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TRANSFER OF TECHNOLOGY FROM JAPAN AND THE UNITED STATES TO KOREAN MANUFACTURING INDUSTRIES: A COMPARATIVE STUDY

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In the controversy relating to the technology transferred through direct foreign investment to a developing host country the issue of its appropriateness has been discussed mostly in terms of factor proportion and the scale of operation. Thus, the multinational firm, in whichever country it may be based, has often been accused of transferring technologies which are overly capital-intensive and better suited to a large-scale operation.[1]

Departing from this line of argument Professor Kiyoshi Kojima (1977) has recently argued, however, that the technology transferred from Japan to a developing country is appropriate whereas that from the United States is not. In Kojima's argument the appropriateness of a technology is less a matter of factor proportion and the scale of operation and more a matter of the degree of technological sophistication. He regards technologies transferred from Japan as being mature and standardized and those from the United States as being new and sophisticated. The former are, accordingly, easily diffused in the developing host country whereas the latter lead only to the establishment of an enclave with little linkage with the rest of the economy. Technology transfer from Japan is, thus, an "orderly transfer of technology" whereas technology transfer from the United States is "technology transfer in reverse order."

The purpose of this paper is to find out whether or not there is any difference between the technology transfers—through licensing and direct foreign investment—from Japan and the United States to Korea. To this end technologies from these two countries are compared in terms of sectoral distribution, specifics of technology, and the mode of transfer. If Kojima's observation is correct, technology transfers from Japan would be concentrated in the industries of mature and standardized technologies whereas technology transfers from the United States would be concentrated in the industries of new and sophisticated technologies. Furthermore, the former would be carried out mostly through direct foreign investment whereas the latter would be carried out mostly through licensing.

In Section I the sectoral distribution of technology transfers through direct foreign investment is investigated for Japan and the United States. There are four sectors or industry groups, and these are the labor-intensive, high-technology industries; the capital-

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[1] For a survey of the literature on this issue see White (1978). See also Chung and Lee (1980) for an empirical investigation of production techniques used by foreign and local firms in Korea.

intensive, high-technology industries; the labor-intensive, low-technology industries; and the capital-intensive, low-technology industries (See the appendix). In Section II, using sample data obtained through a survey, we compare some specific aspects of technology transfers from the two countries. In Section III the sectoral distribution of technology transfers through licensing is investigated for Japan and the United States. Section IV investigates the difference in the mode of transfer for the two countries, and Section V concludse the paper.

I

It is impossible to obtain a direct measure of the sectoral distribution of technologies transferred through direct foreign investment, since a technology is an inseparable part of the bundle of factors transferred through direct foreign investment. Even if it could be unbundled from other factors, there is no natural unit for measuring a technology transfer. In this paper we, therefore, propose to use the sectoral distribution of direct foreign investments as a surrogate measure of the sectoral distribution of technology transfers. Thus, our assumption is that one direct foreign investment corresponds to one technology transfer.

During the 1962–1978 period Japan and the United States were the two major investors in Korean manufacturing industries. There were 68 direct investments from the United States, amounting to a total sum of approximately $146 million, and 413 direct investments from Japan, maounting to approximately $332 million.[2] The distributions of these investment projects among the four industry groups are reported in Table 1.

It is clear that as of the end of 1978 Japanese direct investments in Korean manufacturing industries were concentrated in the labor-intensive, high-technology industries. US direct investments were also concentrated in the same group, albeit to a lesser extent. When investments are divided only between the labor-intensive and the capital-intensive industries, Japanese direct investments were more highly concentrated in the labor-intensive

TABLE 1. DIRECT INVESTMENTS FROM JAPAN AND THE UNITED STATES IN KOREAN MANUFACTURING INDUSTRIES, 1962–1978

[Japanese Direct Investments]

Industries	Low-Technology	High-Technology	Sub-Total
Labor-Intensive	100 (24%)	209 (51%)	309 (75%)
Capital-Intensive	46 (11%)	58 (14%)	104 (25%)
Sub-Total	146 (35%)	267 (65%)	413 (100%)

[US Direct Investments]

Industries	Low-Technology	High-Technology	Sub-Total
Labor-Intensive	20 (29%)	25 (37%)	45 (66%)
Capital-Intensive	5 (7%)	18 (26%)	23 (35%)
Sub-Total	25 (37%)	43 (63%)	68 (100%)

Source: Economic Planning Board-Korea Industrial Bank (EPB-KIB) Survey, Seoul, Korea, 1979.

[2] These are figures based on a survey carried out by the Economic Planning Board of the Republic of Korea and the Korea Industrial Bank in 1979 and thus represent direct foreign investments extant at the time of the survey.

industries than US direct investments. This difference may reflect the difference between factor endowments of the two countries. When we group direct investments into the high-technology and the low-technology industries, we find no significant difference in the sectoral distribution of technology transfers between Japan and the United States. Technology transfers from both countries were, however, concentrated in the high-technology industries.

The figures in Table 1, which are cumulated values for the 1962–1978 period, do not inform us whether or not there was any change in the type of technology transferred in the course of the period. By the early 1970s Korea was well on the way to rapid industrialization and its industrial structure was being transformed away from unskilled labor-intensive industries to skilled labor-intensive ones such as heavy and chemical industries. It is, therefore, possible that in the early 1970s there were changes in the type of technology transferred from Japan and the United States.

In order to test this hypothesis we divided the period into 1962–1972 and 1973–1978 and report Japanese and US direct investments for the first and the second subperiod in Tables 2 and 3. It is clear from Table 2 that during the first subperiod both Japanese and US direct investments were concentrated in the labor-intensive, low-technology industries

TABLE 2. DIRECT INVESTMENTS FROM JAPAN AND THE UNITED STATES IN KOREAN MANUFACTURING INDUSTRIES, 1962–1972

[Japanese Direct Investments]

Industries	Low-Technology	High-Technology	Sub-Total
Labor-Intensive	40 (48%)	21 (25%)	61 (73%)
Capital-Intensive	14 (17%)	9 (11%)	23 (27%)
Sub-Total	54 (64%)	30 (36%)	84 (100%)

[US Direct Investments]

Industries	Low-Technology	High-Technology	Sub-Total
Labor-Intensive	14 (39%)	12 (33%)	26 (72%)
Capital-Intensive	4 (11%)	6 (17%)	10 (28%)
Sub-Total	18 (50%)	18 (50%)	36 (100%)

Source: Economic Planning Board, ROK, *The Current State of Foreign Investment*, 1975.

TABLE 3. DIRECT INVESTMENTS FROM JAPAN AND THE UNITED STATES IN KOREAN MANUFACTURING INDUSTRIES, 1973–1979

[Japanese Direct Investments]

Industries	Low-Technology	High-Technology	Sub-Total
Labor-Intensive	60 (18%)	188 (57%)	248 (75%)
Capital-Intensive	32 (10%)	49 (15%)	81 (27%)
Sub-Total	92 (28%)	237 (72%)	329 (100%)

[US Direct Investments]

Industries	Low-Technology	High-Technology	Sub-Total
Labor-Intensive	6 (19%)	13 (41%)	19 (60%)
Capital-Intensive	1 (3%)	12 (38%)	13 (40%)
Sub-Total	7 (22%)	25 (78%)	32 (100%)

Source: See Tables 1 and 2.

with the former being more so than the latter. US direct investments were equally divided between the low-technology and the high-technology industries whereas Japanese direct investments were concentrated in the low-technology industries. This pattern is certainly consistent with Kojima's observation regarding the type of technology transferred from Japan and the United States.

The figures in Table 3, however, demonstrate a drastic change from this pattern. During the period of 1973–1978 both Japanese and US direct investments were concentrated in the labor-intensive, high-technology industries, the former being more so than the latter. They were now highly concentrated in the high-technology industries, although US direct investments were more concentrated in the capital-intensive, high-technology industries relative to Japanese direct investments.

The change described above may be viewed as a consequence of the conjunction of two structural changes that culminated in the early 1970s. One is the phasing-out of low-technology industries in the Japanese economy and, consequently, Japan was running out of low technologies to export. The other is the transformation of the Korean industries mentioned above and, consequently, there was an increasing demand for high technologies in Korea.

II

In the preceding section we have compared Japanese and US technology transfer through direct investments in terms of the level of technology and factor intensity. This exercise is, however, relevant to the issue of appropriateness to Korea of technologies transferred from Japan and the United States only so far as the hypothesis that low technologies are more easily transferable to the host counrty than high technologies is true. Although it is highly plausible, the hypothesis remains as yet untested.

In this section we report the answers made by some Japanese and US affiliates to questions on technology transfer. These answers provide some direct evidence on technology transfer although their reliability is, of course, open to question.

The answers we compare are from 51 Japanese affiliates and 21 US affiliates extant in Korean manufacturing industries as of the end of 1978. These are some of the affiliates that were in the survey carried out by the Economic Planning Board and the Korea Industrial Bank in 1979.[3] In the survey questionnaire there were four questions relevant to technology transfer, and the sample answers are reported in this section.

The first question is related to the kinds of assistance provided by the foreign partner of the affiliate. The questionnaire listed seven kinds of assistance that could be provided by the partner, and the figures in Table 4 show the proportion of the sample with affirmative answers for each kind of assistance.

The figures indicate that proportionately more US affiliates received assistance in management know-how, patented technology and technical assistance than Japanese affiliates. In the assembly of machinery and maintenance, however, proportionately more Japanese

[3] Although a 75.5% of all the foreign affiliates responded to the survey questionnaire, the author was able to obtain the answers of only a random sample of 51 Japanese affiliates and 21 US affiliates. The survey results are kept at the Korea Development Institute as confidential records.

TABLE 4. RESPONSES OF JAPANESE AND US AFFILIATES IN KOREAN MANUFACTURING INDUSTRIES TO "WHAT ARE THE TYPES OF TECHNICAL OR MANAGERIAL ASSISTANCE PROVIDED BY YOUR FOREIGN PARTNER?

[Percentage of Affirmative Answers]

Types of Assistance	Japanese Affiliates*	US Affiliates*
Management Know-How	16%	33%
Patented Technology	16%	43%
Technical Assistance	78%	90%
Assistance in Marketing	49%	48%
Assembly of Machinery and Maintenance	35%	29%
Supply of Raw Materials and Intermediate Products	49%	48%
Others	4%	0%

Source: See Table 1.
**Sample size*: 51 Japanese affiliates and 21 US affiliates.

TABLE 5. RESPONSES OF JAPANESE AND US AFFILIATES IN KOREAN MANUFACTURING INDUSTRIES TO "HAS TECHNOLOGY OR MANAGEMENT KNOW-HOW BEEN TRANSFERRED?"

[Percentage of Affirmative Answers]

Possible Answers	Japanese Affiliates*		US Affiliates*	
	Technology	Management Know-How	Technology	Management Know-How
Effectively Transferred	76%	37%	76%	33%
Not Effectively Transferred	12%	14%	14%	24%
Others	6%	6%	5%	0%

Source: See Table 1.
**Sample size*: 51 Japanese affiliates and 21 US affiliates.

affiliates received assistance than US affiliates. In marketing, the supply of raw materials and intermediate products, and other assistance there seems to be very little difference. A test for the difference between two proportions could not reject at 1% level of significance the null hypothesis that the two population proportions are the same for each of the seven kinds of assistance.

In both groups of affiliates the most important kind of assistance was provided in the form of technical assistance, marketing, and the supply of raw materials and intermediate products. It also appears that relatively more US partners provided patented technology whereas relatively more Japanese partners provided assistance in the assembly of machinery and maintenance. This difference is consistent with Kojima's observation that US direct investment transfers sophisticated technology whereas Japanese direct investment transfers general industrial experience involving person-to-person contact.

The second question is whether or not there is the transfer of technology and management know-how to indigenous personnel. Although assistance of various kinds may be provided to affiliates by their foreign partners, they may not become part of the technological knowledge of indigenous personnel. Kojima's contention is that this indigenous absorption of foreign technology is greater with Japanese direct investment than with US direct investment. There were three possible answers to the question, and the sample responses are distrubuted as shown in Table 5.

In a large proportion of both US and Japanese affiliates technology was effectively transferred to indigenous personnel, but only in a third of the affiliates management know-

how was effectively transferred. In their responses to this question there is very little difference between the affiliates of the two countries.

Foreign technology and management know-how, although effectively absorbed by indigenous personnel, may not be regarded as having any beneficial effect on the economy of the host country. The responses to the third question thus reveal some interesting aspect of technology transfer. It asked about the extent of the contribution made by foreign technology and management know-how to the improvement of indigeous technology and management know-how. There were three possible answers to choose from in the questionnaire, and the sample responses are shown in Table 6.

It appears that, although in most of the US and Japanese affiliates the contribution to indigenous technology was regarded as being large, in only a relatively small number of affiliates the contribution to indigenous management know-how was also regarded to be large. What is interesting is the fact that Japanese direct investments made large contribution to indigenous management know-how relatively more than US direct investments. Also interesting is the fact that local partners of some Japanese affiliates regarded Japanese technology and management know-how inferior to theirs.

The fourth question inquires about the reasons for no or little transfer of technology and management know-how. There were four possible answers, and the sample responses are shown in Table 7.

Only 6 out of 21 US affiliates and 15 out of 51 Japanese affiliates in the sample responded to this question. This is due to the fact that these are the firms which responded negatively to the first question. In the case of US affiliates the reason for non-transfer is said to be

TABLE 6. RESPONSES OF JAPANESE AND US AFFILIATES IN KOREAN MANUFACTURING INDUSTRIES TO "WHAT IS THE EXTENT OF THE CONTRIBUTION MADE BY YOUR FOREIGN PARTNER TO INDIGENOUS TECHNOLOGY AND KNOW-HOW?"

[Percentage of Affirmative Answers]

Possible Answers	Japanese Affiliates*		US Affiliates*	
	Technology	Management Know-How	Technology	Management Know-How
Large Contribution	78%	24%	95%	8%
No Large Contribution	14%	33%	5%	19%
Inferior to Indigenous Technology and Management Know-How	6%	2%	0%	0%

Source: See Table 1.
**Sample size*: 51 Japanese affiliates and 21 US affiliates.

TABLE 7. REASONS GIVEN BY JAPANESE AND US AFFILIATES IN KOREAN MANUFACTURING INDUSTRIES FOR NON-TRANSFER OF TECHNOLOGY AND MANAGEMENT KNOW-HOW

Possible Reasons	Japanese Affiliates*	US Affiliates*
Lack of Absorptive Capacity	20%	50%
Restrictions Imposed in the Contract	20%	17%
Conscious Attempt to Prevent the Transfer	60%	0%
Other	0%	33%
	100%	100%

Source: See Table 1.
**Sample size*: 15 Japanese affiliates and 6 US affiliates.

the lack of absorptive capacity on the part of indigenous personnel whereas in the case of Japanese affiliates it is said to be the unwillingness of Japanese partners to effectuate the transfer. Although the sample size is too small to attach much significance to this result, it seems to be consistent, nonetheless, with Kojima's observation that US direct investments bring in technology too sophisticated for indigenous personnel.

III

During the 1962–1980 peirod a total of 1,726 licences were approved by the Korean government to be imported from Japan, the United States, the Federal Republic of Germany, the Great Britain, France and other countries. Among these Japan and the United States were the two largest suppliers of licences, together accounting for 81.4% of the total (Table 8).

The rate of technology inflow increased dramatically during the period. During the 1962–1966 period the annual average of licences approved was approximately 7 per year. It increased to 57 during the 1967–1971, to approximately 87 during the 1972–1976 period, and during the 1977–1980 period it went up to about 244 licences per year. The overall trend seems to follow the development path of the Korean economy, and the dramatic increase during the last subperiod reflects the structural change carried out in Korean manufacturing industries away from unskilled labor-intensive industries toward skilled labor-intensive industries.

Of the two major suppliers of licences Japan was the more important one; the number of licences from Japan was two and a half times larger than that from the United States.

TABLE 8. LICENCE IMPORTS APPROVED BY THE KOREAN GOVERNMENT, BY COUNTRIES OF ORIGIN

Period	Japan	United States	Sub-Total	Others*	Total
1962–1966	11	13	24	9	33
1967–1971	203	61	264	21	285
1972–1976	280	90	370	64	434
1977–1980	520	227	747	227	974
1962–1980	1,014	391	1,405	321	1,726
	(58.7%)	(22.6%)	(81.4%)	(18.6%)	(100%)

Source: Economic Planning Board, *Current State of Technology Imports* (in Korean), Seoul, Korea, 1980.
*West Germany, Great Britain, France and others.

TABLE 9. LICENCE FEES PAID BY KOREA

(in Thousand Dollars)

Period	Japan	United States	Sub-Total	Others*	Total
1962–1966	0	553.1	553.1	224.2	777.3
1967–1971	5,041.6	7,816.2	12,857.8	3,399.9	16,257.7
1972–1976	58,653.5	21,265.5	79,919.0	16,588.5	96,507.5
1977–1980	104,412.4	111,174.8	215,587.2	128,700.2	344,287.4
1962–1980	168,107.5	140,809.6	308,917.1	148,912.8	457,829.9
	(36.7%)	(30.7%)	(67.4%)	(32.6%)	(100%)

Source: See Table 8.
*West Germany, Great Britain, France and others.

TABLE 10. SECTORAL DISTRIBUTION OF LICENCES APPROVED BY THE KOREAN GOVERNMENT

[From Japan]

	Low-Technology Industries	High-Technology Industries	All Manufacturing Industries
1962–1972	29 (13%)	186 (87%)	215 (100%)
1973–1978	80 (17%)	379 (83%)	459 (100%)
1962–1978	109 (16%)	565 (84%)	674 (100%)

[From the United States]

	Low-Technology Industries	High-Technology Industries	All Manufacturing Industries
1962–1972	18 (26%)	52 (74%)	70 (100%)
1973–1978	32 (20%)	130 (80%)	162 (100%)
1962–1978	50 (22%)	182 (78%)	232 (100%)

Source: See Table 8.

In terms of fees paid, however, the difference was not that large, as can be seen in Table 9. Korea paid approximately $168 million to Japan for the entire period and $141 million to the United States. The average fee for the Japanese licence was $166,000 whereas the average fee for the US licence was $360,000.

In order to test the hypothesis that US technology transfers are in the industries of new, sophisticated technology whereas Japanese technology transfers are in the industries of mature, standardized technology, we divided licences approved for transfer from these countries during the 1962–1978 period into high- and low-technology industry groups.

Table 10 reports the sectoral distributions of licences from Japan and the United States for the 1962–1978 period and for the two subperiods. The inflow of both Japanese and US licences was clearly concentrated in the high-technology industries during the entire period and in fact the inflow of Japanese licences was slightly more concentrated in this group than the inflow of US licences. The basic pattern still holds when we divide the period into the two subperiods. Given the fact that there was a significant shift in concentration of Japanese direct investments from the low-technology industries during the first subperiod to the high-technology industries during the second subperiod, we may infer that any difference between Japanese and US technology transfers would be found in technologies transferred through direct investments and in the proportion of technologies thus transferred to total transfers.

In section I it was shown that a significant difference existed between Japanese and US direct investments during the 1962–1972 period but that it disappeared during the 1973–1978 period. In the following section we attempt to find out whether Japanese technology transfers were carried out more through direct investments than through licensing in comparison with US technology transfers.

IV

In discussing the difference between Japanese and US technology exported to develop-

ing countries Kojima (1977) and Ozawa (1971) argued that the former was mostly in the form of know-how or general industrial experience whereas the latter was largely patented, "high-level" technology. In the terminology of Hall and Johnson (1970) the technology transferred from Japan is "firm-specific" technology whereas the technology transferred from the United States is "system-specific."[4] System-specific technology is more easily reduced to manuals and blue-prints and thus more easily transferable through licensing than firm-specific technology.[5] Thus, if the characterization of Japanese and US technology transfers of Kojima and Ozawa is correct, technology transfers from the United States would be carried out more through licensing than direct investments relative to those from Japan.

Table 11 reports the ratio of licences to direct investments for the low-technology, the high-technology and all manufacturing industries for both Japan and the United States. It is clear that for both countries technology transfers in the high-technology industries were more through licensing than through direct investments when compared with technology transfers in the low-technology industries. We may thus infer that low technologies are relatively firm-specific whereas high technologies are system-specific.

The figures in Table 11 for both the entire period and the second subperiod are consistent with the hypothesis that technology transfers from the United States were carried out more through licensing than through direct investments relative to those from Japan. The 1962–1972 figures for the high-technology industries do not, however, support the hypothesis. What they seem to indicate is that Japan did not then lack in high technologies to export. The relatively small number of direct investments in this group may therefore have to be explained in terms of other limiting factors such as managerial experience in carrying out direct investments in high-technology industries. It seems that by the early 1970s they were no longer binding constraints.

TABLE 11. RATIO OF LICENSE TO DIRECT FOREIGN INVESTMENTS IN KOREAN MANUFACTURING INDUSTRIES

[From Japan]

	Low-Technology Industries	High-Technology Industries	All Manufacturing Industries
1962–1972	0.5	6.2	2.6
1973–1978	0.9	1.6	1.4
1962–1978	0.8	2.1	1.6

[From the United States]

	Low-Technology Industries	High-Technology Industries	All Manufacturing Industries
1962–1972	1.0	2.9	1.9
1973–1978	4.8	5.2	5.1
1962–1978	2.0	4.2	3.4

Source: See Table 1, 2 and 8.

[4] "Firm-specific" technology is not necessarily associated with any product or process but is based on the experience related to the operation of a firm. "System-specific" technology is specific knowledge related to a product or process possessed by its makers but also known in general terms to other firms in the industry.

[5] Contractor (1981).

V

The main focus of this paper was to compare technologies transferred from Japan and the United States to Korean manufacturing industries in terms of the level of technological sophistication. No significant difference could be found in technologies transferred, whether through direct foreign investments or licensing, during the 1962–1978 period. When this period was divided into the 1962–1972 and 1973–1978 subperiods a significant difference was found between Japanese and US direct investments during the first subperiod. During this period Japanese direct investments were concentrated in the low-technology industries relative to US direct investments. The difference, however, disappeared during the second subperiod. It was also found that in technologies transferred through licensing no significant difference existed between the two countries.

When sample answers from a questionnaire survey were compared, we found the results to be consistent with Professor Kojima's observation that technologies transferred from the United States were more sophisticated than those from Japan. Since we were unable to separate the answers of the affiliates established during the 1962–1972 period from those of the affiliates established later, it is impossible to tell whether our results are due to over-representation in the sample of the affiliates established during the first subperiod.

What seems to emerge from the research reported in this paper is that in terms of our admittedly crude criteria used for comparing Japanese and US technology transfers there was a significant difference only during the 1962–1972 period and only in technologies transferred through direct investments. It seems, however, that little difference is found in technologies transferred since then. Of course, this does not mean that when finer calibration is applied we may not find differences in these technologies.

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*APPENDIX**

Labor-intensive, high-technology industries:
Printing, Publishing and Allied Industries; Machinery; Electrical Machinery, Apparatus, Appliances and Supplies; Transport Equipment; and Professional and Scientific Equipment.

Capital-intensive, high-technology industries:
Industrial Chemicals; Other Chemical Products; Petroleum Products; and Basic Non-Ferrous Metal Products.

Labor-intensive, low-technology industries:
Food; Tobacco, Textiles, Wearing Apparel; Leather, Leather Products, Leather Substitutes and Fur; Footwear; Wood and Wood Cork Porducts; Furniture and Fixtures; Rubber Products; Plastic Products; Fabricated Metal Products (except Machinery and Equipment); and Other Manufactures.

Capital-intensive, low-technology industries:
Beverage; Paper and Paper Products; Pottery, China and Earthenware; Glass and Glass Products; Other Non-Metallic Mineral Products; and Basic Iron and Steel Products.

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* For classifying industries into the above four groups we used Hufbauer's (1970) estimates of factor- and skill-intensities of US traded goods. Factor-intensity is thus measured as capital per man in US industries in 1963, and skill-intensity is measured as the percentage of professional, technical and scientific personnel employed in an industry in 1960. Since professional, technical and scientific personnel possess more human capital than other personnel, this skill-intensity may also be regarded as a measure of human capital-intensity. The respective median values of these estimates are then used as the criteria for classification. This classification is the same as the one used by Dunning (1979) with only one exception. Here, Paper, Printing and Publishing is in the high-technology group whereas it is in the low-technology group in Dunning's classification.

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