

“Growing Mangoes in Iceland”: How Social Media and Online Communities Enable an Antifragile and Propitiously Unpredictable Innovation Model

Dr. Christian DeFeo, Professor Jennifer Harding, Robert Wood

Loughborough University, Loughborough, United Kingdom

c.j.defeo@lboro.ac.uk | j.a.harding@lboro.ac.uk | r.l.wood@lboro.ac.uk

Abstract: Online communities, in combination with innovation contests and social media, can create a context for ground-breaking innovation. Coalesced communications, accompanied by the long-standing "Hacker Ethic", and bolstered by the increasing prevalence of inexpensive tools such as the 3D printer and Raspberry Pi, have re-invigorated an older model of innovation whereby the tinkerer and hobbyist were positioned as a main source of invention. This paper states that this innovation model, following the ideas of Nassim Nicholas Taleb, can be accurately described as “Antifragile”: i.e., it is not solely dependent on the success of one inventor, and can be geared to become stronger through the “failure” of individual projects and the sharing of data. Evidence is also presented which shows that this paradigm can also lead to “happy accidents”, following Morton Meyers' assertion that “Three things are certain about discovery: Discovery is unpredictable. Discovery requires serendipity. Discovery is a creative act” (Meyers, 2011, p. 24). For example, an innovation contest in 2014 hosted by the online electronics engineering community element14 whose original intent was to create a new “networked pollution sensor” instead enabled the development of a Carbon Monoxide detector for Latvian classrooms, a dust sensor for Singaporean streets, and an algal bloom detector for water supplies in the Philippines. As this example suggests, this paper also argues that setting ambiguous goals can inspire the aforementioned “happy accidents” that could potentially “grow mangoes in Iceland”; too tightly defined aims can diminish the potential for this form of innovation.

Keywords: online communities, innovation, social media, hacker ethic, 3d printer, antifragility

Introduction

In June 2014, element14, the online engineering community created and managed by the British-based electronic component reseller Premier Farnell, launched a design challenge entitled “Forget Me Not”. Engineers were tasked with creating “Internet of Things” solutions, which would address gaps in memory. Some of questions that these projects could answer included:

- “Did I leave the door unlocked?”
- “Did I leave the iron on?”
- “Did I water the plants?”
- “Did I feed the cat?” (DeFeo, 2014)

The winner was an engineer from Belgium named Frederick Vandenbosch. He created an “Internet of Things Cat Feeder” which can:

- “easily turn off all appliances when leaving home using a master switch
- “monitor rooms' temperature and ensure the important doors are closed
- “automatically feed the cats and keep track of their habits” (Jethani, 2014)

As this final feature set indicates, there was considerable distance between the initial prompts of the competition, for example, the requirement to feed a pet, and the ultimate solution, i.e., keeping track of cats' habits and turning appliances off easily. The initial prompts also did not provide a specific prescription for what a “winning” solution would be: the first runner up, an engineer from the United States named Jay Morreale, created a system to put modern sensors in a home that was over 100 years old (Jethani, 2014). Solutions were not treated as carefully guarded secrets; rather it was part of the conditions of the competition that the competitors had to blog about their projects (DeFeo, 2014). Competitors often shared code and traded advice during and after the challenge.

This activity was repeated later in 2014 with similar results: this next challenge, entitled "In the Air", was undertaken by element14 in collaboration with Cisco Systems and Texas Instruments. The initial brief to the competitors asked that they create a "connected pollution sensor". As the challenge title indicates, the element14 community and its partners believed that solutions would focus on the measurement of air pollution: however, the projects varied from a dust pollution sensor created by a Singaporean engineer (Swee, 2014) to a carbon dioxide monitor for Latvian classrooms (Alnis, 2014) to an algal bloom detector built by a Filipino inventor (Labutap, 2014).

Serendipity is defined as "an aptitude for making desirable discoveries by accident" (serendipity, 2017). These examples from element14 are incidents of what may be described, perhaps paradoxically, as "directed serendipity", or alternatively "utilitarian serendipity". Despite the connotations of randomness and disorder rather than scientific method, serendipity has long been cited as a means of propitious investigations. In his tome, "Happy Accidents: Serendipity in Major Medical Breakthroughs in the Twentieth Century", Morton Meyers cited how happenstance was critical for the discovery of medical breakthroughs. Penicillin was a leading example; as its discoverer, Alexander Fleming stated in a speech to the Académie de Médecine in September 1945 –

"Have you ever given it a thought how decisively hazard - chance, fate, destiny, call it what you please - governs our lives...had I been a member of a research team, engaged in solving a definite problem at the moment of this happy accident that led me to penicillin, what should I have done? I would have had to continue with the work of the team and ignore this side entrance." (Meyers, 2011, pp. 79 & 80) As Meyers noted, "Discovery is unpredictable. Discovery requires serendipity" (Meyers, 2011, p. 24).

The ability to direct and harness, albeit in an oblique or fuzzy manner, the innovation proffered by serendipity, has been facilitated by a series of developments:

1. **The proliferation of online communities;** New communications technologies, in the words of Daniel Bell's prescient 1973 work, "The Coming of the Post-Industrial Society", have created "new densities, physical and social," which have "become the matrix of human action" (Bell, 1976, p. 189). These contexts provide a means by which ideas can be shared and remixed to create new innovations.
2. **The availability of inexpensive tools:** for example, 3D printers and the Raspberry Pi, allied with open source software allows the home or workshop to build advanced prototypes which were once solely available to major industrial concerns.
3. **The prevalence of open innovation ideas:** as described by Henry Chesbrough, firms and individuals are increasingly alive to the necessity of looking for innovation beyond the walls of a single institution. As Bill Joy of Sun Microsystems stated, "No matter who you are, most of the smartest people work for someone else" (Anderson, 2012, p. 144); the increasing adoption of open innovation ideas are a response to this issue.
4. **The development and spread of the "Hacker Ethic":** as chronicled by the writer Steven Levy, this system of belief prevalent among computer enthusiasts (notable for its emphasis on the creation of "The Right Thing") has spread via the Internet and Maker Movement.
5. **The continued value of competitions:** challenges have long been used to stimulate innovation. Prussia, a predecessor state to Germany, utilised the talents of its engineers via this means to help build its industrial capacity; General Electric utilised a competition in its recent environmental technology challenge.

These developments have had the effect of reinvigorating an older method of invention, whereby the dilettante or tinkerer was a central player in the creation of innovative products as was the norm in the 18th and early 19th centuries. Additionally, this model can be utilised to create, using the term coined by Nassim Nicholas Taleb, an "antifragile" innovation model, i.e., one that is strengthened by "stressors" and what would be called "failures".

Enablers of Serendipitous Innovation

Online Communities

A community is defined as "a social, religious, occupational, or other group sharing common characteristics or interests and perceived or perceiving itself as distinct in some respect from the larger society within which it exists" (community, 2016). Online tools, including social media, are enablers for the formation of communities, however are not communities in and of themselves. Confusion may arise from the utilization of the word "community" in reference to the tools alone. Networked communities can exist in the absence of these tools. For example, in the case of Benjamin Franklin's invention of the lightning rod in the 18th century, according to Professor Lewis Hyde, "the actual experimentation was highly social; the theory came out of a four-man laboratory furnished with materials sent by friends in London" (Hyde, 2012, p. 179). Letter writing and publishing were the connective tissues of this "community"; this was further spread when "Franklin published...detailed instructions for how to how to make a lightning rod" so the wider public could make them for themselves (Hyde, 2012, p. 116).

A similar "community" emerged in the iron and steel industry of 19th century England, as Canadian historian Robert Allen stated: "...there were both regional societies (e.g., the Institution of Cleveland Engineers and the South Wales Institution of Engineers) and national societies (e.g., the Institution of Mechanical Engineers). In 1869 the Iron and Steel Institute was established. It concentrated the presentation of much of the research for that industry. These societies served as forums for the presentation of technical material. Papers were presented which disclosed considerable detail about the design and efficiency of different plants" (Allen, 1983, p. 8).

Stewart Brand's "Whole Earth Catalog" is also a leading example of a networked community that existed prior to the existence of modern online tools. This catalog, which was published between 1968 and 1971, was intended to provide "tools for living" for those who had a survivalist or "New Age" mentality. The first edition was written by Brand himself; it was 61 pages long; in contrast, the final 1971 version was 448 pages. This substantial expansion was only possible because "(Brand) called for readers to suggest and review items for the Catalog, offering them ten dollars for an accepted evaluation" (Turner, 2006, pp. 89-90). Furthermore: "Those who first suggested or reviewed an item would have their name listed in the Catalog" (Turner, 2006, p. 90). The practical effect of establishing this community was significant. According to Fred Turner, "...in this way, Brand accomplished several entrepreneurial purposes: he enlarged the range of the Catalog's contents by appealing to "experts" outside his organisation: he increased his readers' sense of commitment and involvement. He also increased the Catalog's own value to the community it served. In the process, he invited the reader to become a producer of economic value, a contributor to a textual community and still a buyer of the Catalog." (Turner, 2006, p. 90)

Online tools have enabled greater "densities" (to use Bell's term) of connections to form and proliferate into wider communities of practice. For example, a Facebook page can be set up within minutes and potentially reach, according to Statista, 1.79 billion monthly active users (Statista, 2017). Electronic component retailers including Premier Farnell, Digikey and RS Components have all set up online communities (element14, maker.io, and DesignSpark, respectively) in order to create and harness these densities. The pervasiveness of these densities are enabling access to what Clay Shirky has called "the cognitive surplus", specifically, "the free time of the world's educated citizenry as an aggregate" (Shirky, 2010, p. 9). This, according to Shirky, represents a significant amount of labour: "...let's start with Wikipedia. Suppose we consider the total amount of time have spent on it as a kind of a unit....that would represent something like 100 million hours of human thought..." (Shirky, 2010, pp. 9 & 10). Communities, in Shirky's view, give utility to this surplus, "the cognitive surplus is not simply trillions of hours of free time spread across two billion connected individuals. Rather, it is communal; we must combine our surplus free time if it is to be useful" (Shirky, 2010, p. 97).

Inexpensive Tools



Figure 1: Elliot 405 Computer Delivered at Norwich City Council, 1957

In 1957, Norwich City Council took delivery of its first computer; it was an Elliot 405, and cost £125,000 priced in 1963 pounds (Lavington, 2011, p. 631). Its feature set included "bulk storage on magnetic film and other features designed for commercial data processing" (Norfolk Record Office, 2016). In contrast, today's Raspberry Pi 3 single board computer, which has a footprint not much larger than a credit card, has a "1.2GHz 64-bit quad-core ARMv8 CPU", and in-built WiFi and Bluetooth capabilities (Raspberry Pi, 2017). Its present price point, according to Amazon.co.uk, is £31.49.

This simultaneous drop in price and increase in power and functionality is reflected in a number of fields; one of the most visible examples is the advent of the 3D printer. Components, which once could only be crafted in an industrial setting, now can be produced in a machine that is no larger than a conventional printer. Tools such as a mill and a laser cutter are now available in workshop settings; costs of tools such as these, has by one estimate dropped by "95-98%" (Hatch, p. 85, 2013).

Furthermore, these tools are supplemented by free software which rivals that produced by commercial concerns; for example, the open source Pocket Sphinx software package developed by Carnegie Mellon University provides voice control functionality similar to Microsoft's Cortana, Apple's Siri and Amazon's Alexa (GitHub, 2016).

Open Innovation

The definition of innovation is "(the use of) a new idea or method" (innovation, 2016); this is distinct from "invention". Its definition is "something that has never been made before, or the process of creating something that has never been made before" (invention, 2016). An invention may sit idle; innovation denotes that it is a change that is actively implemented.

The innovation model which has dominated much of the 20th century led to the creation of research labs by large firms such as Xerox's Palo Alto Research Centre and Bell Labs. Their function was and is to develop new products, which then could be deployed by the companies which provided the funding. Any innovation was treated as a carefully guarded secret, the returns on which were to be maximized as much as possible. However, as knowledge has proliferated via the new densities, and the costs associated with developing new products has decreased, there is a growing recognition that firms need to access innovation happening outside their boundaries. This was articulated in Henry Chesbrough's 2006 tome, "Open Innovation: The New Imperative for Creating and Profiting from Technology"; in this work, he stated that companies should work with universities and start up firms (Chesbrough, 2006). Later, firms such as General Electric specifically adopted Open Innovation approaches as per Chesbrough's prescriptions (Chesbrough, 2012).

Open Innovation's penetration of the innovation landscape is not limited to Chesbrough's efforts: it comes in a number of guises and has existed for centuries; the Canadian historian Robert Allen stated in a 1983 paper

that the English iron industry of the 19th century had benefitted from "collective invention", which involved at least a tolerance to knowledge sharing, and even outright copying (Allen, 1983). Eric von Hippel referred to "Democratizing" innovation in his 2006 book in which called for more "open" and collaborative approaches to innovation (Von Hippel, 2006).

The Hacker Ethic

The "Hacker Ethic" was best summarized by the writer Steven Levy in his work, "Hackers: Heroes of the Computer Revolution". There are two discrete parts of this way of thinking, the primary element being an impulse to explore and a willingness to execute upon it. As Levy stated, "if we all acted on our drive to discover, we'd discover more, produce more and be in control of more" (Levy, 2010, p. 86).

Just as important is a desire to produce what Levy calls "The Right Thing". As he clarifies: "The Right Thing implied that to any problem, whether a programming dilemma, a hardware interface mismatch, or a question of software architecture, a solution existed that was just...it. The perfect algorithm. You'd have hacked right into the sweet spot, and anyone with half a brain would see that the straight line between two points had been drawn, and there was no sense trying to top it" (Levy, 2010, p. 69).

This way of thinking, which was initially limited to a subculture of computer programmers at the Massachusetts Institute of Technology in the 1950's, has become more pervasive and communal. It spread in part due to the sixties "hippie" subculture, as exemplified by a group entitled Community Memory who set up a terminal to create an "electronic community" in San Francisco. As Levy further explains: "...according to a handout (Community Memory) distributed, the terminal was 'a communication system which allows people to make contact with each other on the basis of mutually expressed interests, without having to cede judgement to third parties.' The idea was to speed the flow of information in a decentralised, nonbureaucratic system....By opening a hands-on computer facility to let people reach other, a living metaphor would be created, a testament to the way computer technology could be used as guerilla warfare for people against bureaucracies" (Levy, 2010, p. 152).

This ethic is also evident in what has been labelled "The Maker Movement"; this Movement can be said to be a combination of hacker ideas with the principles of the economist E. F. Schumacher. As he articulated in his book, "Small is Beautiful: A Study of Economics as if People Mattered": "We need methods and equipment which are: cheap enough so that they are accessible to virtually everyone, suitable for small-scale application; and, compatible with man's need for creativity." (Schumacher, 1993, p. 21) This shift, Schumacher states, would yield an alteration in the economy in which "There would be six times as much time for any piece of work we chose to undertake - enough to make a really good job of it, to enjoy oneself, to produce real quality, even to make things beautiful" (Schumacher, 1993, p. 125). The value of this has already been recognized by companies such as Levis Jeans, who turned to an individual craftsman named Alice Saunders to create "\$165 one-of-a-kind tote bags" which Levis has promoted and sold with its "Levis' Makers tag". (Voigt, 2014)

Competitions

Competitions, also known as "challenges", have long been a lever of innovation. The so-called "father of Prussian business promotion", Christian Peter Wilhelm Friedrich Beuth, founded a club in 1821 entitled the "*Verein zur Beförderung des Gewerbefleißes*" (translated as the "Club for the Promotion of Industriousness"); this organization held annual contests to find "solution(s) for a particular technical problem or industrial development" (Runge, 2014, pp. 163 & 164).

Beginning in 2010, Henry Chesbrough worked with General Electric in the creation of the "ecomagination" challenge, a "\$200 million innovation experiment where businesses, entrepreneurs, innovators, and students shared their best ideas on how to improve our energy future" (Chesbrough, 2012, p. 140). These proposals were submitted to "a panel of GE executives, leading academics, and technologists to evaluate the viability of ideas" (Chesbrough, 2012, p. 140).

This activity created more innovation than GE and its partners had anticipated. As Chesbrough notes: "GE began receiving ideas from people even before the announcement event itself had concluded. At the event,

nearly 4,000 entries were received, with 1,600 companies and institutions participating, from 160 countries around the world. Many of these were not the "usual suspects" (Chesbrough, 2012, p. 146). Furthermore, "Each reviewer had to deal with 10 times more submissions than initially expected. And some of the ideas received were unconventional, to say the least" (Chesbrough, 2012, p. 150).

Similarly, competitions held by element14 and its partners, including the aforementioned "Forget Me Not" and "In the Air" challenges have a stimulating effect on innovation, leading to the near-spontaneous development of inventions ranging from an internet of things cat feeder to an algal bloom detector for water supplies.

Effects

Return of the Dilettante

A dilettante is defined as a "a person who takes up an art, activity, or subject merely for amusement, especially in a desultory or superficial way; dabbler" (dilettante, 2017). The new paradigm has re-enabled their historic involvement in innovation.

Nassim Nicholas Taleb has stated a strong preference for amateurs participating in the inventive process: as he wrote, "Unlike dilettantes, career professionals are to knowledge what prostitutes are to love" (Taleb, 2013, p. 331). Taleb also cited the work done by "amateur and tea-drinking English clergyman" (Taleb, 2013, p. 418) in furthering the Industrial Revolution: "An extraordinary proportion of work came out of the rector, the English parish priest with no worries, erudition, a large or at least comfortable house...and an abundance of free time...the enlightened amateur, that is" (Taleb, 2013, p. 226).

Chris Anderson noted also how much work arose from these "dilettantes"; had stated that had he not been open to working with them, he would have missed the talents of "the graphics artist working for the Brazilian ad agency, the guy who runs the Italian ambulance radio company, the retired car-dealership owner, the Spaniard working for an energy company in the Canary Islands..." in designing advanced drones (Anderson, 2012, p. 149).

Antifragility

As per Taleb, "Antifragility" is defined by systems which "benefit from shocks; they thrive and grow when exposed to volatility, randomness, disorder, and stressors and love adventure, risk and uncertainty" (Taleb, 2013, p. 3). Taleb visualized systems as existing along a spectrum –

FRAGILE – ROBUST – ANTIFRAGILE (Taleb, 2013, p. 20)

In Taleb's view, the moniker of "fragile" applies to systems that are vulnerable to or threatened by shocks. Robust systems are those that can withstand significant ruptures. Antifragile systems, by contrast, gain from "stressors". Taleb has argued that these "stressors" are necessary for innovation to take place; as he states: "How do you innovate? First, try to get in trouble. I mean serious, but not terminal trouble. I hold - it is beyond speculation, rather a conviction - that innovation and sophistication spark from initial situations of necessity; in ways that go far beyond the satisfaction of such necessity (from the unintended side effects of, say, an initial invention or attempt at invention)" (Taleb, 2013, pp. 41 & 42). Furthermore, he adds, "The excess energy released from overreaction to setbacks is what innovates!" (Taleb, 2013, p. 42)

However, the biases of the modern shareholder economy are geared towards risk avoidance; paradoxically, this evasive propensity may increase the fragility of the organization. This bias has effects on nations; it has been reported by academics at the University of Sheffield that research and development investment in the UK is now less than 2% of GDP, a decline which is mainly due to curtailed expenditure by firms in order to maintain their balance sheets and thus reduce the perception of investment risk (Jones, 2013).

The utilization of online communities in combination with the hacker ethic and obliquely targeted competitions, however, provides a container for "failure" which can strengthen the whole. This can be done

cheaply; for example, if a Raspberry Pi computer is made inoperable by an experiment, the cost of replacement is limited to \$35. The hacker ethos of sharing and the utilization of online communities, however, also provides a context whereby the "failure" can be reported. This "failure" does not stand alone, rather, other engineers can provide suggestions as to what went wrong, and record what led to the mishap. Furthermore, sharing creates impetus for further sharing, not only of problems but also of achievements. As Chris Anderson noted:

"When you share, community forms, and what community does best is remixing, exploring variation in what a product can be and in the process improving it and propagating it far faster than any individual or single company could." (Anderson, 2012, p. 74)

As time goes on and both failures and successes accrue, the collective inventive efforts of the online community are strengthened; in a direct sense, the innovative system has become "antifragile". Stressors, shocks, setbacks all have an integrating, dynamic function rather than create disruption to the system. For example, the existence of the "bug report" in Linux, an open source, community developed operating system is an opportunity for its improvement. For the developer of a proprietary system, it is a product weakness that diminishes the value of the product and harms the organization.

Discussion

Serendipitous innovation availed by the rise of online communities, inexpensive tools, open innovation principles, the hacker ethic and innovation contests has revived an older innovation model in which the dilettante and hobbyist was a key source of invention. Also, it can potentially enable an antifragile research and development model, which not only tolerates "failure" but grows stronger by its occurrence. However, the model contains fragilities which merit consideration.

In 2015, element14 launched yet another design challenge entitled "Vertical Farming"; the intention was for competitors to create connected solutions that would enable growing lettuce plants in indoor environments (Element14.com, 2015). The winning solutions ranged from a "Modular Farm Project" to an "Automated Green House": however, the limitations of the challenge, specifically, only allowing the competitors to grow lettuce, may have hindered the serendipitous innovation that could have been generated. As the "Forget Me Not" and "In the Air" challenges showed, maintaining some leeway in the challenge specifications allowed for a wider variety of solutions; had this principle prevailed in the "Vertical Farming" challenge, there would have been more room for creativity to expand the possibilities availed by the contest, indeed, a solution may have been created that could, for example, grow mangoes in Iceland.

A further weakness is its reliance on individual motivations to participate in the model; as Levy wrote about hackers: "...the best way to get hackers to do things was to suggest them, and hope that the hackers would be interested enough" (Levy, 2010, p. 115). However, what is "interesting" is not something that can always be anticipated and is subject to the vagaries of fashion.

An additional (and perhaps the most significant) fragility of the model is that it requires an acceptance of project failure; online communities may consistently deliver innovative solutions, as the examples from element14 suggest. However, this is not a foolproof process; business planning in a shareholder economy displays an aversion to ambiguity and a tendency to see failure as waste rather than part of a strengthening process. In short, perhaps paradoxically, there are inherent difficulties in building antifragile systems when "failure" is seen in isolation, rather than as part of invigorating whole.

Further research will be required to ascertain the optimal modes of deploying this innovation model; how much can serendipity be directed? Are there areas of endeavor, e.g. electronics engineering, that are particularly suitable for this method? Are there fields, e.g. pharmaceuticals, for which this model is completely inappropriate? What are the motivations of the participants, and how can this understanding be used to optimize the model? How can companies adopt this model, best appropriate the knowledge accrued and satisfy the requirements of their shareholders?

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