

Software Engineering and the Production of Surplus Value

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Abstract

The aim of this paper is to outline some aspects of a Marxist labor theory of value in the Information Age. There are very differing views on productive and unproductive labor in this new informational phase of capitalism that we are witnessing today. Some argue that all types of services and knowledge work produce value; others say that all of these works are unproductive types of labor. I will argue for a layered approach that covers multiple aspects of productive labor, including: 1. the production of use values; 2. individual labor processes that result in the production of material-substantial outputs that can be accumulated in order to make profit; and 3. the co-operative dimension of labor, i.e., the collective labor process that covers a combination of workers, each of whom plays only a part, more or less, in the production of the object of their labor. Surplus value can only be produced if there is a physical output that can be accumulated, stored, warehoused, transported and resold.

This approach is explained by taking a look at the software engineering process. The shift from software engineering methodologies based on the waterfall model towards "participatory" and evolutionary methods reflects

economic and ideological changes in late capitalism. Capital accumulation in the software industry is not only based on intellectual labour, but it is also in need of a substantial-material carrier of knowledge. Profits in the New Economy result from a large difference between the value of an information commodity and its price.

Keywords: productive labour; surplus value; information commodity; software engineering; capitalism; knowledge

Introduction

This paper has two aims: first, to show that in order to avoid idealistic conceptions of production such as "immaterial labour," "post-industrial society" or "weightless economy," one must assume that the accumulation of capital from information commodities is in need of a substantial-material carrier. I argue that what secures higher-than-average profits and profit rates in the New Economy is the fact that information commodities are sold at a market price that is much higher than the average commodity value. This is made possible by the specific characteristics of information that can be employed in an economically advantageous way. Second, I show how surplus value and profit are produced in the software industry. This example illustrates that value production is in need of a physical medium.

In order to outline these aspects, first a materialist and labour-value theoretical conception of productive labour is worked out with reference to the works of Karl Marx (part 1). To provide a concrete example of productive labour in informational capitalism, I point out aspects of surplus value production in software engineering: I show that the transition from so-called waterfall models of software engineering to "participatory" and evolutionary software engineering methodologies reflects economic and ideological changes of late capitalism (part 2); and that the specific characteristics of information (low costs of reproduction and distribution, knowledge does not have to be [re]produced permanently, information is not devalued by use or non-use, fast transmission and distribution over global networks) form the essential mechanism employed for capital accumulation in the software industry (part 3).

1. Productive and Unproductive Labour

Information--or knowledge work--can be defined as the creation, processing, usage, and maintenance of social knowledge. Knowledge is a systematised and integrated type of information. Information refers to facts about life, ideas, values, views, discoveries, perceptions, norms, rules, conclusions, data, experiences and interpretations. Knowledge can only be produced by referring to information. Knowledge is always related to social dimensions. For example, even if you read a book, you are referring to knowledge as a product of social relationships. Information and knowledge are not independent from social relationships. But there is a difference between knowledge that is individually produced and consumed (such as the notes that I make for my lectures or the unpublished essays I store on my computer) and knowledge that is generalised in a social process

(such as the publishing of a book). The socialisation of knowledge is an important process that takes place permanently and is a necessary part of the existence and reproduction of social systems and society as a whole.

We can summarise the following characteristics of knowledge (see also Picot 1997)¹ that are very advantageous for capital accumulation:

- Information is a non-substantial (*nichtstofflich*) good that is generally not used up by its manifold usage.
- Information expands during its usage.
- Information can be compressed.
- Information can replace other economic resources.
- In fast networks information can be transported at the speed of light. Purchasers of information only buy copies of the original data.
- The costs of reproducing information are generally very low and are further diminished by technological innovations and progress.

Very dissimilar types of jobs, such as, for example, software engineer, author, reporter, secretary, scientist, librarian, information-broker, etc., can be considered as knowledge work. It is an important question whether such sectors of the economy should be considered as value-producing or value-consuming. If the question shall be answered whether we are witnessing a crisis of value production today or not, it must be clear which labour produces value and which does not. In Marxist theory, we today find very different views on this question. In this paper, I want to point out some aspects of value production in the Information Age. Existing views range between two extreme positions: 1. that all types of information labour produce surplus value, and 2. that all types of information labour are unproductive labour. Let us first discuss some of these views.

There are some approaches that argue that software production and services are generally a type of productive, surplus-value producing labour because labourers work more than they are being paid for. Those taking this position also say that the important criterion for the usage of the scheme of extended reproduction of capital--described in the second volume of *Capital* by Marx--is not the accumulation of an output, but of money capital. They do not see that value is an end in itself, that there are multiple layers of productive labour, and that capital accumulation is only possible with a material carrier of reproduction that can be accumulated. Such arguments can be found, for example, in Davis/Stack (1992) and Gough (1973):

Money capital is accumulated whether the workers labour to produce food, steel, bullets or concerts, provided they exchange their labour with capital and work long enough to more than cover their necessary labour [...] The production of these services, as much as of material goods, follows Marx's circuit of money capital: M-C...P...C'-M'. The fact that the production and consumption of the commodity coincide is of no relevance--the commodity is produced capitalistically and it is exchanged with money to realize the surplus value produced. It is naive materialism

to equate the accumulation of money capital with the physical accumulation of products. (Gough 1973, 69)

Workers who process information can create surplus value (i.e., are productive workers in the Marxist sense)--researchers and data collectors are the miners of information production; programmers, the tool and die makers; computer operators, the forge hands; desktop publishers, the trim workers. (Davis/Stack 1992, Footnote 23)

Ralf Kraemer (2000) says that the wages of knowledge workers are not determined by the value of their labour power, but that they exceed this value by far. Extra surplus value is produced at the expense of other areas of the economy. Knowledge workers are considered producers of surplus value because they work more than they are being paid for and their labour power is exchanged for money. He says that labour power already produces surplus value if it is wage labour for capital. The realisation of profit with information products in the area of the New Economy is, in this view, due to license fees. This would not be simply commercial profit, but an information rent. Kraemer argues that the driving force of the information economy is the appropriation of information rents.

Thomas Hagenhofer's (2001) view is that information labour is the generation, storage, transport, processing, presentation, and archiving of information. He says that it does not produce new knowledge, because knowledge production is confined to the area of research and development. Hence, information labour--if it is not part of the process of circulation (commerce, banks, etc.)--means activities that produce surplus value, according to Hagenhofer. He does not see that surplus production is in need of a material-substantial medium, an output that can be accumulated. Only in this way does the Marxian concept of the accumulation of a surplus product make sense. Gough, Davis/Stack, Kraemer, Hagenhofer and others (such as Daempfling 2000) do not take into account that there are certain types of information labour that do not result in material commodities and that therefore cannot be seen as immediately producing surplus value (e.g., a secretary, archivist, librarian, information broker, market researcher, etc.).

Kenney (1997) argues that one must distinguish between physical- and knowledge-based production of value. The driving force of the economy today is the production of knowledge. Hence the knowledge that is part of a commodity is the determining factor of value production. Value today is mainly produced by mental creations of knowledge workers. Kenney misunderstands, however, that mental and material production cannot simply be treated separately. Today, mental labour quite often manifests itself in material commodities (like compact discs, videos, computer games, etc.). Marx argued in many passages that such a material foundation of the accumulation of capital and the production of surplus value is a necessary stipulation of capitalism. Hence we cannot generally say that each type of information labour immediately produces surplus value.

James Curry (1997) argues that knowledge is not a thing, but a social process, a general abstraction outside the nexus of capital, a general pool that is non-proprietary and

available for everyone. When it is subsumed under capital, knowledge becomes information. Applying Hegel's categories of universality, particularity and individuality, Curry says that knowledge is a universal determination, information is something particular that is related to ideas and meaning, and data is something individual that is related to syntactic aspects. He continues that all material products of human activity contain knowledge and, as commodities, information, that the use value of information products is their information content and that all commodities have a knowledge composition consisting of the technical knowledge embodied in both the design and production of a commodity and an ideational content which is a symbolic aspect created through marketing and advertising. In Curry's view with the rise of informational capitalism, the information content of commodities increases and the value of an information commodity is relatively autonomous from its material form (paper, film, magnetic media, etc.) and because there is no value without circulation, the value form has to be consummated in order to have meaning in capitalism. "The vast majority of the value of a particular knowledge-content commodity comes from the content, i.e., Spielberg's or Lucas' idea" (Curry 1997). If this means that the surplus value contained in an information commodity is mainly an ideational content that is derived from an innovative idea, one must be careful because this implies that an idea by Spielberg or Lucas is the source of surplus value and that hence there must be a tendency of exploitation to decrease or vanish. In fact there is an idea for a book, a piece of software, etc., but there are also a number of workers realising the idea and this results in the actual information commodity that has a material reality. They are employed and exploited by a corporation. The actual value of a single piece of an information commodity is relatively low due to the qualities of information that favour capitalist interests. Information is only produced once, but copied millions of times very cheaply. The average value of one piece can be calculated by counting the number of necessary working hours and the number of produced pieces in a certain period and figuring out the average number of working hours needed for the production of one piece. This will be a very low number compared to traditional industrial production. In my view an information product doesn't have a high value due to its symbolic value; it has a very low value, but is sold at prices much higher than its value. And for justifying this I would argue that it has a high symbolic value. The surplus value contained in an information commodity is related to the time spent by employees in material and ideational production. Value isn't something subjective that is related to ideas (this would mean that the more important an idea, the more value the commodity that represents this idea) as sometimes suggested by postmodern theory (Baudrillard); value is something objective, a relationship in the material world, and it emanates from human beings' practical existence in the real world. It is true that frequently more time is spent developing marketing strategies and the knowledge contained in an information commodity than is spent in doing the actual reproduction process (software is a very good example of this), but as a whole information commodities don't have more but, rather, much less value than traditional commodities. Nonetheless they are a major source of profit due to the difference between value and price that is justified by the ideological construct of the importance of subjective ideas and symbolic value. So it is important to say that the ideational content doesn't have subjective value, but objective value in the sense of hours spent in production by employees who are dependent on the wages paid by capitalists. Surplus value can only be

created by variable capital; it exists prior to circulation and consumption and is only transformed into profit by the sale of a commodity on the market. A commodity that doesn't sell, still does have value, but doesn't result in profit.

Ernest Mandel (1972) argues that in late capitalism unproductive private labour is transformed into surplus-generating labour. He says that domestic helpers, private cooks, or private tailors do not produce surplus value, but the production of vacuum cleaners, central-heating facilities and electricity for private consumers, as well as the industrial production of ready-to-serve meals, are an immediate production of capitalist commodities and surplus value just like any other industrial type of capitalist production is (Mandel 1972, 354).

In Mandel's view the service sector includes many unproductive activities like packaging, marketing, advertising, market research or consumer credit. More and more workers are rendered redundant in the area of industrial production and become unproductive labourers in the service sector. With Marx, Mandel correctly argues that it is not sufficient to say that productive labour can be defined as producing surplus value; but there must be an additional criterion--the material production of commodities. Not each type of labour that is exchanged with capital is productive labour--e.g., wage labour in the sphere of circulation (capital in the areas of commerce and banking) (Mandel 1972, 368). The exchange of personal services with revenues, Mandel says, cannot generally be considered as productive labour simply due to the fact that it is organised as a capitalist business employing wage labour (369). A necessary criterion for productive labour, Mandel says, is the production of material-substantial commodities. Hence, for example, passenger traffic, concerts, a circus or a practice organised in a capitalist manner are not productive, for Mandel. If services include the production of material commodities as an industrial process, surplus value is created. But this would not be the case for all services.

Considering software engineering, Tessa Morris-Suzuki (1997) argues that by automation the production of value shifts from the production of commodities to innovations (i.e., the creation of knowledge). This Schumpeterian argument does not take into account that software engineering as a mental activity cannot be seen as being independent from material-substantial commodities. The value that is produced and that is objectified in commodities can only exist because there is a material object. Hence, intellectual and industrial production are interrelated in the framework of the manufacturing of information products.

These examples show us that it is not clear which activities should be considered as productive or unproductive ones in the Information Age. I now will outline my own view of productive and unproductive labour, and then I will discuss some aspects of the productivity of information labour by taking a look at scientific labour and software engineering.

According to Marx, abstract labour is labour that produces value. Concrete labour can, on the other side, be seen as the production of use values. "On the one hand all labour is, speaking physiologically, an expenditure of human labour-power, and in its character of

identical abstract human labour, it creates and forms the value of commodities. On the other hand, all labour is the expenditure of human labour-power in a special form and with a definite aim, and in this, its character of concrete useful labour, it produces use-values" (Marx 1867, 61).

In a very broad sense, each type of labour is productive in the sense that it is "human action with a view to the production of use-values, appropriation of natural substances to human requirements; it is the necessary condition for effecting exchange of matter between man and Nature; it is the everlasting Nature-imposed condition of human existence, and therefore is independent of every social phase of that existence, or rather, is common to every such phase" (Marx 1867, 198). But there is also another understanding of productive labour in a narrower sense: "That labourer alone is productive, who produces surplus-value for the capitalist, and thus works for the self-expansion of capital" (Marx 1867, 532).

Marx is using the category of revenue in a double sense: On the one hand, the word is used "to designate surplus-value so far as it is the fruit periodically yielded by capital" (Marx 1867, 618). On the other side Marx is dividing surplus-value into two parts: capital and revenue. Capital remains in the processes of circulation and accumulation whereas revenue is removed from circulation by the capitalists. Revenue is the part of surplus-value "which is periodically consumed by the capitalist, or added to the fund that supplies his private consumption" (Marx 1867, 618). Considering the category of productive labour, the second understanding of revenue is very important. This can also be seen by taking a look at the *Theories of Surplus Value* (Marx 1861ff): There Marx sees productive labour as labour which is exchanged directly with capital and unproductive labour as labour which is exchanged with revenue (wage or profit). As examples he mentions a clown and a tailor. For Marx, the clown is a productive labourer if he gives more labour to his employer than he is getting as wage in return. The tailor is producing a use value which is exchanged with revenue. In the first case we have a production of surplus value, in the second one a consumption of revenue. So here Marx sees as productive labour that produces surplus value and is exchanged directly with capital. Unproductive labour is exchanged with revenue and does not produce surplus value.

I now want to define three levels of productive labour:

1. On the first level, productive labour is labour that produces use values. This level is independent from the formation of society we are considering, i.e., it is not only specific for capitalism. Here the category of productive labour refers to a "purposive productive activity" (Marx 1858/59, 23; Marx 1894, 833). For our further analysis, mostly two other levels of productive labour (which are specific for capitalism) are important:
2. On the second level, the labour of an individual is productive (a) if it is part of a social aggregate of labour that covers all labourers who contribute directly to the process of producing a commodity or a mass of

similar commodities, (b) if this results in a new commodity that is sold on the market, and (c) if this activity is carried out again and again in order to increase the surplus product. (B) encloses the production of value; (c) shows that the accumulation of capital must also cover an increase of the surplus product. According to Marx, the surplus product is the part of the product that represents surplus value. In order to speak of capital accumulation and productive labour (2), a surplus product must exist; i.e., accumulation can only take place if the commodities produced can be accumulated materially. This means the physical mass of products is increased by accumulation. Capital accumulation always presupposes a material dimension.

3. The third level is the one of the collective labourer which covers all labourers that participate directly in the process of producing a commodity or a mass of similar commodities. On this level, each type of labour is a productive one that takes part directly in the process of production where at the level of the collective labourer a mass of commodities is produced that can be accumulated physically, that is sold on the market (realization in the sphere of circulation) and increases by capital accumulation. Marx has outlined this idea of the collective labourer in part V of *Capital* (Vol. 1): "The product ceases to be the direct product of the individual, and becomes a social product, produced in common by a collective labourer, i.e., by a combination of workmen, each of whom takes only a part, greater or less, in the manipulation of the subject of their labour. As the co-operative character of the labour-process becomes more and more marked, so, as a necessary consequence, does our notion of productive labour, and of its agent the productive labourer, become extended. In order to labour productively, it is no longer necessary for you to do manual work yourself; enough, if you are an organ of the collective labourer, and perform one of its subordinate functions" (Marx 1867, 531).

All three levels of analysis can be found in the works of Marx. A broad conception of productive labour seems useful in order to establish a multi-dimensional analysis of capitalism. Traditionally, the analytical category of "unproductive labour" opposed to "productive labour" has been treated as being less important for the overall reproduction of capitalism. As a result, reproductive labour and the exploitation of reproductive labourers has been treated as an antagonism of minor importance. To avoid such reductionism, the introduction of and difference between levels two and three is important because it stresses that unproductive labour (2) such as reproductive labour nonetheless is a necessary condition for the overall reproduction of capital. Because most unproductive labour (2) is productive (3), the dangerous undertone of the term "unproductive" is weakened. One must furthermore realise that productive and unproductive labour are analytical categories in Marxist theory and not moral ones. Some interpreters of Marx do not understand this point.

Some remarks on these definitions: The extended reproduction of capital, i.e., the accumulation of capital, is described by Marx in the second volume of *Capital* (Marx 1885) in the form $M-C..P..C'-M'$ (where M' is reinvested, this results in the existence of value as an end in itself and in the expansion of value). C' encompasses a surplus product, the part of the product that represents surplus value. Besides this circuit of capital, Marx also describes the circuit of productive capital $P..C'-M'-M..P$ and the circuit of commodity capital $C'-M'-C..P..C''$. Hence accumulation of capital also means the accumulation of commodity capital, and this is just another expression for the increase of the surplus product and hence of the quantity of produced output. The circuit of commodity capital refers to "the movement of the general mass of products" (Marx 1885, 102) and to a "representation of the components of the value of the product by corresponding proportional parts of the product itself" (Marx 1867, 234) that always takes place. And: "surplus-value is convertible into capital solely because the surplus-product, whose value it is, already comprises the *material* elements of new capital" (Marx 1867, S. 607). Marx also speaks of the "material conditions" of accumulation (ibid. 607, FN 21b). All of this shows us that seen as a quantity of commodities, $C''=C'+DC$ is larger than C' .

Also in his "Results of the Direct Production Process" (Marx 1864, this is the sixth chapter of the draft of *Capital* written in the years 1863-1865), Marx pointed out that productive labour is in need of a surplus product:

From the simple standpoint of the *labour process* in general, such labour appeared to us to be *productive* as was realised in a *product*, or more precisely in a *commodity*. But from the standpoint of the capitalist production process, this element has to be added to the definition: such labour is productive as directly valorises capital, or produces *surplus value*, hence is *realised*, without any equivalent for the worker, for the performer of the labour, in a surplus value, expressed in a surplus produce, hence in an *excess increment of commodities* for the monopoliser of the means of labour, for the *capitalist*; only such labour is productive as posits the variable capital, and therefore the total capital, as $C + DC = C + Dv$. It is therefore labour which directly serves capital as the agency of its *self-valorisation*, as a means to the production of surplus value (Marx 1864, 108).

There is a technical and a value-aspect of commodity. Hence, accumulation also means an increase of the surplus product DC , i.e., a quantitative increase of the stock of commodities: "If reproduction takes place on an extended scale, then the final C' is greater than the initial C' and should therefore be designated here as C'' " (Marx 1885, 91). This shows us that we indeed have to assume that an accumulation of capital always encloses a material accumulation of the output of commodities. Hence, I have argued in the definition of productive labour (2) that a necessary stipulation is the production of a physical commodity that can be accumulated, stored, warehoused, transported and resold. In his *Theories of Surplus Value* (Marx 1861ff), Marx shifts between two positions: On the one hand he says that each wage labour that is bought by capital is productive labour;

on the other hand he also argues that there must be a material-substantial foundation of productive labour. In the second volume of *Capital* (Marx 1885), Marx finally argues that productive labour encompasses the material production of commodities and value. Hence, not each labour that is exchanged with capital is a productive one.

Very similar to my approach is that of the Austrian Marxist Peter Fleissner (1987; 1995), who argues that it cannot generally be assumed that information and knowledge jobs produce surplus value. This is due to the fact that their output cannot be accumulated:

The Theory of Labour-Value can in its traditional form not be applied to such type of labour that has an output that can not be accumulated. Some services, those which are consumed in the moment of their production, which can not be warehoused and resold and which must be consumed instantly can be seen as use values, but due to the missing possibility of their accumulation no surplus-product is produced and due to the missing material base no surplus value is produced. Exchange values are consumed and hence I call these areas in difference to the classical value generating sectors value-consuming. The production of knowledge in capitalist service industries, research and development are part of this category.

In German, there is a difference between *Materie* (matter) and *Stoff*. Matter is the basic entity the universe and all being is composed of. It is the totality that constitutes reality and is itself constituted in space and time by an interconnected totality of moments which react on one another (motion), i.e. they repulse and attract each other. Motion is the mode of existence of matter in space-time. Matter is an eternal process of becoming and passing away, a ceaseless flux; it is uncreatable and indestructible. Matter is the totality of objective, really existing systems that are interconnected and obey different physical laws. It is unresting, in permanent motion, in ceaseless flux and a self-producing entity. Phenomena such as life and consciousness are specific forms of the self-organisation of matter; the physical world is a necessary precondition for all existence. Matter has an eternal existence and all that is or that has been, will or could become, results from the self-organisation and differentiation of matter (see Fuchs 2002c). It has a concrete form and as such is an expression of matter taking shape. Materialism is grounded in the view that all reality has matter as its foundation. In English, the term "material" is used both in the sense of the German expressions "*materiell*" and "*stofflich*." "*Stofflich*" could best be translated as "substantial" (it has to do with real objects we find in the world), although this term can be confusing because in Substance-Philosophy matter is interpreted as substance of the world in line with the thinking of Giordano Bruno, Benedictus de Spinoza, Friedrich Wilhelm Schelling and Ernst Bloch (see Zimmermann 1999, 2001). The stuff our world is made of consists of atoms, pure materials, elements. We know 118 pure materials (periodic table). They combine and form molecules which have new qualities. Ideas are a form of matter, but they don't exist as pure materials. They are non-substantial.

In the broad sense of the term, each labour is material labour. For example, consider a story teller: there are material processes going on in his/her brain and the cognitive information flows have the nervous system as its material carrier. But such an activity is not a material one in the narrower sense because there is no substantial object that results from it. Marx himself was aware of the difference between the fundamental material character of the world and the fact that not all activities result in material-substantial objects; nonetheless he used the term "material" for both aspects. When one defines materiality in the broad sense of the term, conceptions such as "immaterial labour" (Negri/Hardt 1994, 2000) or the "dematerialising" of production (Kenney/Curry 1997)² don't make sense because all human labour has to do with material processes and the exchange of matter and energy with nature.

Defining the production of surplus value as a sufficient condition for productive labour will result in idealistic conceptions of society because if the question of the substantial or non-substantial character of the output of the labour process is conceived as being independent from the productive or unproductive character of labour, one could think of a mode of development of capitalist society where all labour is emancipated from objective reality and where the accumulation of capital functions fully dependent on activities that are only grounded in the subjective, and no longer in the objective world. This would mean that the materialist world view is only true for the early stages of capitalism, but that with the development of the productive forces Idealism proves right.

The economy can't work without a substantial foundation. Idealistic conceptions such as the "weightless economy" (Coyle 1997, Kelly 1998, Quah 1997) or the "post-industrial society" (Bell 1976) suggest that capitalism can exist without material-substantial objects. But capitalism and economic processes in general are always in need of materiality in the broader as well as in the narrower sense. "Immaterial" (i.e., non-substantial), mental, and knowledge labour are becoming more and more important, but they are dialectically related to material-substantial production. The necessity of a material-substantial (*materiell-stofflich*) base of accumulation in the New Economy can also be shown by the fact that non-substantial products don't operate without material-substantial conditions (infrastructures, modems, computers, fibre optical cables, networks, circuits, wires, data carriers etc.). Ecological analyses of the New Economy have shown that the production of a single PC results in 16-19 tons of resources and 700 different substances, including metal (50%) and numerous heavy metals, synthetic materials (23%), glass (15%), and electronics (12%). More than 300 kilograms of waste and 3 tons of carbon dioxide are also produced (see Grote 1994, 1996; Junker/Lang 2001). Ursula Huws (2000) argues that the transformation of services into physical products is nowadays a long-term tendency in capitalism. Wolfgang Fritz Haug (2000) says that it is not true that information products are something completely new. The book in a library of the 18th century already had similar characteristics.

In order to avoid idealistic conceptions of society, we suggest that productive labour (2) is not just labour that produces surplus value, but an additional necessary condition is also a material-substantial output that can be accumulated, resold, warehoused, resold and transported. Marx's position on this point was a rather contradictory one.

He pointed out that the human world is an objective one, purely subjective and idealistic conceptions of society such as the ones mentioned above don't fit within a Marxist framework. Humans make use of objects in the world and they actively create new objects in the labour process. Hence for Marx, man is objective man (*gegenständlicher Mensch*). In this process, his living labour power is being objectified in use values which are a type of dead labour that store information about the world and society. This objectivity of human existence also finds an expression in the fact that all human organs and senses are in their *orientation to the object*, the appropriation of the object, the appropriation of human reality (Marx 1844, 539). So the objective world becomes the world of man's essential powers for man in society and "all *objects* become for him the *objectification* of himself, become objects which confirm and realise his individuality, become his objects: that is, man *himself* becomes the object" (Marx 1844, 541). Man is a *corporeal*, living, real, sensuous, objective being that has real, sensuous objects as the object of his being; he can only express his life in real, sensuous objects. Just like objects as material-substantial aspects of society, labour as a physical process is a necessary condition for human being: For Marx, labour is an "activity that appropriates particular nature-given materials to particular human wants" (Marx 1867, 57) and "a process in which both man and nature participate, and in which man of his own accord starts, regulates, and controls the material re-actions between himself and Nature" (Marx 1867, 192). Nature-given materials and the metabolism between man and nature refer to the fundamental material aspects of society.

In the first part of the *Theories of Surplus Value* (Marx 1861), which were pre-studies for his main work and have frequently been described as the fourth volume of *Capital* (although they had been written prior to the first volume), Marx points out that Adam Smith had two different conceptions of productive labour: 1. productive labour as labour that produces surplus value and capital, 2. productive labour as labour that produces value. Smith himself and some of his followers deduced from the second understanding the view that the production of a physical good is a sufficient condition for productive labour. But in fact non-wage labour that doesn't produce capital to some extent produces physical things; think, for example, of someone tailoring a pair of trousers or a dress for a friend. Hence Marx stresses that not every activity that results in physical things is a type of productive labour.

So Marx rightfully realised that the existence of a physical-substantial output is not a *sufficient* condition for productive labour (2), but his view on whether it is a *necessary* condition is somehow contradictory. On the one hand, he stresses that value has an objective existence (*Wertgegenständlichkeit*, Marx 1867: 80).³ The objective value of a commodity can only be observed in its exchange relationship to other commodities. Commodities have both "a physical or natural form, and a value-form" (Marx 1867, 62). Marx suggests that there is a body of a commodity (Marx 1867, 57) with a "material substratum" (ibid.). In the *Theories of Surplus Value*, Vol. 1, he defines a commodity as a thing that materially confronts man, has a certain usefulness for him and in which a certain quantum of labour is fixed and materialised (Marx 1861: 134).⁴

Marx knew that not all commodities have a material-substantial character (just think of the story teller selling his creations), but in his time almost all commodities were physical objects and therefore he neglected labour that results in non-substantial products. On the one hand, Marx stresses that productive labour is in need of a substantial-material substratum and a surplus product that depends on "the representation of the components of the value of the product by corresponding proportional parts of the product itself" (Marx 1867, 234) and that can be accumulated; but on the other hand, he mentions examples of productive labour where there is no physical-substantial output: "If we may take an example from outside the sphere of material production, [5](#) a schoolmaster is a productive labourer when, in addition to belabouring the heads of his pupils, he works himself into the ground to enrich the owner of the school" (Marx 1867, 532). Similarly in the *Theories of Surplus Value*, Vol. 1 (Marx 1861), Marx mentions examples such as actors, cooks or clowns as productive labourers if they are employed by capitalists (Marx 1861, 127, 129), whereas he says in the section "Productivity of Capital. Productive and Unproductive Labour" (1861, 365-388) that productive labour is not just a surplus-value producing activity, but also a separate, objective activity (ibid., 371) that results in commodities as material-substantial wealth (ibid., 385) and that only objectified labour that produces a larger quantum of objectified labour is productive labour (ibid., 376). The *Theories of Surplus Value* are very inconsistent, confusing and contradictory concerning the question of productive labour, whereas in *Capital* there is only the one example of the schoolmaster, just mentioned, that contradicts Marx's own assumption of a material-substantial substratum of surplus value. In addition, Marx uses the term "material" in the sense of the fundamental physical materiality of production as well as in the sense of the substantial-material character of certain labour and he occasionally (especially in the *Theories of Surplus Value*) uses the term "immaterial commodities" that adds confusion and inconsistency. In Marx's works, there is a contradiction between productive labour as a physical-substantial activity and examples such as the schoolmaster as productive labourers.

In his writings, both views on productive labour (2)--the one that assumes that the production of surplus value is a necessary condition and the one that introduces a physical-substantial output that can be accumulated as an additional necessary condition--can be found. But as mentioned above, one runs the risk of arguing idealistically if one sticks to the first interpretation. The assumption of a (substantial-)material substratum of productive labour (2) and surplus value, i.e., a physical output that can be accumulated, stored, warehoused, transported and resold and that represents value as an end in itself (Marx 1867, 167) that was mentioned by Marx doesn't mean stuff-fetishism (*Stofffetischismus*), as argued by Bjoern Daempfling (2000); it is an element of a *Materialistic* Labour Theory of Value that avoids idealistic turns. So our assumption is that surplus value is in need of a physical-substantial carrier that is extrinsic to man himself is produced within the sphere of production and results in the realisation of value, i.e., in the emergence of profit, in the sphere of circulation. A hair cut, for example, is a physical transformation of the head, but not a physical carrier of value that can realise itself in circulation. The product can't be circulated; the human labour objectified in it can't take the form of value. This shows that a necessary condition for productive labour

(2) is not just a physical transformation of the world or objects, but the production of a physical output that can be accumulated, stored, warehoused, transported and resold.

In parts two and three of this paper, I want to go into some details of the software engineering process in order to give an example of productive labour in informational capitalism and of how it has undergone economic and ideological changes.

2. Software Engineering: The Economic and Ideological Shift from the Waterfall-Model to Evolutionary and 'Participatory' Systems Design

Traditionally, the design methodology employed in software engineering was the so-called "waterfall model" (Royce 1970; see fig. 1).

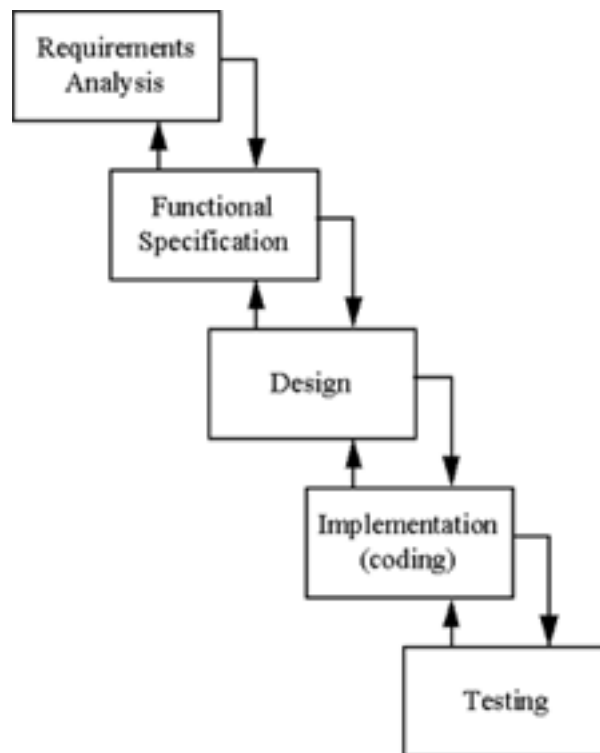


Fig. 1.: The waterfall model: a linear software engineering design methodology

Software engineering is conceived as a linear, sequential process which consists of successive phases:

1. *requirement analysis*: System requirements are identified and analysed; the end-users are asked to state the requirements of the technological system that should be developed.

2. *specification*: The necessary functions of the software that is to be developed are specified.
3. *design*: The system is broken into pieces and the functions and user-interface of each piece are conceived.
4. *implementation*: Each system component is coded and tested, the overall system is integrated.
5. *testing*: Test routines are run which help in finding system errors.

There have been numerous criticisms of the waterfall model: it misconceives software engineering as a static process; problems are not discovered until the test phase; the system requirements must be fixed before the system is designed although frequently new requirements show up during design and implementation; system performance can't be tested until the system is coded; and end-users are not integrated adequately into the process by software engineers. In order to avoid such shortcomings, which can result in major increases of overall costs, first some alterations were made to the waterfall model which resulted in methodologies such as the spiral model (Boehm 1986) or waterfalls with overlapping phases. However, these modifications couldn't avoid the overall problems of static design methodologies.

As a result of these persisting problems, a new paradigm of software engineering methodologies has emerged during the last 15 years: participatory and evolutionary software engineering. These methods try to improve the requirements process by involving users and are based on the idea that "barriers between technical specialists and people using computer applications need to be broken down in order to build effective communication during the design process" (Greenbaum 1993). Participatory design (Schuler/Namioka 1993) originated in Scandinavia and meanwhile a respectable amount of participatory methods has emerged, such as, for example, Paper Prototyping, Explorative Prototyping, Experimental Prototyping, Evolutionary Prototyping, Rapid Prototyping, Case-based Prototyping, Co-operative Prototyping and STEPS. These new methods are evolutionary in the respect that software engineering is conceived as a non-linear process where the designers frequently switch from one stage to another and phases overlap. Engineering in the tradition of the waterfall model assumes that the end-users can completely and precisely describe their needs during the phase of requirement analysis. Evolutionary systems design intertwines specification and implementation and focuses on the creation of models (so-called "prototypes") which give the end-user an idea of how the system can function and what it will look like. Possibilities and design alternatives are explored and discovered, feedback of the end-users is incorporated into systems design, and a series of ever-improved prototypes which reflect concrete ideas and needs of the end-users is developed. Prototyping and evolutionary systems design are non-linear and cyclical methods which try to avoid the shortcomings of the linear waterfall model.

Software systems are too complex to be fully specified and conceived accurately in advance and to be built without error based on one initial specification. Evolutionary and participatory methods are based on the assumption that specification and implementation have to co-evolve and that the end-users must be present in the software-engineering process in order to achieve good results.

Evolutionary approaches are based on the assumption that users need to see pieces of the system before they can know what they want. The development process is furthermore seen as a process of mutual learning where the designers and end-users are equally important, and designers can also learn from the users and improve their abilities by examining the work situation of the end-users co-operatively. Furthermore, much emphasis is given to explaining technical options to the users because one thinks that understanding how a technical system works helps the user in developing ideas about the requirements of the systems and helps him/her in using the end-product. In evolutionary and participatory software engineering approaches, software development is seen as a co-operative design task between software developers and users. The term "participation" in participatory systems design not only refers to the involvement of the end-users in the development process; it also refers to the rise of team work and participatory management in software corporations.

An example of evolutionary and participatory design methods is the cyclical STEPS-model (System for Evolutionary Participatory System Design; see Floyd et al. 1989) where software-realisation and maintenance is seen as the task of the developers, usage the task of the end-users, and systems design as a joint, co-operative task. The development takes place in such a way that successive versions are created in a process where there are feedback mechanisms. Users are integrated systematically, analysis and design are interconnected, metaphors are used for describing the system, development is conceived as an iterative, and participative process and prototypes are created.

This paradigm-shift in software engineering has not been an accidental one. In the early 1970s, the Fordist mode of development of capitalism entered crisis. One of the reasons was that the hierarchical Taylorist model of organising work reached its limits and promoted refusal of work and class struggle because the work force couldn't stand the permanent and extraordinary psychological and physical burdens. Other reasons were the technological and organisational limits the centralist Taylorist methods had reached. As a result, the growth rate of productivity decreased and wages and constant capital relatively increased. Together with the tendency of profit rates to fall, this produced falling profit rates and an overall crisis of capitalism (Fuchs 2002a). The economic diffusion of computer technology is also related to the crisis of Fordism (see Fuchs 2001a, b, 2002a). As a reaction to the relative fall of the profit rates, computerisation and automation have been put forward in order to save labour costs and to increase the rates of profit again. Informatisation and computerisation are medium as well as the outcome of the crisis of Fordism. The transition from Fordism to Postfordism took place in the framework of the search for a solution of the crisis of Fordism and capital accumulation. Neo-liberal politics aim at creating a framework for the economy that makes it possible to raise profits by minimising the costs of investment (constant and variable capital),

reducing social security, and preaching self-help and self-responsibility of the individual for his/her problems and of the capability of the market to regulate itself without human intervention.

This results in de-regulation, precarious job relationships, the dismantling of the welfare state, deterioration of labour and social policies, lowering of taxes on capital, flexible labour times, "housewifization," etc. Other characteristics of the post-Fordist mode of capitalist development are a new phase of economic globalisation (see Fuchs/Hofkirchner 2001, 2002a, b), the creation of national states of competition, the outsourcing, decentralisation and "flexibilisation" of production, lean management, just-in-time production, the flattening of internal hierarchies in corporations, small organisational units in corporations, delegation of decision-making from upper hierarchical levels to lower ones, decentralisation of organisational structures, team work, semi-autonomous working groups, tertiarisation and informatisation of the economy, triadisation of international trade and of capital-export, and diversified quality production. The use of modern information and communication technologies (ICT) in organisations is due to economic interests. Without the global crisis of Fordism, the new technological paradigm would have emerged sooner or later, but this process would have taken place much more slowly. The massive diffusion of ICT results from capitalism's permanent search for effective means of production, rationalisation and mechanisation. ICT make outsourcing and de-centralisation of production, team work, the "flexibilisation" of jobs and the flattening of organisational hierarchies much easier. These new technologies are a logical result of the development of the productive forces.

Today, we live in a post-Fordist, neo-liberal, information-societal type of capitalism (see Fuchs 2001a, b, 2002a). A new mode of development has emerged which has new emergent qualities. It involves a post-Fordist regime of accumulation, a neo-liberal mode of development and a disciplinary regime that has been described by the term "society of control." The disciplinary regime that dominated during the area of Fordism operated with the help of disciplines and disciplinary milieus. Disciplines are methods that secure the submission to external forces by surveillance and punishment (Foucault 1976). They are inherent in modern institutions such as schools, prisons, families, universities, hospitals, corporations, etc. because these milieus try to enclose the individual. Disciplines were also incorporated into the Fordist apparatuses of mass production, especially into assembly lines. These aspects still exist today to a certain extent, but concerning the disciplinary regime there is also a shift from the "disciplinary society" (Foucault) to what Gilles Deleuze (1993) calls the "society of controls." Controls are internalised disciplines, forms of self-discipline that present themselves as liberating and operate in a more subtle manner:

Enclosures are molds, distinct castings, but controls are a modulation, like a self-deforming cast that will continuously change from one moment to the other, or like a sieve whose mesh will transmute from point to point [...] The old monetary mole is the animal of the space of enclosure, but the serpent is that of the societies of control. We have passed from one animal to the other, from the mole to the serpent, in the system under which we

live, but also in our manner of living and in our relations with others. The disciplinary man was a discontinuous producer of energy, but the man of control is undulatory, in orbit, in a continuous network. [...] The coils of a serpent are even more complex than the burrows of a molehill (Deleuze 1992).

The mole as a symbol of disciplinary society is faceless and dumb and monotonously digs his burrows; the snake is flexible and pluralistic. The individual in Fordist capitalism was expected to carry out monotonous labour; management expects individuals in post-Fordist capitalism to be flexible, innovative, motivated, dynamic, modern, young, and agile, and it wants them to identify with the corporation and to have fun at work. Strategies of participative management aim at the ideological integration of labourers into corporations. This is a new quality of the disciplinary regime that does not aim at a humanisation of work and life, but at a rise of profits by an increase in productivity and cost reductions achieved by the workers' disciplining themselves. Bonus systems, team work, share options, corporate identity, attractive design of the work place, construction of a community between management and workers ("we"-identity), advancement of spirit of enterprise within the workforce etc. are part of this strategy that constitutes new qualities of the disciplinary regime.

So what I am arguing is that the shift from hierarchical expert software design, for which the waterfall model was characteristic, towards participatory and evolutionary software engineering reflects an ideological shift in capitalism which no longer involves a dominance of hierarchical control, but a strategy of integration that is expected to result in a rise of profits. Participation in social systems (not only in socio-technical systems) understood as the individual and collective right and responsibility to design those systems in which people live all by themselves can be justified in two ways: either by arguing that there is a political right to self-determination, democratic involvement, and participation, or by arguing in an instrumental sense that in order to achieve good results, participation is necessary. In informational capitalism, "participation" is participation in the second, instrumental sense, which serves economic interests and hence is pure ideology. If one takes a look at the precarious living and working conditions that the majority of the population of the world society has to endure today, it becomes clear that participatory management does not at all result in a humanisation of work and life.

Also in participatory software engineering where the involvement of the end-users in the design process and the propagation and dispersion of team work and internal co-operation within software corporations has become a very important organisational aspect, "participation" is understood in a very narrow sense of the term that excludes overall societal and political issues and serves capitalist interests. Participation would have to include a control of products and the means of production by the immediate producers and on the political level overall direct democracy in the sense of people affected by determining decisions collectively and by themselves (see Fuchs 2001b). Capitalism in this sense is an anti-participatory society, and participatory management is an ideology that helps to convince the exploited and dominated that their exploitation is just, fair, democratic and "participatory." "Participatory" software engineering is a

method of rationalising and optimising the software production process in such a way that profit can be achieved effectively. The division of labour inherent in capitalism that requires a class relationship between those owning the means of production and the results of the production process and those depending on the entrance into labour relationships is maintained in informational capitalism. Despite all the changes we are witnessing today, the antagonism between the owners of property and the owners of labour remains an unchanged central characteristic of society. "There is still a division between those who own the valuable resources on which the information economy is dependent and those who merely own their ability to labour in such an economy. [...] In the information economy even if knowledge creators are themselves individuals, the ownership of the bulk of valuable knowledge resources remains with capital" (May 2000). "Participatory" methods of management and design help to ideologically forestall social change towards a real participatory society and upholds what has in Critical Theory been called "false consciousness."[6](#)

Software is a type of coded knowledge that is produced by sticking to formalised rules and production-algorithms. It is an objectification of intellectual labour that has a physical reality. Software engineering methods such as the ones outlined above describe the intellectual process involved in producing a piece of software, but they abstract from the part of the production process where knowledge gains a physical carrier, which is a necessary condition for making profit with coded knowledge. The shift from software production based on the waterfall model to "participatory" and evolutionary production reflects economic and ideological changes of capitalism, what both types have in common is that they describe the first step of software production, the basic intellectual labour employed. Let me explain the main argument of this paper that in order to make profit from an information commodity, there must be a physical (material-substantial) carrier of knowledge in respect to the realm of software engineering.

3. Software Engineering and the Production of Surplus Value

Information is not objectified in a single product and cannot be renewed by rebuying it, as is the case with constant and variable capital. It is objectified in many products at the same time (not only by one firm, but possibly by many firms at the same time) although it must only be produced once. Furthermore it does not wear out nor is it used up. Fixed constant capital, like machinery, gets worn out or is devalued morally. Circulating constant capital, like resources, is objectified in commodities physically; they get used up and must be renewed for the process of production. Information is not used up materially, and it need not be repurchased. But in most of the cases, information must be further developed. This produces costs, but there are almost no reproduction costs. Knowledge does not have to be (re)produced permanently as does variable capital and circulating constant capital. It can be reproduced industrially very cheaply and in unlimited numbers very quickly. So copies are made but knowledge does not have to reproduce itself. In its digital form it can be distributed globally very quickly and efficiently by making use of modern information and communication technologies.

Software engineering is not a scientific labour because it does not produce new knowledge that is related to already existing scientific discourse. Software engineering is the processing and integration of already existing knowledge. A computer program is coded knowledge of the programmers in abstracted form. The real industrial process of production can only be accomplished with the help of a material-substantial carrier (CDs, disks, the Internet, etc.) and by making use of some mechanism of reproduction--or the commodity is directly distributed with the help of the Internet as a material medium. The costs of reproduction are very low; software that has once been coded can be reproduced easily, quickly and very cheaply. The constant and variable capital that must be invested for this process of reproduction are very low. Only the material-substantial carrier of the information as part of the fixed constant capital must be renewed permanently. But this is not the case for the knowledge that has been produced by software engineers: The costs of production must only be paid once. By making use of so-called Intellectual Property Rights (for example, copyright and patents), software companies try to guarantee an exclusive expansion of value with the help of a special piece of software for themselves.

Does a software engineer produce surplus value? Let us reconsider the definition Marx gave us: "This increment or excess over the original value I call 'surplus-value'" (Marx 1867, 165). According to this definition software engineers produce surplus value because the capitalist buys labour power and the necessary means of production and the piece of software is sold at a value which is higher than the capital invested. The value of a software does not amount to its sum of constant and variable capital. So surplus value must have been produced. Programmers work more than they are being paid for; hence, they perform surplus-labour and produce surplus value. But surplus value is also an end in itself, i.e., surplus value is expanding value. One part of the surplus value remains in circulation and is the starting point for another process of accumulation in the form of money capital M that is being reinvested. "The circulation of money as capital is, on the contrary, an end in itself, for the expansion of value takes place only within this constantly renewed movement. The circulation of capital has therefore no limits" (Marx 1867, 167).

The production of, say, a car is in accord with the scheme of reproduction on an expanded scale $M-C..P..C'-M'$ (process of accumulation). M' is being reinvested and more cars can be produced in order to further increase M' . Hence we can say that the output of this production process can be accumulated. More and more cars are being produced in order to accumulate more capital.

Can the direct output of software engineering be accumulated? A piece of software is not being produced and sold in order to program the same piece of software in a higher quantity. So we cannot speak of the possibility of accumulating software or other information products. This is due to the earlier-mentioned fact that knowledge must only be produced once and does not have to be reproduced permanently in order to be available. That is not the case with, for example, raw material. Value is an end in itself in the form of surplus value because value is being fed back on itself in the circulation of capital. The end point of the metamorphosis of capital, M' , is the starting point M for another circulation. Hence software engineering is not a feedback process: it is not the

case that more software of the same type is being programmed with the help of the reinvestment of accumulated capital. As a result, software engineering as an intellectual labour cannot be considered as productive (2). At this point, no material-substantial commodity that is sold on the market and that can be accumulated is produced. There is no surplus product in the phase of intellectual production. This is true for the production of all information commodities (CDs, software, films, videos, digital-versatile-discs, laser-discs, mini-discs, etc.). The intellectual labour that is employed in order to produce an information commodity is productive labour (1), but not productive labour (2).

But we also have to take a look at the level of the collective or social labourer. In order to become profit, knowledge must have a material carrier. It is stored on different carriers of data in order to be marketed. The exchange value of knowledge does not exist before the data is stored on such a carrier. The software as such that is stored on a local computer cannot be exchanged as a mass product with money. Only if it is saved on a carrier like a disk, a CD-ROM or the Internet can it be exchanged as a mass product for money. In most of the cases a piece of software is reproduced industrially. In this manner the product gets a material-substantial base. The process of industrial reproduction must either be bought as a service or it is accomplished by the software corporation itself. For this industrial process, human labour in the form of variable capital and constant capital in the form of machinery and raw material (disks, CD-ROMs, etc.) must be purchased.

Knowledge which is objectified in a piece of software does not have to be reproduced for each copy. As soon as it exists once and the workers who have produced it are paid, it costs the capitalists nothing and it becomes a part of the industrial production process that is free of charge. So coded knowledge is part of each copy of a software and does not produce further costs. A single copy is sold at prices much higher than its costs of production. Copies are produced and sold in order to reinvest and to accumulate capital. By getting a material-substantial carrier and being reproduced industrially, a piece of software can be accumulated. The industrial process of reproduction conforms to the Law of Value just like the production of cars. It is still true that the more labour is objectified in a commodity like a piece of software the more expensive the product will be. But it is not the case that the price of a commodity amounts exactly to the value of labour that is objectified in it. The specific characteristics of knowledge (must only be produced once, and can be reproduced very quickly, easily and cheaply) favour this. Commonly, software is sold at prices that are much higher than its value.

At the level of the collective labourer that is involved in the engineering of a piece of software (or more generally speaking an information commodity), a surplus product and surplus value are created. Capital and the output of production are accumulated and the surplus product is increased. An increase of the surplus product can only be achieved with the existence of a material carrier. C' is exchanged with M' and M' is fed back and becomes the starting point G of a new process of accumulation. Hence considering the level of the collective labourer, the production of a mass software is a type of productive labour (3). The scheme of extended reproduction as described by Marx can be applied. The intellectual labour that is employed is unproductive (2), but productive (3). It is a necessary condition for the accumulation of capital in the software industry, but it does

not directly produce a surplus product in the sense of productive labour (2). It is only carried out once and hence it does not contribute to the increase of the surplus product at each turnover of the capital. The labour that must be applied in order to produce the material-substantial carrier of knowledge, i.e., the process of objectifying knowledge materially, must be carried out again and again. It directly results in an output that can be accumulated and in a surplus product. Hence it is productive labour (2). The process of reproduction is value-producing on level (2), but the intellectual production of knowledge is a necessary presupposition for it. On level (3), all labour that is employed directly as a part of the collective labourer in order to produce software can be considered as productive labour (3). This includes not only intellectual and manual labour, i.e., the production of knowledge and material carrier, but also maintenance, administration, distribution, advertising, delivery, transport etc.

Information commodities are a major source of profit today. This is due to the fact that knowledge has certain characteristics that are very advantageous for capital and help to lower the costs of investment and maintenance. Value and price of a software vary. Whereas the value of a single piece of software is very low due to the specific characteristics of knowledge, it is sold for hundreds or thousands of dollars. In this way, extra surplus-value can be achieved.

Individual software is only produced and sold once (in contrast to mass software). This is a simple type of commodity production in which there is no output that is accumulated and no accumulation of a surplus product. If new software is produced by the same company and profit is invested into this process, this must be regarded as a new production process. Surplus value is only produced as a surplus to the value of the capital invested, but here surplus value is not an end in itself no permanent accumulation of capital and commodities takes place on the foundation of a single loop of (re-)production.

So the main idea I want to emphasize is that capital accumulation in the software industry is not only based on intellectual labour, but is also in need of a substantial-material carrier of knowledge and that profits in the New Economy result from a large difference between the value of an information commodity and its price. Let's consider an example that shows that capital can make use of the specific characteristics of information in order to yield large profits with information commodities. Imagine the production of a mass-software with a certain turnaround time. The production time of the necessary knowledge is best assigned to the first turnover period of capital. We assume that all copies are sold, that already after the first turnaround a profit is achieved, and that there is no interest and rent to be paid. The market price of one piece of software is \$119. We have to distinguish the constant and variable capital in the production of knowledge (c_1 and v_1) from the capital involved in the physical reproduction process (c_2 and v_2). Let's also assume that at the first turnover 100,000 pieces of commodity are produced, that $c_1 = \$1,000,000$, $v_1 = 5,000,000\$$, $c_2 = \$500,000$, $v_2 = \$200,000$. Hence the total investment costs are \$6,700,000. We assume a rate of surplus value of 100%. The mass of constant capital is $c = c_1 + c_2 = 1,500,000$, the mass of variable capital $v = v_1 + v_2 = 5,200,000$. Due to a rate of surplus value of 100%, the mass of surplus value produced is $s = \$5,200,000$. All copies are sold; hence, the revenues are $119 * 100,000 = \$11,900,000$.

Subtracting the investment costs from this sum results in a profit of \$5,200,000 for the first year. The average value of a single copy is $v = cd + vd + sd$, where cd , vd und sd describe the average proportions for one commodity of the total constant and variable capital as well as of the total surplus value produced. Hence the average commodity value is

$$v = \frac{15 \cdot 10^5}{10^5} + \frac{52 \cdot 10^5}{10^5} + \frac{52 \cdot 10^5}{10^5} = 119$$

Hence in this example the value of the commodity equals its market price. Let's take a look at the second turnover of capital: We assume that the conditions of production, the costs and the total amount of produced commodities remain the same. How does profit develop? The investment costs for knowledge production don't have to be spent by the capitalists this time due to the specific characteristics of information ($c1 = 0$, $v1=0$). Hence the average commodity value is reduced to

$$v = \frac{5 \cdot 10^5}{10^5} + \frac{2 \cdot 10^5}{10^5} + \frac{2 \cdot 10^5}{10^5} = 9$$

This means that the average value of a single piece of software has massively decreased without a change in the conditions of production! This is due to the fact that knowledge only has to be produced once; it only has what Marx called a "moral" devaluation, but doesn't loose value by ageing, use or non-use, it can be reproduced easily and very cheap, etc. The software is still sold at \$119, hence the profit increases from \$5,200,000 to \$11,200,000. This amounts to an increase of average profit from \$52 to \$112 per commodity and an increase of the profit rate from 0,78 to 16 (profit rate = profit / (c+v))! This shows that the value of a piece of software is much lower than its market price and that the specific characteristics of knowledge are the mechanism that secures higher-than-average profits and profit rates in the software industry.

Summary of the main arguments:

- In order to avoid idealistic conceptions such as "immaterial labour," "dematerialised economy," "weightless economy," "post-industrial society" and to adequately ground a *Materialistic* labour theory of value, one must stress that informational capital has a material base and that the surplus value objectified in information commodities is in need of a physical-material carrier/medium.
- The higher-than-average-profits achieved in the New Economy by producing and selling information commodities have to do with the specific characteristics of information: it is generally not used up by its manifold usage, it expands during its usage, it can be compressed, it can replace other economic resources, it can be transported at the speed of light over the global information networks, and the costs of reproducing it are generally very

low and are further diminished by technological innovations and progress.

- Capital accumulation in the software industry is not only based on intellectual labour, but is in need of a substantial-material carrier of knowledge. Profits in the New Economy result from a large difference between the value of an information commodity and its price.
- The part of the software engineering process where knowledge is created is in Computer Science described by software engineering methodologies.
- The shift in software engineering methodologies from waterfall models towards evolutionary and "participatory" design methods is a reflection of economic and ideological changes involved in the transition from Fordism to post-Fordism. The spreading of "participative" methods of design and management don't result in a democratisation and humanisation of labour and society; rather, they are an ideological mechanism that is employed in order to increase profits and uphold "false consciousness."

Notes

[1](#) The title of Picot (1997) sounds promising ("The Surplus Value of Information"), but really does not live up to the expectations one might have. Picot does not understand surplus value in the sense of Marx; hence, his article does not provide a Marxist analysis of the Information Age.

[2](#) The work of Kenney and Curry (1997) is important and suggests that the advent of the computer and data communication networks has accelerated knowledge creation, but with this has come a more rapid obsolescence in the things that objectify this knowledge. "Production equipment loses market value quickly and simultaneously as factories become more automated there is more capital at risk. Profits must be made before the equipment is superseded by a dramatically superior machine. This gives real meaning to the term "speed-based" competition. The introduction of electronics makes machines more productive, but simultaneously, because it helps accelerate technological change, the machine's productive life decreases making it a wasting asset. In many fields, the factory comes under increased pressure to operate constantly, because physical depreciation no longer bears any relationship to obsolescence". Nonetheless the authors argue in a rather idealistic manner that there is a dematerialization of the economy and commodities, that software is entirely a creation of the mind and that the Internet represents an extremely powerful dematerialization. Such formulations don't take into account the material nature of informational capitalism and of value production in the information age.

[3](#) The translation of the term *Wertgegenstaendlichkeit* in the English edition of *Capital* is not exact because it simply refers to "values" instead of "objective value."

[4](#) "*Ware--im Unterschied zum Arbeitsvermoegen selbst--ist ein dem Menschen stofflich gegenueberstehendes Ding von gewisser Nuetzlichkeit fuer ihn, worin ein bestimmtes Quantum Arbeit fixiert, materialisiert ist*" (Marx 1861: 134).

[5](#) The phrase "outside of material production" here refers to labour that results in a non-substantial output. Marx's terminology is confusing because, as shown above, at other instances he says that all labour is a material metabolism and a material activity. To avoid such confusions, it is better to use the terms physical-material (*physikalisch-materiell*) and substantial-material (*stofflich-materiell*).

[6](#) For an essay on the topicality of the critical theory of Herbert Marcuse in informational capitalism, see Fuchs (2002b).

[7](#) This is also stressed by Robert Kurz (1986): "There is no accumulation without a material carrier, although this would be the ideal of capital."

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