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J. H. M. POPPE'S "HISTORY OF TECHNOLOGY" AND KARL MARX

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I. Introduction

"A critical history of technology (Eine kritische Geschichte der Technologie) would show how little any of the inventions of the 18th century are the work of a single individual. Hitherto there is no such book." (K. Marx, *Capital*, ed., by F. Engels, Vol. I, Charles H. Kerr, p. 406, [1])

This paragraph is a statement of foot-note ⑧ in Chapter 13 of *Das Kapital*. And it also was an issue at dispute of "Yuibutsuron-Kenkyukai" (Society for Research on Materialism) in Japan before World War II. During this dispute, the materials and books Marx had used were not examined in detail because of the insufficiency of the materials available.

But lately, new materials have been published. These are ① Marx's „Manuskript 1861-1863“ (*Karl Marx Friedrich Engels Gesamtausgabe (MEGA)* II. 3. 1.~6. *Karl Marx, Zur Kritik der Politischen Ökonomie*, Dietz Verlag, Berlin [2]), ② Marx's technological-historical excerpt (*Karl Marx, Die technologisch-historischen Exzerpte*, Hans-Peter Müller hrsg., Ullstein, W. G. 1982, [3]), ③ Marx's excerpt about C. Babbage and A. Ure (*Karl Marx, Exzerpte über Arbeitsteilung, Maschinerie und Industrie*, Rainer Winkelmann, hrsg., Ullstein, W. G. 1982).*

* According to *International Review of Social History* (Vol. XXVII-1982-Part I, False Alarm), ②, ③ materials have been published without the permission of I. I. S. G. I feel much regret at this fact. At some other time I will reexamine these notes by *MEGA* edition.

In this paper, I will reexamine that dispute and the hitherto understanding of *Das Kapital* on technology and science according to these new materials.

II. Marx's Technological-Historical Excerpt

In 1851 Marx studied agricultural science (J. Liebig and Johnston) and technology in relation to Ricardo's theory of rent. And the Great Exhibition of 1851 at London, which Marx viewed, was also a chance to study tech-

nology for him.*

* See also my paper, "The Industry of Nations and Marx's *Das Capital*," *Historia Scientiarum*, No. 24 (1983).

According to the decipherer, Marx's technological-historical excerpt was written about from Sept. to Oct., 1851 ([3] S. [15]). This excerpt has 44 pages and the following contents.

J. H. M. Poppe, "*The Mechanics of the 18th Century and the Early 19th Century*" (1807) (one sentence)

Poppe, "*Textbook of General Technology*" (1809) $\left(2\frac{2}{3} \text{ pages}\right)$

Poppe, "*Physics, especially as used on Arts, Manufacturing and Other Useful Industries*," (1830) $\left(6\frac{1}{2} \text{ pages}\right)$

Poppe, "*History of Mathematics*" (1828) (1 page)

Poppe, "*History of Technology*" (3 vols, 1807-11) (26 pages)

A. Ure, "*The Dictionary of Arts, Manufactures and Mines, German edition*," (3 vols. 1834-1844) $\left(7\frac{2}{3} \text{ pages}\right)$

J. Beckmann, "*History of Inventions*" (5 vols, 1780-1805) $\left(\frac{1}{4} \text{ pages}\right)$
([3] S. LXXVII)

The main part of this excerpt involves Poppe's "*History of Technology*". At that time in England there was no original book about the history of technology, so that J. Beckmann's "*History of Inventions*" (translation of „*Beyträge zur Geschichte der Erfindungen*“) was in circulation. Hence, Marx gave attention to J. Beckmann's and Poppe's books. Marx excerpted from Poppe's "*History of Technology*" („*Geschichte der Technologie*“) as follows.

Vol. I. Grain-mill and mill-machine in general [107], woolen fabrics [88], cotton and spinning [22], silk fabrics [58], knitting [24], preface [53].

Vol. II. Watchmaker art [124], papermaking [67], optical, general physical science instruments [37], arms [50], coinage [23].

Vol. III. Lamps and light [41], tobacco [27], bookbinding [22], salt and sugar [35], leather [25], spirits [19], dyeing art [31] ([3] S. LXIII.

[]=number of lines in excerpt)

Marx used this excerpt for „*Grundrisse*“, „*Manuskript 1861-1863*“ and *Das Kapital*, again and again. So in this paper, I will analyse Poppe's book, mainly "*History of Technology*," and Marx's usage of it in *Das Kapital*. For this analysis, as a premise it is indispensable to survey Poppe's life and books and to examine Poppe's whole theory of technology.

III. Poppe's Life and Works

On the 16th of January, 1776, Johann Heinrich Moritz Poppe (1776–1854) was born as the eldest son of a mechanic of Göttingen University. He was educated under German philanthropism of the 18th century (W. L. Volz, Nekrolog, „*Zeitschrift für Gesamte Staatswissenschaft*,” Bd. 10, 1854, S. 375). Helping his father, Poppe had acquired a practical knowledge of watch mechanics. After his military service, Poppe entered into Göttingen University in 1794. He would learn mathematics and physics from A. G. Kästner (1719–1800) and G. C. Lichtenburg (1742–1799) and technology and secretariat-science (Kameral-wissenschaft) from J. Beckmann (1739–1811) later.*

* J. H. M. Poppe, Autobiographie. in E. Heyden, hrsg., *Galerie berühmter und merkwürdigen Frankfurter*, 1861, S. 245.

To help the household economy, Poppe contributed to magazines and published some dictionaries and a history of watches. These works were the base of “*History of Technology*” (Vol. II, watchmaker art). When Poppe was a student, he wrote some prize articles. In 1800, he wrote a mathematical article, winning the prize from the Faculty of Philosophy, Göttingen University. This was a starting point for the study of the history of mathematics and physics. In 1805, Jablonowstysch Society of Science in Leipzig gave a prize to Poppe's article, *De incrementis et progressibus literarum mechanicarum seculo duodevigesimo*, which was published in 1807 as a German book, “*The Mechanics of the 18th Century and the Early 19th Century*” (1807). This book was a base for the history of mechanics in “*History of Technology*.”

In 1805, Poppe became a lecturer of the Gymnasium at Frankfurt. The early years at Frankfurt were his most fruitful period. In 1803, he began to publish „*Encyclopaedia of General Mechanical Engineering*” (Vol. 1–7, 1803–1818, Vol. 8, 1827). In 1804, he wrote an article “An essay on the history of all manufacturing and factories ...”, which first showed the plan of “*History of Technology*”.

In 1806, J. Beckmann wrote, “*A Plan of General Technology*” („*Entwurf der allgemeinen Technologie*”), which became a monumental work for the study of technology. At the same year, Poppe published “*Handbook of Technology*” (1806), accepting J. Beckmann's plan. In 1807, Poppe published “*History of Technology, from the Restoration of Sciences to the End of the 18th Century*” (1807–1811) as Part IV, “History of Technology” of Vol. 8, “History of Natural Science” under the editorial supervision of “Society of the Learned Man.”

In 1809, Poppe published "*Textbook of the General Technology*." These works tried to develop J. Beckmann's theory of "the General Technology." During his period in Frankfurt, Poppe also worked for the Society for Promoting Useful Arts and the Sunday School. With these works, he published many popular science books. But from this period, Poppe, who had explained the steam engine without seeing it, took a step forward to over-production.

In 1818, Poppe became a full professor of Technology at the Faculty of State-economy, Tübingen University. In the period of Tübingen, Poppe published more books than before.

He became far apart from new technology. According to his successor, W. L. Volz, his works constituted 98 books (without articles and new editions) and 149 vols. But, two thirds of his works were reproductions. Hence, it is inevitable to characterize Poppe of the Tübingen period, as an "out-of-date vulgar science-writer." So, it is necessary to appraise Poppe as a technologist during the periods of Göttingen and Frankfurt. The works of Poppe which Marx used belong to this period.

IV. Poppe's Theory of Technology

① J. Beckmann's Theory of General Technology

Poppe's study about technology had a close relation to J. Beckmann's "*A Plan of General Technology*." This plan defined technology as follows.

„Die Technologie lehrt sowohl die rohen als schon bearbeiteten Materialien zu allen den höchst verschiedenen Arten des Gebrauchs, welchen die Menschen davon zu machen wissen, zurichten.“ (S. 3)

Beckmann gave attention to the "many ways of utilization" by the use, application and development of technology. And J. Beckmann called all catalogues of means to accomplish purpose „*Allgemeine Technologie*“ (*General Technology*). He proposed *Allgemeine Technologie* (*General Technology*) to promote industry by "transfer of means and tools." „Dereinst, wann die allgemeine Technologie ausgearbeitet seyn wird, und wenn die Neigung der Gelehrten zu technologischen Kenntnissen zuzunehmen fortfährt, so werden von diesen viele, welche dazu Zeit und Gelegenheit haben werden, veranlassen, daß Uebertragung verschiedener Mittel und Werkzeuge von geschickten Meistern versucht werden.“ (S. 10)

He tried to define the general purpose of special works and make clear the condition by which it may be transferred to the other object. „... was zum Verständniß und zur Beurtheilung der eizelnen Mittel, und zu ihrer Auswahl bey Uebertragungen auf andere Gegenstände, als wozu sie bisjetzt gebraucht sind, dienen könnte.“ (S. 19)

The special branch of general technology was developed later by Poppe

as a special technology (besondere oder speciele Technologie).

② Poppe's Theory of Technology

In accordance with J. Beckmann, Poppe's "*Textbook of General Technology*" tried to make perfect the catalogue for improvement. Poppe also proposed "general technology" to promote industry. For examples, "*Spirits of English Manufacturing*" (1812) recommended his "*Textbook of General Technology*" and "*History of Technology*" for teaching the history of invention as a means of leveling up German manufacturing to that of England. (*Geist der englischen Manufakturen*, S. 41-S. 43)

Technology as a policy of promoting industry belonged to the school of German *secretariat - science*. Poppe's "On the Study of Technology" (1818), when he became a full professor of Tübingen University, showed the relation between technology and the state economy. For example, "*Textbook of Mechanical Engineering*" (1821) supposed *state - secretariat* for the main reader. But the level of these works was lower than that of Robert Willis' "*Principles of Mechanism*" (1841) and had many mistakes.*

* See also my paper, "Robert Willis' theory of Mechanism and Karl Marx." *Historia Scientiarum*, No. 25 (1983).

So, Marx did not excerpt Poppe's works relating to mechanical engineering. By the way, Marx excerpted Poppe's "*Textbook of General Technology*" equally about $2\frac{2}{3}$ pages.

Marx's definition of technology, "Technology also discovered the few main fundamental forms of motion, which, despite the few main fundamental forms of motion" ([1] p. 532), showed the conception of Poppe's "*General Technology*."

Marx also, used the "General Technology" in his „*Grundrisse*“ as follows.

"If there is no production in general, then there is also no general production. Production is always a *particular* branch of production — e. g. agriculture, cattle-raising, manufacturing etc. — or it is a *totality*. But political economy is not technology."*

* „*Grundrisse*“, Trans. by M. Nicolaus, Pelican Books, p. 86. *MEGA* II.1.1. S. 23.

Here Marx said that "But political economy is not technology," because, differing from "*General Technology*," it seemed for him that to analyse production in general beforehand is not right.

Marx's term "universal general labour" had some relation to this "*General Technology*", because „*Grundrisse*“ calld „technologische Anwendung der Naturwissenschaft.“ (*MEGA*, II.1.2, S. 577)

And also *Das Kapital*, Bd. III, Chapt. V. "Economies in the employ-

ment of constant Capital" Sec. V, "Economies due to Inventions" stated as follows.

"Universal labour (Allgemeine Arbeit) is scientific labour, such as discoveries and inventions." (*MEW*, Bd. 25, S. 114, *Capital*, Vol. III, p. 124)

V. An Analysis of Poppe's "*History of Technology*"

① An Analysis of the Preface and Part I

The main part of Marx's excerpt was Poppe's "*History of Technology*." In this book Poppe tried to show the transfer of the handling of tools and machines in "history of technology."

„Alle Handwerke und Künste sind zurverlässig weniger durch ganz neue Erfindungen, als vielmehr durch Uebertragung der Mittel aus einer Werkstatt in die andere erstaunlich vervollkommenet worden. Viele Handwerke, so verschieden auch ihre Materialien und ihre Waaren sind, verrichten manche Arbeiten zu ... einerley Instrumente, Maschinen und andere Mittel nöthig.“ (Poppe, "*Geschichte der Technologie*", Bd. I, 1807, S. 72, [4])

And Poppe understood the history of technology as, „die Geschichte aller Künste (im weitläufigen Sinne) zur Veredlung der Naturprodukte [history of all arts (in a wider sense) for the process of natural-products]“ ([4], S. IV)

Here we can find the object and character of this book.

First. Poppe tried to write "a history of handicraft, manufacturing, and the factory" in this book. This shows that the book surpassed J. Beckmann's "*History of Invention*."

Second. Poppe tried to write "② a history of handicraft, manufacturing and the factory" under the title of "① history of technology" and understood "① history of technology" as "③ a history of all arts (in a wider sense) for the process of natural-products." Then what relations do the three ① ② ③ have? Poppe commented on this as follows.

„Aus der Kenntniß der Handwerke, Manufakturen und Fabriken ist eine eigene Wissenschaft entstanden, welche auf Universitäten und andern hohen Schulen gelehrt wird. Herr Hofrath Beckmann in Göttingen nannte sie im Jahr 1772 zuerst *Technologie*, da man dafür sonst unrichtig Kunstgeschichte gesagt hatte. In der Technologie wird nicht bloß die Geschichte der Handwerke gelehrt, es werden darin vielmehr alle Arbeiten, ihre Folgen und Gründe ordentlich und deutlich erklärt. ... Von der Kunst selbst unterscheidet sie sich, wie Wissen von Können, oder wie Theorie von Praxis“ ([4], S. 64)

As technology came into existence from handicraft, manufacturing and the factory, it is necessary to examine "a history of handicraft, manufacturing and the factory" as a premise for a history of technology. So this book

was written at first as a history of each industry and then an original history of technology of that industry. Hence, we must not view this book as a mere "History of Techniques (Technik)".

By the way „Preface“ explained the whole five parts of this book, and four distinctions of industry on the basis of production-means as follows. Part I; general preface, Part II; mechanical process, Part III; mechanical-chemical process, Part IV; chemical-mechanical process, Part V; chemical process.

Part I. "General preface in a history of technology" surveyed the history of handicraft. The most important part of Part I is the explanation about manufacturing and the factory.

„Handwerke und Künste waren nun einmal im Emporschießen, und konnten darin nicht mehr gehemmt werden. Das *siebenzehnte* und *achtzehnte Jahrhundert* wurden daher nach reicher an vielen Erfindungen und Entdeckungen; die eigentlichen *Manufakturen* und *Fabriken* in allen Arten von Arbeiten vermehrten sich nun außerordentlich.“ ([4] S. 31)

Here Poppe took the general view that the distinction between manufacturing and the factory is the usage of "fuel and hammer." And he also explained the superiority of manufacturing and the factory by A. Smith's theory. By the way, Marx commented on the insufficient level of knowledge about production by the merchant as follows.

„...Nach und nach fing aber an vielen Orten der Kaufmann an, sich zum Meister aufzuwerfen und für Tagelohn Gesellen in Arbeit zu nehmen, die er wegen anderer Geschäfte nur selten beobachten, und wegen Mangel an Kenntnissen nur selten richtig beobachten und beurtheilen konnte.“ ([4] S. 71)

Marx excerpted this part for use in Chapt. XX, "Historical Data concerning Merchant's Capital" of the Vol. III, *Das Kapital*, as an example of the merchant becoming an industrial capitalist. (MEW, Bd. 25, S. 348, *Capital*, Vol. III, p. 395)

But Marx used it in a different context from that of Poppe.

② An Analysis of Part II, Chapt. I, "History of Mills"

Part II, "History of Mechanical Process until the End of the 18th Century" Chapt. I, "Handicraft, Manufacturing and the Factory for Processing of Men's Foods" dealt with a history of mills. Poppe, at first, analyzed the improvement of milling, mainly grain-mill instruments, and later the origin of technology concerning the mill (water-mill). Poppe was the first to do so. Poppe surveyed the history of theoretical research for the improvement of mill-construction, and introduced the study of the fly-wheel, oscillation, friction, and epicycloid wheel. Concerning the water-wheel, Poppe said the following:

„Newton, Mariotte, Johann und Daniel Bernoulli, d'Alembert, Euler, und Kästner besonders haben in die Lehre vom Widerstande oder Stoße des Wassers durch ihre tiefsinnigen Untersuchungen viel Licht gebracht.“ ([4] S. 165)

Therefore, concerning water mill technology, Poppe made clear how technology was studied at the request of the improvement of the mill. Marx excerpted the main part of Part II, Chapt. I in his „*Manuskript 1861-1863*“, and further *Das Kapital*. The most important problem is how he drew the conclusion. He reread this excerpt and wrote a letter dated the 28th of January, 1863 to Engels as follows.

(① Poppe's "*History of Technology*" corresponding to the letter, ② the page of Marx's excerpt note. ③ the page of *Das Kapital*, Bd. I [Werke edition] corresponding to the letter.)

„Das Wiederdurchlesen der technologisch-historischen Exzerpte hat mich zu der Einsicht gebracht, daß, abgesehen von den Erfindungen von Pulver, Kompaß und Buchdruckerei —diesen notwendigen Vorbedingungen der bürgerlichen Entwicklung— vom 16. bis zur Mitte des 18. Jahrhunderts, also für die Periode der vom Handwerk aus sich entwickelnden Manufaktur bis zur eigentlichen großen Industrie, die zwei materialen Basen, an denen sich innerhalb der Manufaktur die Vorarbeit für die Maschinenindustrie bildet, *Uhr* und *Mühle* (zunächst Kornmühle, und zwar Wassermühle) sind, beide von Altertum überliefert. (Die Wassermühle zur Zeit von Julius Cäsar aus Kleinasien nach Rom gebracht). —[① Bd. I. S. 109, ② S. 12, ③ S. 368] ...Bei der *Mühle* andererseits von vornherein, sobald die Wassermühle geliefert, die wesentlichen Unterschiede im Organismus einer Maschine da. Mechanische Triebkraft. Primo Motor, worauf sie wartet. Transmissionsmechanismus. Endlich Arbeitsmaschine, die den Stoff anfaßt, alle in selbständiger Existenzweise gegeneinander. [the developed machinery, ③ S. 393]. Die *Lehr von der Friktion* und damit die Untersuchungen über die mathematischen Formen von Räderwerk, Zähnen etc. allen an der Mühle gemacht; [① Bd. I., S. 140-S. 170 ② S. 13, ③ S. 369] ditto hier zuerst die Lehre vom dem Messen des Grades der Bewegenden Kraft [① Bd. I. S. 162, ② S. 13], von der besten Art, sie anzuwenden etc. [① Bd. I. S. 164 ② S. 13]. Fast alle großen Mathematiker seit Mitte des 17. Jahrhunderts, [① Bd. I. S. 165, ② S. 13, ③ S. 369], soweit sie sich auf praktische Mechanik einlassen und sie theoretisieren, gehn von der einfachen Wasser Kornmühle aus. In der Tat daher auch der Name *Mühle* und *mill*, der während der Maunfakturperiode entsand, für alles auf praktische Zwecke gerichtete mechanische Treibwerk. [③ S. 368-9].

Aber bei der Mühle, ganz so wie Preßmaschinen, [① Bd. I, S. 224, Bd. II, S. 209, Bd. III, S. 150-151, ② S. 14, 25, 33], Hammerwerk [① Bd. II, S. 427-8, ② S. 28], Pflug, usw. von vornherein die eigentliche Arbeit, Schlagen, Zerquetschen, Mahlen, Zerkleinern etc. *ohne* menschliche Arbeit getan, wenn auch die moving force menschlich oder viehisch. Daher diese Art Maschinerie wenigstens in ihren Anfängen sehr alt und früher bei ihr eigentlich mechanische Triebkraft angewandt. Daher auch fast die einzige Maschinerie, die in der Manuktureperiode vorkommt. [③ S. 368]. Die *industrielle Revolution* beginnt, sobald der Mechanismus da angewandt, wo von alters her das finale Resultat menschliche Arbeit erheischt, also wo nicht, wie bei jenen Werkzeugen, *von jeher* der eigentlich zu bearbeitende Stoff *nie* mit der menschlichen Hand zu tun hatte; wo der Mensch der Natur der Sache nach nicht von vornherein als bloße *power* wirkt. [③ S. 392].“ (MEW, Bd. 30, S. 321-S. 322. Also see [3] S. [209]-S. [210])

The results of analysis of the history of the mill from this letter, in „*Manuskript 1861-1863*“ und *Das Kapital* are as follows.

① „Die Mühle dagegen kann als das erste *Arbeitswerkzeug* betrachtet werden, auf das das Princip der Maschinerie angewandt worden ist.“ (Note-XIX-1163) [(The mill is the first work-instrument to which is applied the principle of machine] ([2], S. 1919) “... for instance, by turning the crank of a mill, ... such implements soon call for the application of animals, water, and wind as motive powers. Here and there, long before the period of manufacture, and also, to some extent, during that period, these implements pass over into machines, but without creating any revolution in the mode of production.” ([1], p. 409)

② In the mill, there are three parts of “*developed machine*.” In the mill, „das Wasserrad an dem das Wasser anfaßt, die Welle desselben, die durch ein System von gezahnten Rädern und Getrieben die Bewegung auf den Mühlstein fortleitet, umfaßte ein ganzes System mechanischer Bewegung.“ ([2], S. 1920)

③ In the mill, all sorts of motion power had been applied, namely, man, animal, water, wind and steam power. ([2] S. 1920)

④ At the mill there developed machinery systems and further automatic machinery systems (Note-XIX-1164, 1168).

The other statement of “the history of the mill” was used for *Das Kapital* as follows.

Poppe's statement about the hand-mill ([4] Bd. I. S. 105) was succeeded into “The Christian philanthropists of Germany, on the contrary, fastened a wooden board round the necks of the serfs, whom they used as a motive

power for grinding, in order to prevent them from putting flour into their mouths with their hands." ([1], p. 409)

Poppe's analysis that "the first water-wheel was built by the river Tiber" ([4] Bd. I, S. 109) became the statement of *Das Kapital* that, "The Roman Empire had handed down the elementary form of all machinery in the water-wheel." ([1], p. 382)

Poppe's foot note about the fly-wheel ([4] Bd. I, S. 138) became the foot note 97 of Chapter 13 of *Das Kapital*. ([1], p. 411)

③ An analysis about Chapter 2, 3, "History of Clothes"

Part II, Chapter 2, "Handicraft, Manufacturing and Factory tendering of Man's Clothes" and Chapter 3 "Process of Fancy Goods from Woolen, Cotton Flax, and Silk," explained the history of each textile product and machine and tools for it. Poppe at first examined woolen clothes closely and explained the history of the textile machines. Marx excerpted the main part of Part II, Chapter 2, 3 of "History of Technology" for „*Manuskript 1861-1863*“ and *Das Kapital*.

The most important part of it was the history of the spinning machine as follows. „Die ersten Spinnräder waren aber Handräder, große Räder, welche von der rechten Hand des Menschen in Bewegung gesetzt wurden, —“ ([4] Bd. I, S. 270), „Man erfand in Teutschland auch ein Doppelspinnrad, oder ein Spinnrad mit zwey Spuhlen, worauf man zu gleicher Zeit zwey Fäden spinnt“ (S. 271), „Man hat aber auch schon in der Mitte des achtzehnten Jahrhunderts Spinnräder zum Vorschein gebracht, —“ ([4] S. 271-2)

This statement succeeded into *Das Kapital* as follows :

“The number of implements that he himself can use simultaneously, is limited by the number of his own natural instruments of production, by the number of his own natural instruments of production, by the number of his bodily organs. In Germany, they tried at first to make one spinner work two spinning wheels, that is, to work simultaneously with both hands and both feet.” ([1], I. p. 408) “In many manual implements the distinction between man as mere motive power, and man as the workman or operator properly so-called, is brought into striking contrast. For instance, the foot is merely the prime move of the spinning wheel, while the hand, working with the spindle, and drawing and twisting, performs the real operation of spinning. It is this last part of the handicraftsman's implement that is first seized upon by the industrial revolution.” ([1], pp. 408-9)

Poppe explained woolen-manufacturing closely, ([4] Bd. I, S. 265). The explanation of woolcombing succeeded into the foot-note 101 of Chapter 13 of *Das Kapital*. Also Poppe commented on French silk manufacturing as follows.

„... Vor etlichen dreyßig Jahren wurden in Frankreich gegen zwey hundert verschiedene Seidenstoffe gewebt, wovon allein seit dem Jahre 1730 hundert und funfzig erfunden worden sind. *Avignon*, das vermuthlich die älteste französische Seidenmanufaktur Stadt war, behielt bis auf die neuesten Zeiten, der vielen dortigen Unruhen ohngeachtet, vor allen andern Orten große Vorzüge ...” ([4] S. 413). Marx said in Chapter 12, “Division of Labour and Manufacture” of *Das Kapital* as follows.

“... Accordingly, in France alone, the first half of the 18th century, over 100 different kinds of silk stuffs were woven, and in *Avignon*, ...”. ([1], p. 388)

Poppe explained the power-loom as follows. „Solche Webemaschine sind im Ganzen genommen einem gewöhnlichen Weberstuhle gleich“ ([4] S. 279), „So liefert z. B. noch jetzt Holland die besten, aber auch die kostbarsten Weberschiffchen“. ([4] S. 280)

Marx also commented on the power-loom, “Especially in the original form of the power-loom, we recognize, at first glance, the ancient loom.” ([1], p. 407) “Thus, the fabrication of shuttles formed, as early as the 17th century, a special branch of industry in Holland.” ([1], p. 388)

At the other part, Poppe analysed the unemployment caused by the textile machinery as follows.

„50,000 Menschen, die bis dahin vom Wollkratzen lebten, beym Parlament gegen ihn auftraten.“ ([4] S. 269) „Im Jahr 1758 gab gewisser *Everet* die erste vom Wasser getriebne Scheermühle an. —“. ([4] S. 290)

In Section 5, Marx also commented on “The Strife between Workman and Machinery” as follows: “Fifty thousand workpeople, who had previously lived by carding wool, petitioned parliament against Arkwright’s scribbling mills and carding engines” ([1], p. 468), “*Everet* in 1758 erected the first wool-shearing machine that was driven by water-power —”. ([1], p. 468)

And Marx examined closely the history of the ribbon-loom (Band-mühle) according to Poppe and Beckmann. ([1], p. 467 [4], Bd. I, S. 484-490, Beckmann, Bd. I. S. 126 ff.)

④ An analysis of Volumes 2 and 3 of Poppe’s “*History of Technology*.”

Volumes 2 and 3 of “*History of Technology*” have extensive and various contents. So here I will analyse mainly the part which Marx used, namely, the history of various manufacturing techniques excepting the textile industry, and the machinery and science during the periods of manufacturing. Poppe, in the Chapter 6 of Volume 2, analysed the history of the manufacture of clocks and watches. Poppe’s analysis on the origin of technology from the clocks and watches is noteworthy. Especially detailed was the cycloidal

pendulum of C. Huygens (1629-1695). Poppe wrote about the clock and watch manufacture as follows :

„— schon seit mehreren Jahren alle die Künstler beysammen, welche in Uhren Fabriken nöthig sind: Räder und Gebtriebmacher, Ketten und Federmacher, Zieferblatt und Zeigermacher, Vergolder, Emailirer, Gravirer.“ ([4] Bd. II, S. 154~S. 155) On this basis, Marx analysed watch manufacturing as heterogeneous manufacturing. ([1], p. 376)

Marx also commented on the watch as automaton and on the science born from the watch as machinery during the manufacturing periods in his letter to Engels dated the 28th of January, 1863 and in *Das Kapital* as follows :

“The sporadic use of machinery in the 17th century was of the greatest importance, because it supplied the great mathematicians of that time with a practical basis and stimulant to the creation of the science of mechanics.” ([1], p. 382-3) Marx also used Poppe for other examples of manufacturing. Following Poppe's statements on paper manufacturing ([4] Bd. II, S. 196-222), Marx stated that, “In the paper industry generally, we may advantageously study in detail not only the distinction between modes of production based on different means of production.” ([1], p. 416)

As to carriage manufacturing, Poppe examined as follows.

„An Kutschen arbeiten mehrere Handwerker, Sattler, Schmiede, Schlosser, Gürtler, Drechsler, Posamentirer, Glaser, Mahler, Lackirer, Vergolder ; in den neuern Zeiten aber sind eigne Kutschenfabriken oder Chaisenfabriken entstanden, worin jene Arbeiter insgesamt vereinigt sind, und worin einer dem andern schnell und gut in die Hände arbeitet.“ ([4] Bd. II, S. 330)

Marx used this paragraph as examples of heterogeneous manufacturing. “A carriage, for example, was formerly the product of the labour of a great number of independent artificers, such as wheelwrights, harness-makers, tailors, locksmiths, upholsterers, turners, fringe-makers, glaziers, painters, polishers, gilders, &c. In the manufacture of carriages, however, all these different artificers are assembled in one building, where they work into one another's hands.” ([1], p. 369) In Part III, Chapter 2, “Pounding and Washing Ore,” Poppe wrote as follows : „Teutschland, ... bediente sich noch im ganzen funfzehnten Jahrhundert der Mörser und Siebe zum Pochen und Waschen der Erze. Frankreich, das seine meisten Bergwerkskenntnisse aus Teuschland schöpfte, ...“. ([4] Bd. II, S. 381)

Marx also said : “Towards the end of the 16th century, mortars and sieves were still used in France for pounding and washing ores.” ([1], p. 382)

VI. Theory of Manufacturing by Poppe and Marx

Here, I will summarize the theory of manufacturing by Poppe and Marx.

① Poppe stressed the large scale work at the manufacture site and the factory. Marx stressed the division of labour, which was characterized as a "special kind of cooperation."

② Poppe stressed the superiority of manufacturing and the factory by the theory of A. Smith. Marx understood Poppe's "manufacturing and factory" as manufacturing, as the typical form of cooperation based on the division of labour.

③ According to Poppe, the period of "die eigentlichen Manufacturen" was the 17th and the 18th centuries. ([4] Bd. I, S. 31) But Marx said that "the manufacturing period proper, roughly speaking, extends from the middle of the 16th to the last third of the 18th century" ([1] p. 369), because Marx used other materials as manufacturing.

④ Marx took the category of "*heterogeneous manufacturing*" from Poppe's statement about watch and carriage manufacturing.

⑤ Also, Marx took the category of "*serial manufacturing*" from Poppe's statement about pin and paper manufacturing.

⑥ Marx used Poppe's statements on woolen and silk textile manufacturing as the data on textile manufacturing.

VII. Machinery and Science during the Periods of Manufacturing

Comments by Marx about relations between machinery and science during the periods of manufacturing in *Das Kapital* as follows, have been in dispute. (See, B. Hessen, F. Borkenau, H. Grossman)

"The sporadic use of machinery in the 17th century was of the greatest importance, because it supplied the great mathematicians of that time with a practical basis and stimulant to the creation of the science of mechanics." ([1] p. 382-3)

This paragraph is so condensed that we can not understand the contents of "machinery," "the great mathematicians," "the science of mechanics." But from analysis, it is clear that the machinery in the 17th century was the pendulum clocks, and mill (involving gearing and water-wheels), the great mathematicians were Galilei, Huygens, Newton, etc. The science of mechanics were theories about the pendulum movement, friction, water-wheel, brake, resistance of water, etc.

VIII. An Analysis of Foot-Note ⑧⑨ of Chapter 13. "Machinery and Modern Industry" of *Das Kapital*

As I have seen, Marx used the term Technology according to Poppe. Marx used the term, *Technologie*, *technologisch* from „*Grundrisse*“ (1857-1858) to the first edition of *Das Kapital* Bd. I, with a few exceptions.

But the following revisions were made in the present edition. ① Marx restricted the term *Technologie* as a modern science. ② Marx changed the term, *technologisch* into the term *technisch*, which meant the "labour instrument," or "conditioned by the labour-instrument." ③ In Volumes, 2 and 3 of *Das Kapital* perhaps Engels used the term „*technisch*“.

Taking into consideration these facts, I will examine foot-note ⑧⑨ of Chapter 13, which has been an issue in dispute. The whole sentence of the foot-note ⑧⑨ is as follows.

"Before his time, spinning machines, although very imperfect ones, had already been used, and Italy was probably the country of their first appearance. A critical history of technology would show how little any of the inventions of the 18th century are the work of a single individual. Hitherto there is no such book. Darwin has interested us in the history of Nature's Technology, *i. e.*, in the formation of the organs of plants and animals, which organs serve as instruments of production for sustaining life. Does not the history of the productive organs of man, of organs that are the material basis of all social organisation, deserve equal attention? And would not such a history be easier to compile since, as Vico says, human history differs from natural history in this, that we have made the former, but not the latter? Technology discloses man's mode of dealing with Nature, the process of production by which he sustains his life, and thereby also lays bare the mode of formation of his social relations, and of the mental conceptions that flow from them. Every history of religion even, that fails to take account of this material basis, is uncritical. It is, in reality, much easier to discover by analysis the earthly core of the misty creations of religion, than, conversely, it is, to develop from the actual relations of life the corresponding celestialised forms of those relations. The latter method is the only materialistic, and therefore the only scientific one. The weak points in the abstract materialism of natural science, a materialism that excludes history and its process, are at once evident from the abstract and ideological conceptions of its spokesmen, whenever they venture beyond the bounds of their own speciality." ([1] pp. 406-7)

To understand foot-note ⑧9 first, we should note the place where the foot-note stood. It is on the spinning machine of John Wyatt. This relates to the fact that Poppe wrote about the spinning-machine of Italy. Second, it is necessary to understand foot-note ⑧9 unified with the other parts. Third, when Marx wrote about "a critical history of technology," it is a "book" and it is also clear that Marx took into consideration Poppe's "*History of Technology*" because Marx used it widely. But Marx did not make it clear. And Marx said that, "Hitherto there is no such book." Hence, Marx took Poppe's "*History of Technology*" as "not critical." Then what did Marx mean by "not critical?"

It is certain that Poppe was prejudiced in believing that many inventions had originated in Germany. And Poppe was "not critical" of Beckmann, so Poppe's work had many defects in his criticisms of materials. But Poppe called spinning machines „technologische Maschinerie,“ which had been completed by mechanics. (*Die Mechanik, op. cit.*, S. 105) So, he showed that inventions of spinning machines were not the work of a single individual. There is some room to examine further Marx's statement. Next, I will analyse the part concerning "Darwin ... Nature's Technology." There Marx compared, "*the history of Nature's Technology*" with "*the formation of the organs of plants and animals*." As Technology came into being from "the instruments of production" as the basis and the object, it is not accurate to compare Technology with "the instruments of production." It is better to compare technique with the instrument of production. Marx distinguished the technology and the technique in the present edition of *Das Kapital*. But only in this part, „Nature's Technology“ had not been changed. In the first place, "*Nature's Technology*" is contradictory to "the Technology as a modern science." So it is presumed that the term, "Nature's Technology" was the omission of the revision, influenced from Poppe's "*History of Technology*." Marx had acknowledged this possibility in „Nachwort zur zweiten Auflage“. (*MEW*, Bd. 23, S. 18) This possibility is high because it is assumed that Marx's revision to technique had been made by Engels' advice. So understood, it is natural to accept "the history of the productive organs of man" as "the history of techniques (Technik)."

Next, the part, "Technology discloses man's mode of dealing with Nature" As I have seen, man has developed the productive organs of man and formed technology and science from it as the material basis.

Then, by this technology and science, man has improved "the productive organs of man." This shows that "man's mode of dealing with Nature." Also plants and animals improve their organs, but they don't develop technology from them. And, as Poppe showed in "*History of Technology*," Marx said that "the sporadic use of machinery in the 17th century was of

the greatest importance, because it supplied the great mathematicians of that time with a practical basis and stimulant to the creation of the science of mechanics" ([1] p. 328-3). Technology, of which "material basis" had been "machinery, became the mediation of the mental conceptions," such as the modern mechanics and mathematics.

Last, it is proper to examine the origin of technology and science from technique as "material basis". In the same way, it is only materialistic to "develop from the actual relations of life the corresponding celestialised forms of those relations."

To summarize foot-note ⑧9, it stressed the *Technik* "as the material basis of the society" and that science and mental conceptions had been formed by technology from *Technik* as the basis. So it gave attention to "the history of the material basis" namely "the history of techniques." This standpoint proposes a very important context also as a methodology of the history of science and ideas.

IX. Conclusion

Poppe's theory of general technology became the basis of Marx's comprehension about technology. Marx took the following conclusions from Poppe's "*History of Technology*" as materials for the history of production-process.

First. Marx drew the conception of machine and the law of development about machinery through examination of the history of mills and watches.

Second. Marx made clear the "*starting point*" of the industrial revolution by the analysis of the history of textile-machinery.

Third. Marx used Poppe's statement about the period, conception and contents of various manufacturing, and added his own definitions to it.

Fouth. About the relations between machines and science during the periods of manufacturing, Marx used Poppe's statements to formulate his own statements.

Fifth. Taking into the consideration of Poppe's "*History of Technology*," Marx wrote foot-note ⑧9 of Chapter 13. "Machine and the Modern Industry" of *Das Kapital*.

This paper aims to clarify these problems.