How Innovation Platforms Emerge: The Unity Video Game Engine

Abstract

With the increase of investments in innovation and R&D activities companies face the question of how to effectively conduct innovation. The development of new technological platforms allows companies to create value through new forms of collaboration (Swink, 2006), creating innovation platforms with large communities and increasingly growing networks of users, providers and end-consumers. Although, the concepts of innovation and digital platforms gains increasing attention from the scholars and practitioners, the question of how does these innovation platforms emerge still remains unanswered (Tilson et al., 2010). We build on the literature of platform architecture design and platform-based ecosystems (Hanseth & Lyytinen, 2010; Tiwana et al. 2010; Tiwana, 2014) to shed light on the mechanisms and dynamics of platform emergence. To articulate our research we conducted an exploratory case study (Yin, 2009; Seawright et al., 2008; Langley, 1999; Romano, 2003), analyzing the creation of the Unity video game engine platform. With the results of our analysis we contribute to the literature on platform architecture design and platform-based ecosystems by providing a deeper understanding of platform dynamics during the platform emergence phase identifying first the different stages of this process and second, identifying how the roles of the different actors change.

1. Introduction

The amount of money that companies spend on innovation and implementing mechanisms to optimize and foster such processes is constantly growing: in 2013 the 1000 Global Innovation companies spent $638 billion on R&D with a yearly growth rate of 5.8% (Booze&Co, 2013). Companies collaborate in innovation activities creating, for example,

platforms that can be seen as a form of collaboration in innovation and existing research has proved that cooperative innovation can bring such benefits as the reduction of the amount of time and workload, improving the development cycle time from 15 to 25%, reduction of product time-to-market by 15% and reduction of non-value-added work up to 60% (Swink, 2006). Given that digital platforms can facilitate the collaboration in innovation and can be a great source of value creation, they are capturing the attention of an increasing number of scholars and practitioners. However, from the existing literature it still remains unclear how innovation platforms emerge (Tilson et al., 2010).

Existing literature on the coevolution of design, governance and environmental dynamics of platform-centric ecosystems provide useful frameworks for building further understanding on platform-based ecosystems (Tiwana et al., 2010; Tiwana, 2014). Scholars have made progress in exploring the paradoxes of change and control for understanding the dynamic nature of digital platforms (Tilson et al., 2010; Yoo et al., 2010), studied the role of the architectural control points (Woodard, 2008) and the generation of value in platforms (Trossen & Fine, 2005). Some scholars also identified that innovation platforms are one of the most well established forms of open innovation and collaboration networks (Marais, Schutte, 2009). However, while all these literatures contribute with valuable insights for firms in multi-platform ecosystems and inter-company collaboration in innovation, they do not address the critical issue on how such innovation platforms emerge (Tilson et al., 2010).

We expect to extend prior literature on digital platform ecosystems (Tiwana et al., 2010; Tiwana, 2014) by describing the process of its genesis and bootstrapping, identifying the main actors that participate in that process and their roles on the different stages. We also

expect to contribute to the development of theory about the evolutionary dynamics in the information systems extending existing literature on the dynamic complexity in the design of Information Infrastructures (Hanseth & Lyytinen, 2010).

To ground our research we used an exploratory case study approach (Yin, 2009; Seawright et al., 2008; Langley, 1999; Romano, 2003) and studied the creation of the Unity video game engine platform, as one of the most distinctive examples of collaboration that allows us to illustrate and answer the calls from the academic world for further investigation of this phenomenon.

We structure our paper by firstly presenting in the literature review section the key concepts used for our study and describing existent research made on collaboration in innovation, innovation platforms, environmental dynamics, platform design and platform governance; then, we explain more in detail the methodology we used to extract all our findings; in the case results we present our findings; then in the discussion section we analyse our findings and present our contributions; and finally, we share our conclusions and indicate possible implications for practitioners acknowledge the limitations of our study and provide direction for further research.

2. Literature review

In order to explore how collaborative networks and innovation platforms emerge in Table 1 we first would like to familiarize the reader with some of the key concepts that we will be using through our research.

Table 1: *Key concepts summary*	
Innovation	Process to search, develop, improve, adapt and commercialize new products, processes, organizational structures and procedures, which is characterized by high levels of uncertainty and risk, continuous research, testing and experimentation (Dosi, 1998; Jorde, Teece, 1990)
Inter-company collaboration or cooperation	Any joint continuous activities conducted by a number of organizations within one or several industry sectors aimed at achieving common goals by combining these companies' resources at hand (Okamuro, 2007; Tuusjarvi, Moller, 2009)
Collaboration in innovation	Active participation of different actors in joint research projects with other actors or organizations from which partners may not receive immediate commercial benefit (Tether, 2002; Mention, 2011).
Digital platforms	Foundation technology or set of components used beyond a single firm that brings multiple parties together for a common purpose or to solve a common problem (Gawer and Cusumano, 2002)
Innovation platform	Type of platform that encourages innovation creation outside of the boundaries of the firm and establishes formal tools and processes providing a mean for external stakeholders to produce and share innovations (Piller, Walcher, 2006).
Platform emergence	Process formed and driven by platform bootstrapping and platform generativity dynamics that enable a platform to emerge.
Bootstrapping	Process which utilizes network effects and spillovers within a growing user base by using simple solutions as a sort of 'stunts,' which offer 'detours' on the road toward infrastructures (Aanestad and Hanseth, 2002), generating early growth through simplicity and usefulness of the platform and by promoting modular and generative platform designs (Hanseth & Lyytinen, 2010).
Generativity	Ability of any self-contained system to create, generate, or produce a new output, structure, or behavior without any input from the originator of the system (Tilson et al., 2010; Zittrain, 2006), forge new sociotechnical relationships and blur organizational boundaries, generating constant rivalries for creating new control points (Tilson et al., 2010).
Platform governance	Who makes what decisions about a platform, acknowledging that one of the main governance challenges is that a platform owner must retain enough control to ensure the integrity of the platform while relinquishing enough control to encourage innovation by the platform's module developers (Baldwin and Woodard, 2009; Tiwana et al., 2010).
Control over a platform	The formal and informal mechanisms implemented by a platform owner to encourage desirable behaviors by module developers, and vice versa (Tiwana et al., 2010)

We understand that when conducting **innovation** (Dosi, 1998; Jorde, Teece, 1990) companies engage in **inter-company collaboration or cooperation** (Okamuro, 2007; Tuusjarvi, Moller, 2009) and combining their resources to pursue innovation goals, **collaboration in innovation** takes place (Tether, 2002; Mention, 2011). Some scholars

identified that **digital platforms** (Gawer and Cusumano, 2002) as one of the most well established forms or as key mechanism of open innovation and collaboration networks (Piller, Walcher, 2006; Marais, Schutte, 2009). Therefore, focusing on **innovation platform** (Piller, Walcher, 2006) and the process of **platform emergence** we understand that this is driven by two dynamics that take place on a platform and that allow it to emerge: first, the platform bootstrapping and second, the platform generativity. For a platform, in order to emerge we understand that it first needs to be launched or to **bootstrap** (Aanestad and Hanseth, 2002) and once the platform has bootstrapped, its inherent scalability and flexibility might foster growth in scale and scope developing new combinations of services and capabilities, referring to this trend as platform **generativity** (Tilson et al., 2010; Zittrain, 2006). At the same time, there are different actors that can influence the bootstrapping and generative dynamics of a platform, including consumers, suppliers and distributors among others (Ford, Johnsen, 2001; De Propris, 2002; Athaide, Klink, 2009; Inemek, Matthyssens, 2013). Other stakeholders might also contribute to the collaborative innovation on the platform and its development, and be occasional or permanent actors (Hagedoorn, 1994, Tether, 2002; Belderbos, R., Carree, M., & Lokshin, B. 2004; Nieto, Santamaria, 2007; Corsaro, Cantu, Tunisini, 2012).

In order to manage the relationships between the different actors and, overall, the relation between platform users and platform owners, digital platforms have **platform governance** (Baldwin and Woodard, 2009; Tiwana et al., 2010) and one of the elements to implement such governance is to exert **control** (Tiwana et al., 2010; Herzhoff, 2011; Herzhoff, Elaluf-Calderwood, & Sørensen, 2010) over a platform. Usually it is the platform owner that can directly or indirectly shape the generativity of the ecosystem and the antagonist can be a

regulator, an intellectual property owner, or another platform owner (Eaton, Elaluf-Calderwood, Sørensen, & Yoo, 2011). One of the main challenges in a platform-based ecosystem is to continuously engage in balancing control and generativity, ensuring an appropriate balance between stability and change, and this paradox of change refers to the concurrent need of a stable and controlled foundation to enroll new artifacts, processes and actors in the development, and flexibility for unbounded growth of the ecosystem (Tilson et al., 2010).

Existing research has shown that innovation can be seen as a cumulative result of collaborative innovative process between company and its environment, or between different actors within and beyond one organization (Mention, 2011), as it is described in the simultaneous model of the nature of innovation (Jorde & Teece, 1990). In the simultaneous model the emphasis is placed on the relationships and mechanisms for ongoing feedback loops between the various market agents, underlining the significance of the internal and external cooperation (Jorde & Teece, 1990; Teece, 1992; Chesbrough, 2006; Erbes, Robert and Yoguel, 2010) and the importance of establishing and maintaining strategic relationships and alliances (Ulaga & Eggert, 2005; Westerlund, Rajala, 2010), so companies create platforms for the communities of users, customers and developers in order to achieve innovativeness improvement (Foss et al., 2011; Foss et al., 2013; Colombo et. al, 2013).

The existing research on open innovation analyzed cooperation in innovation with external sources at the phases of obtaining, integrating and commercializing of the innovation along with the emphasize on the interaction stage (West, Bogers, 2013). This stream of research considers platforms as an enabling or filtering mechanism for innovation obtaining (Piller,

Walcher, 2006; West, Bogers, 2013) and feedback, co-creation and communities as the elements of the interaction (West, Bogers, 2013). Existing research also investigated the linkage between network structure (Colombo et al., 2011) like the number of networks competing to develop a product and the number of alternative technology platforms (Amaldoss, Rapoport, 2005), network competences and network location (Chiu, 2009).

On the other hand, existing literature on platforms (Gawer, 2006) and platform architecture has made progress in exploring the role of platform governance through the paradoxes of change and control for understanding the dynamic nature of digital platforms (Tilson et al., 2010; Yoo, Henfridsson, & Lyytinen, 2010; Tilson, Sørensen, & Lyytinen, 2012). Platform governance have been studied as well from the perspective of architectural control points (Woodard, 2008), the generation of value (Trossen & Fine, 2005) or as elements that can migrate value from one layer to another in layered ecosystems (Woodard et al., 2013) while other scholars presented empirical evidence on how different approaches to open a system might influence the rate of innovation (Boudreau, 2010) providing conceptual frameworks for understanding multi-sided platforms (Boudreau & Haigu, 2009). Other scholars has focused on a variety of aspects of platforms and platform innovation (Eaton et al., 2011; Gawer, 2009; Gawer and Cusumano, 2012; Ghazawneh and Henfridsson, 2010, 2013; Hanseth and Lyytinen, 2010; Herzhoff, 2011; Herzhoff et al., 2010; Monteiro, 1998; Zittrain, 2006, 2009) and shed light on the relationships between platforms and the systems in which they are embedded (Baldwin and Woodard, 2009).

Some scholars conducted research on innovation research focusing on networks of heterogeneous actors (Tuomi 2002, Van de Ven 2005) and existing research showed that increased network diversity promotes new combinations, fosters learning, and enables

faster diffusion (Tuomi 2002; Brown and Duguid 2000, von Hippel, 2005). However, other scholars have also pointed that such networks can also limit their spread because of increasing boundaries (Ferlie, 2005) as collaboration in innovation can be bounded by a set of different factors such as: physical and temporal; organizational and hierarchical; relational barriers; or knowledge barriers (Swink, 2006). Although all these scholars have made valuable contributions to the existing research on platforms and collaboration in innovation, there is still a need to build further understanding on how innovation platforms emerge (Tilson et al., 2010).

Existing literature on the coevolution of design, governance and environmental dynamics of platform-centric ecosystems provide useful frameworks for building further understanding on platform-based ecosystems (Tiwana et al., 2010; Tiwana, 2014) and further contribute to the development of theory about the evolutionary dynamics in the information systems. At the same time, existing literature on the dynamic complexity in the design of Information Infrastructures (IIs) provide us the necessary lenses to build further understanding on the evolutionary dynamics of IIs. We use a theoretical framework that helps to understand the tensions between two main design problems: the **bootstrap problem** understood as the need of the IIs to meet early users' needs in order to be started, and the **adaptability problem** understood as the need of local designs to recognize II's unbounded scale and functional uncertainty (Hanseth, Lyytinen, 2010).

3. Methodology

The empirical data for this paper was collected from a contested generative digital platform case (Yin, 2009; Seawright, Gerring, 2008). For the purposes of this research we identified

the extreme case by the criteria of whether the main characteristics of innovation platforms were implemented from the beginning and thus determined the success of the company and whether the company's mission expressed the ideas stated in the theoretical section of this paper as well as the level of its realization. That is how we choose the case of Unity Technology as one of the outstanding examples of creation of a platform used by millions of users all over the world.

We considered a case from the software video game industry for several reasons. First, understanding the video game industry as the unit of analysis, the main actors can be clearly identified and represented according to their platform governance roles, which allows observing systematically how their decisions affect the platform's architecture and platform's generativity. Second, the design moves that affect the platform's architecture are observable, displayed through discrete changes and can be traced over time. Third, the amount of publicly available and accessible sources allowed capturing rich historical context information and objective data (e.g. annual reports, financial statements) allowing a deep understanding of the industry and the platform governance dynamics. Considering the changes that happened in the industry over longitudinal periods of time allows isolating specific events where the introduction of architectural design decisions can be observed, enabling the temporal decomposition (Langley, 1999). To face the methodological challenge of collecting historical data (Table 2) and to allow for a limited amount of rigor to be applied, the analysis of the collected data was done iteratively, through different stages and following the elicitation, reduction, visualization approach (Romano, 2003).

Table 2: Data sources	**Number of records**
Hours of video records of conferences and presentations	7
Documents, press releases, briefings	47
Number of interviews	17
Hours of interviews	5

4. Case results

Unity is a company that was established in 2004 as a result of unsuccessful launch of a video game: the founders were trying to exploit the video game engine and tools used. Their main value proposition was focused on providing a quality game engine by affordable price that could be used by all. Unity mission was concentrated on democratization of game development by providing tools and mechanisms ("*technological tools of collaboration*"[1]) for game development. Therefore, Unity game engine directly falls into the definition of platform used in this research by implementing platform characteristics in the core of its functioning. It was already in year 2004 when three young programmers, David Helgason, Nicholas Francis and Joachim Ante, without much money, started coding what they expected to be their first game – the GooBall, a game about an alien stranded on Earth that had to roll around, collecting gems and making his way to the end gate. At that moment in time, when Helgason and his colleagues started to work on their project in Copenhagen, Denmark, they were facing a pretty closed game industry:

> *"At one point in time, every game company in the world had their own proprietary technology - which made a lot of sense in a more constrained world where device memory was low by today's standards. Game engines, in their natural state, were little more than minimal scaffolding around a particular game." (D. Helgason)*

[1] David Helgason, CEO of Unity Technologies

To accomplish their aim of building their video game they started to develop their own game engine. The three programmers were very engaged and after passing through some economic difficulties, they managed to release in 2005 the GooBall game, together with the Unity game engine pre-release, launching it in March of 2005. In June of the same year the first commercial version of the Unity game engine was officially released at Apple's Worldwide Developers Conference and included a full graphics engine and game physics/scripting system. At launch, Unity was developed specifically for Mac OS X and could produce only games for Mac. The game engine was made available in two versions - the Unity Pro and the Unity Indie, and by that moment in time was already used to produce games, including their own GooBall that was published for Mac by Ambrosia Software, and in the Parsons School of Design in New York. As Helgason shared through different interviews, that the idea of his team was to provide a platform that could help small developers to enter into the video game industry:

> *"We have always wanted to change the way the game industry looks today where it requires a ridiculous amount of money to make PC and Mac games. With the release of version 1.0.2 of Unity, our flagship product is finally ready for the mass market…" (D. Helgason, 2005)*

> *"When we released Unity 1.0 back in 2005, we didn't even dream numbers like that, but simply started by trying to be a great tool for the few hundred customers who adopted Unity" (D. Helgason, 2012)*

Soon after its release Unity included support for Windows PC and Web browsers by releasing Unity 1.1 and among other features, included a new C/C++ plug-in SDK[2] that

[2] Software Development Kit

enabled to interface with any hardware or software that Unity could not support out of the box by that time. Additionally, Unity implemented support for asynchronous internet access through an API as well. The rationale behind was to provide creative teams the tools that could enable them to develop and collaborate together:

> *"What the casual revolution needs most is not huge art teams, but creative individuals with clever, different, wacky ideas. With Unity, creative teams can develop on their beloved Macs with the best workflow and tools available on the market" (D. Helgason, 2005)*

In 2006, one year later, the game engine was nominated for the Apple design awards in the category "Best OS X Graphics" and in August Freeverse Software, a game development studio, announced that they were going to use Unity to develop their games as no alternatives to what Unity was proposing were available on the market.

> *"We have started using Unity for two of our future games, and expect more to follow. We can create games for multiple platforms that include the latest bells-and-whistles and rock-solid gameplay. No alternatives to Unity exist on the market today." (Colin Lynch Smith, the vice-president of Freeverse, 2006)*

By 2008, Unity expanded to a dozen of employees as their game engine became more sophisticated but, at the same time, its software sales were already covering its development costs. It was also in mid-2008 when Unity reached a turning point, when Apple unveiled the iPhone App Store and Unity, quickly reacting to that, was the first game engine to support the iPhone.

> *"We rushed and managed to support the iPhone, the first game engine to do that in late 2008 (…) It happened really quickly. Suddenly, a lot of people wanted Unity." (D. Helgason, 2013)*

Being the first to provide support for the development of games for the iPhone Unity became even more popular across its community and very soon more significant advances for the platform happened. Also in 2008, the Cartoon Network used Unity3D to create FusionFall, a MMORPG that has been played by more than 8 million people. But it was not only small and medium game developers who started using Unity, other companies, such as Electronic Arts used Unity3D as well in 2009 to make Tiger Woods PGA Tour Online, and even other large companies from the video game industry, like Microsoft and Ubisoft, became Unity customers, fueling even more the rapid growth of Unity's customer base.

While all this was happening and the Unity users community was growing, a new market started to emerge around the Unity platform, where open source libraries, individual assets and other features created by Unity users were traded. Seeing this trend, in 2010 together with the release of the version 3.1 of the platform, Unity announced the launch of their own marketplace, called the Unity Asset Store, providing developers the opportunity to exchange and trade their assets developed for the Unity game engine through their platform. The store included already 70 'products' at the moment of its launch and allowed developers to sell and buy assets from each other.

> *"We noticed that users were already building business like this themselves (…) Unity Asset Store is a platform for sharing and trading between users, and it's a pretty wild piece of software" (D. Helgason, 2010)*

The form and logic of the Unity Asset Store appeared to be similar to the App Store and Unity offered a 70/30 per cent revenue share to those developers who decided to sell their assets on the store, although some items on the store were also offered for free. As David Helgason shared, one of the reasons to launch the Unity Asset Store was not only the growing complexity of the game development industry and its fast growth, but also to provide individual developers a way to monetize their skills, through a collaborative platform:

> *"Even after we made the Unity tools as simple as we've made them, game development is inherently hard (…) But by launching the Unity Asset Store, we're giving developers a way to easily combine their work with that of others, making game development easier than ever before. Because Unity is so widely used inside and outside of the game industry, it is becoming a standard around which developers collaborate, learn, recruit and share and trade assets (…) And not least, individual developers can now monetize their skills in an entirely new way!" (D. Helgason)*

5. Discussion

We observed that one of the antecedents for platform emergence is that at the beginning there should be a product with certain degree of innovation. In the case of Unity we observed that, indeed, the creation of the game engine was the spillover of game creation process. The development of the game engine was initially designed and executed in order to be ready for direct use, in this case Unity's creators as game developers at that moment. Since these first users where already in a position to start providing feedback to the Unity developers on what other features they were missing in the very first, bootstrapping version of the game engine, at that moment in time we observed the first platform feedback loops appearing. This finding is in line with the existing literature concerning platform design

principles. We observed that at the early stages of platform emergence collaboration with other actors was not as important for the successful launch of the platform as the presence of the antecedent in the form of similarity in needs along with the willingness and intent of the platform owner to further adopt and improve initial product.

Building on the previous section, it worth also noting that for these first users it was key feature that the game engine that Unity was providing to them could enable building games and applications that could meet the expectations and needs of their own final customers, such as game players, or other companies who subcontracted 3rd party developers to create games for them. This finding signals the existence of a second crown of customers that, although not using the Unity game engine directly, still had an impact on the design of the Unity game engine architecture, as without meeting the final needs of the customers from the 2nd crown, the 3rd party game developers from the first crown would not have had the incentive the use the game engine to develop their games. This is a contribution to the existing literature on architecture design principles as it refines the concept of users suggesting the existence of a first and second crown users differentiation.

Our research showed that as the Unity platform kept growing, on one hand increasing the number of features that the platform core could offer and, on the other hand, in terms of the number of users who started using the Unity game engine, new dynamics started to emerge around the platform. We observed that one of the dynamics that appeared to have a significant impact on the further development of the platform was the appearance of a secondary market, created by Unity's users, on which different modules and plug-ins for the platform were traded. In our findings we detected that this secondary market appeared

on its own, without any intent or control from the platform owner. Moreover, our findings indicate that providing SDKs and APIs to 3rd party (as platform control points) enabled the existence of such market, providing evidence on how the introduction of certain control points by the platform owner could also lead to the creation of such secondary markets.

We believe that the emergence of a secondary market can be motivated by the existence of network effects, thus providing the evidence of the platform generativity, and being something that we observed in our findings. Moreover, after analyzing the nature of the secondary market on which Unity users exchanged and traded their assets we identified that it appears to be a necessary condition for a platform to have a modular architecture design and the creation of certain "inbound/outbound" control points to allow such markets to exist. This finding extends the existing literature on platform governance as it refines the concept of control point. In this case we also identified that creation of this control points (in the form of Unity Asset Store) on an early stage of development of the secondary market appeared to be key, as the secondary market did not have the chance to develop enough and to become a significant threat for Unity's possibilities to capture the value generated around its platform.

6. Conclusion

Establishing collaboration networks and innovation platform can become a challenging endeavor due to the high degree of uncertainty perceived by the platform owner concerning the possible platform dynamics that might take place in such attempt. Conducting our research on the Unity game engine and studying its evolution since the moment of its birth until its maturity we observed how different these platform dynamics can be depending on

the stage of development of the platform. We realized that during the first stages of the platform emergence if the platform owners overlook, already at the moment of its release, the need of adapting their platform core to the needs and requirements of the platform's first customers, then it might become even more challenging to bootstrap it. From our findings this seems to be true for those cases when the platform creators do not expect themselves to become their first consumer. In order to avoid such situation it might be useful to establish some sort of mechanisms that could provide feedback loops to the platform owner, facilitating collection of this very valuable information that could foster the adaptability and adoption of the platform.

Among other limitations, we would like to acknowledge the fact that we have used for our findings only one extreme case of platform creation, understanding the fact that our observations cannot be generalized or ported to other cases in which the context might be different. However, it was not our intend to provide any normative judgements concerning the path that an incipient platform owner should follow, but to illustrate and provide a better understanding about what dynamics might arise during such process. With our findings and contributions we hope to provide practitioners with some valuable insights to evaluate and assess platform deployment strategies, thus ensuring a more rational use of resources.

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