



Do-It-yourself laboratories as integration-based ecosystems

Wilson Ng, Félix Arndt, Tori Y. Huang

► To cite this version:

Wilson Ng, Félix Arndt, Tori Y. Huang. Do-It-yourself laboratories as integration-based ecosystems . Technological Forecasting & Social Change , 2020, 161, pp.120249 -. 10.1016/j.techfore.2020.120249 . hal-03491520

HAL Id: hal-03491520

<https://hal.science/hal-03491520>

Submitted on 22 Aug 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial 4.0 International License

“Do-It-Yourself laboratories as integration-based ecosystems”

Wilson Ng*

Emlyon Business School, France

Félix Arndt

University of Guelph, Canada

Tori Huang

University of Nottingham

Authors' Contacts

Wilson Ng* (PhD, University of Cambridge) is an Adjunct Professor of Corporate Finance at Emlyon Business School in Lyon, France. He is also a Visiting Professor in Entrepreneurship and Family Business at Regent's University London. Wilson was recently Professor in Entrepreneurship & Innovation Studies at the University of Roehampton, London.

Address: 7 St. Michael's Mews, London SW1W 8JZ, United Kingdom. NgW@regents.ac.uk; 00 44 755 709 8046 (DL), 00 44 207 730 3818 (O), 00 604 229 2437 (Fax).

*** Corresponding author**

Félix Arndt (PhD, Technische Universität Ilmenau) is the John F. Wood Chair in Entrepreneurship at the University of Guelph, Canada. He is also Professor in Entrepreneurship at the University of Agder, Kristiansand, Norway. Félix was recently Professor of Strategy at Leicester Castle Business School, De Montfort University, UK.

Address: Leicester Castle Business School, De Montfort University, The Gateway, Leicester LE1 9BH, United Kingdom. ffarndt@gmail.com 00 44 759 868 2005 (DL).

Tori Yu-Wen Huang (PhD, Cass Business School, City University London) is an entrepreneurship and organizational behavior scholar whose research is focused on entrepreneurial emotions and team decision-making. Tori is COO of Nceno.app and is an entrepreneur, designer-maker, consultant, and homebrewer. Tori was an Assistant Professor in Entrepreneurship and Program Director of the MSc in Entrepreneurship & Innovation Management, at Nottingham University Business School, China.

Address: contact@nceno.app. tori.huang@gmail.com 00 44 86 574 8818 0282.

All three authors have contributed substantially in the preparation of this manuscript. No financial support has been sought or received either in conducting the research in this paper or in writing it. Declarations of interest: None.

TF&SC Special Issue

The Rise of Do-It-Yourself (DIY) Laboratories: Implications for Science, Technology, and Innovation (STI) Policy

Do-It-Yourself Laboratories as Integration-based Ecosystems

Abstract

We develop theory on integration-based business ecosystems. Based on the phenomenon of do-it-yourself laboratories (DIY labs), we argue that prior theory of ecosystems have not adequately considered the possibility that participants in ecosystems may play multiple, as opposed to discrete, roles. The paper suggests that actor roles in ecosystems develop in an integrated way over time. We theorize on the implications of this integrated actor perspective for the dynamics of ecosystems. In substantiating our arguments, we draw on three vignettes of DIY labs in the craft beer industry and reflect on why these DIY labs emerged. This development depends principally on whether DIY labs choose to adopt a “logic” of value creation, value appropriation, or both. The possibility of participants’ multiple roles bears important implications for the nature and effects of ecosystems dynamics and for incumbents. These views are developed in four researchable Propositions of integration-based ecosystems in DIY labs. The paper concludes with implications of the dynamics of integration-based ecosystems for science, technology, and innovation (STI) research and policy on DIY labs.

Keywords: craft beer; DIY labs; digital technologies; digitalization; ecosystems; value creation.

Introduction

The call for this special issue observes that DIY labs are “‘popping’ up in cities across the world.” This statement suggests that DIY labs are an observable and growing phenomenon. Yet we do not know why DIY labs have emerged (anywhere). In addressing this question, we reflect on the business ecosystems¹ of organizations and theorize on the possible ecosystems of DIY labs. Ecosystems are the “alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize” (Adner, 2017, p. 40). To date, there has been a paucity of ecosystems theory underpinning the phenomenon of DIY labs. It follows that there has been little understanding of their economic and social importance, as the call suggests. Hence we begin to build ecosystems theory in DIY labs in creating a basis for understanding this phenomenon.

We define DIY labs as informal organizations that conduct experiments by amateur scientists². The overarching aim of these scientists is to improve products or services that motivate their continuing interest in experimentation. DIY labs are organized and often continue to operate at home (Grushkin et al., 2013). DIY scientists mainly comprise inventors and entrepreneurs who are inspired by

¹We adopt a definition of business ecosystem(s) used by management scholars. This definition focuses on our interest in the structure(s) in which DIY participants interact and collaborate (Jacobides et al., 2018).

² We refer to amateur scientists, actors, consumers, consumer-innovators, DIY scientists, participants, and users interchangeably throughout this paper. These individuals are defined under the single definition for DIY scientists in the body of the text.

potential user benefits of creating new products and services in industries of their interest. DIY experiments are usually enabled by digital technologies³ (Richards, 2016; Grohn et al., 2015). The principal aim of enhancing product and service portfolios is to overcome chronic problems that users typically experience in products and services offered by “expert” institutions. In such a setting, the roles of user-customers, entrepreneurs, and complementors merge, and a single actor can play multiple roles in the ecosystem in an integrated way. Complementors are participants in ecosystems who offer expertise that is additional to the expertise of incumbents (Brandenburger and Nalebuff, 1996, in Helfat and Raubitschek. 2018, p.1395). We theorize on some of the consequences of the multiple roles of DIY lab participants by exploring the ecosystem of the craft brewing industry. We suggest that this industry offers an unusual context for user-driven innovation, principally because of the industry’s culture of experimentation. Many craft brewers are individuals who have at one time experimented with recipes in small-scale brewing for personal consumption (homebrewing). A number of homebreweries have then grown into substantial craft breweries.

There is no commonly agreed definition of ecosystem. Teece (2017) suggests

³ Digital technologies are electronic tools, systems, and devices that generate, store, and process data. Examples of digital technologies are social media, online games, and mobile phones. Digitalization is the process of integrating digital technologies into everyday life by converting all data (that can be digitized) into a digital format. In this format, data are organized in discrete “bits” that computers can process.

that ecosystems are increasingly replacing industries as ecosystems allow transient boundaries more efficiently than industries. While there are many types of ecosystems, business ecosystems have been associated with value capturing, and innovation ecosystems have generally been associated with value creation (De Vasconcelos Gomes et al., 2018). In this paper, we begin to merge these two perspectives as we explore situations where: 1) consumers become innovators, and 2) these innovators grow into potential competitors of industry incumbents. As such, much of the subsequent value creation may come from consumers, although we suggest that those consumers may also appropriate some value, either through their own commercial activities or in selling new product developments to incumbents (Narayanan et al., 2009).

We make two contributions with our theoretical arguments. First, we add to the discussion on definitions of ecosystems by setting out a number of boundary conditions of traditional classifications and propose a more dynamic nature of actor-participants within ecosystems. As we illustrate in our example of a pertinent, international ecosystem, DIY labs comprise chiefly R&D hubs and consumers within their ecosystem. While the fact of these multiple roles is unsurprising, what is unusual is the extent of these (and other) roles in a business-to-consumer setting. By contrast, ecosystems research has emphasized the supply-side role in value creation and has shown limited interest in the demand-side role for value creation

(see, for example, Massa et al., 2017). A chief implication of this shift in the nature of DIY labs towards consumers is that industries, including established industries such as beer brewing, may witness the emergence of engaged, passionate consumers. Enabled by the internet, these consumers seek to innovate in order to address poor product performance (von Hippel et al., 2011). This issue then becomes the consumers' principal motivation in experimenting with improvements among similarly minded consumers and other stakeholders in DIY labs. We therefore study the dynamics of multiple roles triggered by DIY labs, wherein consumers are also producers of essentially the same product(s).

Secondly, we contribute to the DIY entrepreneurship literature by theorizing on the impact of digitalization in open economies where access to the internet by participants in DIY labs is free of government and institutional influence and control. We suggest that digitalization is an enabler of DIY activities that in turn changes the dynamics of actor-roles in ecosystems. This argument differs from prior work on digitalization in which the use of digital technologies is often seen merely as best practice (see Zaheer et al., 2019 for a review of this literature). By contrast, recent research considers digitalization as a technological change with fundamental consequences for the structure of ecosystems (Sjodin et al., 2016; Ritter and Pedersen, 2019; Sklyar et al., 2019).

We now review literature on DIY labs, digitalization, and on business and

innovation ecosystems. We draw up three researchable Propositions for the development of DIY business ecosystems based on three vignettes of craft brewing DIY labs. We do not provide empirical validation with these vignettes. Our aim is to draw on the nature of the ecosystem supporting craft brewing DIY labs in building and supporting our Propositions. We discuss the implications of our Propositions for ecosystems theory and offer suggestions for STI research and policy of DIY labs based on the dynamics of our integration-based theory of ecosystems.

DIY Labs and Digitalization

Since the turn of the Millennium, a number of major consumer industries in western economies have experienced significant structural change. This change has focused on relationships between supplier-providers in the industries and mass consumers who continue to be attracted to those industries because of their needs (Denicolai and Previtali, 2020) and wants (Kim et al., 2019; Wolf and McQuitty, 2011). The Millennium remains a convenient demarcation point for provider-consumer relational changes because of the emergence of entrepreneurial opportunities that have been created and enabled by digitalization. For example, faster and broader access to the internet has prompted structural change in major industries following pressure from non-scientific, external stakeholders (Autio et al., 2018; von Briel et al., 2018).

Researchers have also suggested how the traditionally hierarchical development of innovation-led industries has seen a shift since the Millennium. For example, the emergence of diagnostic medicine aiming to “prevent disease on the basis of a person’s unique genetic makeup, lifestyle habits, and environment” (Denicolai and Previtali, 2020, p.1), without treating common ailments has been initiated by amateur bio-scientists (Meyer, 2013). Precision-medicine service platforms provide a compelling opportunity for many consumers to alter their habitual relationships with hospitals and other service-based institutions. This opportunity is founded on diagnostics that are tailored for individual patients, while the opportunity for change is enabled by the open-sourced digitalization of patient data. As a result, consumers have access to better, and potentially cheaper, medical services (Denicolai and Previtali, 2020).

In studying this apparent change in innovation systems and the work of DIY scientists, a growing body of literature has begun to move away from the traditional, uni-directional causality between expert knowledge and innovation outcomes to a process-based approach of experimentation by non-expert users (see, for example, Caraça et al., 2009). This research argues that in creating knowledge of technology-based ecosystems, a process-based approach favors direct interaction between suppliers and users in the market (Caraça et al., 2009, p. 864). Such users mainly comprise amateur scientists who are passionate about developing the

technology for public use, such as patients in healthcare and craft beer drinkers, and even artists who seek to present the technology behind DIY bio-labs in artwork (Grushkin et al., 2013). These participants share a common characteristic: They use digital technologies for data access, storage, and activities that share and develop their passion for experimentation⁴.

From the outset, DIY labs have intentionally organized themselves outside formal research institutions and structures (Meyer, 2013). Their overarching aim continues to be to overcome the typically substantial barriers between R&D and commercialization. Much of the DIY lab literature has been about DIY bio-labs that test and collect data on personal health. Yet there are thriving examples of DIY labs in other industries, such as the craft brewing industry, which is founded on a homebrewing culture of experimentation. Here too the core platforms of data access and storage that enable DIY lab participants to share and develop their passion for improvements in their industry are offered by digital technologies (cf. Zaheer et al., 2019), chiefly the internet and social media.

DIY labs as digital ecosystems

Participants of DIY labs also connect across industries. Cross-industry DIY communities have been an active part of “megatrends”, namely, potentially socially

⁴ Scholars have suggested that digital technologies also include laboratory automation technologies to “improve experiment reliability, drive down costs, and offer early-stage revenue” (Grohn et al., 2015, p.67). While we acknowledge the importance of this point, we see that a core enabler of experimentation in DIY labs is open access to data through the internet.

transformative forces, such as globalization, corporatization, digitalization, and the enabling of individuals (Richards, 2016). The DIY concept empowers individuals to be part of a larger, borderless community principally interested in a topic, area of science, activity space, or movement (Kuznetsov and Paulos, 2010). A rich literature on DIY enterprises has explored possible connections among maker-spaces, co-working spaces, labs, communities, art, activism, and how megatrends have contributed to developments in these areas (see, for example, Munro, 2005; Richards, 2017). In particular, digitalization through the internet and social media has been instrumental in connecting novice entrepreneurs with similar interests. Moreover, digital technologies in app-based software have been used by social entrepreneurs with little prior experience of digitalization to build communities and enable first-time DIY participants located wherever there is internet access to engage with DIY activities (cf. Zaheer et al., 2019).

Observers of DIY labs have noted how DIY scientists are brought together by a strong, shared passion for scientific experimentation⁵ (Meyer, 2013). This collective need for experimentation, which in DIY bio-labs could be in techniques of testing and measurement, or in small-batch DIY brewing, in a blending process of grains, yeast, and hops. The compact, focused environment offers space for DIY

⁵ We refer in this article to scientific experimentation as a methodical process of performing scientific trials, typically in a laboratory, with suitable equipment to continually test or measure new ideas, methods, and activities (Radder, 2009). In DIY labs, experimentation is undertaken principally to improve products or services in the market that consumers are unhappy with.

scientists to share their knowledge in the community openly and diligently (Meyer, 2013). Recent research suggests that the continuing emergence of DIY labs in different fields may be coterminous with an increasing diffusion of digital technologies, with improved access to the internet (Richards, 2016) and greater availability of cloud storage of data and digital programs for disseminating stored data (Grohn et al., 2015, Kuznetsov et al., 2012).

Today's DIY communities are therefore essentially digital ecosystems. They rely on open sharing of new ideas and values (Kuznetsov and Paulos, 2010) and an identity based on a passion for experimenting with something they care deeply about. Importantly, these ecosystems identify through a common purpose that they practice. This purposeful process and the interconnections among DIY labs worldwide have been facilitated by the emergence of digitalization and digital technologies (Rauffet et al., 2008). Practices in DIY labs and interconnections among their members do not exist in isolation, but often overlap and interact with existing ecosystems. The use of these technologies has enabled the dispersion of knowledge and the creation of new knowledge in technology-reliant industries (Meyer, 2013). The key element in these activities is the role(s) that DIY lab users may adopt in sourcing data to advance the development of their knowledge. The aim here is to radically improve existing products, principally for the users' own benefit. Initially, these improvements are typically unattractive to incumbents, who

ignore the DIY labs and their users.

Ecosystems

Much of the ecosystems literature defines ecosystems by how they are structured and function (Jacobides et al., 2018). In essence, typical ecosystem models set out different versions of how new innovations are adopted within the ecosystem by different actors. For example, Dedehayir et al. (2018) identify four key actors in innovation ecosystems: supplier, assembler, complementor, and user. While these models are useful for classifying and understanding actor-coordination in such a system, there is little consideration of circumstances within an ecosystem wherein actors do not take on discrete and distinct roles.

However, we are sensitive to the ecosystems literature that adopts actor, structure, and governance perspectives to classify different ecosystems. Jacobides et al. (2018) suggest a classification based on the structure of the value chain and its modularity: hierarchy-based, ecosystem-based, and market-based systems. The role of complementors is central to understanding coordination among the ecosystem's actors. Ecosystems differ from market-based transactions that occur directly between multiple sellers and customers.

By drawing on publicly available data on the craft brewing industry, we suggest how DIY lab enterprises may be analyzed with our multiple-actor conception of ecosystems. Our conception and propositions then form a basis for

setting out policy implications and potential public benefits from our analysis. This conceptual approach is similar to Sarasvathy (2001), Goldenberg and Oreg (2007), and De Haan and Rotmans (2018), where imagined scenarios and thought experiments were drawn on to illustrate a proposed framework. De Haan and Rotmans (2018) reflected on a well-known case (of the Dutch government being compelled to act against climate change, following legal action by a Non-Governmental Organization) as a basis for analyzing key concepts in their theory of transformative change. Methodologically, De Haan and Rotmans (2018) suggested that their theoretical framework was in fact a Proposition to stimulate debate and research on transformative change consequent upon the intentional actions of actors and networks of actors (ibid., p.285).

This article is likewise a developed opinion piece that begins to explain how, in ecosystems, innovative consumers and other participants who establish and operate DIY labs may adopt multiple actor-roles, for example, as innovators, complementors, and consumers. We now reflect on the emergence of craft brewing and draw on vignettes of three contrasting craft brewers in developing four Propositions. In our Discussion, we suggest how these Propositions may form key functions of our ecosystems theory for DIY labs.

A Single-Actor, Multiple-Role Ecosystem: Homebrewing and Craft Brewing

The global beer industry is dominated by large conglomerates, among which the

largest, Anheuser-Busch InBev (InBev), owns more than 500 brands globally, with annual sales of US\$52.3 billion (AB InBev, 2020) and an estimated global market share of 28% (Brown, 2016). By contrast, in the USA, craft beer accounts for approximately 13.6% of the total beer market (by volume) and more than 25% of the \$116.0 billion USA beer market (in dollar sales) (Brewers Association, n.d.). More than six thousand craft beer breweries have been established in the USA alone over the past decade (Brewers Association, n.d.). In 2019, the growth potential of craft beer industry in the USA is supported by a growth of 4% in craft beer sales, despite a decline in overall USA beer volume sales by 2% (Brewers Association, n.d.). In the USA where homebrewing is well established, homebrews still account for 1% of total beer production.

The beer brewing industry suits our definition of an ecosystem-based value system, where complementarities between beers allow for the existence of multiple parties that may act as complementors. Yet from a supplier perspective, relationships among beer brewers suggest that there can be cooperative as well as competitive relationships among breweries and beer brands. Competition can occur within the ecosystem of the beer-brewing industry and across ecosystems, for example, between beers and other mass-market alcoholic beverages (cf. Adner, 2017). Secondly, craft brewing DIY labs are similar in nature to DIY bio-labs. For example, craft brewing- which is the commercial industry that has grown out of

homebrewing- also requires considerable manual and mental labor. Home-brewed recipes are formatted in the manner of lab protocols, with detailed steps and timelines. In DIY craft brewing labs, participants are drawn by a passion to experiment, which is continuous and does not diminish with the labs' growth and development (in several cases, into large businesses, as with BrewDog). Hence, a culture of continuous experimentation that draws individuals to DIY craft brewing labs lies at the heart of their existence. We now draw on the following vignettes of three home-to-craft brewing enterprises in suggesting how key functions of an operating ecosystem are defined and performed by its actors. Our vignettes are defined, and serve, as brief characterizations of key functions we perceive that enable the ecosystem of our respective DIY labs to operate.

Three vignettes of homebrewing-to-craft brewers

BrewDog, now one of UK's best-known and fastest-growing independent breweries, sells globally in more than 27 countries. Founded in 2007, James Watt and Martin Dickie took out loans, set up a production facility, and began experimenting to produce better-tasting, high-strength beer. The venture took off in 2008 when BrewDog's high-strength beers as well as their disputes with the UK industry watchdog were widely reported. The founders' motivation to brew the world's strongest beers was to "push boundaries and smash people's perceptions of what beer can be" (Watt, 2015). This thinking was enshrined in BrewDog's motto:

“Experimentation is our art, revolution our weapon.” One of the key attributes of BrewDog has been the brand’s signature style of “in-your-face” and “aggressive and attitude-driven” marketing (Curtis, 2015). For BrewDog, its stunts- in brewing at the bottom of the ocean, smashing bottles of industrial beers with a golf club, airdropping stuffed animals into the city from a helicopter- have reflected its rebellious spirit. Effective communication of this spirit quickly amassed a following of “bold, irreverent, and uncompromising” customers (BrewDog, 2015a).

By seeking to offer better alternatives to beer drinkers, BrewDog has taken a strong stance against industry giants such as Diageo and AB InBev. BrewDog calls their enterprise “beer for the people” that saves consumers from bland, poor-quality, and overpriced beers in the global market.

Sierra Nevada, founded in 1980, is one of the oldest craft breweries in USA. The founder, Ken Grossman, started home brewing at a young age and set up a homebrew shop before homebrewing was legalized. Sierra Nevada’s best-known product is their Pale Ale, which used the then-new Cascade hop in pioneering a new category of craft beer. Today, Sierra Nevada is the third largest craft brewery (Brewers’ Association, 2019) in USA, producing 1.25 million barrels a year, amounting to less than 1% of the total beer market.

Sierra Nevada has enjoyed continuous year-on-year sales growth since its founding. Faced with a persistent buyout threat from conglomerates, Grossman has

chosen to remain independent, making no compromises in products and processes, and by working with other small, independent breweries. For example, Sierra Nevada has initiated collaborative brew projects “to trade in some of its operational know-how and national exposure for ties to younger, hipper brands” (Grossman, 2014). The firm also continues to produce trendy novelty beers, such as the extra hoppy Torpedo Extra IPA, which has become Sierra Nevada’s #1 product.

Goose Island was founded in 1988 as a pioneer of craft brewing in its adoption of European-style brewing practices and novel beer styles. Because of this novelty, Goose Island was known for decades as one of the best craft beer breweries from Chicago. It is now also known for its acquisition by AB InBev in a US\$38 million “sell-out” in 2011. Since then, the brand has been absorbed, with the founder joining InBev to grow their craft division. Many craft beer drinkers expected the taste of Goose Island beer to change as production was moved to InBev (Noel, 2018). In fact, the acquisition marked the start of several InBev buyouts of craft beer breweries with niche followings. Along with InBev’s premium import brands, Goose Island has become part of the conglomerate’s “High End” growth engine.

DIY labs as consumer-innovators

Jacobides et al. (2018) define distinct actors for classifying ecosystems based on a transaction cost logic. In practice, however, this assumption often seems to be violated. We exemplify this violation by consumer innovators in our three

vignettes, which we observe is a role that is also adopted in other DIY labs (cf. Von Hippel et al., 2011).

The phenomenon that consumers also innovate in their space of interest is not new. Foxall (1994) observes that early adopters of innovations are themselves often active in the same sphere of innovation. Our argument runs parallel to this view. For example, passion as a consumer in innovating in a shared space may trigger experimentation in the same area in DIY labs. Recent research on consumer innovations expands this work and suggests that market failures from limited incentives may hinder the process of new innovations coming to market (De Jong et al., 2018). Instead, market space may be taken by consumer-innovators who fill the space with their innovations based on product improvements and novelty. A further view is offered by Halbinger (2018), who finds that maker-spaces represent self-selection into communities with resources that trigger innovations of consumers.

Integration-based ecosystems are a manifestation of the above logic in which the roles of consumers and innovators may merge in the same actor. DIY labs experiment in a space of interest with the support of physical and/or digital communities (Sussan and Acs, 2017). The motivation here is again to address market dissatisfaction or failures. While often rewarded by outcomes of experimentation, consumer-innovators and their success often depend on the results

of experimentation, the lab's experience in commercialization, and the novelty of their discovery (De Jong et al., 2018).

We suggest that different roles that can be borne by a single DIY lab actor distinguish our concept from Jacobides et al.'s (2018) conception. This conception works on the basis that actors adopt clearly defined and discrete roles: ecosystems then emerge from the activities of actors that may deliberately influence incumbents. This influence may also create rules for other actor-complementors by shaping the way in which ecosystems operate. The integrated actor role of DIY labs can play a crucial role in mitigating, or avoiding, business and corporate control by industry incumbents. We suggest that DIY lab actors are able to do so because of their dexterity in role-playing. This role-playing by single actors then enables DIY labs to either change the dynamics of existing ecosystems or create new markets. In the craft beer industry, this was an actual scenario in the proliferation of craft beer enterprises soon after the Millennium when BrewDog and other new, craft beer enterprises appropriated existing customers from incumbents and established a new craft beer market. By contrast, in the industrial beer market, incumbents continue to exert market control because of the size of their networks and resources. Yet, however powerful, those incumbents are still governed by existing rules and standards of their industry that cannot accommodate DIY labs and their innovations. Only over time have these industries begun to merge.

The same trajectory in the development of DIY labs is visible in our three vignettes. As the brewing ecosystem consists principally of a few industry giants, small enterprises in craft brewing, and end-consumers, a core question is about the role of homebrewers in this ecosystem. DIY labs such as home breweries and micro-breweries are operated by passionate and frustrated consumers. These consumers may take on the roles of innovators. Our notion recalls Von Hippel et al.'s (2011) perspective of “consumer-innovators”, namely, consumers, who being dissatisfied with current market offers, feel compelled to pioneer new products for themselves. By contrast, large beer producers are not interested in eclectic, niche markets with small numbers of consumers who cannot support industry growth (ibid.). Furthermore, when a market is established and the industry's potential become salient, producers may begin to enter the market (ibid., pp.29-30). Here, it follows that DIY labs may acquire value, either by selling their improved products or services to the market, or by selling the lab and its know-how to an incumbent, such as in Goose Island's “sell-out” to InBev, or to other multinationals not in the beer market who seek a foothold in a high-potential segment (Waterworth, 2018).

It follows that as craft beer DIY labs are usually operated by former homebrewers with an intrinsic interest in innovating, these amateur scientists are likely to have a degree of self-trained expertise to support their passion for experimentation. The subsequent innovations are often driven by the absence of

satisfying, long-lasting solutions to their specific problem(s). Craft beer DIY labs operated by consumer-innovators are therefore their vehicle of innovation in the old industry of beer manufacturing. These consumer-innovators lead innovation in their enterprises by enacting multiple, conjoined roles in promoting and developing the ecosystem that governs their enterprise (cf. Von Hippel et al., 2011):

Proposition 1: DIY labs are operated by consumer-innovators within an integration-based ecosystem.

DIY labs, value creation, and value appropriation

The DIY lab literature suggests that most DIY labs that create new solutions start with a value creation logic. This is because their scientists find enjoyment and satisfaction in experimenting for their own needs (Grushkin, 2013). The initial aim is not to compete in the market, but for DIY labs to create new, innovative solutions to persistent issues that have prompted consumers to set up DIY labs (Fox, 2014). Emergent solutions may then create value by complementing existing solutions in the industry.

However, DIY labs may also apply a value appropriation logic to their solutions based on factors such as experience and novelty of the innovation (De Jong et al., 2018). DIY labs with a value appropriation logic generally exhibit this logic together with a value creation logic by bringing new solutions to the market. In this scenario, scientists in DIY labs do not merely use their solutions for their

own, non-commercial purposes (Priem et al. 2018). In the example of craft brewing, craft brewing DIY labs serve individual preferences of beer drinkers that industrial brewers ignore. The individualization and nurturing of consumers' taste lie at the heart of these DIY labs (Scheifele and Burkett, 2016). Homebrewing suits this need because it offers freedom in the choice of recipes and preferences in style and ingredients. More importantly for amateur brewers, homebrewing has enabled them to avoid control by large beverage producers. Consequently, homebrewers who establish DIY lab-ventures have enriched the ecosystem not only as consumers, by adopting roles further up the value chain, but also as innovators, suppliers, and new entrant competitors. This was the case with all three of our craft brewing examples:

Proposition 2: Activities in DIY labs typically begin with experimentation based on a value creation logic. With innovations consequent upon this experimentation, DIY labs may subsequently move away from a value creation logic and adopt a value appropriation logic.

DIY labs and innovation outcomes

Baldwin and Von Hippel (2011) elaborate on the implications of consumer innovations. These authors argue that producer innovation is only one mode of innovation. Instead, Baldwin and Von Hippel (2011) suggest that user innovations

are a principal way in which innovation can be meaningfully organized as a set of activities with impactful outcomes. User innovations may involve either small or large-scale solutions for niche, in-house, or open commercial markets.

BrewDog is an example of a DIY lab that initially focussed on a value creation logic in order to produce an in-house solution. With advanced design, BrewDog subsequently found solutions first in a niche market for high-strength beer, and thereafter for large-scale applications of individual, better-tasting beer. However, DIY labs that take on a value appropriation logic may also see their solutions filling the needs of niche markets. Goose Island filled this role following their sale to InBev when the brand was subsumed into the conglomerate's vast range of products. Typically, niche solutions, such as Goose Island's current products are part of Inbev's "High End" growth brands, and do not threaten the markets of existing producers as those brands target unserved, latent, or exclusive consumer demand (cf. Von Hippel et al., 2011).

Taking a different strategic path, DIY labs may grow to develop large-scale solutions that are capable of appropriating market share from incumbents. DIY labs that continue to develop larger-scale solutions are likely to invade existing markets with growth and expanding categories. Some smaller companies may choose to adopt a differentiated and low-cost, or "blue ocean", strategy (Kim and Mauborgne, 2004) by limiting their growth to avoid drawing attention from incumbents and

potentially face retaliation (Mitsubishi and Alcantara, 2019). However, De Jong et al. (2018) note that those innovators who are confident of using their experience and creativity may pursue a value appropriation logic that creates direct rivalry to incumbents. These consumer innovators may then become new participants in the industry and enter the game for market share by competing with incumbents. We suggest that this was the case with Sierra Nevada, which resisted takeover attempts by beer industry incumbents. Instead, Ken Grossman continued to produce novel products by drawing on his experience to build a craft beer community and cultivate its culture. Unusually, he achieved this by collaborating with small ventures to create value for Sierra Nevada, while the firm's new and old products continue to appropriate value from incumbents. Our three vignettes therefore offer examples of each of the following Propositions:

Proposition 3a: DIY labs with a value creation logic may create one or more new markets (cf. BrewDog).

Proposition 3b: DIY labs that compete in the market with a value appropriation logic can potentially reduce the market share of incumbents as DIY labs grow in scale (cf. Goose Island).

Proposition 3c: DIY labs may adopt both a value creation and a value appropriation logic, at least while their founders are able to sustain both logics in competition with incumbents (cf. Sierra Nevada).

Responses of incumbents to DIY lab activities

DIY labs with value appropriation logic may pose threats to incumbents and trigger a range of responses. First, if the consumer innovator is sufficiently strong, the incumbent may have to engage with the new rival (Baum and Korn, 1996). Typically, we would see behaviors as discussed in the literature on interfirm rivalry where resources are dedicated to offensive or defensive actions that are not necessarily focused on developing the core business (Chen, 1996). Secondly, incumbents may attempt to acquire the DIY lab and integrate it in order to increase market share and reduce competition (Baden Fuller and Stopford, 1991; Chen, 1996). Incumbents may also use its processes and products to complement their innovation activity, or to substitute for the incumbent's innovation activity (Burgelman, 1983). This rationale may be accompanied by another intent, namely specialization (Cacciatori and Jacobides, 2005). Specialization of activities is typically performed in areas where incumbents can use scale effects, as opposed to areas where inertia may hamper their activities. InBev can be considered an example of this further intent of specialization. Because of its poor record of product innovations with craft brew consumers and subsequently lower-growth potential in this category, InBev began acquiring new product lines while specializing in the production and sale of mass-produced, industrial beer:

Proposition 4: In response to 3a and 3b, incumbents may 1) engage with the new competition, 2) acquire DIY labs' expertise or

innovation, or 3) enhance their advantages of specialization.

Discussion

DIY labs in many industries remain typically at home. Yet this phenomenon, informally organized and without an organization structure, may be able to create and/or appropriate value from neglected market opportunities in a structured way. Central to this phenomenon and its potential effects on innovation are the multiple roles played by DIY lab consumer-innovators within an integration-based ecosystem (Proposition 1). We propose that this ecosystem consists of two distinct “logics” of innovation. Firstly, under a value creation logic, DIY labs are created and sustained by multiple roles that may be enacted by a single participant. In our vignettes, we do not dispute that these roles comprise Dedehayir et al. (2018)’s four key roles in innovation ecosystems. The focus, however, of our Propositions is in suggesting that these roles need not be distinct and separately enacted by discrete actors. The ability of scientist-participants in DIY labs to play multiple roles in an integrated way lies at the core of our explanation for the proliferation of DIY labs.

We have suggested that the multiple role-playing nature of integration-based ecosystems arises at least partly because of participants’ regard for DIY labs as a R&D hub for developing novel solutions to product and service problems. Another rationale for integration-based ecosystems may be in the ability of actors in this system to create new markets under a value creation logic without falling under the

control of incumbents (Proposition 2).

Furthermore, we have suggested how a value appropriation logic may also produce competitive innovation performance, for example as a DIY lab commercializes their innovation and scales up (Proposition 2). Under a value appropriation scenario, there is already evidence that some of the subsequent innovation in DIY labs has been subsumed, through acquisition, by large incumbents. We have suggested that at least some of the expected improvement in innovation performance may be due to the particular ecosystem of DIY labs that continues to enable value creation activities. Central to these activities is the founding scientists' drive for innovation by experimentation. Hence, for example, InBev's acquisition of Goose Island as a high-growth brand, which was based on its track record (including know-how, reputation, and branding) of creating novel styles.⁶ Similarly, incumbents and consumers have valued Sierra Nevada for its value creation, as reflected in its growing market share.

In the broader context of DIY labs, we have suggested how the home-to-craft brewing trend in many economies is an example of value creation that can be powerfully present in industries that have long been the domain of expert scientists and industry professionals. Industries such as industrial beer brewing have not

⁶ Follow-on, empirical research would be required to investigate the actual innovation performance of DIY labs acquired by InBev and other incumbents.

satisfied the needs of consumers who were once perceived as niche drinkers, as InBev's recognition of Goose Island's high-growth potential suggests. This dissatisfaction has presented an entrepreneurial opportunity for craft brewers such as BrewDog to create a valuable new market as an iconic beer brand in opposition to key incumbents, initially as value creation enterprises (Proposition 3a).

On the face of it, there is therefore an important rationale for the existence of DIY labs. In craft brewing, this rationale is based on sustaining market innovation by closing periodical gaps in innovation expected by proactive consumers who demand continually improving, better-tasting beer. In theorizing on the behavior of DIY lab actors, we have also explored the deeper, more important question of the way they have emerged spontaneously in and beyond the craft brewing industry. We have argued that a possible, pertinent answer to this question has been to study the nature of the ecosystem in which DIY labs are located. By exploring the ecosystem of a contemporary DIY lab at the level of its lead participants, we have extrapolated from the example of homebrewing and craft brewing DIY labs that these organizations may "pop up" when they develop an integration-based ecosystem in creating and/or appropriating value from innovative activity. An integrated approach in DIY labs involves aligning their ecosystem(s) with consumers and other partners, who then interact in order to continually generate products that satisfy its lead-users' dynamic requirements of innovation

performance (Adner, 2017). Lead participants in DIY labs may engage with this alignment process over time as they grow and develop their lab ventures (cf. Proposition 2). A core difference between incumbents and consumer-innovators is in the former's apparent interest in operationalizing either a value creation or value appropriation logic. By contrast, in the integration-based ecosystem of DIY labs, consumer-innovators would seek to create value from the introduction of novel products and/or services, as in the case of BrewDog.

At the same time, adopting an appropriation logic would also enable DIY lab founders to appropriate value from incumbents by scaling up their commercial activities. This was the case with Goose Island prior to its acquisition by InBev (Proposition 3b). However, with confident founders who are able to draw on their experience and other capabilities, DIY labs may continue with a value creation logic while embarking on value appropriation activities that draw value from incumbents. This was Sierra Nevada's market position, where the founder was clearly enjoying his independence in collaborating with small but ambitious ventures while spurning takeover approaches from incumbents (Proposition 3c). Spurned incumbents may respond to the appropriation of their value by actions that leverage their specialized assets in production and capabilities. For example, InBev subsumed the operations of Goose Island into its production network and hired the services of its founder, while Diageo and other incumbents have sought to engage

with BrewDog (Proposition 4).

The possibility of participants' multiple roles in a DIY ecosystem suggests important implications for classifications of existing ecosystems. Principally, we suggest that DIY labs contribute to ecosystems theory because of their fit with both a value creation and value appropriation logic. This integration-based nature of business ecosystems is important because it enables DIY labs to better orchestrate alignment of activities among participants and external partners, possibly across geographical distances. This dual, integrated feature was evident in the ecosystem of BrewDog and Sierra Nevada despite the former being UK-based and the latter in the USA. In their own ways, each of these ventures arose, and moreover have persisted, with a common, unusual feature that distinguishes them from other non-DIY lab ventures. This feature is the multiple roles enacted prominently by their founders in operating across role boundaries. A common bind we have suggested in role-activities is in our participants' passion for experimentation in search of innovation performance (Landrain et al., 2013; Meyer, 2013). The fact of the paucity of this performance perceived by consumer-innovators strengthens the bind between value creation and value appropriation in DIY labs because the rationale for DIY users to create value also nourishes their appetite for establishing suitable business models to appropriate value from, and thereby to sustain, their experimentation.

By contrast, incumbents in the industrial beer industry, while initially overlooking the activities of DIY lab-ventures, became attracted principally by the DIY labs' potential for market growth. We have illustrated the nature and powerful effects of this integration-based business ecosystem product in the way that homebrewing grew into a commercial industry under multiple, role-playing stakeholders of craft beers. Based on this integration-based ecosystem, we have suggested how DIY labs contribute to ecosystems theory because of their fit with both a value creation and value appropriation logic of industry value (cf. Helfat & Raubitschek, 2018). Integrated roles help to create value in a number of ways. For example, Helfat & Raubitschek (2018, p.1396) specified how transaction costs carried by a platform leader in contracting with complementary asset providers may be reduced by drawing on integrative capabilities⁷ in firms, which expands at a firm level our view of integrated roles in ecosystems. By extension in this view, integrated roles of our amateur scientists can also help lead scientists in our DIY lab-ventures to appropriate value (cf. Helfat & Raubitschek, 2018) by positioning themselves in an indispensable position within the venture.

Digitalization, specifically digital platforms, play an important part in enabling these activities. This is because digital platforms often provide interfaces

⁷ Integrative capability refers to the capacity for effective communication and coordination of activities, resources (including knowledge, and capabilities), investments, and objectives within firms (Helfat & Campo-Rembado, 2016, in Helfat & Raubitschek, 2018, p.1396).

with, and among, groups of internal actors (DIY lab participants) and external actors (representatives of incumbents) who are located in different, and often opposing parts of the platform in any industry (ibid., p.1392).

In the multiple role-playing nature of DIY lab participants, we augment Jacobides et al. (2018)'s view of the discrete nature of participants' roles in ecosystems. Apropos, based on our beer brewing DIY labs, we suggest that the antipodal roles, for example, of customers and complementors can be enacted by a single participant. This has arisen at least partly because of participants' regard for DIY labs as a hub for their engagement in solving their industry's problems that drew them to the DIY lab. This integration-based nature of business ecosystems is important because it may enable the DIY lab-venture to more efficiently orchestrate the alignment of activities and products among its participants and external partners, including the venture's customers (ibid., p. 1395f; Teece, 2018). Hence BrewDog's ability, despite its initial inexperience of the beer industry, to lead product innovation by aligning this process with the evolving tastes and lifestyle preferences of the lab-venture's now multinational customers.

BrewDog and Sierra Nevada's success in the market also suggests that these (and other) craft brewers have succeeded in their principal aim of continuous innovation in order to avoid being controlled by incumbents. The example of Goose Island, on the other hand, presents a different picture. Here, consumer-

innovations, as reflected in the brands that Goose Island built, were absorbed by InBev soon after its acquisition and integrated into the incumbent's ecosystem in the form of additional, complementary product offerings. A number of implications for STI policy arise from our Propositions:

1) Prescient business leaders and policymakers may consider harnessing the social trends and forces behind DIY lab-ventures by investing in and collaborating with efforts at public experimentation, instead of diminishing the value of this core activity among amateur scientists. The focus on experimentation of DIY scientists who are able to play multiple roles in value creation has effectively changed the brewing industry by gradually establishing a culture of persistent individuality and quality behind craft beers as core values in the marketing of all beers (Hodgson, 2017; cf. Proposition 1). While top industrial beers always valued manufacturing quality, persistence in the form of continually evolving creativity in beer has been a contribution of craft beers.

As the call for this Special Issue has suggested, the proliferation of DIY labs suggests that this phenomenon is likely to stay, particularly in advanced economies with open processes of creating public access to knowledge. By collaborating with DIY labs, it may be possible to harness changing social demands with the evolution of technology and innovation in certain industries. This outcome would avoid the unfavorable consequences for users and industries of a continuing contest for

control of innovation in industries such as beer brewing, where innovation may well be reduced by hostile contestation.

2) Although consumer-innovators are typically motivated by personal interests, in creating innovation value, what in fact consumers achieve in appropriating value from industry incumbents offers valuable lessons for incumbents. Craft brewers such as BrewDog and Sierra Nevada appropriate value by integrating their interests as complementors, innovators, and consumers in the focal task of producing individually crafted beer. Without merely positioning themselves against beer conglomerates, DIY craft brewers set out to first create value in individualized, differentiated beer. They have then drawn new consumers by appropriating value from incumbent beer brands in establishing the greater appeal of individualized, differentiated beer. Incumbents and established institutions may learn an important lesson from this process of value appropriation: apparent “niche” markets may in fact hold substantial consumer appeal and growth potential. This may happen if incumbents consider why those markets exist, and what their consumers want that incumbents do not offer (cf. Proposition 2).

3) Not least, DIY labs can have significant implications for STI education policy. Researchers and their students could learn from the lessons of the persistent survival and success of craft breweries and other DIY labs. This learning would reach beyond new venture creation and address the nature of innovation. In this

paper, the concern for innovation performance by lead users have acted as a key driver in the creation of newly emerged industries as well as in the appropriation of significant value of DIY lab-ventures. As our BrewDog case has suggested, this innovation needs to stay close to and be capable of influencing social trends, as processes for user adoption of market products and services require early and persistent proximity to potential users (Chesbrough et al., 2006). The perpetual, interactive dialogue between BrewDog and its audience suggests how market interaction can produce commercial products and services by drawing on widely available digital technologies in open, digitalized economies. Conglomerates in and beyond craft beer can learn from this approach to market proximity, which we have suggested, is a question of understanding the nature of innovation and their effects in these markets, and not one merely of developing marketing skills (cf. Proposition 3).

The core features of an innovation ecosystem of any major industry may involve a user-led process of social change, as previous research has suggested (see, for example, Von Hippel et al., 2011). By contrast, the principal contribution of this study has been in understanding the emergence, scaling-up, and commercial success of DIY lab-ventures that constitute a rare example of value creation and appropriation in this form of organization. The developing lifecycles of all three of our craft breweries have in turn allowed us to apply a multi-role perspective of

social change in explaining how organizations founded by amateur brewers have created a new market that beer industry incumbents now recognize as high-growth. On one hand, the spate of their acquisitions of craft breweries is a testament to the value creation capability of businesses that were of little interest to incumbents not long ago. On the other hand, acquisitions such as that of Goose Island and the attempted acquisition of Sierra Nevada have suggested how large incumbents have deemed it possible to enter new markets created by DIY labs with a view to value appropriation by acquisition (cf. Proposition 4). Empirical assessment of the performance of both innovation strategies in the ecosystem of DIY labs as well as the development of these strategies in maturing markets created by DIY labs will be important questions posed by this research.

References (All referenced websites were accessed on 12-6-2020)

AB InBev, 2020. 2019 Annual Report. Available at: https://www.ab-inbev.com/content/dam/abinbev/news-media/press-releases/2020/02/final-full-ab-inbev-annual-report/Updated_FYReport2019_EN.pdf

Adner, R. 2017. Ecosystem as structure: an actionable construct for strategy. *J. Manag.* 43(1), 39-58.

Autio, E., Nambisan, S., Thomas, L., Wright, M. 2018. Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems. *Strat. Entrep. J.* 12(1), 72-95.

Baum, J., Korn, H. 1996. Competitive dynamics of interfirm rivalry. *Acad. Manag. J.* 39(2), 255-291.

Bell, F. 2014. Making MadLab: a creative space for innovation and creating prototypes. *Technol. Forecast. Soc. Chang.* 84, 43-53.

Brandenburger, A., Nalebuff, B. 1996. *Co-opetition*. New York: Doubleday.

BrewDog. 2015a. BrewDog welcome video. Available on YouTube:
<https://www.youtube.com/watch?v=FFMOVOSvHq4>.

BrewDog. 2015b. BrewDog - Equity for Punks IV. Available on YouTube:
<https://www.youtube.com/watch?v=fkMbDEtHB0A>.

BrewDog. n.d. Craft beer for the people. Available at:
<https://www.brewdog.com/uk/beers>.

Brewers Association. n.d. National Beer Sales & Production Data. Available at:
<https://www.brewersassociation.org/statistics-and-data/national-beer-stats/>

Von Briel, F., Davidsson, P., Recker, J. 2018. Digital technologies as external enablers of new venture creation in the IT hardware sector. *Entrep. Theory Pract.* 42(1), 47-69.

Brown, L. 2016. A-B InBev finalizes \$100 billion acquisition of SABMiller, creating world's largest beer company. *Chicago Tribune*. Available at:
<https://www.chicagotribune.com/business/ct-megabrew-ab-inbev-sabmiller->

merger-20161010-story.html

Burgelman, R. 1983. A process model of internal corporate venturing in the diversified major firm. *Admin. Sci. Quart.* 28(2), 223-244.

Carpenter, D. 2014. Homebrew safety. *Beer & Brewing*. Available at:
<https://beerandbrewing.com/homebrew-safety/>.

Chen, M. 1996. Competitor analysis and interfirm rivalry: toward a theoretical integration. *Acad. Manag. Rev.* 21(1), 100-134.

Chen, X.-P., Yao, X., Kotha, S. 2009. Entrepreneur passion and preparedness. In *Business Plan Presentations: a persuasion analysis of venture capitalists' funding decisions*. *Acad. Manag. J.* 52, 199-214.

Chesbrough, H. 2006. The era of open innovation. *Manag. Innov. & Chang.* 127 (3), 34-41.

Chesbrough, H., Vanhaverbeke, W., West, J. Eds. 2006. *Open innovation: researching a new paradigm*. Oxford University Press on Demand.

Curtis, M. 2015. Born To Survive – On Brewdog's Beginnings, Growth and Coming to America. Available at:
<https://www.goodbeerhunting.com/blog/2015/7/26/born-to-survive-on-brewdogs-beginnings-growth-and-coming-to-america>

Dedehayir, O., Makinen, S., Ortt, R. 2018. Roles during innovation ecosystem

genesis: A literature review. *Technol. Forecast. Social Chang.* 136, 18-29.

Denicolai, S., Previtali, P. 2020. Precision Medicine: Implications for value chains and business models in life sciences. *Technol. Forecast. Social Chang.* 151 (February, Early View), 12 pages.

Fältström, P., quoted in Murgia, M., Gross, A. 2020. The Battle to Control the Internet. *FT Weekend Magazine* 28/29 March, 15-16.

Ferretti, F. 2019. Mapping do-it-yourself science. *Life Scien. Soc. Pol.* 15(1): 1-23.

Cacciatori, E., Jacobides, M. 2005. The dynamic limits of specialization: vertical integration reconsidered. *Org. Studies.* 26(12), 1851-1883.

Fiske A., Del Savio L., Prainsack B., Buyx A. 2019. Conceptual and ethical considerations for citizen Science in biomedicine. In Heyen N., Dickel S., Bruninghaus. A. Eds. *Personal Health Science. Öffentliche Wissenschaft und gesellschaftlicher Wandel.* Springer, Wiesbaden.

Fox, S. 2014. Third Wave Do-It-Yourself (DIY): potential for prosumption, innovation, and entrepreneurship by local populations in regions without industrial manufacturing infrastructure. *Tech. in Soc.* 39, 18-30.

Gielnik, M., Spitzmuller, M., Schmitt, A., Klemann, D., Frese, M. 2015. “I put in effort, therefore I am passionate”: investigating the path from effort to passion in entrepreneurship. *Acad. Manag. J.* 58 (4), 1012-1031.

Goldenberg, J., Oreg, S. 2007. Laggards in disguise: resistance to adopt and the leapfrogging effect. *Technol. Forecast Soc. Chang.* 74(8), 1272-1281.

Griffiths, A. 2014. DIY labs offer an agile alternative to university-based research. *The Guardian*, 6 June. Available at: <https://www.theguardian.com/higher-education-network/blog/2014/jun/16/diy-labs-exciting-alternative-university-science-research/>.

Grohn, K., Moody, K., Wortel, D., LeClair, N., Traina, A., Zluhan, E., Feuer, G. 2015. Lean start-up: A case study in the establishment of affordable laboratory infrastructure and emerging biotechnology business models. *J. Commercial Biotechnol.* 21(2), 60-68. Available at: <https://doi.org/10.5912/jcb698>

Grossman, K. 2014. “King of craft beer: how Sierra Nevada rules the world”. In Solomon, B. 12-2-2014, *Forbes*. Available at: <https://www.forbes.com/sites/briansolomon/2014/02/12/king-of-craft-beer-how-sierra-nevada-is-winning-the-hops-war/> - 7d693e796727

Grushkin, D., Kuiken, T. Millet, P. 2013. Seven myths and realities about do-it yourself biology. Synthetic Biology Project. Woodrow Wilson International Center for Scholars, Washington, D.C. 27 pages. Available at: <https://www.wilsoncenter.org/publication/seven-myths-and-realities-about-do-it-yourself-biology-0>.

- Helfat, C., Raubitschek, R. 2018. Dynamic and integrative capabilities for profiting from innovation in digital platform-based ecosystems. *Res. Pol.* 47(8), 1391-1399.
- De Haan, F. Rotmans, J. (2018). A proposed theoretical framework for actors in transformative change. *Technol. Forecast. Soc. Chang.* 128 (March), 275-286.
- Helfat, C., Campo-Rembado, M. 2016. Integrative capabilities, vertical integration, and innovation over successive technology lifecycles. *Organ. Sci.* 27(2), 249-264.
- Hodgson, S. 2017. Breakthrough brands: the BrewDog marketing strategy, promotion for punks. Fabrik, 29 November. Available at:
<https://fabrikbrands.com/breakthrough-brands-brewdog-marketing-strategy/>.
- Von Hippel, E., Ogawa, S., De Jong, J. 2011. The age of the consumer-innovator. *Sloan Manag. Rev.*, Fall, 27-35.
- Jacobides, M., Cennamo, C., Gawer, A. 2018. Towards a theory of ecosystems. *Strat. Manag. J.* 39(8), 2255-2276.
- De Jong, J., Gillert, N., Stock, R. 2018. First adoption of consumer innovations: exploring market failure and alleviating factors. *Res. Pol.* 47(2), 487-497.
- Kim, S-H., Bowen, M., Wen, X-H. 2019. The ultimate co-creation: leveraging customer input in business model innovation. *Acad. Market. Sci.* 9 (3-4), 339-356.
- Kuznetsov, S., Taylor, A., Regan, T., Villar, N., Paulos, E. 2012. At the seams: DIYbio and opportunities for HCI, *Proceedings of the Symposium on Designing*

Interactive Systems, Newcastle, June 11-15, 258-267. Available at:

<https://dl.acm.org/doi/pdf/10.1145/2317956.2317997>

Kuznetsov, S., Paulos, E. 2010. Rise of the expert amateur: DIY projects, communities, and cultures. Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries, Reykjavik, October, 295-304.

Available at: <https://dl.acm.org/doi/abs/10.1145/1868914.1868950>

Landrain, T., Meyer, M., Perez, A., Sussan, R. 2013. Do-it-yourself biology: challenges and promises for an open science and technology movement. *Sys. Syn. Bio.* 7 (3), 115-126.

Malerba, F., Orsenigo, L. 1996. The dynamics and evolution of industries. *Industrial and Corp. Change.* 5(1), 51-87.

Massa, L., Tucci, C., Afuah, A. 2017. A critical assessment of business model research. *Acad. Manag. An.* 11(1), 73-104.

Mathias, B., Huyghe, A., Frid, C., Galloway, T. 2018. An identity perspective on coopetition in the craft beer industry. *Strat. Man. J.* 39 (12), 3086-3115.

Meyer, M. 2013. Domesticating and democratizing science: a geography of do-it-yourself biology. *J. Mat. Cul.* 18 (2), 117-134.

Mitsubishi, H., Alcantara, L. 2019. Off the rivals' radar in emerging market segments: non-mutual rival recognition between new firms and incumbents. *Long*

Range Plan. Available at:

<https://www.sciencedirect.com/science/article/abs/pii/S0024630118303406>

More 4 News. 2008. Interview with BrewDog's co-founder, James Watt. Available on YouTube: <https://www.youtube.com/watch?v=l5FQTAV7Z08&t=>

Munro, L. 2005. Strategies, action repertoires and DIY activism in the animal rights movement. *Soc. Move. St.* 41 (1), 75-94. Available at: 10.1080/14742830500051994

Narayanan, V., Yang, Y., Zahra, S. 2009. Corporate venturing and value creation: a review and proposed framework. *Research Policy*, 38(1), 58-76.

Noel, J. 2018. *Barrel-aged stout and selling out*. Chicago: Chicago Review Press.

Radder, H. 2009. The philosophy of scientific experimentation: a review. *Autom. Exp.* 1(2). Open Access. Available at: <https://aejournal.biomedcentral.com/articles/10.1186/1759-4499-1-2>.

Rauffet, P., Bernard, A., Da Cunha, C., Du Preez, N., Louw, L., Uys, W. 2008. Assessed, interactive and automated reification in a virtual community of practice. In TMCE symposium.

Revill, J., Jefferson, C. 2013. Tacit knowledge and the biological weapons regime. *Sc. and Pub. Pol.* 41 (5), 597-610.

Richards, J. 2016. Shifting gender in electronic music: DIY and maker

communities. *Contemp. Mus. Rev.* 35(1), 40-52.

Richards, J. DIY and maker communities in electronic music. In: Collins, N., Escrivan, R. 2017. *The Cambridge Companion to Electronic Music*. 2nd ed. Cambridge: Cambridge University Press.

Ritter, T., Pedersen, C. 2019. Digitization capability and the digitalization of business models in business-to-business firms: past, present, and future. *Ind. Market. Manage.* Early View:

<https://reader.elsevier.com/reader/sd/pii/S0019850119300999?token=92D9B2F671696E2A53E8F03D28A3AE0191CA4FBA9E0B6C4E042BC187D8EB17AF8DE2FE9DE467900838C0216C8F4E9474>

Sarasvathy, S. 2001. Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Acad. Manag. Rev.* 26(2), 243-263.

Scheifele, L., Burkett, T. 2016. The first three years of a community lab: lessons learned and ways forward. *J. Microbio. Biol. Edu.* 17 (1), 81-85.

Seyfried, G., Pei, L., Schmidt, M. 2014. European Do-it-Yourself (DIY) Biology: beyond the hope, hype and horror. *Bioessays* 36 (6), 548-551.

Sjödin, D., Parida, V., Kohtamäki, M. 2016. Capability configurations for advanced service offerings in manufacturing firms: using fuzzy set qualitative comparative

analysis. *J. Bus. Res.* 69 (11), 5330-5335.

Sklyar, A., Kowalkowski, C., Tronvoll, B., Sörhammar, D. 2019. Organizing for digital servitization: a service ecosystem perspective. *J. Bus. Res.* 104, 450-460.

Sleator, R. 2016. DiY biology-hacking goes viral. *Sci. Prog.* 99 (3), 278-281.

Teece, D. 2018. Profiting from innovation in the digital economy: enabling technologies, standards, and licensing models in the wireless world. *Res. Pol.* 47(8), 1367-1387.

Sussan, F., Acs, Z. 2017. The digital entrepreneurial ecosystem. *Small Bus. Econ.* 49(1), 55-73.

Teece, D. 2017. Dynamic capabilities and (digital) platform lifecycles. In: *Entrepreneurship, Innovation, and Platforms (Advances in Strat. Manage. 37)*. Furman, J., Gawer, A., Silverman, B., Stern, S. (Eds.), pp. 221-225. Bingley, Yorkshire, UK: Emerald Publishing. Available at: <https://doi.org/10.1108/S0742-332220170000037008>.

Vallerand, R., Mageau, G., Ratelle, C., Léonard, M., Blanchard, C., Koestner, R., Marsolais, J. 2003. Les passions de l'Âme: on obsessive and harmonious passion. *J. Pers. Soc. Psych.* 85, 756-767.

De Vasconcelos Gomes, L., Facin, A., Salerno, M., Ikenami, R. 2018. Unpacking the innovation ecosystem construct: evolution, gaps and trends. *Technol. Forecast.*

Soc. Chang. 136, 30-48.

Waterworth, S. 2018. Major acquisitions of craft beer could "fragment" industry.

Drinks International.

https://drinksint.com/news/fullstory.php/aid/7920/Major_acquisitions_of_craft_beer_could__fragment__industry.html

Wenger, E., Snyder, W. 2000. Communities of practice: the organizational frontier. Harv. Bus. Rev. 7/8 (1), 139-146.

Wolf, M., McQuitty, S. 2011. Understanding the do-it-yourself consumer: DIY motivations and outcomes. Acad. Market. Sci. 1 (3-4), 154-170.

Wolinsky, H. 2005. Do-it-yourself diagnosis: despite apprehension and controversy, direct-to-consumer genetic tests are becoming more popular. EMBO Reports 6 (9), 805-807.

Zaheer, H., Breyer, Y., Dumay, J., 2019. Digital entrepreneurship: an interdisciplinary structured literature review and research agenda. Technol. Forecast. Social Chang. 148 (August, Early View), 1-20.