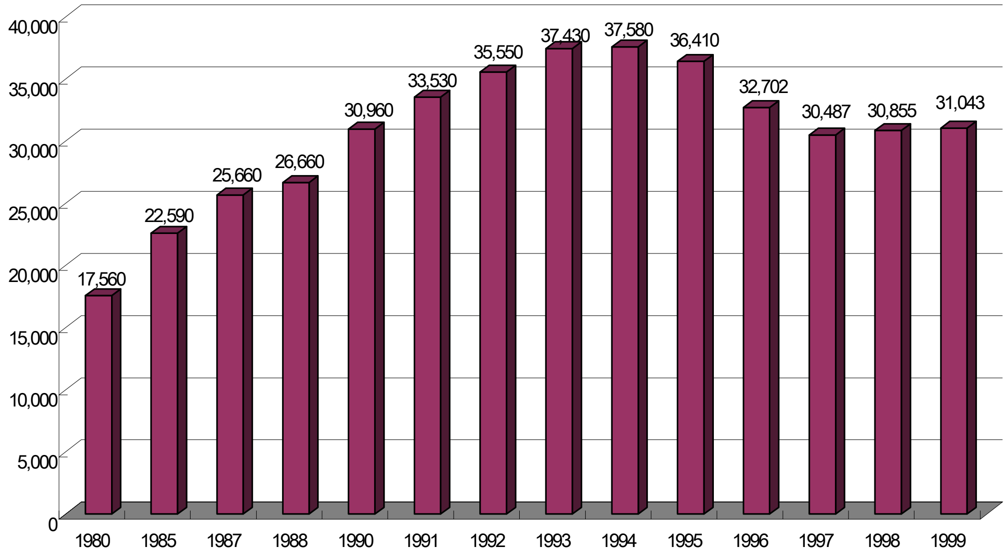


Figure 3 Number of graduates returning from the United States



Source：Ministry of Education

Figure 4 Number of students studying in the United States



Source : Ministry of Education

Table4 Government Programs to Attract Talents: 1999

Organization	Program	Persons/Times
Academia Sinica	Post-doc Fellows and Foreign Schlors	207
Youth Development Comissio	Post-doc	51
	Short-term Research(People,w/Masters Degree)	224
National Science	Support for Employing High-tech Personnel	98
Council	Support for Post-doc Research	675
	R&D Professionals from Mainland China Short Visit	29
	R&D Professionals from Mainland China Participating in I	67

Source : CEPD