Open Source Development of Tangible Products

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Abstract

This article's objective is to set up some foundational theory and practices for Open Source Development (OSD) of tangible products, a novel and emerging approach derived from the well-known open source software movement. As a contribution to the first steps of research in this discipline a clear definition for OSD is proposed and used to describe the key elements of a suggested OSD Process model. Several case studies are analysed to create an Archetypal Business Model characterising OSD of tangible products and the possibilities and delimitations within. Furthermore, strategic tools are suggested for companies that wish to explore the potentials OSD brings which form a so called OSD Method. The result of the method is the OSD Strategy and implementation thereof. This is done with the objective of determining the potential profitability that lies within OSD of tangible products and how companies can utilise this new approach to improve their business models and capture value in innovative ways.

Keywords: Open Source Development, Open Design, Open Source Hardware, Platforms, Business Models, Communities

Introduction

Open source as a phenomenon emerged in the 1980s amongst software developers. Richard Stallman then founded the Free Software Foundation in 1985 to satisfy the need for software freedom to computer users, meaning that copying, redistributing and modifying computer programs would be more easily practiced. He developed the General Public License or GPL – sometimes referred to as "copyleft" – a play on the word copyright [16], to ensure that modified and extended versions of free programs would be published under the same principles [9].

Open source has proven to be a billion dollar business, with a vast number of communities contributing to software development and prominent companies, such as IBM and Linux, being able to capitalise on this input and the outcome [8]. This has led to the speculation of whether this product development process can be taken one step further, namely towards development of tangible products, as opposed to solely focusing on software. The principles remain the same; *open* allowing anyone interested to adopt the source, change it, reproduce or copy, and *source* being a denominator for code, blueprints, drawings and other elements needed to produce the end result. The main difference is the physical aspect of the latter category; tangible products require materials and physical production to work which inevitably increases the complexity of the open source process and poses new challenges that need to be addressed.

The open source paradigm requires a distinctly different type of business model to that of the traditional "protect and hide" approach to tangible product development. In order to make open source a viable alternative, an OSD methodology for tangible products needs to be created and exemplified with success cases. Unfortunately, these methodologies are currently unavailable and a lack of case studies and flagship success stories currently form a major barrier. However, through research presented in this paper, the authors have mapped several open source development strategies that are currently being deployed by successful companies that produce tangible products (as opposed to being purely software related). These cases have been analysed from a business perspective to capture and evaluate their viability for other businesses to follow. An archetypal business model is introduced, based on today's OSD businesses, along with an OSD Method which entails steps that can be used to form an OSD Strategy. The objective is to translate current situation (As-Is) to future scenarios (To-Be) where OSD business models are utilised.

The authors hope that their contribution to the definition and model of the process will support further research of open source development for tangible products. Furthermore they hope that this will encourage companies to consider OSD practices and allow for emerging and at times disruptive strategies to influence their business models, competitive advantage and profitability.

Research Methodology

As the topic of open source in relation to product development is a nascent one, finding relevant literature on the subject was a challenge. Literature on open source *software* development has been used as important background information on how open source development within the software world has evolved and matured throughout the years. Experience and challenges from that area have been used and taken into account when analysing the emerging practice of OSD within tangible product development. After weeks of extensive research, four companies were chosen as case studies. These cases demonstrate relevant examples of how variations of OSD models can be used in different industries and business contexts. The companies chosen were *Arduino*; an open source microcontroller [4], *Adafruit*; an open source hardware distributor and developer [1]; *Architecture for Humanity*; a non-profit organisation deploying open source architecture services [3] and *IDEO*; a consultancy firm using an open source platform to provide solutions for greater good [11]. An interview taken with one of the founders of the companies, discussion with experienced open source practitioners, in addition to Internet resources such as the companies' homepages, wikis, forums and videos, have been used to understand the settings and environment of these companies. Literature on business models and their generation has been utilised to identify and characterise the business models of the OSD companies chosen.

The OSD Definition

As mentioned earlier, the open source practice is not new to the scene of software development. In this analysis, differentiation is made between tangible and intangible products as shown in Figure 1. Intangible products present software products while tangible products present physical elements. Some products may entail both elements (hardware & software) such as Arduino and RepRap [14].
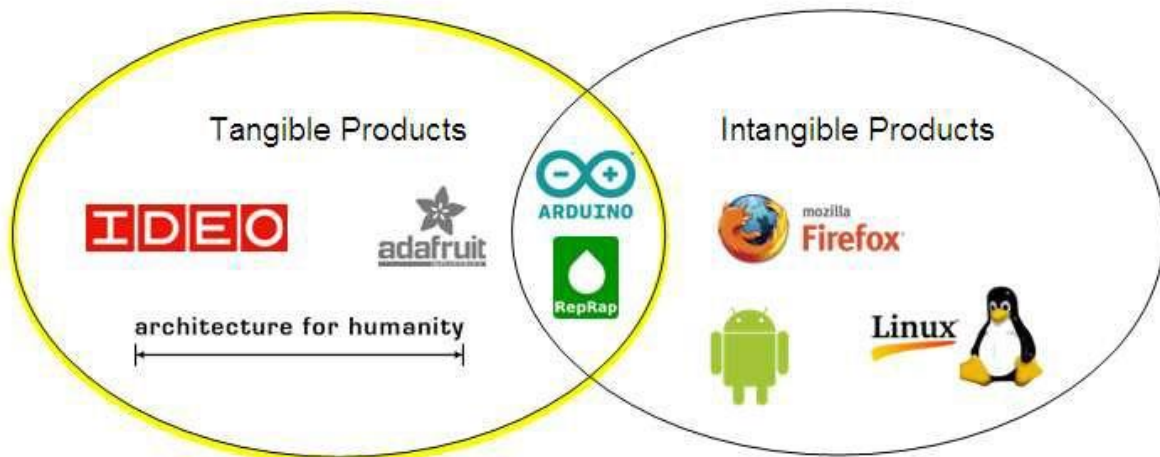
Figure 1: The demarcation of the analysis. OSD of Tangible Products highlighted on the left.

Peter Troxler [15] defines "*open design*" (a term referring to OSD) as a practice that borrows its operating principles from open source software and applies them in the domain of design. He describes it as a peer-oriented form of production, which makes production tools, methods and experience accessible to everybody as a common infrastructure, giving people options for controlling their productivity.

In Michel Avital's definition [15], open design signifies open-access digital blueprints that can be adapted at will to meet situational requirements, and can subsequently be used by consumers to fabricate products on demand by commercial, off-the-shelf production methods. The open design model diminishes the traditional vertical value chain that is formed by designer-manufacturer-distributor-consumer relationships and offers an alternative, open web of direct links between designers and consumers. The resulting short-spanned, transient and non-hierarchical relationships forge dynamic and flexible arrays of design blueprints that are not only user-centred but also user-driven.

It is perhaps Avital's definition that captures the essence of OSD practices so clearly; the change of relationship between stakeholders with a new proposed value chain that is characterised by co-creation and continuous communication. This furthermore encourages an examination of the supply chain that is affected by the physicality of the product; increasing the complexity level of the chain compared to a simple compilation of a software source code.

From these considerations it is the authors' opinion that open source development as a term covers the development of intangible as well as tangible products, through accessible and sharable platforms, where motivated communities with common practices share, adopt, produce and further develop innovative solutions, under commonly agreed credits and licensing. Open source development being free to anyone can still encompass revenue streams from related services and branding recognition, which enforce new business opportunities within the open source world.

The OSD Process
Careful analysis of the chosen cases has resulted in a model which demonstrates the process and fundamental elements of OSD practices. The model is based around a core element; the

platform, through which a network of symbiotic connections are created between stakeholders. There are additional elements which make up the process and represent the most important dimensions of OSD, namely drive, community, development and business (see Figure 2).
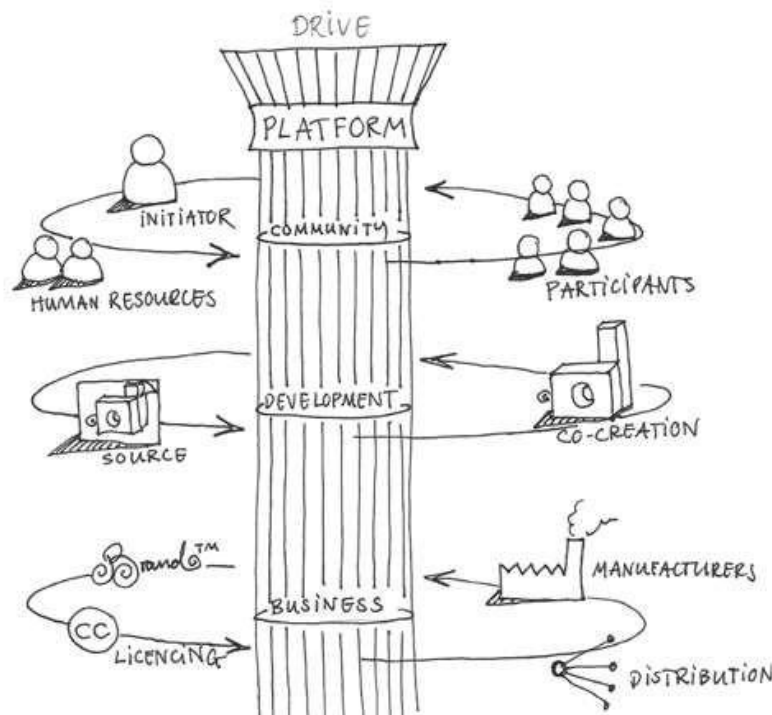

Figure 2: The OSD process model

Platform – the core
The core of the OSD model is the platform. The platform enables, facilitates and empowers interaction and development between participants through a symbiotic relationship. In most cases this platform is created by the company initiating OSD and specifically designed for the OSD project.

Drive
In order to attract crowds of developers to the platform there needs to be a drive that motivates participation. There needs to be a benchmark of some kind, which can be expressed in acts such as going against monopolistic giants (Linux against Microsoft), reducing cost of products (Arduino) or collaborating for the sake of good cause (IDEO).

Community
The community is first and foremost made up of the users who wish to participate in the development of the product and administration which usually is provided by the initiating company. These two parties interact and build on each other's feedback with the common objective of creating an improved product [10]. Together they create a network which is based on values of reciprocity, recognition and a desire to make an impact.

Development
The development of a product starts with the company posting a 'challenge' on the platform. This most often includes a product's code, blueprint or something of that nature, which participants can build upon. This sets the frame for OSD collaboration. Through interaction

between the participants and the challenge initiators continuous development takes place. This is in most cases supported by the company's administration team. The result is then a co-created product that has provided all members of the community with some type of value; customised/improved product, recognition within the community, or exposure and marketing.

Business
The business aspect related to OSD entails the business model needed to make OSD a viable and desirable option for product development. This includes resources, key partners, value proposition and so forth, which is mapped by using the Business Model Canvas [5,13]. Another important business aspect is the matter of licensing. The so called Creative Commons [6] provides a common framework for legally sharing and adapting tangible design while trademarks also play a very important part in capturing value. Furthermore, manufacturers, distributors and others, whose aim is to capture value and generate revenue, need to respect the community practices and settings.

Together these elements make up the fundamentals of the OSD practices, which will be used in the OSD Method and Strategy explained later.

OSD Archetypal Business Model
The four cases chosen for the project were analysed through the lenses of the previously mentioned Business Model Canvas [5,13] This has resulted in the identification of an OSD Archetypal Model presented in Figure 3.
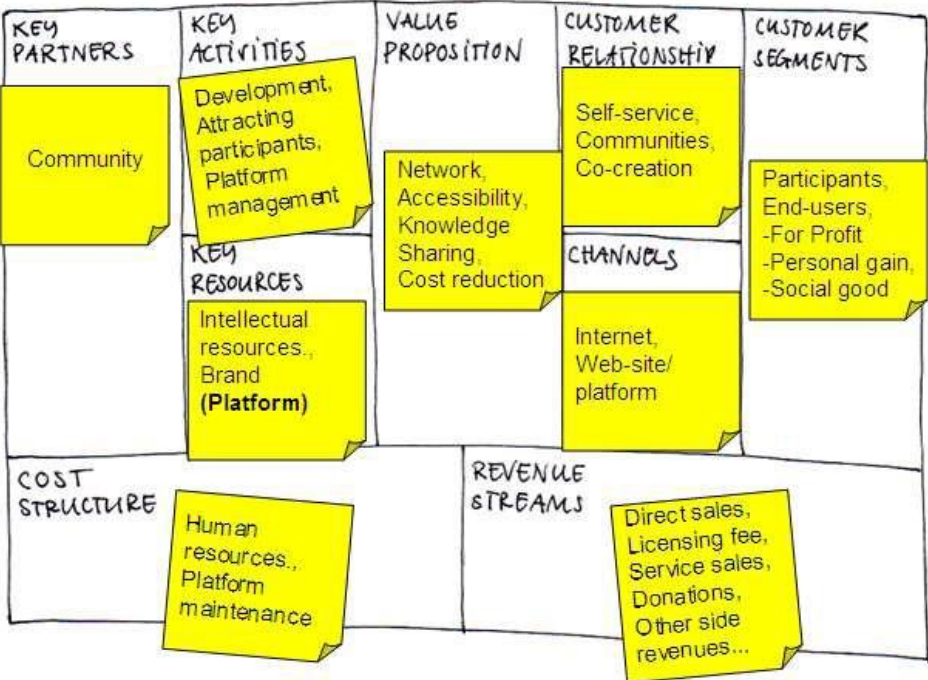

Figure 3: The OSD Archetypal Business Model

The OSD Archetypal Business Model displays the commonalities that have been identified with the four cases. It is clear that despite the difference in end-products (i.e. electronics, constructions, and societal solutions) the cases are built upon the same principles with operations and functions needed to utilise OSD practices generally being the same. The elements of most importance which to a large degree shape the business model are the

platform and the *community*. The platform is the core, as previously mentioned, and the community is the engine that drives the process.

Despite the resemblance in business models for these cases there is one segment that highly differs depending on the case; the revenue streams. There seems to be no rule of thumb as to where these companies generate revenue. These can range from direct product sales and licensing to consulting and donations. This is highly interesting since it differs from open source software where the primary revenue streams have most often included advertising and charging for advanced features [2]. It is here that a potential opportunity is presented in the form of new or improved business models, which will be further touched up on in the following section.

The OSD Method

Some *tools* have been gathered and created for the OSD Method which has two main objectives; namely to understand the current business environment of which the company interacts, and how to take proactive actions in order to grow, prosper and transform the market. These tools are divided into *As-Is Tools* and *To-Be Tools*. See figure 4 below:
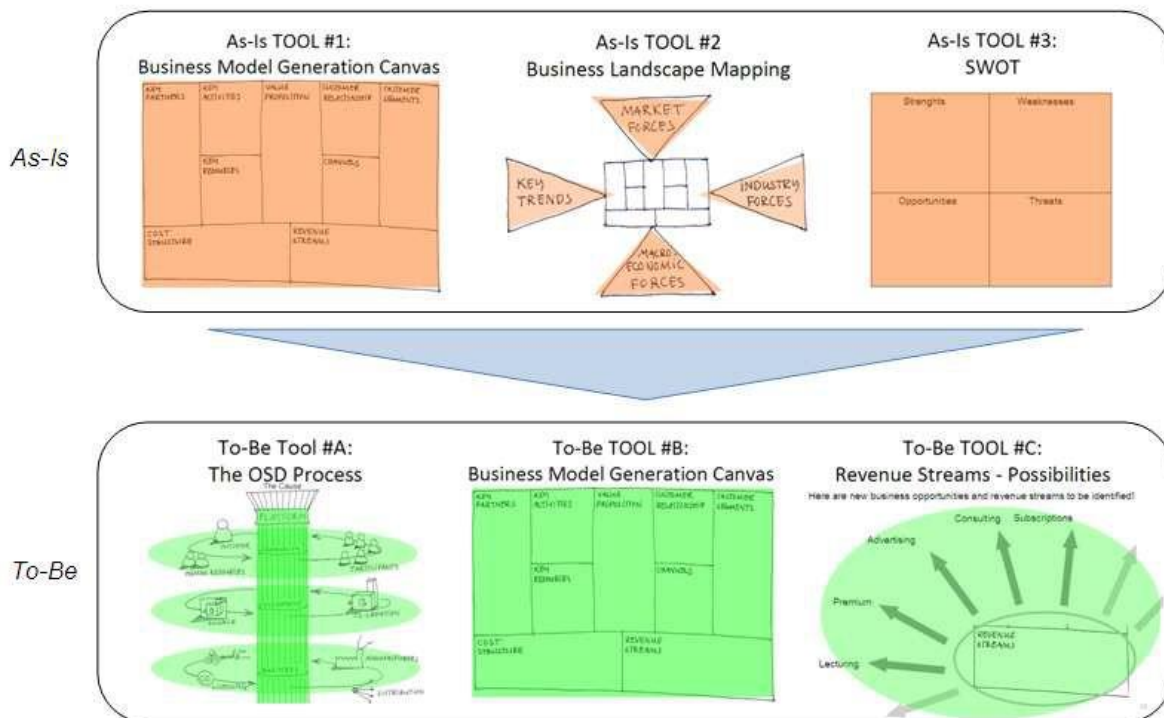

Figure 4:The OSD Method - The Tools for mapping As-Is situation of the business and transforming it To-Be Open Source Development Business.

The method starts off with using *As-Is Tool #1: The Business Model Canvas* [5] to map the business model in its current situation. In the case of a start-up company the canvas is used to map general business models in the environment which the company wishes to enter. Secondly, *As-Is Tool #2: Business Landscape Mapping* [13] is used to analyse the external environment of the company using four key drivers; market trends, industry factors, key trends and macro-economic forces. This is done to get an understanding of the environment and what challenges and opportunities it poses. To summarise on the first two elements of the method the *As-Is Tool #3: SWOT* [12] analysis is made.

When these three steps have been completed, an understanding of the inner and outer environment of the company should be obtained making it possible to continue into the To-Be phase, which starts with *Tool #A: The OSD Process* model described earlier. That model is used to identify how the findings from the previous three stages can be incorporated into OSD practices. Here the company is challenged to consider how the OSD community will be composed, how the development of the product will be conducted and what kind of business model they are willing to implement.

Having spun around the centre of the OSD process and touched upon elements that form the OSD strategy, the *To-Be Tool #B: Business Model Canvas* is filled out in a more systematic way resulting in a structured business model. The final step is to take *To-Be Tool #C: Revenue Streams* and test the different possibilities of revenue streams, such as consulting, premium, advertising, governmental contracting, subscriptions, in-house manufacturing and distributing, service sales and so forth, which then again will affect other blocks of the business model, resulting in an iterative process which may produce different versions of business models for a company to choose from.

OSD STRATEGY
The OSD method provides companies with the tools needed to lay the foundation for their OSD strategy. However, the method must also take into consideration some underlying aspects for success when determining their approach to OSD. What follows is a short description of these, namely the desired crowd, platform management, product characteristics, and OSD principles.

In terms of crowd it is important to be aware of what type of participants the OSD product would and should attract. There seems to be a direct link between the product that a company is offering and the composition of the community. Companies must therefore ask themselves what kind of product they are offering and how it can be adjusted and introduced to attract the 'right' OSD community. In continuum the platform is of great concern since it acts as a focal point and foundation for OSD. The platform must enable transparent communication between stakeholders, increase customer relations and support brand recognition. This requires responsiveness, management and support from administration which can result in a costly and time consuming process. Segmentation and delegation of tasks is therefore of great importance to achieve a functional communication platform.

In regards to the product at stake it must be *unfinished enough* [7] or have the potential of being further built upon, allowing multiple variations and customisation, depending on what requirements the participants and end-users have. Participants need to have access to information that empowers them to 'play' with the products and adapt it to their own ideas and needs. This information needs to be accessible through a self-serviced platform, where participants can figure out by themselves where, why and how to use the platform. Highly related to this are the principles that OSD is based on. Collaborating and co-creating tangible products requires a specific mentality based on respect, trust and credibility. This cannot be emphasized enough. Furthermore, businesses need to be aware of the power of the crowd and their sensibility towards businesses trying to reap benefits from their participation without being true to these OSD principles.

Conclusion

The research of OSD for tangible products has led to a clear definition of the term and the identification of an archetypal business model. Furthermore, a model of the OSD Process has been made and used to describe the fundamental elements needed for successful OSD approach. This has contributed to a clearer understanding of the emerging practice of OSD and created a foundation for further research. Additionally, a methodology has been suggested which relies on analytical tools to further shed light on the inner and outer environment of businesses, with the aim of generating an OSD Strategy best suited to their specific needs.

This has furthermore led to a conclusion that the area in most need of further research and consideration within the OSD Archetypal Business Model is the revenue streams. The lack of dominant revenue streams poses an interesting challenge for identifying where OSD businesses can capture most value and it allows for exploration of new and disruptive business model generation. It is the authors hope that further research and testing will provide a valuable input to this important aspect of OSD and furthermore that businesses will be encouraged to exploit this emerging approach. For now, current businesses utilising OSD of tangible products continue to prove their success by demonstrating the ability to transform their business models and outperform competition due to low cost of development, low sales prices and deep understanding of their customers and markets.

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