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Commons-based peer production and digital fabrication: The case of a RepRap-based, Lego-built 3D printing-milling machine ☆

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ABSTRACT

Through the case of the RepRap-based, Lego-built three-dimensional (3D) printing-milling machine, this paper sets out to discuss and illustrate two points: First, on a theoretical level, that modularity, not only in terms of development process but also of hardware components, can catalyze Commons-based peer production's (CBPP) replication for tangible products enabling social experimentation and learning. Second, the hybrid 3D printing-milling machine demonstrates the digitization of material and the potential of digital fabrication. We show how the synergy of a globally accessible knowledge Commons as well as of the CBPP practices with digital fabrication technologies, which are advancing and becoming more and more accessible, can arguably offer the ability to think globally and produce locally.

1. Introduction

Plenty of attention has been gathering around the information production models enabled by the modern information and communication technologies (ICT) and brought to the forefront by collaborative projects such as the free/open source software (FOSS) movement or the free encyclopedia Wikipedia. On the other hand, authors, such as Webster (2002a, 2002b), have argued against the idea of an 'information society'. They emphasize the continuities of the current age with former capitalist-oriented social and economic arrangements (Schiller, 1981, 1984, 1996; Webster 2002a,b). Kumar (1995: 154) maintains that the information explosion 'has not produced a radical shift in the way industrial societies are organized' to conclude that 'the imperatives of profit, power and control seem as predominant now as they have ever been in the history of capitalist industrialism'. The widespread adoption of ICT cannot automatically produce a better world for humanity: Some technologies need the appropriate social environments to be structured in a certain way (Winner, 1986). For instance, that could be one reason why in the past decades attempts for more autonomous forms of production based on novel technologies – from the 'small-is-beautiful-experiments' (Winner, 1986) to the development of wind power from below in the 1970s (Glover, 2006) – proved unsuccessful. The case of the RepRap-based, Lego-built 3D printing-milling machine, with regard to Winner's and Glover's concerns, attempts to show that new means of production, such as the ICT and

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the emerging digital fabrication capabilities, could create the appropriate knowledge-based social environments and make possible not only the independent production of information but also the independent production of modular hardware, even in such an infancy form.

Through several cases of successful networked-based, collaborative projects such as FOSS or Wikipedia, some see the emergence of new 'technological-economic feasibility spaces' for social practice (Benkler, 2006: 31). These feasibility spaces arguably include different social and economic arrangements, in contrast to what Kumar and Webster claim, where profit, power, and control do not seem as predominant as they have been in the history of modern capitalism. In this technological-economic feasibility spaces a new social productive model, i.e., Commons-based peer production (CBPP), is emerging different from the industrial one. CBPP, exemplified by various software (GNU, the Linux kernel, KDE) and content (Wikipedia) projects, makes information sharing more important than the value of proprietary strategies and allows for large-scale information production efforts (Benkler, 2006). In this context, CBPP could be considered an early seed form stage of a new mode of information production enabled through Internet-based coordination where decisions arise from the free engagement and cooperation of the people, who coalesce to create common value without recourse to monetary compensation as key motivating factor (Bauwens, 2005; Orsi, 2009; Kostakis, 2013).

So far CBPP practices have been a subject to systematic research for productive fields of information such as software, news, knowledge, design and literature (Benkler, 2006, 2011; Bauwens, 2005, 2009; Bruns, 2008; Weber, 2004; van Abel et al. 2011; Kostakis and Drechsler, in press). However, only a few studies (for instance Siefkes, 2007; Carson, 2010; Troxler, 2011; Kostakis, Fountouklis and Drechsler, 2013) have dealt with the transferability of CBPP's processes to physical manufacturing. In addition, most of the scholars seem to agree that one of the key conditions for CBPP to emerge, either in the immaterial or material sphere of production, is modularity in the development processes.

This paper attempts to examine the feasibility of CBPP's expansion into physical manufacturing focusing on digital fabrication technologies and the possibility for modular design in hardware components as well. Our discussion is tentative and illustrative, built on the project of a Lego-built three-dimensional (3D) printing-milling machine, and, thus, an all-inclusive instantiation is out of scope. We begin with a brief outline of the theoretical background concerning CBPP addressing its conjunction with desktop and digital manufacturing capabilities. Next, we present the case study of our hybrid 3D printing-milling machine, a project run by one of this paper's authors. We then discuss the results in relation to the potential of CBPP's transferability to physical manufacturing, with particular reference to hardware components' modularity.

2. Theoretical background

2.1. Commons-based peer production and modularity

CBPP projects produce use value, i.e. an informational good (e.g. software, design, cultural content) free to use, modify and redistribute, part of the knowledge or cultural Commons. In addition, CBPP's development processes are based on the self-selection of tasks by the participants, who cooperate voluntarily on an equal footing (as peers) in order to reach a common goal. It has been claimed (see only Benkler, 2006; Bauwens, 2005; Tapscott and Williams, 2006; Dafermos and Söderberg, 2009) that modularity is a key condition for CBPP to emerge: 'Described in technical terms, modularity is a form of task decomposition. It is used to separate the work of different groups of developers, creating, in effect, related yet separate sub-projects' (Dafermos and Söderberg, 2009: 61). Torvalds (1999), the instigator of the Linux project, maintains that the Linux kernel development model requires modularity, because in that way people can work in parallel. Empirical research (see only MacCormack et al., 2007; Dafermos, 2013) shows that modular design is characteristic not just of Linux but of the FOSS development model in general. 'The Unix philosophy of providing lots of small specialized tools that can be combined in versatile ways', Carson (2010: 208) writes, 'is probably the oldest expression in software of this modular style'. We also observe the same approach in the development of one of the most prominent CBPP projects, that of the free encyclopedia Wikipedia. Articles (i.e., modules), which are consisted of sections (i.e., sub-modules), are built upon other articles and entries produced and, thus, can be used individually as well as in combination.

Therefore, by breaking up the raw elements into smaller modules there is both an abundance of options in terms of remixing them as well as a low participation threshold, since the individuals can have access to the modules, rather than centralized forms of capital (Bauwens, 2005; Carson, 2010). So, in theory, we can assume that if physical objects could be designed to be modular – i.e., consisted of several interchangeable parts that could be swapped in or out without influencing the performance of the rest –, then individuals could engage in production processes of collaborative designing and manufacturing (Tapscott and Williams, 2006). If the interconnected personal computers are considered fundamental means of information production whose democratization gave rise to CBPP, then what could our expectations be if digital fabrication and desktop manufacturing technologies, such as 3D printing, follow a similar path?

2.2. Desktop manufacturing and digital fabrication

The conjunction of CBPP practices with desktop manufacturing capabilities, which themselves can be products of CBPP (see, for instance, the RepRap 3D printer), can arguably give us the chance to (co-)design globally – taking from and contributing to a knowledge Commons – and produce locally responding to certain needs (Kostakis, 2013; Kostakis, Fountouklis and