The First and Modern Notion of Technology: from Linnaeus to Beckmann to Marx

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Abstract: The paper shows that the English language has great limitations in the treatment of the concept *technology,* and provides a rough but necessary taxonomy of the main uses of the term 'technology' in the present Anglo-Saxon debate on social sciences and humanities. Then, it shows the first steps of the modern notion of technology, which formerly referred to rhetoric and philology. Christian Wolff (1679-1754) introduced the notion of *Technologia* (in Latin) with little success within a philosophical essay in 1728. The actual development of technology (*Technologie*) as an autonomous subject is due to the work of Johann Beckmann (1739-1811), and particularly to his seminal work *Anleitung zur Technologie* (*Direction for Technology*, 1777), which draws significantly on Linnaeus' work and the social requirements of Cameralism. Much time later, the notion of *Technologie* was taken up and re-elaborated by Karl Marx (1818-1883), inserted in the manuscripts preceding the *Capital,* and finally in the *Capital (*1867).

Keywords: Technology; *Technologie*; Linnaeus; Wolff; Beckmann; Marx; Critique of Technology.

> *At least these words are old: τεχνολογία (technologia), τεχνολογέω (technologheo), τεχνολόγος (technologos); but of course the Greeks did not think probably in all cases of crafts, as little as they thought under οἰκονομία (oikonomia), πολιτικὴ (politike) and a hundred other words, what we think of them.*
> Beckmann (1777, XVI)*

1. Introduction

The modern debate on the use and meaning of the old term *technologia* dates back to the first half of the eighteenth century, while the scientific use of the term *technique* is due to Marcel Mauss in the first half of the twen-

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* "Alt sind wenigstens diese Wörter: τεχνολογία, τεχνολογέω, τεχνολόγος; aber freylich dachten die Griechen wohl dabey nicht allemal an Handwerke, so wenig sie unter οἰκονομία, πολιτικὴ und hundert andern Wörtern, das dachten, was wir darunter denken".

tieth century. The modern meaning of the term *technology* refers to the description of the production process from the outsider's point of view, external to the labour process, whereas *technique* represents the actor's point of view. *Technologia* and *technique* are two antonymous concepts, but in the present brief work we treat only the first notion, with the purpose to show that *technology* is a specific kind of knowledge, and is historically determined. We first show that the English language has great limitations in the treatment of the concept *technology,* and provide a rough but necessary taxonomy of the main uses of the term 'technology' in the present Anglo-Saxon debate on social sciences and humanities. Then, we show the first steps of the modern notion of technology, which formerly referred to rhetoric and philology.

The modern concept of *Technologia* (in Latin) was firstly introduced by Christian Wolff (1679 – 1754) with little success within a philosophical essay in 1728[1]. The actual development of technology (*Technologie*) as a topic and university subject is due to the work of Johann Beckmann (1739–1811)[2], and particularly to his seminal treatise *Anleitung zur Technologie* (*Direction for Technology*, 1777). Beckmann's notion of technology draws significantly on Linnaeus' work and the social requirements of Cameralism. Much time later, the notion of *Technologie* was taken up and re-elaborated by Karl Marx (1818-1883), inserted in the manuscripts preceding the *Capital,* and finally in the *Capital (*1867).

2. A map of the utilization of the English notion of technology

The notion of technology in social sciences and humanities encompasses a vast and confusing set of phenomena with strong cross-cultural and unli-

1 Seibicke, *Technik;* Garçon, "Mais d'où vient la technologie". The first modern definition of the *technologia*'s concept is due to Christian Wolff' *Discursus Praeliminaris* (1728)(see the 1983 Wolff critical edition): §71 "Possibilis quoque est philosophia artium, etsi hactenus neglecta. Eam Technicam aut Technologicam Appellare posses. Est itaque Technologia Scientia artium & operum artis, aut, si mavis, scientia eorum, quae organorum corporis, manuum potissimum opera ab hominibus perficiuntur". §71 "A philosophy of the arts is also possible, although it has up to now been neglected. One should call it technica or technologia. Thus technologia is the science of the arts and of the works of arts. Or if you prefer, it is the science of the things which man produces by using the organs of the body, especially the hands" Wolff Christian, 1963, *Preliminary Discourse in Philosophy*, translated by Blackwell J. Richard.

2 On Beckmann's biography, see Exner (Exner, *Johann Beckmann*), Beckert (Beckert, Johann *Beckmann*) and Klemm for a short biography of Beckmann as a scientist (Friedrich Klemm, "Beckmann, Johann"). Troitzsch underlines the two new disciplines (technology and science of commodities) founded by Beckmann (Ulrich Troitzsch, "Landwirtschftslehre").

mited temporal characteristics. This is likely to be due to the fact that the 18th century new meaning of the term *Technologie,* developed by Christian Wolff, Johann Beckmann and Karl Marx, did not enter into the 19thcentury English lexicon. A new meaning of the term technology was imported into the American English language by 20th century social scientists (Thorstein Veblen, for example), deriving from the German *Technik*[3]. Moreover, it mismatches two terms ('technique' and 'technology') of the Continental languages, where technique refers to specific craft procedures and technology denotes a "logos" relating to the same activities[4].

The semantic domain of 'arts/crafts/trades' is included in the Anglophone notion of technology, as exemplified by the phrase '15th century Inca technology'. For example, the 17th century debate on mechanical arts is treated as an example of technology[5]. Similarly, the 12th century Western positive reception of labour and mechanical arts is considered to be the development of a medieval philosophy of technology[6]. According to some anthropological formulations, the art of illiterate cultures should be treated as an aspect of technology[7], where technology means art/craft abilities. Therefore, it is not surprising the following reinterpretation of the *Genesis*: after the expulsion from the Eden, Adam and Eve "used technology to transform an uncultivated physical environment into a cultivated and human-built one"[8].Although 'technology' is a social phenomenon, the conviction that this object cannot be defined has existed since the1960s[9], and its conception as an unsolvable ontological problem is dated to the 2010s[10]. Neo-classical economics presents a clearer notion of technolo-

3 Schatzberg, "Technik Comes to America".

4 Salomon, "What is technology?".

5 Eamon, "Technology as Magic".

6 The twelfth-century monastic appreciation of the *artes mechanicae* is often exemplified by Theophilus' De *diversis Artibus* and Hugh of Saint Victor's *Didascalicon*. Hugh considered the seven mechanical arts a branch of knowledge, and inserted them nearby the theoretical, practical, and logical disciplines (Hugh of St. Victor, Hugonis *de Sancto Victore*). On Theophilus, see Van Engen, "Theophilus Presbyter". For the Anglophone interpretation of medieval appreciation of the labour in terms of technology, see for example Newman, "Technology and Alchemical Debate", and Whitney, "Paradise Restored".

7 Gell affirms: "In this essay, I propose that the anthropology of art can do this by considering art as a component of technology. We recognize works of art, as a category, because they are the outcome of technical process, the sort of technical process in which artist is skilled". Alfred Gell, "The Technology of Enchantment," 43.

8 Hughes*, Human-Built World: How to Think about Technology and Culture,* 7**.**

9 See for example Melvin Kranzberg, and Carroll W. Jr. Purcell, "The importance of Technology, "4.

10 According to Bijker, "Constructivist technology studies are relativistic in only one sense: methodological. They are agnostic with respect to the ontology of technology. Constructivist studies of technology thus do not primarily answer the question 'what is

gy through the production function, which links known productive input and output, using technology as a variable: nevertheless the internal mechanism of technological change is unknown and is therefore called a 'black box'[11]. To sum up, the Anglophone notion of technology is vague, timeless, trans-cultural, and does not have a clear frame of reference.

"Recent years have seen in philosophy and cultural studies something like a thingly turn, a *neue Sachlichkeit*, a *nouveau chosisme*"[12]. Sociologists of technology are not at ease with 'things', and add to the notion of 'thing' a further theoretical step that transforms 'things' into social objects, but diverge on how things become social. By simplifying one could say that in the 1980s three families of theories on technology emerged, denoted by the following acronyms: the 'Social Shaping of Technology (SST)', the 'Social Construction of technology (SCOT)', and the 'Actor-Network Theory (ANT)'. Leaving aside the three above schools of thought, which deserve a greater attention, the remaining part of the literature on technology may be subdivided into four main sub-fields, which are in large part complementary. These subfields relate to:

i) How things are made by humans.

ii) What humans think about things that are socially produced when they are exchanged and consumed?

iii) Bodily techniques.

iv) How an observer describes in written records the productive activities performed by other social actors.

The first approach is generally typical of the American history of technology: the monumental eight volume history of technology edited by Charles Singer et al. (1954-1988) established a reference[13], according to

technology?' they trace *the process 'how to make technology'.* Bijker, "How is technology made?", 63.

11 According to the Nobel Prize Robert M. Solow ("Technical Change and the Aggregate Production Function".), the aggregate production function may be written as follow: Q = A(K,L), where, the output Q is the value of produced commodities, A is a factor representing technology, K is the capital value, and L the value of labour. Joel Mokyr's definition of technology is less cumbersome and more intuitive, because the nature of technology as information is indicated: "By technological progress I mean any change in the application of information to the production process in such a way as to increase efficiency, resulting either in the production of a given output with fewer resources (i.e., lower costs), or the production of better or new products". (Mokyr*, Lever of Riches,* 6). Nevertheless Mokyr's definition overlooks how this information is obtained and how it is implemented in the production.

12 Connor, "Thinking things", 1.

13 "The editors have treated it [technology] as covering the field of how things are commonly done or made, extending it to describe what things are done or made". Singer, Preface, vii.

which the origin of technology and man are coterminous[14]. Nevertheless, B. Franklin's dictum "Man is a tool-making animal" preceded the modern English notion of technology: it was used by K. Marx[15] and is today common sense. An example of this class is the constructivist school (SCOT), which focuses more on learning in context and the process of learning: its starting point is the conception of technological change as a thing, whose connections with social-economic variables are to be researched.

The second theoretical tradition dedicates little attention to technological studies and focuses on the circulation and consumption of goods and their corresponding value judgments; its starting point is the notion of artefact[16].

The third approach analyses bodily techniques as the technologies of the self, or ways in which people present and police themselves in modern societies[17], and the changes caused by literacy to the organization of society. According to this tradition, writing constitutes an important technology'[18]. Anyway, writing in general implies different scripts and therefore different writing abilities.

The fourth method, inaugurated by Christian Wolff, was elaborated by Beckmann and Marx, as well as by Marcel Mauss, who contributed much later from an ethnographic standpoint. Mauss' work is nonetheless beyond the chronological limits of the present work. The starting point of this approach is not how 'things' are made, but the corresponding written and changing records on how 'things' are made, which are collected by active social actors. According to Wolff, Beckmann and Marx, the discipline of technology provides naturalistic descriptions to social subjects that exert domination about working procedures.

14 Forbes sustained that:"Technology is as old as man himself", Robert J. Forbes, "The beginnings of Technology and Man,"1: 11.

15 "The use and fabrication of instruments of labour, although existing in the germ among certain species of animals, is specifically characteristic of the human labour process, and Franklin therefore defines man as a tool-making animal". Karl Marx, Frederich Engels, *Collected Works*, 35:189, see also: 331 n. 4,777 n. 151.

16 As an introduction to material culture, we quote only the two following papers out of a very large literature: Paul Basu, "Material culture", and Christopher Tilley, "Ethnography and material culture".

17 See Michel Foucault,"Technologies of the self".

18 The anthropologist Jack Goody affirmed: "But in itself writing constitutes an important technology requiring a category of highly trained specialist which has to be maintained at the expense of the community". Goody, *The logic of writing and the organization of society*, 45.

3. Cameralists and Cameralism

Eighteenth century Cameralists were civil servants from the German principalities, who were responsible for regulating productive activities through police ordinances. Academic Cameralism, or the set of disciplines taught in German universities since 1727 (Public finance, *Oeconomie* and *Science* of *Police*)[19], cannot be understood as a form of mercantilism[20], but likely as economic policy directions[21] with a "managerial" approach[22]. Beckmann's lectures on technology were not addressed to artisans, but to aspiring Cameralists, who, after becoming civil servants, could organize, judge, rule, improve or utilize, and for these reasons were expected to be educated[23].

19 The Prussian universities of Halle and Frankfurt/Oder inaugurated their first academic chairs of Cameralistic subjects in 1727, upon the order of the king Frederick William I. Cameralistic *Oeconomie* (*Oeconomia*) did not mean economics, but a general discourse on agriculture and its administration (Johannes Burkhardt, "Der Begriff des ökonomischen in wissenschaftgeschichtilicher Perspektive"). *Polizei* concerned not only public policy but also the research of happiness (see Knemeyer, "Polizei", and Keith Tribe, "Cameralism and the sciences of the state").

20 Tribe (Keith Tribe, "Cameralism and the sciences of the state,") and Priddat (Priddat, "Kameralismus als paradoxe Konzeption der gleichzeitigen Stärkung von Markt und Staat") deal with two specific aspects of Cameralism. The socio-economic nature of Cameralism and whether Cameralism is a form of Mercantilism are still matter of debate. Spector gives an overview of the notion of Mercantilism (Spector, "Le concept de mercantilisme"): for two opposite opinions from the stand point of economics and history of economics, see for example Allen (Allen, "Modern defenders of mercantilist theory"), Tribe (Keith Tribe, "Mercantilism and the economics of state formation"), Magnusson (Magnusson, " Was Cameralism really the German version of the Mercantilism?") vs. Heckscher (Heckscher, *Mercantilism*) and Rothbard (Rothbard, *Economic thought before Adam Smith*, 492-494).

21 The "Economic policy" entry of a standard dictionary of economics reads as follows: "The set of controls used by the government to regulate economic activity. Economic policy can be broadly classified into three areas: fiscal policy (issues related to taxation, government spending, and public deficit), monetary policy (interest rates and inflation), and trade policy (tariffs and trade agreements)" (John Black et al. *A Dictionary of Economics*). Rothschild delineates the changes introduced by the 19th century classical school of economics in the paradigm of Smith's *Wealth of Nations* (Rothschild, "Political economy").

22 The sociologist Albion Small underlined the managerial dimension of Cameralism: "Economic science in Germany was merely a subordinate and subconscious factor in the cameralistic theory of governmental management. It had not gained independence as a science of wealth relations, irrespective of the forms of government under which they exist" (Small, *the Cameralists,* 20). Colbert's, today considered by some scholars as the ideal form of Mercantilism, has been meant as "the first attempt to put the fundamental principles of the theory of management on a scientific and orderly base" (Small, *the Cameralists,* 12).

23 Beckmann, *Anleitung zur Technologie*, *Vorrede* (unnumbered pages): "Denn was man veranstalten, anlegen, anordnen, beurtheilen, regieren, erhalten, verbessern und nu-

4. Linnaeus and Beckmann: *Oeconomia* and Technology

Beckmann owes much to Linnaeus, both personally and scientifically. Beckmann was a Linnaeus' pupil during his one-year trip to Sweden[24]. For this reason, Linnaeus wrote Beckmann a glowing letter of introduction[25] and a recommendation letter to the Chancellor of Göttingen University. As a result of this recommendation letter, Beckmann was appointed in 1766 as the extraordinary professor[26] of *Oeconomia*, which was actually a discourse on agriculture[25]. Subsequently, in 1769 Beckmann published *the Principles of German Agriculture*[27], which was re-printed in many editions and, in 1770 he was appointed to the position of *Professor Ordinarius*.

From the outset, Beckmann's teachings promoted the science of agriculture as based on natural science, and expressly acknowledged Linnaeus as having founded the approach of combining natural history and *œconomia* [2828]. Along the same path, Beckmann further expanded on this concept by

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tzen soll, wird man doch wenigstens kennen müssen".

24 Beckmann**,** *Beckmanns Johann Schwedische Reise*.

25 Hulth, Bref *och skrifvelser*, 168, letter dated May 30th, 1766 from Linnaeus to Beckmann.

26 Literary evidence shows that Linnaeus' recommendation was decisive: in a letter (August 14th, 1766) Beckmann asked Linnaeus a recommendation letter to be send to Otto von Münchhausen "*Tu, Vir illustris, multum sane me poteris iuvare, si, quemadmodum pro humanitate et favore erga me Tuo, pollicitus es, commendare velis Ottoni Munchhusio, qui mihi a Te admonitus facile locum inter professores Goettingenses comparabit*".(Hulth, *Bref och skrifvelser,* 259). On August 27th, 1766 Linnaeus answered as follows: "….*mox Munchhausio scribo. Mittas literas vel eum cum literis adeas*". (Hulth, *Bref och skrifvelser*, 261). Subsequently, on November 17th, 1667 Beckmann thanked Linnaeus and informed him that he was appointed as *professor extraordinarius*: "*Itaque mihi officium professoris extraordinarii Göttingensis mandabant, etsi cum salario admodum exiguo*". (Hulth, *Bref och skrifvelser*, 262). After his appointment. Beckmann cultivated not only Cameralistic disciplines, but also wrote various books on natural history. His friend Christian. G Heyne, head of the Göttingen's University Library, wrote in Beckmann's obituary: "*Disciplina Linnaei imbutus erat eiusque admiratione percussus; cum in Suecia peregrinaretur, eius auditione et familiaritate se usum esse exultabat;…*" Heyne, "Memoria Io. Beckmann," 8.

27 The teachings of *Oeconomia* at Göttingen university, referred to land cultivation, meadows, fields, forests and cattle breeding (on this topic and the way of the appointment of Beckmann see Wakefield, *The disordered police state,* 75-7). The contents of Beckmann's first handbook of *Oeconomia* (Beckmann, Gedanken *von der ökonomischer Vorlesungen,* 23-4) were as follows: part I on agriculture; part II on cultivation of plants; part III on breeding; part IV: on the use of certain natural objects of the countryside; part V on investing and administration of country estates. Beckmann's *Grundsätze der teuschen Landwirthschaft* runs six editions, until it was superseded by Thaer, Grundsätze *der rationellen Landwirthschaft*, the founder of modern scientific agronomy. On the notion of agronomy, see Denis Gilles, "L'agronomie au sens large".

28 Linnaeus, Beckmann and other 18th century scholars considered their scientific works as operating at the Intersection of natural history, agriculture, and administration

applying it to agriculture, and subsequently to the new discipline of technology, which originated from Linnaeus'*œconomia* and the specialization process of Cameralism.

For both Linnaeus and Beckmann natural history enables one to identify *Naturalien* (natural things studied by the naturalist). Trades that use *Naturalien* are classified by Beckmann using a method similar to natural orders, which was already introduced by Linnaeus in botanic taxonomy. Trades are classified according to identity or likeness in their main working procedures, along a scale from simple to increasing complexity e.g. from weaving to ceramics and metallurgy. In this way, Beckmann listed 324 trades by grouping them into 51 classes[29]. Beckmann's lectures of technology were integrated with models of tools and samples of raw materials, and continued with visits to workshops and manufacturing factories[30]. This represented a notable step forward with respect to Diderot's and D'Alembert's *Encyclopaedia*, in which arts and crafts were alphabetically classified.

5. The diffusion of technological teachings

The spread of the term *Technologie* and Beckmann's work in German-speaking universities was fast (the first year in which technological matter was lectured is indicated in brackets): Gießen (1777), Stuttgart (1781), Ingolstad (1782), Mainz (1784), Kaiserslautern (1778), Wien (1781), Magde-

(Cameralism). About the use of natural history in *œconomia*, Beckmann affirmed in a letter to Linnaeus (June 5th, 1769):"*Operam dedi in hoc libello, ut videant cives Mei, usum historiae nat. in Œconomia, quem Tu primus & vidisti & docuisti, maximum omnino esse*". The *libellum* was likely Beckmann *Anfangsgründe der Naturhistorie,* 1767 (Hulth, Bref *och skrifvelser*, 264). Since 1740, Linnaeus meant *œconomia* as a discipline that teaches how to use nature's products (*naturalia*) to human uses, and for that reason, it draws on natural history and physics: "§. 5. Scientiam itaque illam, qua naturalia mediantibus elementis præparare ac usibus nostris accomodare docemur, hic loci, ego Œconomiam dico". According to Linnaeus, happiness draws on *œconomia*: "§. 7. *Œconomia autem nihil sane præstantius, nihil utilius, nihil magis necessarium, quippe quæ; hominum quorumvis felicitati in terris pro fundamento venit".* (Carolus Linnaeus, "De fundamento scientiae œconomicae", 518, firstly published in 1740 in Swedish). Other "o*economic*" Linnaeus' works are meaningful, e.g. *Philosophia Botanica* (1751), *Instructio Peregrinatoris* (1759), and *Usum Historia Naturalis in vita communis* (1766); for a thorough analysis, see Frison, "Linnaeus, Beckmann, Marx," 150-4.

29 Beckmann, *Anleitung zur Technologie*, Einleitung, XVII. "Nach vielen Versuchen, scheint es mir am vortheilhaften zu seyn, die Handwerke, deren vornehmesten Arbeiten eine Gleichkeit oder Aenlichkeit in dem Verfahren selbst und in den Gründen, worauf sie beruhen, haben, in einerley Abtheilungen zu bringen, dergestalt daß die einfachen zuerst, die künstlichern zulest genant werden".

30 Pütter, *Versuch einer academischen Gelehrten-Geschichte,* 388.

burg (1785), Halle (1785), Freiburg (1785), Leipzig (1790), Heidelberg (1803), and Tübingen (1818)[31]. Beckmann's technology spread to a lesser extent in France[32], Italy[33], Russia[34], Scotland[35] and the USA[36].

From the point of view of history of ideas, the notions of *technology* and *aesthetics* may be considered sister disciplines of two connected and parallel rationalizations, which corresponded with changes in the character of the artist/artisan: unlike the Renaissance artist, the modern one was supposed to be concerned with beauty only, and the artisan with the production of useful goods. Linnaeus set the basis of one over the two rationalizations, connecting the notion of usefulness with the description of natural objects, which was further developed by Beckmann, particularly in relation to the new discipline of technology. The other rationalization developed as a result of increasing bourgeois demand, and a new system of the arts, which empowered the notion of beauty, and the creation of the aesthetics, as new branch of philosophy[37].

6. Marx and Technology

At the turn of the 18th and 19th centuries, many factors weakened the role and functions of the Cameralistic studies and Beckmann's technology, including changes to the Prussian administrative system, the Napoleonic wars, the Kantian critiques on the notion of happiness, and so on[38]. Ca-

31 Eulen, "Die Technologie als ökonomische und technische Wissenschaft", and Kernbauer, "Beckmann und der 'technologische' Unterricht".

32 Technological matter was taught at Strasbourg university by Isaac Haffner (1751-1831). Jean Henri Hassenfratz (1755-1827) promoted the diffusion of the contents of this discipline in various French institutions (Grison, L'étonnant *parcours du républicain J. H. Hassenfratz*).

33 Technology was lectured at Padua university in the years 1819-23 (Di Lisa, "Dalla storia delle arti," 307).

34 See Timm, *Kleine Geschichte der Technologie,* 48-49.

35 George Wilson (1818–1859), was appointed Regius Professor of technology at Edinburgh on November 1855, but the chair of technology did not survive his death. On technology's chair, see Wilson, *Memoirs of George Wilson*, 400-51.

36 The botanist and physician Jacob Bigelow (1787 -1879) had a weak concept of technology (Schatzberg, "Technik Comes to America, "491-2).

37 Shiner, *The invention of art*, 99-129. From taste to aesthetics, see Shiner, *The invention of art*, 130-151. On the origin of the modern system of arts and aesthetics, see also Kristeller, Renaissance *Thought and Arts,* 163-227, and Buchenau, *The Founding of Aesthetics in the German Enlightenment*.

38 Other determinants were the diffusion of Smith's *Wealth of Nations* (Tribe, *Governing economy*, 133-148) and the fact that the knowledge of Cameralistic disciplines were no more compulsory for the civil servants. Kant argued against the principle of

meralistic technology survived into the 19th century mainly as a history of technology. Starting from the second half of the 19th and in the 20th centuries, the German term *Technik*, already present in Kant's works[3939], substituted and gradually included the semantic domain of *Technologie*.

To rationalize the change caused by machinery, Marx re-interpreted the old category of *technology*, which he borrowed from Johann Heinrich Moritz von Poppe, a Beckmann's pupil[40], and merged it with the works of Charles Babbage, Andrew Ure, Robert Willis (a scholar of kinematics), and the anonymous 1855 *Industry of Nations*[41]. Marx, expanded the category of 'production' by distinguishing the process of obtaining values from the process of obtaining use-values or the 'labour-process'. The distinction between 'value' and 'use-value', whilst tracing back to Aristotle[42], was common in economic literature, but the application of this common distinction to the production process and the introduction of the concept of the 'labour process' was an original innovation by Marx.

In agreement with Beckmann, Marx states that, just as the investigation of the *use-values* of commodities belongs to the *science of commodity* (*Waarenkunde* – a discipline founded by Beckmann), so does the investigation of the labour process which belongs to *technology*[43]. Marx's new approach to *Technologie* was an important change, because he defined technology as the impersonal principle of the modern industry of resolving each process into its constituent movements, without any regard for their possible

happiness as the ground of a *system* of legislation (Kaufman, Welfare *in the Kantian State*). On the change of Prussian administrative system see Mayer "Der Weg der deutschen Verwaltung".

39 Ferrari, "Kant et la technique".

40 On Marx's notebooks see Marx, *Die technologisch-historischen Exzerpte* and Marx, *Exzerpte* über *Arbeitsteilung, Maschinerie und Industrie.* On Poppe (1776-1854), the main German technological author, read and quoted by Marx, *see* Yoshida, "J. H. M. Poppe's 'History of Technology' and Karl Marx".

41 On Marx's English sources, which refer to Charles Babbage (1791 –1871), Andrew Ure (1778-1857), Robert Willis (1800–1875, a scholar of kinematics), and the anonymous 1855 *Industry of Nations,* see Yoshida, "Robert Willis' theory of Mechanism and Karl Marx", and Yoshida, "The Industry of Nations and Marx's Das Capital". On Willis' kinematics, see Moon, "Robert Willis and Franz Reuleaux".

42 Schefold, "Use value and the 'commercial knowledge of commodities'".

43 In the present passage Marx compares the science of commodities (*Waarenkunde*) with technology: "Just as the investigation of the *use values* of commodities as such belongs in *commercial knowledge,* so the investigation of the labour process in its reality belongs in *technology".* N.B.: 'commercial knowledge' is the debatable translation of the German *Waarenkunde*. Marx, *Economic Manuscript of 1861-63*, Vol. 30, 55.

execution by the hands of man[44]. In this way, Marx brought Beckmann's notion of technology back to life again.

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44 Marx defines technology as follows: "The principle which it pursued, of resolving each process into its constituent movements, without any regard to their possible execution by the hand of man, created the new modern science of technology". *Capital*, Vol. 35, 489.

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