Who Inhabits a Business Ecosystem? The Technospecies as a Unifying Concept

Michael L. Weber and Michael J. Hine

> *For evolution is not only substitution of independent components; it is also integration of the components to form adaptively coherent systems.*
>
> Theodosius Dobzhansky (1900–1975)
> Evolutionary biologist
> In "Mendelism, Darwinism, and Evolutionism" (1965)

Currently, many terms are used to describe business ecosystems and their inhabitants. These terms have meanings that can cause definitional confusion and an ambiguous level of analysis as to what constitutes a business ecosystem. To understand business ecosystem relationships, an unambiguous understanding of the ecosystem components is required. The importance of standardized terminology and clear definitions of these components has been recognized in the literature. From a managerial perspective, identifying the relationships a firm is situated in is valuable and useful information that can be practically applied. We propose a business ecosystem model anchored around interdependent technospecies similar to the biological model that many of the existing concepts are drawn from. Technospecies are unique entities based on their organizational routines, capabilities, and use of technology. This article will present an alternative formulation of the business ecosystem model with the aim of synthesizing the diverse terminology presently in use into a concise, common language.

Introduction

Natural ecosystems provide a powerful metaphor to aid in understanding business ecosystems given that both consist of inhabitants with different characteristics and interests, joined together by diverse mutual relationships (Corallo & Protopapa, 2007). Analogous to the supply chain concept, business ecosystems focus on the connections and interrelationships between firms (Moore, 1993; Bailetti, 2008; Carbone, 2009; Hurley, 2009; Adner, 2012; Muegge, 2013; Muegge & Haw, 2013) because organizations do not exist in isolation but depend upon the capabilities and resources of their ecosystem (Hakansson & Snehota, 1995). Unless a company is completely vertically integrated, it cannot successfully compete alone and thus requires relationships, interactions, and resources provided by the ecosystem (Rice & Hoppe, 2001).

Most previous research on business networks examines dyadic (or triadic) connections of network inhabitants and the consequences of particular network positions (Anderson et al., 1994). This focus does not identify or control for higher-order dependencies and influences that are typically present with inter-organizational systems (Moore, 1993, 2006; Peltoniemi & Vuori, 2005). Although research has made important contributions toward the understanding of business connections and structures (Hakansson & Ford, 2002; Iansiti & Levien, 2004a, 2004b; Kambil, 2008; Henneberg et al., 2010), a holistic understanding of business ecosystems is absent (Corallo & Protopapa, 2007; Li, 2009; Satsangi, 2012). Business ecosystems have been conceptualized as platforms (Muegge, 2013), multi-sided platforms (Iyer & Davenport, 2008; Bailetti & Bot, 2013), communities (Carbone, 2009; Muegge, 2011), networks (Iansiti & Levien, 2004b; Corallo & Protopapa, 2007; Basole, 2009), value blueprints (Adner, 2012), and institutions and resource flows (Hearn & Pace, 2006; Muegge, 2011, 2013; Bailetti et al., 2013); these models are often viewed separately and studied independently even though a holistic view is required. Firms, government and regulatory agencies, non-governmental organizations, and open source platforms, among others, all interact (Hurley, 2009) and create value (Basole, 2009). It is thus important to understand and chart these interrelationships as each firm engages in an ongoing exchange with its environment, including other ecosystem inhabitants (Marin et al., 2008). In order to interact and engage effectively, a firm must be able to identify the members of the ecosystem(s) with which it interacts. Where a firm is situated in the ecosystem and the connections within that ecosystem are of primary concern to each business ecosystem inhabitant (Chesbrough, 2006; Moller & Rajala, 2007; Basole, 2009) and hence are of practical relevance to the managers of those firms.

Although business ecosystem research has matured and proliferated, advancement has been limited by different terminology and nomenclature and inconsistent usage of said terminology. To move forward in both academia and industry, the field requires standardized terminology so academic literature can be synthesized, compared, and applied to real managerial situations. This standardization would allow managers to make improved decisions and apply research findings based on a common understanding of the structure and organization of the business ecosystem (Bardawil, 2011). In turn, this standardization would allow managerial situations to more tightly link and thus influence academic undertakings (Astley & Zammuto, 1992). Without common terminology, research progress is difficult or impossible (Astley & Zammuto, 1992; Shoemaker et al., 2004) and whatever results are derived are difficult to transmit to management as message content degrades as it is passed from the business to academic realms and vice versa (Ortenblad, 2005). This article proposes a new model of business ecosystems with the potential to unify the multiple current business ecosystem perspectives using standardized and consistent terminology.

The remainder of this article is organized as follows. First, current views of business ecosystems are presented. Next, we expand on the biological species metaphor to introduce the new technospecies construct that forms the foundation of our business ecosystem model presented in the third section. The description of the model is followed by conclusions, research and managerial implications, and future research directions.

Business Ecosystems

Moore (1996) defined a business ecosystem as: "…a foundation of interacting organizations and individuals – the organisms of the business world." To date, there is no clear definition for these organisms with the literature focusing on dyadic, triadic, or limited network interactions when discussing business ecosystems. Although widespread interaction and resource sharing are recognized as existing in a business ecosystem (Bailetti, 2008), the terminology describing these interactions continues to be drawn, primarily, from the industrial and organizational behaviour literatures and resource-based views (Wernerfelt, 1984). A common theme in that literature is goal-directed behaviour, that a business ecosystem can be "organized" around a platform (keystone) and managed based on the limited interactions arising from the resulting connections (Holling, 2001; Gunderson & Holling, 2002). For example, keystones such as Microsoft, Apple, Wal-Mart, and Mozilla provide platforms to their ecosystems allowing value creation both for themselves and for other ecosystem members (Moore, 1993, 2006; Cusumano & Gower, 2002, Iansiti & Levien, 2004b, Tiwana et al., 2010).

Peltoniemi and Vuori (2005) state that a business ecosystem is a socioeconomic system where its population develops through coevolution with the environment resulting in self-organization and emergence (i.e., the ability and process to create new order), and adaptation to the environment. An ecosystem is therefore a complex adaptive system that is more than the sum of its parts and cannot be understood except by considering the entirety of the ecosystem rather than a limited number of connections. The concept of the Internet of Things represents a network of connections including people–people, people–things, and things–things via the Internet allowing virtually unlimited connections (Morgan, 2014; Westerlund et al., 2014) between all inhabitants of a business ecosystem, resulting in connections that may or may not be accessed.

Much of the business ecosystems literature is based on Moore's (1993, 1996, 2006) ecosystem perspective and has advanced definitions and operationalizations for limited domains. There has been much in the literature concerning platform architecture (Cusumano & Gower, 2002; Milinkovich, 2008), keystones (Heikkilä & Kuivaniemi, 2012), networks (Iansiti & Levien, 2004b; Greve et al., 2014), communities (Moore, 2011; Muegge, 2013) and ecosystems (Moore, 2006; Carbone, 2009). However, these bodies of knowledge are not well integrated, tend to be studied in isolation, and often diverge in approach depending upon the level of analysis (Muegge, 2011). The focus is frequently on a single actor, feature, or platform that, while providing depth of coverage, does not adequately address holistic ecosystem complexity. For example, Bailetti (2008) applied

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the ecosystem approach to the commercialization of technology products and services. Bailetti and Hudson (2009) adapted Moore's definition to include the use of a "community oriented out-of-the-box platform", and describe the Lead To Win ecosystem designed to create technology jobs and attract technology investment in a similar manner as keystones described by Iansiti and Levien (2004). Bailetti (2010a) recognized that any firm that is unable to envisage and understand the ecosystem in which it operates is at a significant disadvantage and uses the analogy of courtship to distinguish between a firm in an ecosystem as compared to a traditional setting (Bailetti, 2010b). Muegge (2011) further advances the concept by defining business ecosystems and resolving various existing perspectives in the literature by applying an institutional theory frame of reference to describe distributed innovation. Although the aforementioned works have been insightful and important in moving forward the concept and application of business ecosystems, the scope of this literature is primarily oriented toward technology and entrepreneurs, and the platform (or keystone) in a business ecosystem. A more general perspective would benefit this area specifically and the blossoming field of business ecosystems in general. Toward this goal, we adopt a more general view of business ecosystems by further connecting the business and biological perspectives.

Other work in business ecosystems has focused on ecosystem leaders (Moore, 1993), platform leaders (Cusumano & Gawer, 2002), or keystones (Iansiti & Levien, 2004a, 2004b) coexisting with other communities and individuals (Milinkovich, 2008; Muegge, 2013). These views follow on the description of a business ecosystem oriented around a hub or keystone by Iansiti and Levien (2004a, 2004b). Using this perspective, a business ecosystem does not necessarily align with a particular industry but may span different industries (e.g., Apple encompasses computer technology, consumer electronics, and information and communication technologies). The crucial factor driving the success of each business ecosystem is the ability of the keystone to provide a platform (i.e., tools, technologies, manufacturing processes, services, etc.) that other members of that ecosystem can leverage to add value to their product or service in a co-evolutionary process. Interactions may be either cooperative, competitive, or coopetive (Smith, 2013). In a business ecosystem, the capabilities of a firm co-evolve around innovations unique to that ecosystem.

Tian and colleagues (2008) define a business ecosystem as a: "…configuration of people, technology, shared information, and value propositions connecting internal and external service systems". This definition is closely related to the value chain and value network concept describing the tangible (e.g., goods, services, and revenue) and intangible (e.g., knowledge and intangible value) transactions between different organizations (Porter, 1980, 1985; Allee, 2000; Walters & Lancaster, 2000) and between organizations and customers (Prahalad & Ramaswamy, 2004). As such, there is reciprocal interdependence where "each node depends on adjoining nodes to perform its role…" (Hult et al., 2004). The implication of this statement is that each node (inhabitant) is connected to adjoining nodes in a network configuration, forming a business ecosystem. Currently, business ecosystems are considered to consist of platforms and communities having a multi-level, hierarchical system and an architecture of participation (Muegge, 2013). As ecosystems are considered to be self-organizing and scale-free, they consist of an interconnected, complex, assemblage of members having resource and information flows and some level of productivity where each ecosystem affects and is affected by the inhabitants of that ecosystem resulting in evolution or adaptation with emergence or emergent features.

However, the conceptualization of the ecosystem inhabitants varies with the area of research and individual researcher, especially concerning how the inhabitants are defined. This tendency is particularly apparent with the species concept borrowed from biology (Prendergast & Berthon, 2000), where the conceptualization within the business literature is quite different than the intention of the original and definitive intention of species. To date, most of the work on business ecosystems has resulted in definitions that vary by researcher, and thus there are differing levels of consistency with the biological definition. For example, multi-sided platforms are considered to bring together distinct but interdependent groups (Bailetti, 2010b; Evans et al., 2011) although exactly where the platform exists remains undefined (Haigu & Wright, 2011).

The Technospecies Construct

Species is a biological term used in many areas of the business literature, including: platforms (Kang & Downing, 2014), keystones species (Iansiti & Levien, 2004a, 2004b), organizational species (Gundlach, 2006; Lemos, 2009; Pagano, 2013), non-profit organizational species (Potter & Crawford, 2008), organizational species barrier (Gaba & Meyer, 2008), flagship species (Kim et al., 2010), leading species (Knight & Cavugil, 2004), ecosys-

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tem species (Guegen & Isckia, 2011), business owner species (Bruhn, 2013), business species diversity (Wright et al., 2009), and endangered (business) species (Cooke, 2000). Although the word is used in the business literature with similar connotation to the biological term (Prendergast & Berthon, 2000) – that of a distinct population of organisms – business species and biological species are very different. In biology, species is the main natural taxonomic unit and is defined as a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding (Lawrence, 2005), and is usually based on genetic (DNA) similarity (Mayr, 1963). For business ecosystem usage, the biological definition of species is restrictive because a species may only mate with members of its own species. Although firms and organizations do not have DNA or genes, it has been argued that organizational routines are the equivalent of genes (Nelson & Winter, 1982).

Nelson and Winter (1982) adopted Darwinian concepts (e.g., variation, replication, and selection) and proposed that evolution occurred at a higher level than individual genes and involved the replication and selection of routines. Organizational routines may be viewed from an evolutionary perspective based on these general Darwinian principles (Hodgson & Knudsen, 2004). This perspective implies that routines are collective-level (i.e., organization-level) constructs that embody prior learning and are selected for by some mechanism. In evolutionary economics, organizational routines and capabilities are of central importance (Felin & Foss, 2004) because they provide the fundamental unit of analysis (Becker, 2004) in the sense of their being the micro-unit of analysis and that they directly link with the evolutionary triad of variation (of routines across a population of firms), selection (based on routine fitness relative to the environment), and heredity (routines being the social equivalent of genes) (Nelson & Winter, 1982). However, routines have also been viewed as generative and as a source of continuous change (Feldman, 2000; Pentland et al., 2011). Feldman and Pentland (2003) suggest the generation of endogenous change as a result of carrying out the organizational routine. By definition, routines involve repetitive or recurrent patterns of action, although each repetition will have observable differences. This observation has been referred to as the "paradox of the (n)ever changing world" (Birnholtz et al., 2007). Each repetition of a routine varies due to improvisation or error; increasing numbers of repetitions create more variation and opportunity for change (Tsoukas & Chia, 2002) similar to the manner in which mutation occurs in DNA. Routines may be considered a particular firm's way of doing things, for example the business model of a firm (Westerlund et al., 2014).

Routines and capabilities differ (Teece et al., 1997; Teece, 2011). Nelson and Winter (1982) see capabilities as at a higher level than routines, although there is some overlap (Dosi et al., 2000). A capability has a recognizable purpose expressed in terms of the outcome that capability enables due to conscious strategic deployment (Felin & Foss, 2004). Capabilities, or processes, are sets of actions that repeat over time and are used to accomplish some business purpose (e.g., product development, acquisition, marketing) (Pentland & Rueter, 1994; Teece et al., 1997; Miner et al., 2001; Ray et al., 2004; Teece, 2011). Organizational routines are a key independent variable in organizational performance research and are the foundation for organizational capabilities (Becker, 2004) bridging the economics and evolutionary literature for organizations (Felin & Foss, 2004; 2009). Organizational routines and capabilities therefore relate to strategic management performance and firm heterogeneity (Nelson & Winter, 1982; Barney, 1991), specifically the core competencies of the organization (Prahalad & Hamel, 1990; Helfat et al., 2007). Organizational routines can be considered as the equivalent of genes with the totality of capabilities representing the genome (Bruderer & Singh, 1996); ultimately, both characterize the phenotype (Figure 1).

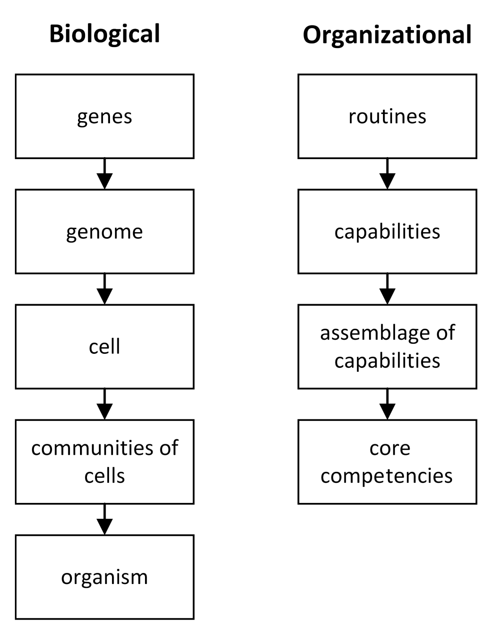

Figure 1. Comparison of biological and organizational entities

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Different organizations may have similar routines but unique interactions of routines, capabilities, and technology. Routines may be similar in outcome but expressed in a completely different way due to the facilitating technology. For example, consider the difference between a manual billing system using paper invoices mailed to the customer and the electronic billing system used by PayPal. Each routine enables a billing capability that has the same goal and outcome but is accomplished differently.

The nature of organizational evolution differs from that of biological organisms due to learning for routines (Nelson & Winter, 1982; Zollo & Winter, 2002). The attempt to adapt evolutionary theory as a metaphor for explaining the business perspective is limited by the lack of unit analysis for the evolutionary process, similar to the gene in biological evolution (Corallo & Protopapa, 2007). For biological organisms, evolution is fundamentally genealogical and based ultimately on the propagation of genes and, for a few species, social learning along lines of descent (Heyes, 1994; Whiten et al., 1999; Laland, 2004).

As with biological organisms, the appearance of novel organizational forms requires an innovation; for business organizations, this innovation is often technological, and disruptive, in nature (Christensen, 1997; Markides, 2005), affecting the routines and capabilities of the firm. However, organizations do not reproduce in the same manner as biological organisms; organizational evolution is thought to begin with the appearance of a new form and end with the disappearance, or transformation to another form, of that variant (Corallo & Protopapa, 2007). This view has created a problem in the application of evolutionary theory to business processes, and some confusion as to the usage of the word "species". Given that there are significant differences between biological species and business species, a distinction would be helpful in order to distinguish between the two forms and to properly define species in the business context.

To distinguish the meaning of species between the biology and business domains, we suggest the addition of the prefix "techno" to differentiate a business species from a biological species. The prefix "techno" is from the Greek *techne*, meaning art, science, or skill and is related to the Greek *technikos,* meaning art, artifice and weave, build, or join. The most common form of this word is "technology", meaning:

> *"The purposeful application of information in the design, production, and utilization of goods and services, and in the organization of human activities" (Business Dictionary, 2015).*

Given that "techno" relates to the use of technology by humans or social organizations, this prefix can be applied to the root word "species", yielding technospecies, referring to an organizational, human construct rather than the biological species describing an extinct or extant biological organism. Only one use of the word technospecies occurs in the literature. Kurylowicz and Gyllenberg (1989) use the term in reference to a genetically engineered, man-made species of *Streptomycetes*. Thus, there is unlikely to be any definitional confusion in the use of the word technospecies, unlike the current situation for species, which requires an adjective to indicate a business species.

Replacing the word species with technospecies for business usage would benefit two areas in business research. First, it will distinguish a business species from a biological species and hence reduce the current definitional confusion in the literature concerning the use of the word species. Second, given that the species definition in biology is restrictive in terms of reproductive and evolutionary processes, – a species may only mate with members of its own species – using technospecies will remove this constraint as it does not hold for business species able to recombine into diverse hybrid forms (Nelson, 2007; Reydon & Scholz, 2009). In a manner similar to biological species, technospecies could exchange routines resulting in genetically different offspring. This view would permit a unique evolutionary assessment of organizations following on the combination of organizational routines and capabilities (Nelson & Winter, 1982; Becker, 2004) and technology that would more resemble the gene-based Darwinian evolutionary model acting on populations of organisms.

Each technospecies is uniquely defined by its routines, which enable capabilities. A technospecies evolves in response to interactions with other technospecies, each of which is also affected by the set of technospecies they interact with. This process is known as diffuse co-evolution (Thompson, 1999) and is also expected to be true for social ecosystems such as a business ecosystem. Analogous to the natural unit of classification in biology (species), technospecies could form the unit of classification for business ecosystems. This would al-

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low technospecies to be typed according to routines and capabilities in a similar manner to genome sequencing for biological organisms. In summary, we define technospecies as:

> *An organizational form consisting of a distinct combination of routines expressed as capabilities that combined with technology encompass the core competencies of that technospecies.*

Technospecies would have the capability of exchanging (mating) the organizational equivalent of DNA (routines) with other technospecies. As with biological organisms, this exchange would result in a novel genome and a new (evolved) technospecies.

Technospecies in a Business Ecosystem

The prevailing view of business ecosystems is that they are dominated by one or more keystones (Iansiti & Levien, 2004a, 2004b; Bailetti, 2010c; Weiss, 2010) utilizing a unique technology or platform to create value in a connected network with distinct boundaries and based on a single product, service, or technology. However, ecosystem boundaries often transcend a single industry (Makinen & Dedehayir, 2012). Examples of boundary spanning ecosystems are: the mobile phone ecosystem (Basole, 2009), the Internet ecosystem (Zacharakis et al., 2003, Nehf, 2007, Javalgi et al. 2005), the microprocessor ecosystem (Garnsey et al., 2008), the biopharmaceutical ecosystem (Garnsey & Leong, 2008), Amazon's web service ecosystem (Isckia, 2009), Google's ecosystem (Iyer & Davenport, 2008), Cisco's business ecosystem (Li, 2009), and the rental car ecosystem (Pierce, 2009). Taking the mobile phone ecosystem as an example, current superphone products by Samsung, Sony, Apple, etc. now span multiple industries including cable, Internet, gaming, media, entertainment, photography, and fitness with integrated and complementary products and services. Value is created across boundaries that are increasingly indistinct but tied to a central platform in a business ecosystem.

With the escalating use of information technology (IT) forming a digital business ecosystem emphasizing technological connectedness (e.g., Alibaba.com) what constitutes a business ecosystem should be reconsidered (Tan et al., 2009; Bharadwaj et al., 2013). The current view is of a group of cooperating or competing firms; our conception is that a business ecosystem consists of an interconnected assemblage of technospecies and additional members (Heikkilä & Kuivaniemi, 2012; Makinen & Dedehayir, 2012). This view requires that the boundaries of a business ecosystem be reassessed because they are less distinct than is suggested by the current literature.

The boundaries of the firm cross a variety of industry boundaries (Moore, 1993, 2006) and extend into multiple ecosystems (Iansiti & Levien, 2004b). However, the common conception is that a firm exists in a single business ecosystem, a model that is poorly understood and conceptualized. What constitutes the boundaries of a business ecosystem should be extended in order to account for all technospecies and other inhabitants of that ecosystem. Synthesizing the features of such a system from Muegge (2013), and using the technospecies and business perspective, results in the proposed definition:

> *A business ecosystem is an adaptive system positioned around a platform encompassing the totality of co-evolved interactions between technospecies and other inhabitants, required to design, improve, produce, deliver, or market a product or service.*

Although in most instances the processes required to produce, market, and deliver a product or service are similar, the interactions will be specific to each business ecosystem for that product or service. For example, the process differences between the manufacturing of a landline telephone and a cellular telephone are immediately evident. Thus, the ecosystem for these two firms would also be noticeably different. More similar products would be expected to have more similar ecosystems, although different firms manufacturing the same product would also be expected to have different relationships, resulting in different ecosystem boundaries even though they exist in a business ecosystem centred around the same platform or keystone.

We propose that a business ecosystem is predominantly comprised of a population of technospecies (with each having a unique combination of routines, capabilities, and access to resources). A technospecies may control (i.e., as a keystone) or utilize (i.e., as a complementor) a technology with value creation arising from a combination of the technology and the other resources available in the business ecosystem environment. The focal firm (keystone technospecies) controls the platform technology that is shared within that ecosystem supporting the value chain. Each uses this technology in a complementary manner to create value across the ecosystem (Iansiti & Levien, 2004b; Adner, 2006; Muegge, 2013). An example instantiation of a business ecosystem model in the context of the Adobe Flash platform is presented in Figure 2. Although there may be more than one keystone in a business ecosystem (Weiss, 2010), only one is presented here for simplicity. In our example, we have listed some of the complementary technospecies for the Adobe Flash ecosystem but the list is not comprehensive.

Adobe is a keystone technospecies based on control of the Flash technology platform. Flash was originally developed by Macromedia using the routines and capabilities of that firm. Other technospecies in this ecosystem (e.g., Google, Mozilla) will assemble a unique set of routines, capabilities, and resources enabling those firms to leverage the platform technology in the ecosystem. External and internal resources, including other forms of technology, may be available to members of the ecosystem (Conner & Prahalad, 1996). Google and Mozilla incorporate Adobe Flash Player for web browsers to enable clients and customers to view content based on their business models and capabilities, search engine, and web browser, respectively. Ecosystem resources (e.g., wireless technology infrastructure, web services, cloud technology) enable interaction throughout this ecosystem. The unique combination of individual routines, capabilities, and the platform technology define each technospecies in the same way that DNA is unique to organismal species. This unique combination for each technospecies could be considered to be the internal platform of that technospecies that is comparable, and complementary, to the external (keystone) platform central to that ecosystem (Gawer & Cusumano, 2014).

A technospecies that is a keystone in one ecosystem may play a different role in a different ecosystem by simultaneously having multiple relationships within and between ecosystems (Bengtsson & Kock, 1999). For example, in Figure 3, Adobe is a complementary technospecies in the Microsoft Office technology business ecosystem via its Portable Document Format (PDF) technology that allows documents to be consistently rendered regardless of application software, operating system, or hardware. Microsoft Office is the most widely used suite of office/productivity software worldwide. In this ecosystem, Adobe is a complementor tied to the Microsoft platform. Therefore, Adobe exists sim-

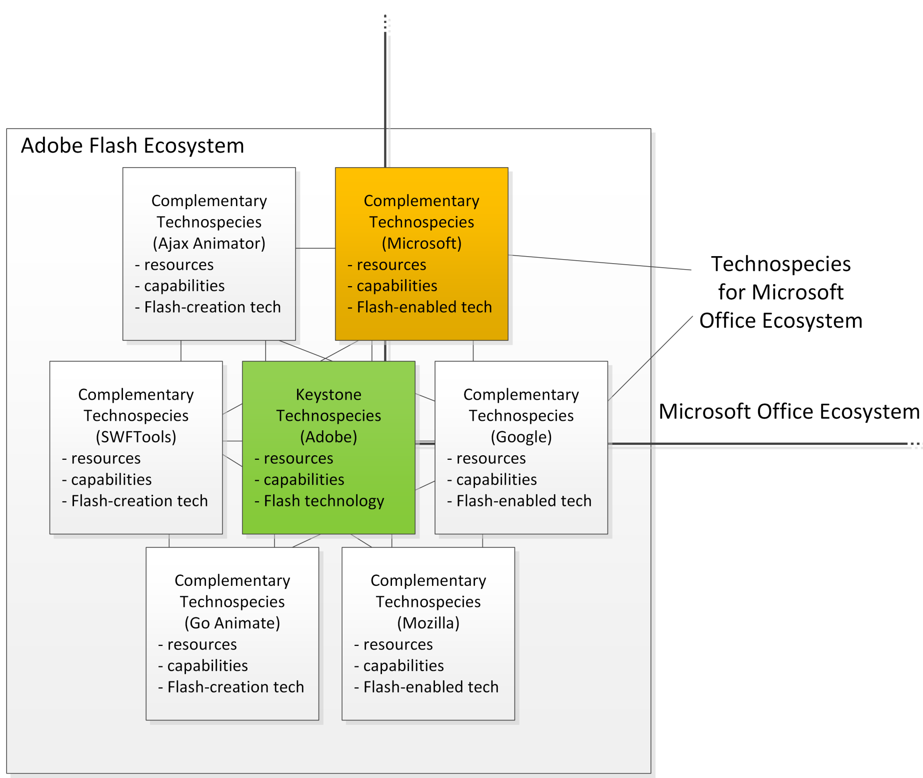

Figure 2. Adobe Flash ecosystem with Abode Flash as the platform technology and examples of complementary technospecies leveraging this technology

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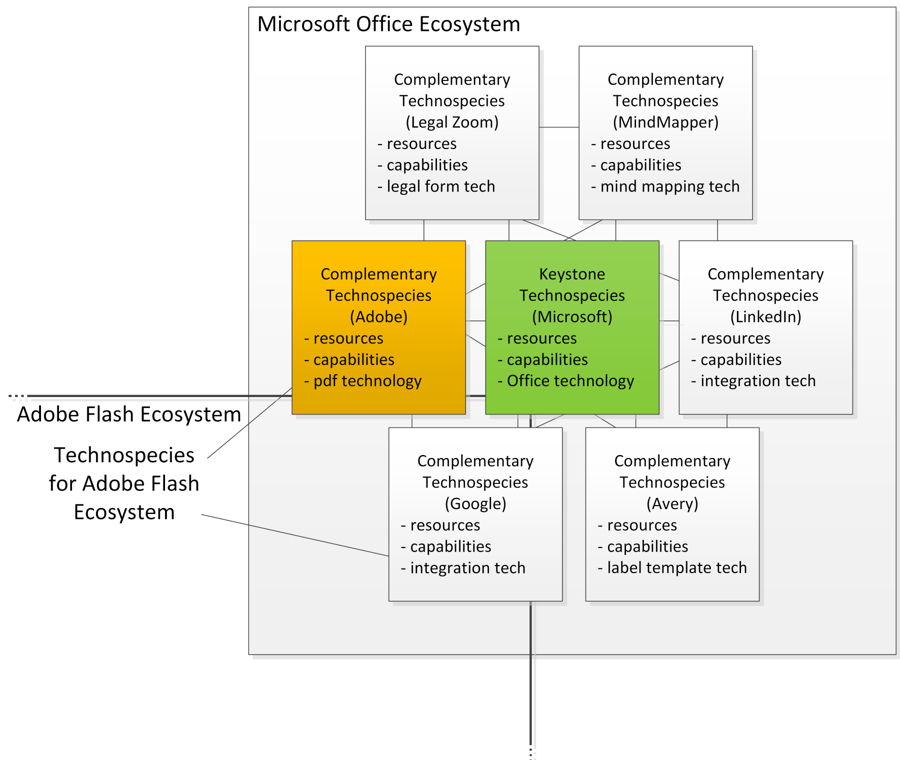

Figure 3. Microsoft Office ecosystem with Adobe acting as a complementor

ultaneously in multiple ecosystems, via the Flash platform in its own ecosystem where it acts as a hub and in the Microsoft ecosystem where it acts as a complementor (Weiss, 2010).

Business ecosystems also include, but are not limited to: suppliers, system integrators, distributors, advertisers, financiers (venture capitalists, corporate investors, investment bankers, angel investors), universities, research institutions, regulatory authorities, standard-setting bodies, the judiciary (Makinen & Dedehayir, 2012), individuals (e.g., customers, open source contributors) (Baldwin & von Hippel, 2011), crowdsourcing and crowdfunding participants (Vukovic, 2009; Kahtan, 2013; Kannangara & Uguccioni, 2013), and not-for-profit organizations such as Mozilla, the Apache Software Foundation, and the Eclipse Foundation (Hurley, 2009). We have not included these additional ecosystem members in the figures because the added detail would render the figures unreadable. These additional members may or may not be considered to be technospecies but are additional resource sources existing in the ecosystem. Thus, relationships between ecosystem members are more complex than simply between the technospecies providing the platform and complementors, and this complexity is not generally recognized (one exception being Heikkilä & Kuivaniemi, 2012). Recognizing the full extent of these connections, and what constitutes a technospecies either controlling or exploiting the focal technology in that ecosystem, is important both in defining the boundaries of a business ecosystem and determining the different ecosystems a technospecies resides in. A firm may exist simultaneously in multiple business ecosystems; the ecosystem boundaries of a firm such as Adobe are not limited to a single ecosystem. Combining this knowledge with the defining features of each technospecies (i.e., routines, capabilities, and resources utilized to create value in that ecosystem) should provide both managers and academics with a much clearer picture of the complex interrelationships in a business ecosystem. For example, software vendors require insight into software ecosystems and relationships (Jansen et al., 2009), because a software enterprise may abolish some, or all, of the barriers surrounding its intellectual property by becoming a keystone or complementor in multiple ecosystems (e.g., the Eclipse Foundation or the Apache Foundation).

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Conclusions and Future Research

Following from biology, we propose a business ecosystem model structured as a population of interacting technospecies. This perspective is in contrast to the current assortment of views including: platforms (Muegge, 2013), multi-sided platforms (Iyer & Davenport, 2008; Bailetti & Bot, 2013), communities (Muegge, 2011; Carbone, 2009), networks (Iansiti & Levien, 2004b; Corallo & Protopapa, 2007; Basole, 2009), value blueprints (Adner, 2012), and institutions and resource flows (Hearn & Pace, 2006; Muegge, 2011, 2013; Bailetti et al., 2013). Adopting this common terminology would allow communication about business ecosystems with reduced ambiguity, especially concerning the biological species concept used in business, and it would enable higher-level learning. These are necessary antecedents to the comprehensive study of business ecosystems involving mapping relationships between technospecies populating multiple, diverse business ecosystems and will allow progress toward describing a holistic view of the business environment.

A broader view of the ecosystem is required, encompassing the platform provider, complementary technospecies, and a variety of other participants. This view requires defining the technological capabilities and the ecosystem relationships for each technospecies. Recognizing technological capabilities would allow a technospecies to extend its connections beyond a single business ecosystem. Close monitoring of the capabilities of other technospecies in an ecosystem would also allow detection of threats and opportunities related to platforms that could displace the incumbent (Christensen, 1997) or could allow the technology to be assimilated and the possible competitor become a cooperator or coopetitor (Zineldin, 2004; Gueguen & Isckia, 2011; Heikkilä & Kuivaniemi, 2012). This approach would extend the value creation confines of the business ecosystem beyond the current view of that created by the technospecies providing the ecosystem platform or a complementor (Bailetti, 2010c).

The business ecosystem conceptualization presented in this article provides several managerial insights. Our model facilitates managerial identification of business ecosystem inhabitants, their interrelationships, and associated boundaries using consistent and semantic terminology. A manager, and thus organization, that is able to more clearly envision and articulate their own business ecosystem, and others that they may interact with, could potentially have a competitive advantage within their industry. A clear understanding of one's business ecosystem may allow an organization to move quicker and more fluidly than their competitors and also leverage resources from other technospecies and inhabitants that may be currently unrecognized. Additionally, understanding inter-ecosystem technology flows has implications for technological standards (Rohlfs, 2001; Laakso & Nyman, 2014), industry consolidation (Puranam et al., 2006; Carbone, 2011) and the emergence of new technologies (Weiss et al., 2013). Given that the number of different entities in a business ecosystem is quite diverse, ranging from competitors to open source contributors, being able to identify and utilize these valuable resources would benefit both the focal firm and the health of the entire ecosystem. Business ecosystems are likely to have quite different populations of technospecies and other participants that vary with different value chains; therefore research in this area based on a common language and definitions would provide deep insight into better management of these ecosystems.

Future research should focus on determining technospecies relationships in a business ecosystem beyond the limited primary relationships currently described in the literature. Similar to the concept of a keystone technospecies providing the platform in a single ecosystem, it may be that the interrelationships of a single technospecies provide unique technology or capabilities that would, if unavailable, result in a trophic extinction cascade in that ecosystem (Eklof & Ebenman, 2006; Nichols et al., 2009). Species diversity is directly implicated in biological ecosystem health (Lundberg et al., 2000; Nichols et al., 2009; Naeem et al., 2012); therefore, monitoring business ecosystem relationships and technospecies population numbers (i.e., if a dominator is present diminishing the critical mass of the ecosystem such that it becomes unsustainable) would seem equally important in terms of operationalizing the business ecosystem health concept of Iansiti and Levien (2004b).

Researchers in technology management and in business could contribute to this area of research by studying the multiple ecosystems technospecies are situated in, either as a keystone or a complementor. The interactions between business ecosystems in this regard is currently an unexplored area. Another research opportunity would be to consider business ecosystems from the perspective of the individual technospecies; this approach would also frame the research questions and results around managerially relevant problems that would be applicable for technology entrepreneurs. Additionally, the unexplored technospecies construct pro-

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posed in this article requires further refinement and development. Specific areas include a better understanding as to the characteristics of this new form and the inter-relationships of technospecies themselves and with other inhabitants in a business ecosystem. The latter concept is a particularly neglected area in research (e.g., the interaction of technospecies with non-technospecies in a business ecosystem). How ecosystem relationships are modified through the lifecycle of the platform technology is a related area of research. As relationships and interactions become more important in value creation (Ritter et al., 2004), a holistic view of business ecosystems and relationships becomes more important.

Acknowledgement

The authors would like to thank the anonymous reviewer for their detailed comments and suggestions that greatly helped to improve this article.

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Citation: Weber, M. L., & Hine, M. J. 2015. Who Inhabits a Business Ecosystem? The Technospecies as a Unifying Concept. *Technology Innovation Management Review,* 5(5): 31–44. http://timreview.ca/article/896

Keywords: technospecies, business ecosystem, business environment, complex adaptive systems