

A Theory on the Structure of Productive Forces

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Introduction

Faced with long-lasting global depression of capitalist economy since early 1970s and its continuity, increasing attention has focused on the Kondratieff-waves, and the role of technological innovation on economy or its impact on society. Because the concern in long-wave is resulted from that this depression could not persuasively explained by the past business cycle theory. However, the long-wave theory is only a cycle theory, overlooks the structural changes behind this depression. I think this depression of a reflection of the ongoing structural changes of capitalism, namely change of technological stage from machinery to automation.

I will comprehend this changes as the second historical changes of the structure of productive forces after the Industrial Revolution. The structure of productive forces I propose, consists of both the system of the instruments of labour and the structure of division of labour. This change has a possibility to collapse capitalist economy because it bring about a radical changes to the capital/wage-labour relations.

1. The Structure of Productive Forces

Karl Marx postulated that a given stage in the development of the material forces of production determines the relations of production.

“The totality of these relations of production constitutes the economic structure of society, the real foundation, on which arises a legal and political superstructure and to which correspond definite forms of social consciousness. --- At a certain stage of development, the material productive forces of society come into conflict with existing relations of production.--- From forms of development of the productive forces these relations turn into their fetters. Then begins an era of social revolution. The changes in the economic foundation lead sooner or later to the transformation of the whole immense superstructure.

--- No social order is ever destroyed before all the productive forces for which it is sufficient have been developed, and new superior relations of production never replace older ones before the material conditions for their existence have matured within the framework of the old society".⁽¹⁾

There stressed an important role of productive forces which determine the economic structure of society, in Marx's way of thinking cited above. I also will make much this thinking as my stand point of view, to examine the current technological changes. Because technological changes of itself occur frequently, we must define what kind of technological changes as economical meanings, in examining not technology itself, but technological impact on economy. By the way, Marx wrote the relations of production as the economic structure of society generate "a legal and political superstructure and to which correspond definite forms of social consciousness". According to my version, there placed human being at the position to connect the productive forces with the relations of production. Because the productive forces are always ones of human being in the one hand, the relations of production are ones of society on the other hand. I will treat of the technological changes which have a possibility to change the role of labour in production/labour process, thus the relations of capital/wage-labour.

The process of the Industrial Revolution specified by Marx typify this way of analysis. This process characterized the transitional process from tool to machine stage in the development of the technologies. Furthermore, it has broken through capital's dependency on craftsman's skill, moved from 'formal subordination' towards 'real subordination' of labour by capital. Capitalism thus created for itself a 'fitting technical foundation'.⁽²⁾ In this sense, what type of division of labour is dominant determines the character of their society. If agricultural type of labour is dominant, who hold the ownership of lands rules the peculiarities of this community. When this is industrial type of labour based on machinery, it sooner or later results in capitalist mode of production.

I propose the structure of productive forces which deals with the technological changes characterized above, therefore within (or beyond) a relations of production (that is capitalism), while Marx formulates the change of society caused by the development of productive forces as a continuous alternation of the relations of production, like "the Asianic, ancient, feudal and modern bourgeois mode of production". The structure of productive forces consists of both the system of the instruments of labour and the structure of division of labour. The system of the instruments of labour here, however, does not mean mere technological changes, but ones that change the needs for the functioning of human works, thus cause a transfer of the occupational structure. Although it is difficult to clarify overall the interrelations between technologies, productive forces and relations of production, this concept devises for to this task. Of course, I

don't stand for technology determinism, rather than against the treatment of technology as outside or neutral to economy.

2. Long-Wave Theories

Recent works referred to long-wave theories are very suggestive in relation to see the meaning of present structural change of capitalism. It is because technological changes usually place a core factor to cause long waves, and the definition of technological changes with a fifty years period has to differ from casual technological changes for its impact to economy. Carlota Perez defines long wave as a change technological and economical as well.

"We propose that the capitalist system be seen as a single very complex structure, the subsystems of which have different rate of change. For the sake of simplicity we can assume two main subsystems: on the one hand a techno-economic, and the other a social and institutional, the first having a much faster rate of response than second. The long waves would be successive phase in the evolution of the total system or, as we have termed them, successive mode of development. --- In essence we assume a strong feedback interaction between the economic, social and institutional spheres which generates a dynamic complementary centred around a technological style ---".⁽³⁾

She places, in addition, 'key factor' that consists of "key technological developments, which result in a substantial change in the relative cost structure facing industry and which, at the same time, open a wide range of new opportunities for taking advantage of this particular evolution". This key factor, or 'technological style' reaches the limits of its potentiality, downswing process of the long wave. Thus, to break away from this limits, a new technological style emerges.

'Key factor' Perez called, fulfills following conditions :

- clearly perceived low - and descending - relative cost ;
- unlimited supply for all practical purposes ;
- potential all-pervasiveness ;
- a capacity to reduce the cost of capital, labour and products as well as to change qualitatively".⁽⁴⁾

And then, she characterize these key factors alongside every long wave.

"We suggest the role of key factor was played by low-cost and steam-powered transportation in the second kondratiev ; by low-cost steel for the third ; low-cost energy, in the form of oil and energy-intensive materials, for the forth ; and is now being played by low-cost microelectronics on the way towards the fifth upswing".⁽⁵⁾

Although I evaluate her approach to connect technological changes with the changes of

economic, social and institutional spheres, just like Marx's one above mentioned, her criteria to extract key technology is confused, lacks coherence. Steam power in the second wave is classified by power technology, however, steel for the third by material, oil for the fourth by energy and micro-electronics technologies toward the fifth is by the control devices. While every technological changes raised above has important impact on economy, there is wide diversity, concerning technological effect on the production process, especially on the capital/wage-labour relations. There occur continual technological changes including minor one in capitalist economies, therefore, we must clarify what is investigated, in case of extracting any meaningful technological changes. As a result, Perez's approach is the same as Schumpeter's one to pay attention the innovations to induce capital investments. There first place the economic fluctuations every 50 years, and then search the important technological innovations around this. In this approach, the technological changes occurred with fifty period are always enclosed basically within capitalist framework, have no possibility to break down capitalism. For the sake of this, it fails to see the ongoing changes of production/labour process.

Technological innovations mainly consist of both product and process innovation. Process innovations are new processes of production or improvements on existing technology, in addition, this type of innovations has a possibility to change the labour process, accordingly the relations between capital to wage-labour which is seldom occur, though. On the other hand, product innovations are the creation of new products or improvements on existing products, play the role which overcomes the saturation of wants, so are vital for existence of capitalism, because it opens up a new market, new capital investment areas. Product innovations change the industrial structures, however, itself has few possibility to change the production/labour process.

As regards a consistent criterion of technological change, Phil Blackburn, Rod Coombs and Kenneth Green, "try to place new technologies currently being developed or innovated into a broader context of historical development of capitalist economies, synthesizing the accounts of long-term economic development and the analysis of technology developed by historians and writers on the capitalist labour process."⁽⁶⁾ From this point of view, they, based on Bell's work that designs to locate automation process by three dimensions, namely transformation, transfer and control,⁽⁷⁾ propose three types of mechanisation : primary mechanisation characterized by transformation in 1850-1900 ; secondary mechanisation characterized by transfer in 1900-1950 ; tertiary mechanisation by control for present long wave.

Their research project is closing in essence of being continued structural changes generated in capitalist economy. However they try to conceptualize its process as the mechanisation process, don't allow the discontinuity between the past mechanisation process and the present technological changes (so called 'microelectronics revolution'). There is a fundamental change between the

stage of machinery and automation in the development of technology, to my thinking.

The transition from tool to machinery stage in development of technology basically (not totally) has broken through craftsman's skill,⁽⁸⁾ with which a prospect of substituting a machine for a function worked by labourer has become real, in a technological sense. However this prospect realizes little spheres on the stage of machinery technology, for it couldn't *economically* attain, by reason of the enormous cost to build up such a 'machinofacture'. So called automation (I call this as 'initial automation'), partly opened up this limits in a few industry which can enjoy economies of scale by mass production, namely consumer durable such as automobile. Agrietta's Fordism theory illustrates this point by linking mass production with mass consumption.⁽⁹⁾ In this sense, initial automation could be said a perfect phase in stage of machinery technology.

On the other hand, integrated circuit technology made possible a wide diffusion of such discipline, because it is a kind of technology to substitute the functioning of brain, as contrast with the machine to substitute only a manual labour. Blackburn *et al's* argument seems to fail to notice the difference of technological stages between machinery and automation. I will deal with this point in next section in depth.

Lastly, let us see shortly David M.Gordon, Richard Edwards and Michael Reich's theory of 'social structure of accumulation', because their concept constitutes the change of labour process and labour market in the United States, as important element.⁽¹⁰⁾ Although I will abridge in detail, since their theory is similar to the theories mentined above, their grouping and characterizing of workers in the stage of 'segmentation of labour' after World War II, aroused my interest. The first group is the independent primary workers consisted of mainly professional, managerial, and technical jobs, second is the subordinate primary workers consisted many semiskilled white-collar jobs, and the last is secondary workers consisted lower layers of service, sales and clerk jobs. They thus characterize their predominant political inclinations as following.

"Independent primary workers and their households were particularly likely to focus on political issues concerning the quality of life and individual autonomy ---. This led, for example, toward a focus on issues concerning the environment, civil liberties, and personal rights, and to demands for freedom from political and social oppression.

Subordinate primary workers and their households, following up on their recent ability to achieve relative security and stability of income and employment, were likely to emphasize the importance of economic growth ; the U.S. international dominance upon which American growth partly depended ; full employment ; and the integrity of the institutions (of the social structure of accumulation) within which their stability and security were rooted.

Secondary workers and their households were likely to place particular importance on access to government services and income support, given their lower and less stable earnings

from employment. Their relatively lower returns from participation in the established economic institutions were likely to translate into relatively lower participation in established political institutions as well – and therefore, into lower rates of voter participation, for example”.⁽¹¹⁾

The transition from machinery to automation in technological stage of development is remarkable for the division of labour, namely the occupational structure. In this sense, the concept of proletariat with common attributes necessarily can't apply to the workers in automation stage. The grouping of Gordon *et al.* suggests a way to analyze the present working class. However, there is great diversity of the labour market or labour management they focus every country. For example, three stage they propose, “initial proletarianization, homogenization, and segmentation”, compresses into the period in a post W.W II in Japan. Therefore, It seems impossible that their concept has a global generalization.

It sums up that the long wave theory lacks a reliable evidence (at least, I am skeptical), thus the description of technological changes linked long waves must of necessity follow an unnatural, distorted interpretation.

3. Automation Stage as the Change of the Structure of Productive Forces

It is certain that the recent technological progress provides a background of growing concern in long wave. Above all, microelectronics technology is decisive. There are two different phases in the development of automation, that is initial phase and genuine phase ; initial automation phase, well-known as Fordism or mass-production system, has based on machinery as technological stage, could applied only to some limited spheres ; on the other hand, genuine automation phase for a reason based on microelectronics technology can apply a wide range. Although the perfect substitute technologies (that is the instruments of labour) for human functioning is almost impossible, a definite partial substitute is of course possible.

From this point of view, the initial automation based on machinery, could substitute the manual functions of human work at the utmost. Against this, genuine automation based on microelectronics technology, can substitute the sensory and control functions, because the one-chip microprocessor (made possible by integrated circuits technology) as a kind of brain, can apply to diversified mechanical instruments. Moreover “micro-electronics-based technologies allow flexible automation to be viable commercially and to obtain low production costs also for small production volumes.”⁽¹²⁾ In this sense, it might be possible to call *automatic operation* in phase of initial automation, and *automatic control* in phase of genuine automation. The developed machinery consists of three essentially different parts, the motor mechanism, the transmitting

mechanism, and finally the tool or working machine, but in genuine phase the control device is incorporated in machinery as a objective mechanism can be manipulated.

I will conceptualize this process as the transformation from the machinery to automation stage (including both phases) in the structure of productive forces. It is the reason to include both phases of automation in the same stage of the structure of productive forces that there played a decisive role of a sort of service, non-material workers in this stage. However there is a difference of work between two phases, in initial phase it is the works related to marketing like advertising, ⁽¹³⁾ in genuine the software works.

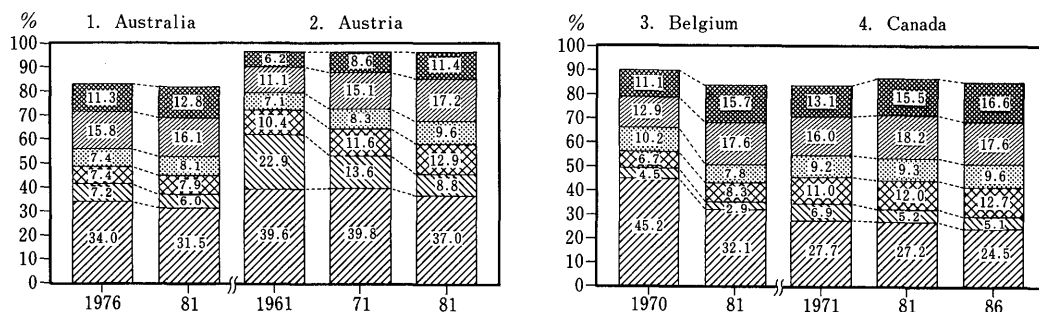
Figure-1 shows the change of occupational structure in OECD countries. First, the workers engaged in the production of some material goods mark a decline, almost in every countries.

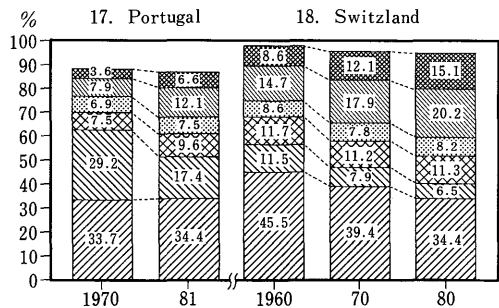
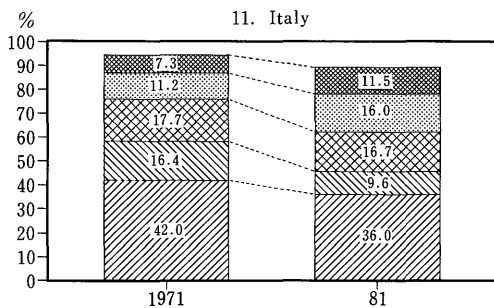
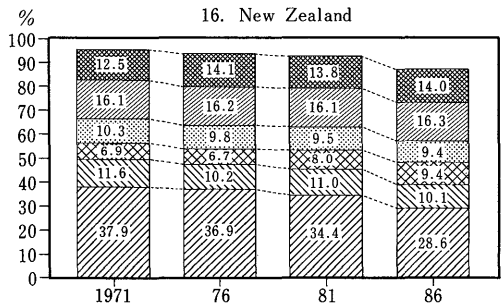
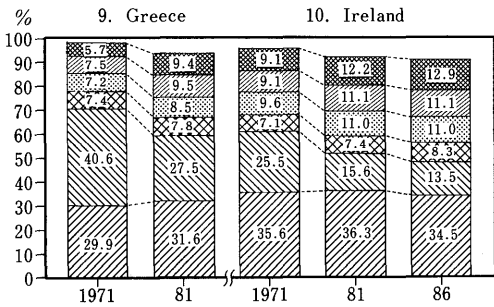
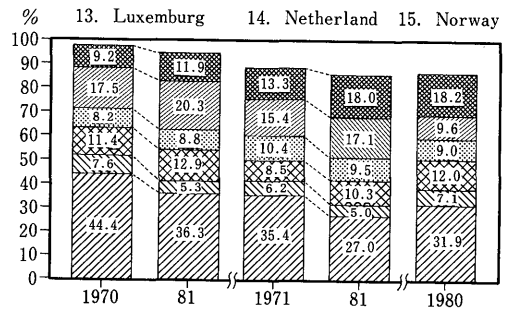
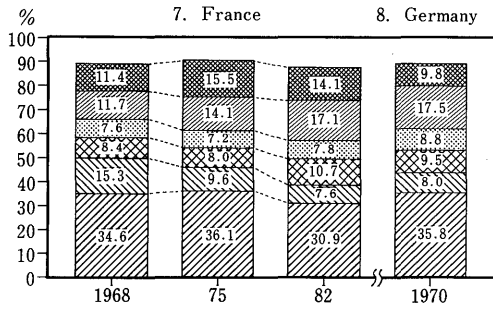
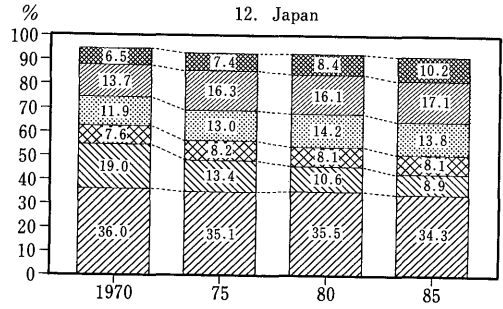
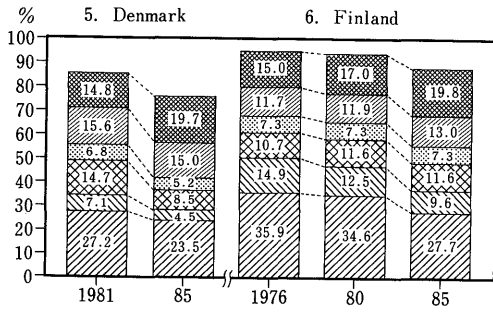
Figure-1 Change of Occupational Structure (OECD countries)

International Standard Classification of Occupations-1968

- 1 Professional, technical & related workers
- 2 Administrative & managerial workers
- ▨ 3 Clerical & related workers
- ▤ 4 Sales workers
- ⊠ 5 Service workers
- ▩ 6 Agric., animal husbandry & forestry workers, fishermen & hunters
- ▧ 7-9 Production and related workers, transport equipment operators & labourers
- x Workers not classifiable by occupation
- Members of the armed forces

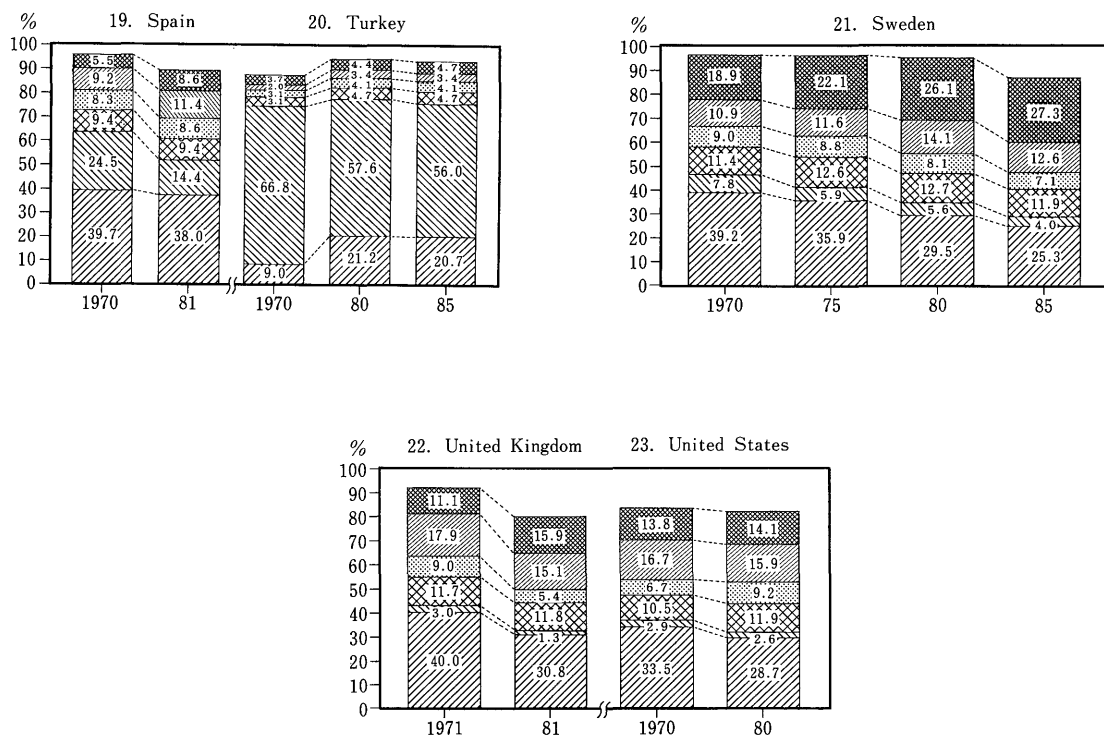
Source : ILO. (1990). *Year Book of Labour Statistics 1945-1989*.





▨ Prod. ▨ Agric. ▨ Sale. & Serv. ▨ Adom. & Cler. ▨ Prof.

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Although it is needless to say the rapid decline of workers of the primary industry, the same is more or less true of the occupations related to the production of material goods. On the other hand, professional, technical and related workers generally show a tendency to increase. These tendency is often said from the context of the transition to service economy. However, service workers don't always increase.

The change of the structure of productive forces to automation stage means, in a sense, the shift to a professional, technical labour (service)-intensive economy. However these occupations consist of social service workers like medical workers and teachers as well. Unfortunately, this data contain little in the occupational composition by industry. To make up for this defects, the composition of occupation by industry in recent Japan is presented in Table-1. This table shows a striking contrast between a rapid decline of the direct, productive workers and an increase of professional, technical workers. Furthermore, in Service industry as major group, the workers of business service is increasing, though social service workers also well. This tendency is more striking in 1980s.

These tendency is a reflection of the change of the structure of productive forces based on the change of technological stage. Figure-2 shows the technological change in development of

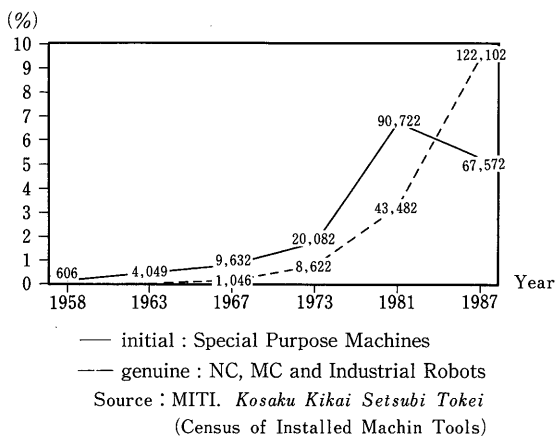
Table-1 Shares of Labour Forces by Occupation and by Industry (Japan)

Industry	Occupation	Year	Total civilian labour forces	Intermediate service			Service industry		
				Material production a)	(1) Distributive service b)	(2) Producer service c)	Business	Consumer	Social
Total		1985	100	44.49	30.16	3.98	6.05	5.77	9.56
		80	100	46.66	30.27	3.75	4.81	5.59	8.91
		75	100	50.44	28.88	3.48	3.83	5.62	7.76
Productive workers d)		1985	41.51	33.87	4.39	0.05	1.24	1.36	0.60
		80	44.03	36.78	4.02	0.05	1.08	1.50	0.61
		75	46.61	40.08	3.89	0.04	0.65	1.58	0.37
Indirect workers e)		1985	21.12	5.33	9.06	1.95	2.02	0.76	1.99
		80	20.19	5.37	8.71	1.94	1.67	0.66	1.84
		75	20.39	5.90	8.78	1.97	1.45	0.69	1.60
Managers		1985	4.06	1.79	1.32	0.32	0.28	0.18	0.17
		80	4.78	2.17	1.60	0.34	0.29	0.18	0.21
		75	4.28	1.96	1.42	0.30	0.25	0.18	0.17
Sales workers		1985	14.77	1.38	11.38	1.49	0.28	0.21	0.02
		80	14.89	1.16	12.07	1.28	0.21	0.16	0.02
		75	13.80	1.21	11.25	1.03	0.17	0.13	0.02
Professional & technical workers		1985	11.15	2.02	0.40	0.08	2.09	0.26	6.29
		80	8.86	1.05	0.31	0.06	1.49	0.23	5.72
		75	7.64	1.02	0.31	0.05	1.10	0.22	4.95
Service workers		1985	7.37	0.09	3.60	0.09	0.13	2.97	0.50
		80	7.26	0.15	3.56	0.08	0.09	2.86	0.52
		75	7.27	0.26	3.23	0.08	0.22	2.84	0.63

Source : Census of Population (Japan)

- a). Agriculture, hunting, forestry and fishing ; Mining and quarrying ; Manufacturing ; Electricity, gas and water
- b). Wholesale and retail trade and restaurants and hotels ; Transport, storage and communication
- c). Financing, insurance, real estate and business services
- d). Agriculture, animal husbandry and forestry workers, fishermen and hunters ; Production and related workers, transport equipment operators and labourers
- e). Clerical and related workers

Figure-2 Phases of development in automation (figures : units of machine)



automation. It needs attention that a technological invention doesn't always bring about innovation, or diffusion of its technology. This data, accordingly indicates real installed machine-tool. It is certain that the transformation from initial to genuine automation is rapidly since 1980s in Japan.

Tessa Morris—Suzuki's proposal of a perpetual innovation economy is interesting to consider this subject. She first grasps today's automation as "a radical departure from earlier forms of the development of machinery." And then, she characterizes this as a "separation of knowledge from labour and machinery".⁽¹⁴⁾ The perpetual innovation society is following ;

"then we might indeed conclude that this would be society where no value could be created and no exchange could occur. But if we look at the continuing uneven diffusion of robotics in the real world of contemporary capitalism we are likely to come to a different conclusion, through one equally compatible with the labour theory of value. This conclusion is that automation causes the centre of gravity of surplus value creation to shift away from the production of goods and towards the production of innovation - that is, of new knowledge for the making of goods. The spread of automated manufacturing, by sundering the labour process and squeezing out surplus value from the production of material objects, forces capitalist enterprises and capitalist economies to become perpetual innovators".⁽¹⁵⁾

Steedman, against Suzuki, criticized her "chain of ideas : profit is explained by the existence of surplus value ; in a fully automated economy no labour is performed and hence no surplus value is generated ; thus a fully automated economy cannot have positive profits."⁽¹⁶⁾ He thus proposes a model which is wholly automated economy, namely no labour economy, while prices and profits continue to exist. According to him, "what is revealed by full automation is not the 'inner limit' of capitalism but rather the 'inner limit' of the labour theory of value and of surplus value theorizing."⁽¹⁷⁾

A full automation model without any living labour by Steedman is, of course a fiction, actually not realistic. The question posed by him is that "'Fundamental Marxian Theorem' --- was always based on the premise that labour is used in production."⁽¹⁸⁾ In this point, as showed by Figure-1, Table-1, there occurred a shift of occupation from the production of goods toward the professional, technical one, in the automation stage of the structure of productive forces. Therefore, Suzuki against Steedman's criticism, defends her view by stressing her reference of the growing share of intellectual workers in advanced economy, the idea of 'the perpetual innovation economy'. However, it is sure that her article contains dual point at issue, and there placed the keynote of Mandel's hypothesis that "the reduced use of living labour power in production will ultimately make it impossible for enterprises to extract the surplus value."⁽¹⁹⁾ Although the labour forces in production in a narrow sense gradually and steadily decline, ones

in a broad sense increase. Strictly speaking, the labourers engaged upon the production of goods decline, but, on the other hand, the indirect workers like sales men and women, designer, programmer, R&D personnel and so on, are increasing.

This situation, accordingly, means that the labour theory of value doesn't lose its effect, but changes the way of its appearance. The task we must solve, is to clarify how to function the labour law of value in automation stage of the structure of productive forces. However, it involves difficulty because the output of this steadily increasing new kind of works resemble service in quality. Although the 'economic surplus' approach by P. A. Baran and P. M. Sweezy was an early trial to this problem, it limited in initial phase of automation stage in the structure of productive forces, especial sales effort.⁽²⁰⁾ In genuine phase of automation, in addition sales effort, such kind of new works as design, software, R&D and so on becomes increasing input to products. It is inevitable that the realization process of the labour law of value is disturbed. Now we must reconstruct the labour theory of value which above mentioned works is incorporated.

NOTES

- (1) Karl Marx. *A Contribution to the Critique of Political Economy.*, p. 20-22 (Lawrence & Wishart, 1971.)
- (2) Karl Marx. *Capital.* vol. I
- (3) Carlota Perez. (1983), "Structural change and assimilation of new technologies in the economic and social system" *Futures.* Vol. 15 No. 5, p. 359-360.
- (4) *Ibid.*, p. 361.
- (5) *Ibid.*, p. 362.
- (6) Phil Blackburn, Rod Coombs and Kenneth Green. (1985) *Technology, Economic Growth and the Labour Process.* (Macmillan)
- (7) R. M. Bell. (1972) *Changing Technology and Manpower Requirements in the Engineering Industry.* (Sussex University Press.)
- (8) A kind of skill is still alive, especially in manipulation of the general-purpose lathe. In this sense, the grasp to stress one-side deskilling by machine is wrong, rather than skills is always reproduced with diversity.
- (9) Michel Agrietta. (1976). *Régulation et Crises du Capitalisme.* (Calmann Levy). "The installation of transfer lines, which is very costly in terms of fixed capital, centralizes production enormously, and only becomes worthwhile from the capitalist point of view if very high levels of output can be regularly maintained. This is why automatic production control has only made its big leap forward very recently, with the introduction of incorporated numerical control." English ed. (1987, Verso) p. 125.
- (10) David M. Gordon, Richard Edwards and Michael Reich. (1982). *Segmented Work, Divided Workers : The historical transformation of labor in the United States.* (Cambridge U. P.). "By social structure of accumulation we mean the specific institutional environment within which the capitalist accumulation process is organized. Such accumulation occurs within concrete historical structures : in firms buying inputs in one set of markets, producing goods and services, and selling those outputs in other markets. These structures are surrounded by others that impinge upon the capitalist accumulation process : the monetary and credit system, the pattern of state involvement in the economy, the character of class conflict, and so forth." p. 9.
- (11) *Ibid.*, p.213-214.
- (12) OECD. (1988) *Industrial Revival through Technology.* p. 10.
- (13) This type of work is much related to the product differentiation. Cf. Victor D. Lippit. (1992) "Reevaluating the Concept of the Surplus". John B. Davis ed., *The Economic Surplus in Advanced Economies.* (Edward Elgar). "In the first place, if economies of scale are present, a high level of marketing expenditure may be necessary to bring production costs down to a minimum. Consider the following example. In the absence of marketing

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expenditure (including advertising), three hundred toothpaste companies might produce toothpastes at an average cost of one dollar per tube. In the presence of marketing expenditure, three toothpaste companies might, benefiting from economies of scale, produce toothpaste at an average cost of ten cents per tube. Even if the marketing expenditure amounts to fifty cents per tube, average costs of production plus marketing will be much lower when marketing expenditure brings about a more concentrated market structure.” (p. 73-74)

- (14) Tessa Morris-Suzuki. (1984) “Robots and Capitalism”. *New Left Review* No. 147, p. 112.
- (15) Ibid., p. 115.
- (16) Ian Steedman. (1985) “Robots and Capitalism : A Clarification”. *New Left Review*. No. 151, p. 125.
- (17) Ibid., p. 126.
- (18) Ibid., p. 127.
- (19) Tessa Morris Suzuki. (1986). “Capitalism in the Computer Age”. *New Left Review*. No. 160, p. 82. About a criticism toward Steedman, refer to Ramin Ramtin (1991). *Capitalism and Automation- Revolution in Technology and Capitalist Breakdown*, (Pluto Press).
- (20) Paul A. Baran and Paul M. Sweezy. (1966). *Monopoly Capital*. (Monthly Review Press). About economic surplus approach, refer J. B. Foster. (1986). *The Theory of Monopoly Capitalism*. and J. B. Davis ed. (1992). *The Economic Surplus in Advanced Economies*. (Eward Elgar).