Dodging Freezie Doom:

Applying Foresight to Inventive Work

by
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Submitted to OCAD University
in partial fulfillment of the requirements
for the degree of
Master of Design
in
Strategic Foresight and Innovation
Toronto, Ontario, Canada, August 2011

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Elizabeth Hassan

Abstract

Based on case studies and literature, this work profiled the modern independent inventor, and developed strategies for improved success rates, including the implementation of foresight work and the creation of lower risk funding models. Both elements were proposed as a means to mitigate cognitive bias and information asymmetries, factors which have historically prevented inventor success. These strategies were combined through the proposed development of an optimized open innovation tool, the parameters of which were outlined in this paper.

Acknowledgements

Thank you to:

Helen Kerr, for her thoughtful guidance

Alexander Manu, for being so inspiring and supportive

Shelley Simmons, for sharing her space and insight

Douglas Reid, for his assistance in mapping out the early stages

and most of all to my sister Tara, for all of her endless support during my time at OCADU

Dedication

To my parents, Judy and Fred.

I never would have been able to go to “art school” without their support over the last 2 years, and I wouldn’t have been curious about this topic without Dad’s constant urging to “be a trendsetter!” rather than a follower.

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Introduction

This work started, interestingly enough with a reality TV show on the CBC. It's called "Dragon's Den" and is about a band of venture capitalists receiving pitches by small entrepreneurs. In this episode was an automotive engineer who quit his job and mortgaged his house to support his pursuit of his "great idea": a magnetic device that attached to your fridge and cut the ends off "freezies"[1].

The problem that this engineer was trying to solve with his device was that his kids love freezies, but are too young to use scissors to cut the end of the tube themselves, and once cut, the end of the tube can become litter. His device cuts the freezie and retains the cut ends for later disposal. The "dragons" all agreed that the device itself was attractive and well-made; it functioned as intended.

They asked him why he had not approached the freezie manufacturer to sell his device as a promotional item. He indicated that he had indeed spoken with the "freezie

1 Freezies are a colloquial name, like Kleenex, belonging to the Kisko brands of freeze pops, but commonly referring to freeze pops of all brands. Freeze pops are frozen, flavoured ice in a plastic tube. They're a convenient and less messy alternative to popsicles or sno-cones.

company", but they rejected his device, since it was too large to fit in their current packaging. The dragons saw no other market for his product and therefore rejected his request for capital; the engineer and his family walked away with nothing, having already lost their house and income.

Watching the show, you could feel this man's heartbreak. He had staked his family's financial well-being on an idea that failed in spite of his own technical aptitude, it failed because of his inability to see the ecosystem surrounding his product: how it would be distributed and who would buy it. It was a fundamental failure of foresight.

I am a mechanical engineer by training and I often think of "great ideas" to solve problems that I encounter, as do many of my colleagues. It's a natural part of having a technical background, when you encounter something that doesn't work as intended you mentally cycle through ways it could be addressed.   But what happens when an idea feels so compelling that it forces you to make the jump from it being an idea to being a prototype or product? It might make you rich and famous like Steve Jobs, the archetype of the nerd-turned-inventor-turned-millionaire. Or it might turn out like the man in the freezie example, at a financial dead end. The fear of ending up in "Freezie Doom", as I call it, prevents many talented engineers, designers and lay people from releasing their great ideas.

In the case of the freezie guy, and many other inventors, there are two ways doom could have been dodged:

1) He could have invented something better.

2) He could have risked less.

This paper addresses both the problem of better inventions and lower risk for individual inventors, while accounting for the cognitive characteristics of both companies and inventors. The aim is to outline how open innovation can encompass these goals and optimize success for both parties.

Chapter 1: How do inventors work?

The inventor as a distinct, different sort of person from the general population is a pervasive and partially accurate archetype. If asked imagine an inventor, most people would describe the Doc Brown character from the Back to the Future movies: eccentric, crazy hair, isolated. This image is becoming less accurate, as described in the following chapter, although inventors do view things differently and are informed by criteria and circumstances that are distinct from business people.

What is an individual inventor?

Individual inventors is defined by the United States Patent and Trademark Office (USPTO) as a patentee whose patent is held by an individual. The interchangeability of patentee and inventor is common throughout the literature; part of the reason for defining a inventor this way is that they are relatively easy to track, since their patent filings contain a wealth of data. Some dictionary definitions restrict the term inventor to people who invent as an occupation, although it should be noted that most independent inventors only have one, or a few patents, with a few prolific inventors as an exception (Göktepe, 2007, Åstebro, 2003).

The preferred domains of individual inventors

Figure 1 illustrates the relative proportion of patents granted by the United States Patent and Trademark Office (USPTO, 2010) to individual inventors, in the year shown. The total number of patents granted to individuals fluctuates year to year, over the period for which data is available it ranged from 25 365 to 44 297.

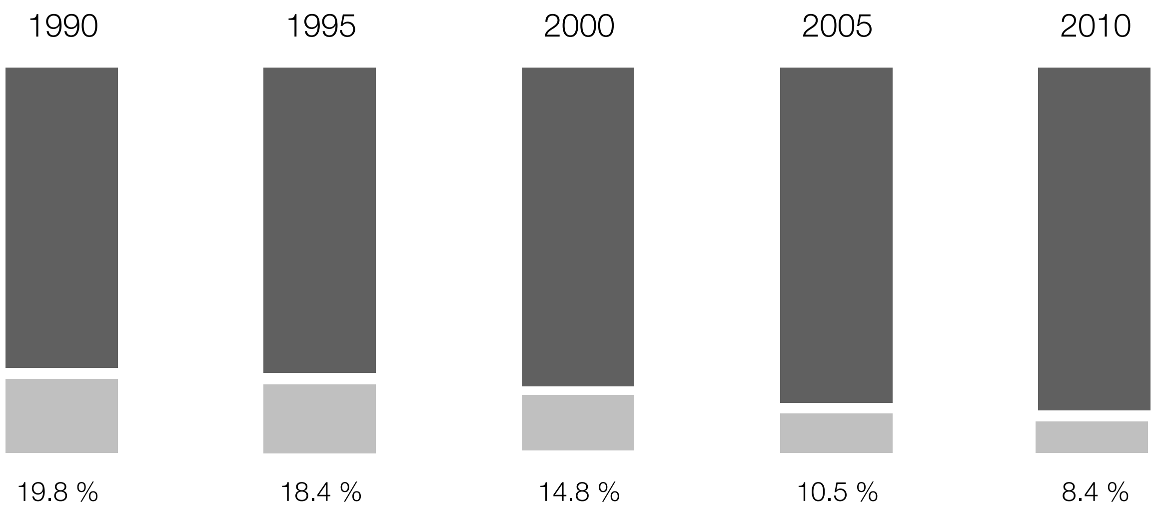

Figure 1: Percentage of patents issued to independent inventors, 1990-2010. Data from USPTO.gov, US patents only.

Åstebro (1998) suggested that the overall proportion of individual patentees over the time interval 1983-1996 was relatively stable, 13%, but more recent data from the USPTO suggests that patenting by individuals has fallen off by about half over the last 20 years.

In the invention literature much has been made of the distinction between what the individual inventor tends to patent and what the corporate inventors tend to patent. In particular, Åstebro's papers assert that individual inventors preferentially solve problems that they encounter, mainly household and leisure products, his data suggests 28% and 15% respectively (Simons and Åstebro, 2010, Åstebro and Dahlin, 2003, Åstebro et al, 2007, Åstebro and Simons, 2003). However, a review of the most recent data for independent inventors published by the USPTO suggests that while these domains are still popular (17% and 5%), and independent inventors are still over-represented in these fields, the fastest growing areas for individual inventors are in data processing and electronics. Growth in these areas mimics the wider patenting trends, as shown in Figure 2; they are the fastest growing areas for corporate patenters as well.

One potential reason for the difference between the USPTO data and the Simons/Åstebro data is that the USPTO data covers all unaffiliated inventors granted patents in the USA, from 1990-2010. The Simons/Åstebro data covers from 1994-2001, and only those who approached the Canadian Innovation Centre for assistance, whether they were successful or not. The growth in electronics and data could reflect the growing familiarity of lay people with technology. It could also reflect that successfully patenting a physical device may be more difficult, as so much prior art already exists. The ability to patent data processing regimes is relatively new, and hence may be more fertile ground, particularly since they may be lower in prototyping and development costs.

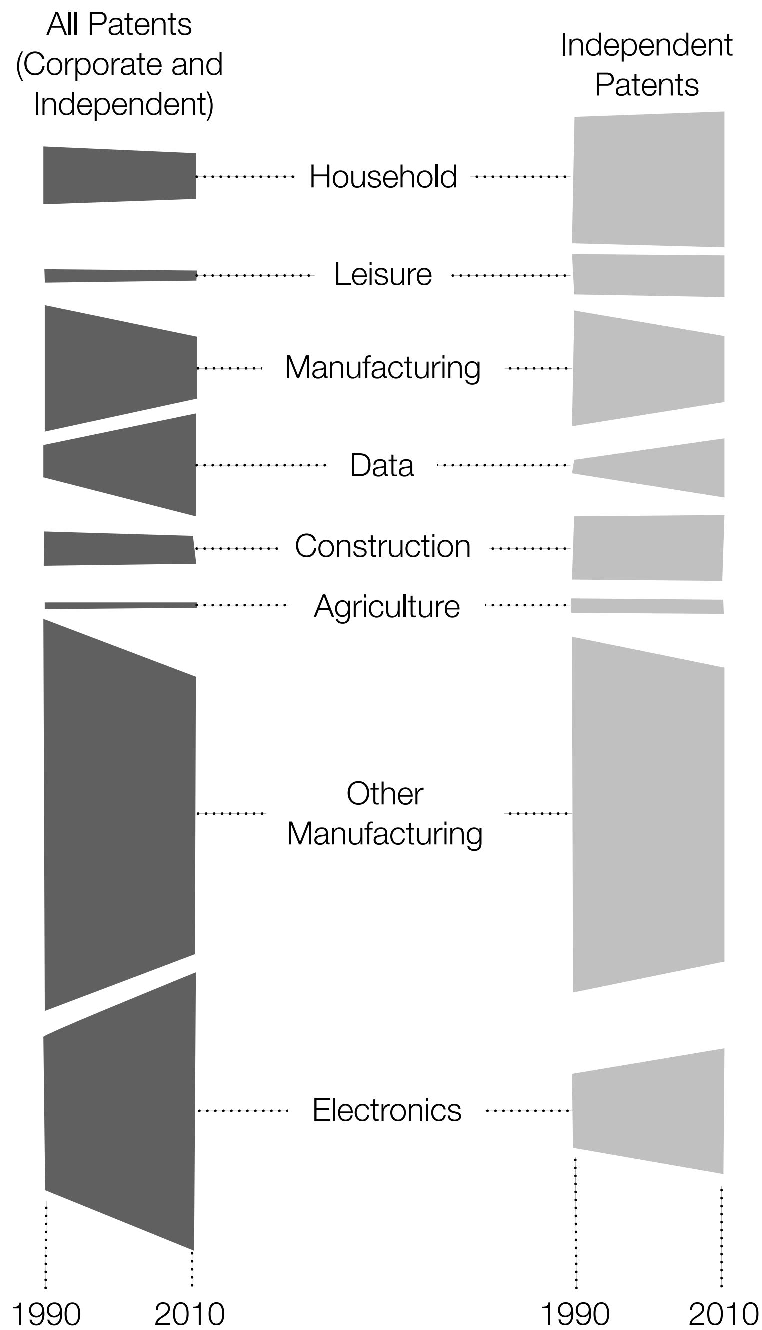

Figure 2: Patenting by sector for all patentees, and independent. The width of the bar indicates the percentage of patents filed in that sector. Bars that narrow show decreasing patent activity, bars that widen show increasing patent activity. Data from USPTO.gov, US patents only.

What makes an inventor?

The idea of a garage inventor working away, by tinkering rather than expertise is the typology most commonly associated with "independence". It is unclear how many inventors are true garage inventors, although based on the rising education levels of inventors and the increasing patent activity in high technology fields, this group appears to be shrinking.

Most inventors are at least slightly better educated than average (Parker et al 1996, Amesse, 1991, Giuri et al 2006), and they often draw on their own technical expertise gained through work as inspiration for their inventions. Their work also may expose them to private or tacit knowledge preferentially,as in the case of the academic inventors profiled by Göktepe (2007). For example, Steve Wozniak was an engineer at HP (Hewlett-Packard) prior to starting Apple with Steve Jobs; Larry Page and Sergey Brin were PhD candidates in Computer Science at Stanford prior to starting Google (Battelle, 2005).

Göktepe (2007) reports that inventors are more "liminal" than other people they work with, his definition of liminal is someone who work at the margins of domains and straddle domain boundaries. The notion of inventors drawing on diverse experience is reinforced by Mieg (2010). Anecdotally, Steve Jobs reports that a calligraphy class that he sat in on after he dropped out of college resulted in Apple computers having beautiful typefaces (Jobs, 2005). Cohen and Levinthal (1990) advanced the theory that possession of existing knowledge made the acquisition and processing of other knowledge easier, which was reinforced by Audia and Goncarlo (2007).

Why do people invent?

The motivations of individual inventors and of entrepreneurs in general have been heavily debated, Shane (2003) outlines the conflict between scholars who chose to focus on individual characteristics, such as optimism, and those who chose to focus on environmental aspects, such as the availability of venture capital. Shane proposes a hybrid model, and suggests that for entrepreneurs at least, it’s a function of a perceived opportunity combined with a combination of traits resulting in an inclination towards starting a new venture. The concept of alertness to opportunities being a key differentiator between entrepreneurs and non-entrepreneurs has also been explored by Gaglio and Katz (2001), Baron (2004), Schumpeter (1947), Braunerhjelm and Svensson (2008), Mieg (2010).

The initial paradox confronted is that almost no one, including inventors, wish to be entrepreneurs, (Astebro 1998, Parker et al 1996) but between 83% (Simons and Åstebro, 2010) and 90% (Amesse, 1991) choose to commercialize their own inventions. The expressed sentiment against new venture formation is possibly the result of the overwhelming statistics regarding the high rate of failure of new ventures; and that self-employment is linked to a 35% decrease in lifetime earnings (Astebro 2003, Hamilton 2000). It seems rational that employed people would wish to stay employed rather than commercialize their inventions.

So why do they choose to commercialize their inventions? The business literature reports that it is due to excess optimism and overconfidence, resulting in a belief that they will be the exception to the statistics, and be the one person who beats the very skewed odds (Åstebro & Adomdza, 2004, Baron, 2004, Arabsheibani et al, 2000, Lowe and Ziedonis, 2004). It is possible that entrepreneurs are optimistic as a group, however; this finding should be interpreted with caution. Firstly, most inventors are men (between 89% (Åstebro, 1998, Canadian data) and 97% (Giuri et al 2006, European data), and men as a group are more optimistic than women (Arabsheibani, 2000). Secondly, all people who start ventures tend to be more optimistic than the remainder of the population, regardless of whether that venture is based on an invention or not (Arabsheibani et al 2000).

The characteristics of what is recognized as an opportunity is highly individual and context dependent. Studies by economists of the behaviour of inventors commercializing their own intellectual property have investigated the seeming irrationality of inventors. As a group they are widely reported as being more optimistic, over-confident, risk-seeking, opportunity seeking and having higher self-efficacy than the general population (Åstebro & Adomdza, 2004, Baron, 2004, Arabsheibani et al, 2000, Lowe and Ziedonis, 2004). A potential explanation for the disconnect between rational economic behaviour and the actual behaviour expressed by inventors is that "opportunity" means something different to an inventor than it does to an economist or business person. I would propose that the argument that entrepreneurship by inventors is driven by optimism is incomplete because it does not incorporate both the different viewpoint of the inventor and the differential in circumstance, between the presumably rational corporations and the allegedly irrational inventor.

Different Criteria

Many inventors don't intend to make a lot of money off of their inventions. Indeed A. E. Moulton, a well-known British inventor said in 1966 that: "I am wary of the inventor who is always overemphasizing the money reward that could result from the exploitation of his idea. Very often the desire for money can invoke wishful thinking around an idea which is in fact invalid." (VADS, 1966)

In fact, the Lemelson-MIT report (2003) indicates that many inventors feel that it's some kind of a primal urge that drives them, a "compulsion to create", a notion that is reinforced by anecdotal stories about great individual inventors like Nikola Tesla, whose concepts came to him in dreams and visions (Tesla, 2007).

A study of Swedish academic entrepreneurs by Göktepe (2007) reported that for many of the inventors the work had more to do with "keeping an idea alive", personal achievement or accruing benefits for their research group at their institution, and less to do with financial gain. Similarly, a study of user-inventors by Chatterji and Fabrizio (2008) indicated that those inventors were addressing a latent need that they themselves experienced but had not yet been identified by a manufacturer. Some user-inventors choose not to patent or commercialize because they wish to keep their invention for themselves or their company as a competitive advantage (Baldwin and von Hippel, 2009).

They may also be exposed to tacit or private knowledge that leads them to arrive at a different evaluation than someone with less technological knowledge. Åstebro (2003) stated that "technological opportunity is an important explanation of the incentive to innovate and that previous research might have underestimated its importance by relying on vague and all-encompassing definitions of demand".

The Simons and Åstebro (2010) paper indicates that decisions to abandon an invention are dominantly rational, financial decisions, but the anecdotal data suggests that the motives are more complicated than an economic model would indicate (Hamiltion, 2000, Frey and Benz, 2003).

Different Circumstances

Comparing an individual's behaviour to that of a corporate entity is complicated by the differences in how they fund invention activities and their financial pressures. Åstebro (1998) attempted to compare the decision-making of individuals and companies with respect to commercialization of new inventions and found that individuals tended to persist longer, but that their cost of development is relatively small compared to a company, approximately 1/8th (Åstebro, 1998). Combining these lower development costs with potential tax incentives, and non-pecuniary benefits like independence, an inventor might be able to develop a prototype further before reaching the point of giving up (Lowe and Ziedonis, 2006) .

Additionally, commercialization is often seen as a last resort after companies have turned them down; the inventor of the Dyson vacuum commercialized both the cyclonic vacuum and a ball-wheeled wheelbarrow after both were initially turned down by manufacturers and retailers (Roy, 1993). This highlights the difficulties of an inventor getting an audience with an established company, even for a product that isn't particularly revolutionary, since the people Dyson sought to meet with already made and sold conventional vacuums. Another well-known example is Google; Larry Page and Sergey Brin attempted to license their algorithm to every search company in Silicon Valley and they were turned down by every one, leaving them to commercialize the technology themselves (Battelle, 2005). Whether this is a case of poor communication on the part of the inventor, or shortsightedness on the part of the company isn't always clear, but it illustrates the sometimes vast information asymmetry inventors must surmount to license their technology. This justifies the perception that it is easier to self-commercialize, even if it is not their original desire.

Conclusion

The current business literature perpetuates several myths about inventors that appear to be dissolving. The modern inventor is more educated and more aligned with current industry trends than in the past. Rather than appearing irrational, my perception is that their behaviour is in response to challenges in the commercialization environment. Some of these challenges come in the form of a lack of foresight on the part of companies they are working with, or poor communication by the inventor. Overcoming these information and perspective asymmetries would be a critical function of any tool aiming to engage inventors and industrial partners.

Chapter 2: How do you have better ideas?

Common definitions of invention usually contain elements of:

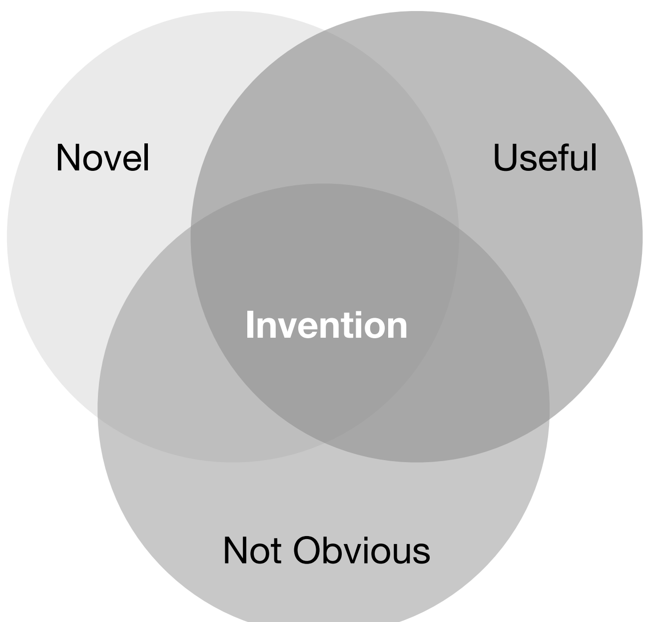

Figure 3: Venn diagram illustrating the essential elements of invention: novel, useful, not obvious.

Therefore, the ultimate invention would maximize all 3 criteria. This chapter discusses these criteria in detail and outlines their relationship to foresight activities.

Novel

Novelty is a prevalent theme throughout the literature, but the precise definition is highly dependent on context, as it's role. Schumpeter is widely quoted as identifying that entrepreneurial opportunities arise from "new information", and is so widely cited in this area that disruptive innovations are sometimes termed "Schumpeterian" (Shane, 2003). However, Shane also notes that an opportunity can arise out of a "new means-end framework", but new is defined relatively broadly, for example, the same restaurant at a different intersection. Encinar and Munoz (2006) notes that novelty can't come purely from a "logical unfolding" of an idea, and therefore can't be predicted, although the paper also acknowledges that a logical unfolding is a somewhat subjective construct, what is logical to one person is illogical to another.

Is disruptive innovation novelty?

A patent or invention itself can't be a disruptive innovation on it's own, Schumpter (1947) makes the distinction between invention, which can potentially have no economic benefit and innovation, which can potentially have no new information. A patent or invention which is not commercialized is not an innovation; Manu (2010) clarifies that innovation occurs at the moment of adoption by consumers, or "at the moment when human behaviour changes".

Many inventors would like to invent something that is the "next" Google or the "next" Facebook: broadly accepted, transformational technologies. These are referred to in the literature as "disruptive" or "discontinuous" technological change, but the definitions associated with he terminology vary widely and appear to be highly context dependent. The original wording of disruptive and incremental innovation is credited to Clayton

Christenesen (2003), but has been reinforced and built upon by numerous other authors, as summarized in Table 1 below.

	Incremental	Disruptive
Christensen (quoted by Danneels, 2004)		simpler, cheaper, more reliable and convenient than established
Daneels (2004)		"Change the basis of competition because they introduce a dimension of performance along which products did not compete previously"
Shane (2003)	Kirznerian: opportunities come from preferential access to information	Schumpeterian: opportunities come from new information
Tushman and Anderson (1986)	Competence-enhancing opportunities: builds on existing skills and know how	Competence-destroying opportunities: require fundamentally new skills and competencies
Encinar and Munoz (2006)	Growth (driven by logical unfolding)	Development (driven by novelty)
Samli and Weber (2000)	Line extensions	Breakthrough products (unique customer benefit, distinct from existing portfolio)
Audia and Goncalo (2007) (quoting Kirton)	Adaptors: do things better within established framework	Innovators: do things differently by breaking with accepted modes of thought
Manu (2007)	Adding new technology to old problems	

Table 1: Summary of relevant definitions relating to incremental versus disruptive innovation

All of these authors are writing from a business perspective, and agree that disruptive technologies create new markets. This makes sense, since innovation occurs at adoption, not at invention. Tushman and Anderson (1986) propose that "Major technological innovation represents technical advance so significant that no increase in scale, efficiency, or design can make older technologies competitive with the new technology”. However, this definition could still be interpreted as describing the phenomenon of products being replaced with other products filling nominally the same function, and is grounded in the technology being the transformational element, not adoption. Shane (2003) notes that Schumpeterian/disruptive opportunities tend to result from changes in the ecosystem, such as a new technology, new policy or social and demographic change. A widely cited example is the microwave oven: the technology existed for years but was not widely adopted until women entered the workforce, requiring quick meals.

All of the literature reviewed identifies disruptive technologies post-hoc. For example, Christensen (2003) uses curves to determine when a disruptive technology has taken over; the use of S-shaped curves to describe technology adoption were also present in Chandy and Tellis (2000). Some of the curves refer to units sold, others the revenue generated. However, both approaches might be flawed, a low end disruption might take a long time to “disrupt” based on revenue, for example the Flip video camera retailed for much less than other digital camcorders, so although many units were sold it would still appear to be not yet “disruptive” based on revenue. Or a disruption could take the form of something longer lasting, for example, unit sales of LED bulbs could be less than incandescent because they last longer.

The “disruptiveness” of a given technology or concept is also time and context dependent. In Drew’s 2006 paper he points to the sale of ringtone as a disruptive innovation but the implementation of widely available 3G data service as an incremental innovation. However, in 2006 the iPhone and other similar smart phones were not widely available, using the internet outside your home was about finding a WiFi enabled hotspot and lugging a laptop. The change in having the internet available at all times prompted changes to the way that people interact with their environments, how they navigate cities and how they work. It's also dramatically changed the way that mobile carriers operate, now data networks are more important than voice. If disruption is equated to a change in behaviour, or ecosystem then 3G networks are overwhelmingly disruptive, even if they don't fit the model of a "low end" disruption outlined by Christensen. This example highlights the perils of declaring something disruptive or not, since it is highly time and context dependent.

The current literature does not outline a set of criteria for identifying these "disruptive" innovations prior to commercialization. The Schumpeter definition of disruption suggests that higher value patents are the result of "new" information, whether scientific discovery or new market information (Shane, 2004). Other authors point to the value of coming from a place of scientific discovery versus market need; Schnieder (2009) and Shane (2001) note that patents with higher technological importance tend to have higher economic value.

A paradox is that inventors must confront is that scientific progress is not necessarily coincident with innovation. For example, in Manu (2007), Chris Matthews proposed that a colony on mars wouldn't be disruptive, since it would only affect a few people and wouldn't substantially change how we or they live, aside from the location. However, to an aeronautical engineer the idea of ongoing life in space is highly scientifically significant. This disconnect between what is commercially "disruptive" and what is technologically significant is likely a source of confusion for many inventors with a science background. To them, a scientifically significant discovery must be important, despite a lack of obvious market application.

I would propose that novelty is something that can be assessed at the time of creation, but disruptiveness can only be accurately assessed in hindsight. I believe that novelty is an essential ingredient in disruptiveness, but it is possible for something novel to not be disruptive, such as Dyson's vacuum, which changes the technology but not outcome of floor cleaning.

Useful

In many cases an individual inventor is addressing a problem that they themselves have experienced and been frustrated by (Lemelson-MIT, 2003), for example, Dyson's ball-barrow. In these cases the inventor is a representative customer. The extent to which an inventor or anyone else who launches new products needs to be oriented towards the potential customer is heavily debated. Henry Ford is famously quoted as saying that if he had asked his customers what they wanted, they would have asked for "a faster horse" rather than the Model T automobile. Steve Jobs is also quoted as being opposed to using customer insights at Apple; IKEA has a similar sentiment (Skibsted, 2011). The companies who ignore customers feel that customers don't truly know what they want and are not forward-looking enough. However, Samli and Weber (2000) indicated that the highest value breakthroughs were ones that addressed customer need that was at least partially expressed, and that breakthroughs that were perceived as too radical were less likely to be successfully developed.

The way that some inventors and companies address this paradox is via lead-user insights. Chatterji and Fabrizio (2008) investigated the contributions of doctor-inventors versus companies inventing in the same domain. Based on the rate of patent citations and literature citations he came to the conclusion that the user-inventors, who were in this case also domain experts, came up with inventions that were "of significantly greater importance, broader impact and that better anticipate future technological trajectories than manufacturers". The value that was brought by the users was that their different motivations and personal needs identified areas of potential innovation that the manufacturers either did not perceive or dismissed as being too low demand. A key caveat is that a lead user is not necessarily your best current customer, since the true lead user may be someone working in an unrelated field who has "hacked" your technology (Danneels, 2004).

Not obvious

Obviousness is another highly contextual element. In the case of the USPTO, they view obviousness in the lens of a solution being obvious to other able practitioners in the field. But in an era of cross-pollination and interdisciplinary work, what is obvious to one person might seem revolutionary to another. For example:

- Larry Page drew on the academic custom of evaluating the quality of a publication by the number of times it is cited, and who cites it when developing his algorithm for what would eventually become Google. To him, citations (links) were an obvious way of quantifying relevance, as a result of his academic background, but in the early days it caused alarm in the web community because owners of websites didn't like the idea of being evaluated remotely and impassively (Battelle, 2005).
- Alexander Graham Bell based his concept for the telephone on his own mental model of a harp, based on his past experience as an audiologist. The harp was a way of transmitting multiple tones at once, which was the original goal of a telephone. The

physical device didn't look or function like a harp, but that was his mental model (Gorman and Carlson, 1990)

- James Dyson developed his vacuum based on an industrial technology he was using to resolve a dust problem in the workshop manufacturing his ball-barrow product. The large scale technology was readily available, but no one had yet applied it to a household product. (Roy, 1993)

Things that are not obvious could also be described as "skew". Singh and Fleming (2009) and Dahlin et al (2004) both report that individual inventors tend to have ideas that land in the "tails" of distributions, that is they have a lower mean value, but a higher variance.

The difference between insight and foresight

The dictionary definitions (McKean, 2005) of hindsight, insight and foresight are summarized below:

Hindsight: Recognition of realities of a situation after it's occurrence

Insight: Ability to perceive clearly, deep understanding

Foresight: Power of foreseeing, prescience. The act of looking forward

Figure 4: Dictionary definitions of hindsight, insight, foresight.

The vocabulary, even in these general, not industry-specific definitions yields an interesting clue:

Hindsight	**=**	**Recognition**
Insight	**=**	**Understanding**
Foresight	**=**	**Power to change**

Figure 5: Key elements of definitions of hindsight, insight, foresight

As one progresses from hindsight to insight to foresight the vocabulary becomes increasingly active. Recognition seems ordinary, like something anyone could develop given enough time. Ability and understanding are a bit more special, but power connotes something very unique and talented about the person capable of it. Within the field of foresight, the definitions of what foresight is vary widely, as summarized in Table 2 on the following page:

Author	Foresight is...
Horton (1999)	looking at possible futures in a range of areas...and deciding what decisions the organization can take today to create the best possible future for itself.
Mietzner and Reger (2005)	the ability to see what one's future needs are likely to be; the basic assumption is that there is a range of possible futures
Slaughter (1990)	Expanding awareness and understanding through futures scanning and clarification of emerging situations....assessing possible consequences, anticipating problems, considering the present implications of possible future events
Drew (2006)	a future-directed perspective and process for identifying understanding and evaluating new opportunities
Fontela et al (2006)	associated with forecasting, conditionality, the existence of alternate paths, the free agency of decision makers
Ringland (2003) (quoting Irvine and Martin)	a process for developing research policies with a long-term perspective using networks of knowledgeable agents who possess improved anticipatory intelligence
Manu (2007)	thinking, imagining, shaping the future the ability to translate this understanding into strategic opportunity

Table 2: Summary of relevant foresight definitions

The key element running through many of the definitions is "variability" and acknowledgment of the existence of alternate futures.

In the freezie example in the introduction, I attributed the inventor's problem to a "failure of foresight". But, in fact his issues were mainly tactical, the device worked but the distribution and sales plan hadn't been considered. In his case the failure came not from failing to predict the future, but a failure to see a few steps in advance, since the distribution of his device would likely not change in the immediate future. Therefore, it is actually closer to insight. The conventional foresight approach is to look further into the future, with 5 years being the shortest time horizon most futurists or forecasters consider. Therefore, I propose that there be a distinction between “pre-foresight” which is related to operational issues in the near future and foresight which is related to the future ecosystem, affecting decisions today. For example, the freezie guy’s (fictional) thoughts at each perspective are shown in Figure 6 below.

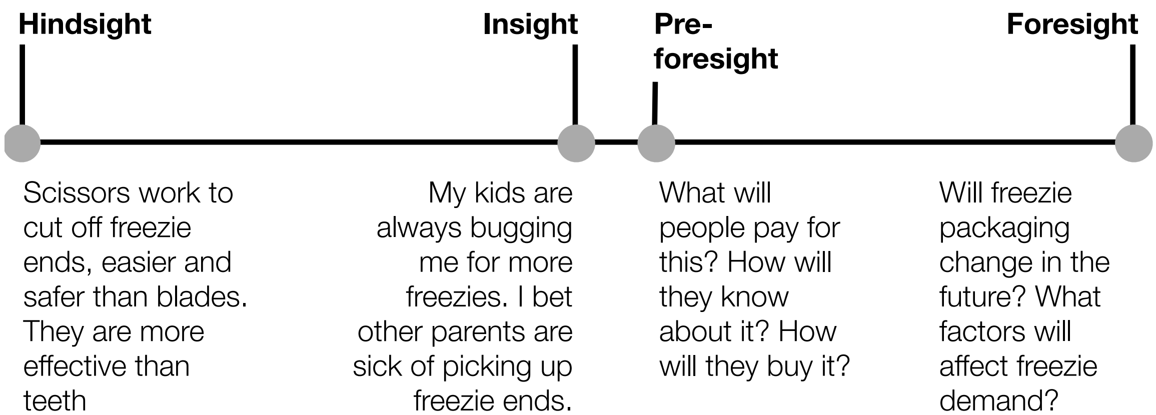

Figure 6: Examples of hindsight, insight foresight and proximal foresight.

I would propose that the distinction is that pre-foresight is related to things that are relatively short term, more or less constant but potentially outside your realm of expertise. Foresight is related to things that are long term, may or may not be specific to your product ecosystem and have the potential to change significantly over the period studied.

In the freezie case, foresight areas for study would be whether in a few years parents will be still be feeding their children freezies, or if they will be a nostalgia product for adults. If the future market is adults, then a safety device for children may not be the correct framing. Or, if freezies continue to be aimed at children, but the manufacturer added some kind of easy-to-open packaging, for example the peel-able package currently used for string cheese, then the invention would be similarly not marketable.

Why is foresight in general tricky?

Companies and individuals very often have failures of foresight, so seemingly obvious in hindsight that outsiders shake their head and think "Really? they didn't think of *that*?". Some recent well-known examples:

- Paul McCartney's lack of a pre-nuptial agreement with Heather Mills
- RIM's decision to launch the PlayBook without native email support

These people aren't stupid: Paul McCartney is a talented musician and millionaire businessman, RIM has had tremendous success in the smartphone market. So, why do they and other smart people fall into these traps?

Trap 1: Simplification Errors

Kahneman and Tversky (1979) proposed that decision making in general is fraught with what they termed isolation effects. The source of these errors is the human preference to simplify decision making, either by removing complexity or confining the solution space. Complexity is reduced by examining only what is different about the solutions, rather than what they share. This over emphasis on differences may lead someone to think that their solution is dramatically different from the existing art, when really it may only be an incremental change, Lowe and Ziedonis (2006) highlighted an example in which the inventors of cochlear implants thought that they were making radical changes, but these changes were less significant than originally thought. In Paul McCartney's case, he thought Heather Mills was significantly different from other women who marry rich men, when in fact she had some very important traits in common, such as litigiousness.

Trap 2: Sequencing Errors

The solution space may also be confined by examining decisions one at a time, in a sequential fashion rather than examining all of the possible end states. This was shown in Kahneman and Tversky's (1979) experiments involving gambling, his subjects were more sensitive to instantaneous gains and losses, and often based their decisions on the magnitude of these changes rather than the overall net result; a concept echoed by Harford in his interview with Iverson (2011). In RIM's case, they may have been sensitive to the immediate bad publicity from their tablet being late, which turns out to have been small compared to the eviscerating reviews of the tablet that resulted from rushing through development.

Trap 3: Self-optimizing behaviour

Kahneman and Lovallo (1993) reports that people become more risk averse when they know their decision will be reviewed by others, therefore the bigger a hierarchy and the more layers of review, the more risk averse an organization will be. This comes from a need not to be "blamed" for a poor decision, Kahneman and Lovallo noted examples of managers who would avoid potentially lucrative idea because of a very small potential downside. This behaviour is driven by the individual's need to optimize their standing in the company, not necessarily the good of the company itself. This is likely a rare problem for individual inventors, but could explain RIM's sluggish entry into the tablet market, or Sony's late entry into the flat screen TV market.

Trap 4: “Really, it’s a sure thing”

Kahneman and Lovallo (1993) pointed out that many managers do not really acknowledge risk or see themselves as making gambles. They suggest that many managers consider themselves to be “prudent agents” instead, and they believe that risk can be mitigated by their hard work and skills. This failure to acknowledge scenarios that are not “success scenarios” could prevent someone from seeing what seems obvious in hindsight. In the Paul McCartney example, perhaps he was confident enough in his skills as a husband and their mutual love, that he didn’t see divorce as a realistic outcome.

Trap 5: “But I’ve been so right in the past”

Fischfoff (1975) notes that people tend to view past predictions more favourably than is accurate when asked to reflect after the outcome is known. As a result we don’t learn from past errors, because in our minds those errors did not exist. Hindsight bias is enhanced when there’s an impression of inevitability and if there’s the impression that it was foreseeable. The more one works to get information related to a prediction, the less hindsight bias, when information is readily available (i.e. stock market) hindsight bias is high.

The effects of these traps in real life are likely amplified, since the odds in these gambling experiments were transparent, but the odds in product development are comparatively unknown.

How can these traps be avoided?

Simply being aware of potential cognitive biases and decision-making fallacies and acknowledging them is a powerful step in a de-biasing framework (Arnott, 2006). In addition to these steps, there are some work practices that individuals can use to reduce the negative effects of cognitive bias, such as collaboration and deliberately shifting perspectives.

Collaboration

Teamwork provides critical perspective and reinforcement, many famous invention teams contain one partner who was more charismatic and business oriented (Steve Jobs, Bill Gates, Sergey Brin) and one who was quieter and more technically oriented (Steve Wozniak, Paul Allen, Larry Page). Paul Allen recalls that:

> "Each time I brought an idea to Bill, he would pop my balloon. "That would take a bunch of people and a lot of money," he'd say. Or "That sounds really complicated. We're not hardware gurus, Paul," he'd remind me. "What we know is software." And he was right. My ideas were ahead of their time or beyond our scope or both. It was ridiculous to think that two young guys in Boston could beat IBM on its own turf. Bill's reality checks stopped us from wasting time in areas where we had scant chance of success." (Allen, 2011)

In the cochelar implant example cited by Lowe and Ziedonis (2006), the use of an external reviewer was key to uncovering potential flaws in the product. Singh and Fleming (2009) notes that "patents generated by inventors with a team and/or organization affiliation are more likely to end up as breakthroughs than those from lone inventors" and that teamwork is particularly good for eliminating poor ideas. Girotra et al (2010) suggests that a hybrid format of individual idea generation, followed by group idea selection yields optimal outcomes.

Alternating Inside/Outside View

Kahneman and Lovallo (1993) advocate moving from the “inside view” to the “outside” view numerous times throughout a project. The “inside view” concerns itself with what is specific to the product itself, the “outside view” compares the product to other similar situations. The inside view is more accurate for rare circumstances and the outside view is more accurate for common circumstances, alternating between the two prevents falling into Trap #1. This ability to shift between perspectives easily is thought to be a key skill of successful entrepreneurs compared to their less successful counterparts (Mieg, 2010)

Foresight by inventors

Most of the anecdotal data regarding inventors suggests that their foresight work is nominally “intuitive”. Indeed, the Lemelson-MIT study (2003) reinforces that sentiment that invention by individuals is inspired, with little formal foresight work. Fontela et al (2006) also points to anecdotal evidence linking intuition with entrepreneurs, terming it “unstructured perception that has unidentified causes and leads to uncertain consequences”.

It has also been suggested that some people be naturally more future inclined than other people. Hayward (2002) suggests that a person’s “Future Time Perspective” (FTP) may be a stable personality trait, and links a long FTP to counterfactual thinking. Gaglio (2004), Hayward (2002) and Baron (2004) postulate that inventors and entrepreneurs may engage in more counterfactual thinking than other people, combined with Hayward’s work on FTP this suggests that they might be naturally more future inclined.

If a person is naturally future inclined then they may not see the need for formalized foresight work.

This lack of formal foresight work by inventors is confirmed by anecdotal case studies, for example the inventor of the Dyson vacuum reported doing some crude market research to determine what the likely maximum price was for a household vacuum to determine if it was financially feasible (Roy, 1993).

Part of the reason that this unstructured approach often works is that as Hellström and Hellström (2002) point out, the process for invention is typically more coherent when done by a sole proprietor or small team, and as a result the accountabilities are more obvious than in an extensive hierarchy. Foresight as conducted in large organizations often has the explicit goal of getting everyone's thinking aligned, in an individual or start-up this may be less critical.

Hellström and Hellström (2002) also point out that the technological inventors studied typically had a more "reflexive view of the future", which links to the idea of managers being "prudent actors" who are able to overcome future roadblocks with flexibility. Small organizations are often more nimble than large ones, for example Shell Oil is deeply invested in formal foresight work partially because their business demands large and costly infrastructure projects.

Simplified foresight framework for individuals

In broad terms most foresight methodologies contain the following elements (Horton, 1999), as summarized in Figure 7:

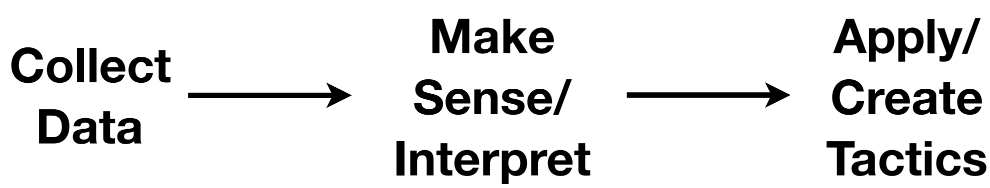

Figure 7: Generalized foresight process

In the data collection phase, the literature advocates as much diversity as possible (Könnölä et al, 2007, Phall et al (2004), In organizations, this step is often conducted as a large brainstorming session, workshop or some form of online contribution, such as a Delphi survey. This work could also be conducted in the form of expert interviews, a literature review, or some form of environmental scanning. This step is likely one of the more difficult ones for an individual to do on their own, since the more people involved the greater the possible diversity of information streams.

Triggers for data collection could come in the form of "What If?" statements. Williams (2011) suggests that disruptive ideas can occur when innovators look for areas that have deep, established clichés and homogeneity and then question what would happen if those clichés became invalid. Williams (2011) terms these "Disruptive Hypotheses". I have summarized his framework in Table 3 on the following page:

Identify segment to be disrupted	Have things been static for a long time?
	Should it be more profitable than it is?
	Does growth seem too slow?
If yes to these questions: segment is ripe for disruption, so, how can we disrupt this segment with an unexpected solution?	
Identify Clichés	What's typical of the existing products? (Product attributes, customers, geography)
	What's typical of the existing interactions? (Purchase method, timing, frequency)
	What's typical of the existing price model? (Discounts, incentives)
Based on these findings, test them by asking:	
What can you invert?	Make it opposite, reverse the relationship
What can you deny?	Eliminate elements of the cliché
What can you scale?	What is scarce that could be abundant? vice versa?

Table 3: Williams' Disruptive Hypotheses construction framework

In the case of Google, Brin and Page challenged the established clichés that portals would rule the internet and that banner-supported websites were the only viable revenue model. Their insistence on an optimized search experience resulted in finding a more lucrative revenue model than their competition: targeted ads (Battelle, 2005).

In the interpretation stage, it is necessary to categorize the information relative to one's own work (since what constitutes a weak signal, driver or trend is contextual). Weak signals have varying definitions, the earliest is by Massé (quoted by Kuosa, 2010) "a sign which is slight in terms of present dimensions but huge in terms of its virtual consequences”. Kuosa (2010) suggests categorizing information according to the criteria in Table 4 below:

	Small Effect	**Big Effect**
Small probability of coming true	Meaningless roaring	Weak Signal
Big Probability of coming true	Original Trend	Megatrend

Table 4: Kuosa’s framework for distinguishing between weak signals and trends

This framework was further expanded on by Kuosa, as shown in Table 5 below:

Levels of futures knowledge		
Weak Signals	**Any observation which is totally surprising, amusing, ridiculous or annoying to you** (Do you find something novel in your observation? could it be a weak signal of emergence)	**Any observation which tells about change and makes sense to you** (Observation which convince you something is increasing or decreasing)
Drivers	**Your understanding of potential seeds of change** (The pushing drivers -what are the issues which may start emergence?)	**Your understanding of the demands of change** (The pulling drivers -what is needed, socially, politically, technically, economically etc and can therefore be expected)
Trends	**Your understanding of blockers of change** (Factors which slow down or prevent the otherwise emerging change -laws, values, interests, buraucracy, taboos, technical necks of bottle, etc)	**Your understanding of inevitable large change processes** (the flowing river of change - megatrends, path-dependence, auto-catalysis etc)
	Disruptors/ non-linear	Promoters/linear
	The fundamental nature of information	

Table 5: Kuosa’s framework for identifying weak signals, drivers and trends

This framework is straightforward enough for an individual to implement and permits the creation of scenarios or roadmaps to further contextualize the data. The use of a 2x2 scenario matrix is commonly applied, with the two axes of the matrix being two critical uncertainties identified in the interpretation phase.

Conclusion

Foresight, both proximal and regular provides a mechanism for inventors to overcome potential roadblocks or identify particularly significant ideas. Although simple, effective frameworks and de-biasing tools and methods exist, the challenge for sole proprietors and small teams is achieving sufficient diversity in their data collection.

Chapter 3: How do you risk less?

In the previous chapter I outlined the ways that foresight could contribute to the emergence of better ideas, or uncovers roadblocks in front of the existing ideas. This chapter will focus on how a minimal risk ecosystem contributes to the cultivation of disruptive or highly profitable ideas.

Invention history is full of people who came up with great inventions at times in their lives when they didn't have much to lose:

- Steve Jobs was a self-proclaimed hippie dropout who worked after hours at Atari
- Steve Wozniak was an engineer at HP
- Bill Gates was a college student
- Paul Allen was a college dropout working for Honeywell
- Larry Page and Sergey Brin were both PhD students

They didn't risk much, when they started the company Steve Jobs wagered his VW van, Steve Wozniak wagered his programmable calculator (Carleton, 1997). In the case of Larry Page and Sergey Brin they didn't wager anything, they cobbled Google's first servers together with spare parts they found at Stanford (Battelle, 2005). Bill Gates and Paul Allen worked out of a computer lab at Harvard and selling their operating system to Altair only cost them the lab fees and Paul's plane ticket to New Mexico (Allen, 2011). In all of these cases, the inventor had access to unique information, facilities or skills and were able to test out their first prototypes at relatively low cost to them. If their invention had failed, they could easily have tried again, or gone back to their previous academic or professional work.

I propose that creating this kind of a low-risk environment is key to fostering breakthrough inventions. This encompasses an accepting attitude towards failure and creating a funding model that doesn't put individuals at risk.

Trial and Error: the acceptance of failure

The trial and error process for inventors has a lot in common with the scientific process, which is informed by theory but is ultimately proven by empirical data. Although some inventors like Tesla report their inventions coming to them fully formed in visions (Tesla, 2007), many more report painstaking iteration. James Dyson is famous for making 5 127 prototypes when theoretical predictions of cyclone activity didn't hold (Dyson, 2011). Edison was a known tinkerer, he and his associates often did elaborate "drag hunts" to search for the appropriate materials, such as the carbon used in the original prototypes of the variable resistance telephone (Gorman and Carlson, 1990). Edison is widely quoted as saying "I have not failed. I've just found 10,000 ways that won't work" (Dyson, 2011).

Both the scientific and invention trial and error processes accept periodic failure as an inevitable consequence. Proving that something doesn't work can be as valuable as being correct, in both science and invention. This isn't to say that there isn't a downside to scientists and inventors being consistently wrong. Scientists who underperform can lose their funding and lose reputation capital. For example, Tim Harford (2011) profiled Mario Capecchi, a successful scientist who left Harvard because he felt pressured for quick results. He started a lab at the University of Utah where he applied for a National Institute of Health grant, most prominent funding agency in his field. The grant contained 3 projects, one of which was highly speculative; he got funding on the basis of the other 2 "solid" projects and chose to redirect the funding to the speculative third one. The work eventually yielded a Nobel Prize, so in this case the risk was worth it, but had Capecchi been wrong it could have cost him his lab and reputation. In response to these types of quandaries, new funding models have emerged with longer time horizons and fewer restrictions on researchers. Capecchi now gets funding from the Howard Hughes Medical Institute, one of the largest agencies with this type of model, which in essence funds the person, not the project.

Establishing Bona fides: lowering risk for funders

What makes individual-centered funding approaches possible? In the science world a person or institution has a guarantee in the form of their past citations. Additionally, tenured faculty are tied to their universities, making it hard for them to disappear or misappropriate the funds. In the case of Mario Capecchi, his initial funding likely at least partially the result of his work as a graduate student at a reputable institution (Harvard) under a well-known name (Watson, one of the discoverers of DNA). Although the work itself is often risky, the people are not.

There are some companies and private entities that are duplicating this approach: Intellectual Ventures' founder Nathan Myhrvold expect 98% of the lab's ideas to fail (Dudley, 2009), Google Vice President Marissa Mayer expects 80% of the projects developed during that companies "20% time" to fail (Iverson, 2011). In both these cases the companies are making an investment in validated, reliable people doing risky, prospective work.

The challenge for individual inventors to establish a "brand" or an identity that an external investor can feel confident in, whether the financial model is venture capital or licensing. An individual is far more mobile than a tenured scientist, and has less reputation capital at stake. In a sense, once the venture capitalist has parted with the money there is little they can do to compel the inventor to actually do the work apart from the inventor's own interest in success. This "moral hazard" lies at the heart of the skepticism surrounding individual inventors (Dushnitzky, 2009). This challenge is often overcome by structuring the contract in a way that doesn't pay the inventor a salary at the beginning of commercialization; if the inventor thinks it will be very successful then they will be willing to delay payment as a good faith gesture.

Incremental funding: reducing exposure

In cases where bona fides are not readily available or sufficiently robust, another alternative is to adopt a portfolio approach on the part of the funders. In this case, rather than making a large investment in a single relatively mature prototype, they would give small amounts of money to more early stage prototypes. As they progress through the prototyping stage they can allocate the next rounds of funding based on which ones are most promising, eventually converging on a few successful solutions. This is the approach of a Scottish company Cherub Ventures, which applies a micro-finance-like approach to funding innovation, by having smaller, more frequent rounds of financing.

The advantage of this approach for individual inventors is they have financing earlier in the process, minimizing the risk to their personal wealth. Additionally, the rounds of funding act as a form of feedback, since poor ideas are weeded out early. It is in essence a form of the maxim “fail early, fail often”. The concept of small scale testing is suggested as an entrepreneurial approach by Harford (Iverson, 2011) and Shane (2003). By forcing an early prototyping round, it also facilitates communication with the funders, as a prototype allows tacit information to be expressed more easily, particularly in the case of physical devices and identifies faults early (Jackson, 2011).

Disclosure: perceived risk for inventors

The blogs and books aimed at individual inventors warn in almost hysterical tones “Don’t tell ANYONE about your invention! They’ll steal it!”. There have been cases of theft by big companies, the most famous is the story of Robert Kearns, the inventor who created the intermittent windshield wiper which was subsequently stolen by Ford and immortalized in a movie (Seabrook, 1993). Examples like these are the deepest fear of an individual inventor: someone else might get rich off their “million dollar idea”. The worst case scenario looks something like this: they approach a company with their good idea, the company feigns disinterest, the inventor either discontinues work on their invention or develops it further, but in any case the inventor is beaten to market by the big company and their army of employees who have raced through development. All of the inventor's effort is for naught and they end up bankrupt and downtrodden, unable to litigate against the behemoth company.

The irony is, in my research I have encountered more examples of companies being truly, authentically uninterested in the work of inventors. Particularly in the case of disruptive technologies like Google and Tesla's electric motors, companies often fail to recognize opportunities when they are presented with them, whether due to institutional lock-in, a lack of foresight or their focus being elsewhere. Inventors like Dyson, Page and Brin, Gates and Allen actually asked the established companies to take their inventions, but were met with indifference. In some cases the companies are contending with a deluge of user ideas and don't have the means to sort through them all, let alone steal them.

It should be noted that the balance of power is still very much in favour of established companies. Unquestionably, they have the resources to beat an inventor in the same competition, with their access to capital, expertise and legal advice. However, the risk of idea theft appears to be minimal relative to the risk of personal bankruptcy. A convenient analogy is the risk of being in plane crash versus being hit by a car. Being in a plane crash is devastating, but it's relatively unlikely; like a stolen idea yielding millions for someone else. In contrast, being hit by a car while crossing the street happens everyday, and is also devastating, like an invention turning out to be a poor idea and bankrupting the inventor. Protecting oneself against idea theft but entertaining the possibility of personal bankruptcy is akin wearing a parachute on a passenger plane but not looking both ways when you cross the street.

The disclosure paradox is summarized by Gans (2002) as:

> “when trading in ideas, the willingness-to-pay of potential buyers depends on knowledge of the idea, yet knowledge of the idea implies that potential buyers need not pay in order to exploit it. Disclosure increases the buyer’s intrinsic valuation but reduces the inventor’s bargaining power.”

Gans (2007) suggests that the timing of disclosure and commercialization is of particular strategic importance given the imperfections of the market for ideas. These imperfections are the result of information asymmetries between buyer and seller, plus the uncertainties around future demand and pricing, a notion reinforced by Shane (2003). A disclosure model that manages the information asymmetry in an equitable way and a pricing model that minimizes future price uncertainty would therefore maximize value for both parties.

Conclusion

Reducing the risk for individual inventors could yield a benefit similar to models that reduce risk for scientists. The hurdles to overcome are establishing bona fides and adjusting attitudes towards disclosure for both the inventor and the corporate partner. Incremental financing models and disclosure models that manage information asymmetry are critical to this process.

Chapter 4: How do you do both? Open Innovation

In the previous chapters I highlighted the challenges facing individual inventors in pursuit of funding and commercialization support, such as information asymmetries and cognitive biases. In this chapter, I discuss how open innovation relates to surmounting these challenges, and how it could develop in a way that is beneficial to the individual inventor.

What is open innovation?

Open innovation is widely believed to have started with the development of open source software, however; collaboration between companies, academics and individuals have been occurring throughout invention history, for example, Edison with Western Union, and Bill Gates and Steve Allen with Altair.

Despite open innovation being a “buzzy” topic in the business world, there is remarkably little divergence in how it’s broadly defined: most of the existing literature references the work of Chesbrough, as summarized in Table 6 on the following page:

Source	Open innovation is...
Chesbrough (2003)	"a company commercializes both its own ideas as well as innovations from other firms and seeks ways to bring its in-house ideas to market by deploying pathways outside its current businesses"
Lichtenthaler (2011)	defined as systematically performing knowledge exploration, retention, and exploitation inside and outside an organization's boundaries throughout the innovation process.
Chesbrough 2004 (Chesbrough and Crowther (2006) is similar, Elmquist et al (2009) cited this definition)	The Open Innovation paradigm assumes that firms can and should use external as well as internal ideas, and internal and external paths to market, as they look to advance their technology. Open Innovation assumes that internal ideas can also be taken to market through external channels, outside a firm's current businesses, to generate additional value.
Gassman and Enkel (2009) (quoting Chesbrough)	Not all the smart people work for us. We need to work with smart people inside and outside our company.
Lazzarotti and Manzini (2009) (quoting Chesbrough)	A large number of studies are adopting this term to describe the phenomenon where firms rely increasingly on external sources of innovation, which means that ideas, resources and individuals flow in and out of organizations.
Dodgson et al (2006) (quoting Chesbrough)	The open innovation process redefines the boundary between the firm and its surrounding environment, making the firm more porous and embedded in loosely coupled networks of different actors, collectively and individually working towards commercializing new knowledge.
West and Gallagher (2006)	systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels

Table 6: Summary of open innovation definitions and their relationships to Chesbrough

Overall, the dominant themes are a selectively permeable corporate boundary through which ideas and intellectual property are exchanged with the outside world, with the goal of increased profitability in the form of new products or processes.

Where there is significant disagreement is in what tactics are considered to be "open", Cooper and Edgett (2008) indicates that traditional marketing activities such as customer insights could be considered open; although I would propose that since customer data is a nominally unidirectional it is not consistent with the idea of two-way exchange widely associated with openness.

Gassman and Enkel (2004) profiled IBM, one of the most prolific large, open innovation companies and suggests that there are 3 broad categories within open innovation:

1. *Outside-In:* The use of external ideas, externally developed products. For example, Procter and Gamble's Connect and Develop (Huston and Sakkab, 2006).
2. *Inside-Out:* The licensing of internal intellectual property or capabilities. For example, Schindler's licensing of cable technology to non-elevator firms (Gassman and Enkel, 2004)
3. *Collaborative:* An ongoing, 2 way relationship. For example, Genentech and Pharmacia developing non-cadaver sourced Human Growth Hormone (Frankelius, 2009).

This categorization is similar to that proposed by Lazzarotti and Manzini (2009) and Elmquist et al (2009). In addition to these processes, there are activities such as sponsorship of symposia and cultivation of relationships with academics.

Based on the tone and publication locations of the current literature, it appears to be targeting management of mid-size or large companies. The implied goal of many of the works is to advance the argument that companies would benefit from incorporating open innovation and then proceeds to outline how they could create the requisite corporate culture change necessary to adopt open innovation methods. Elmquist et al (2009), Lazzarotti and Manzini (2009), Almirall and Casadesus-Masanell (2010), Lichtenhaler (2009), Dodgson et al (2006), Huston and Sakkab (2006) all address this subject area.

However, there is a dearth of scholarly literature regarding how an individual might best navigate open innovation; I am not aware of an academic or working paper profiling individual successes with open innovation, or what the best practices for individuals are. The only readily available sources of information that exist on the topic are testimonials on the websites of the open innovation tools themselves, which I regard as too vague ("P&G treated me fairly", "it was a great experience" are typical statements) and potentially biased.

Corporate Benefits

Chesbrough's primary justification for open innovation is that the pace of technology, availability of venture capital and knowledge worker mobility make investments in large firm R&D unprofitable. He cites large companies such as Cisco and Intel that have thrived with almost no internal R&D, whereas industrial giants with large R&D investments, such as Hewlett-Packard and Xerox, have faltered.

The documented advantages of open innovation for large companies are as summarized in the following section:

- *Reduced R&D costs:* Academics often conduct basic research in government-funded labs, companies can choose the best mature IP without investing years into the process, or risking failure. In the case of Pepsico trying to reduce the sodium in chips, they used micro-milling technology from a Swiss university (Drummond, 2011)

- *Increased alignment with product ecosystem:* In Cisco's case they provided their technology to partners to establish a new industry standard (Gassman and Enkel, 2004). In the case of the sustainable furniture fabric profiled by Gorman and Mehalik (2002) co-operation allowed for synergies between the mill, dye and sourcing operations.
- *Increased revenue from existing internal IP:* IBM obtained $10 billion in licensing revenue between 1993 and 2002 (Gassman and Enkel, 2004). For IBM licensing served a dual purpose, when they observed a licensed technology achieving success they applied the insight to their core products. This process often revealed new applications that were previously unknown.
- *Solicitation of novel ideas:* Companies and individuals tend to get increasingly incremental and risk-averse over time (Audia and Goncarlo, 2007). Soliciting input from outside sources can generate entirely new ideas, free of institutional biases.
- *Increased customer responsiveness:* Chatterji and Fabrizio (2008) study of physician user-inventors found that inventions involving doctors and companies were more significant than either alone, as a result of uncovered latent needs.
- *Communication of tacit knowledge:* Agrawal (2006) found that companies that formed ongoing collaborations with the academic inventor of IP licensed from MIT realized larger profits than those who just licensed the IP. They attributed this effect to the communication of unpublished tacit knowledge that the inventor gained throughout the process, for example, failed experiments. It can also be useful in cases where the desired outcome is difficult to articulate, for example Bush Boake Allen (BBA) a flavour producer gave customers a tool kit to create flavours so they could experiment without the difficulty of expressing something as intangible as flavour (Cooper and Edgett, 2008).

Individual Benefits

Although I am not aware of any documented case studies of individuals interacting with open innovation tools, based on the work in the previous chapters I expect that the following benefits would exist:

- *Alignment and Feedback*: Open innovation for individuals may serve the same function as foresight activities currently do in large companies, which is to align the perspectives and objectives of multiple groups (as in the sustainable furniture fabric example described by Gorman and Mehalik (2002)). Open innovation also could function as a form of early feedback, particularly in the case of some of the online tools.
- *Leveraging of corporate skills, knowledge and facilities:* Individual inventors may be limited by their own prototyping abilities, production scale or market knowledge. Working with an industrial partner with access to these capabilities could allow an inventor to think beyond their own abilities.
- *Exposure to previously unknown applications:* Pepsico's search for a reduced sodium salt led them to a Swiss university's orthopaedics lab that was micro-milling salt as a practice medium for simulating osteoporotic bones, an entirely unrelated application. (Drummond, 2011)
- *Synergies with complimentary IP*: Companies may have other inventions or distribution channels that would enable a new product (e.g. an iPhone app is made complete by the iTunes store and iPhone itself)

Drawbacks of Open Innovation

There is still skepticism regarding open innovation and many companies are reluctant to enter the field. The commonly stated reason are: poor fit with culture and existing processes, fear of telegraphing strategy to competitors, distrust of external ideas and hesitancy to take on the burden of sorting through external ideas. These problems are in some cases industry or company specific. In the case of open source software, these challenges have been surmounted because:

- it was already common for programmers to share pieces of code
- code is highly modular
- code has low communication cost, since text is low bandwidth
- the prototyping process is relatively fast, code either runs or it doesn't.

Open innovation has been slower to be adopted for physical products, but if a product fits the criteria of being culturally acceptable, modular, easy to communicate and validate, as open source software did, then there is no reason physical devices couldn't be created through open innovation. Raasch et al (2009) profiled some examples of physical products using open innovation, although it has focused on crowd-sourced items, rather than those resulting from industry collaboration. As the communication costs associated with producing physical products drop, prototyping cycles shorten and the costs of transporting goods from a centralized location rise, it is likely that open innovation of physical products will become increasingly viable. All of these trends are currently emerging: 3D visualization tools such as Google Sketchup are getting cheaper and easier to use, facilitating remote communication between designers, rapid prototyping is moving from university labs to industrial parks and oil and carbon prices are predicted to rise precipitously.

The online tools

Overall there is positive sentiment regarding open innovation, but Cooper and Edgett (2008) reports that feelings about the usefulness of the tools themselves are mixed, but attributes some of this attitude to the relative novelty of the tools. The highest rated open innovation tool by the management they surveyed was interaction with partners and vendors; the lowest rated were external ideas contests, submissions and designs.

The online tools that are open to anyone are summarized in Table 7 on the following page. Note that I have focused on tools that are aimed at developing physical products rather than software, as they are more likely to be of interest to individual inventors.

Tool	Profile
quirky.com	Focuses on consumer goods retailing for less than $100, many products are household goods or technology accessories. Members submit ideas and vote on them, the idea with the highest rank is selected for development. Development is done with input from the community and an in-house team of designers. Community members get credit for assisting with the development in the form of a share of the profits, and the person with the initial concept gets about 12% of the revenue from online sales on Quirky's website, and 4% of the retail sales.
innocentive.com	Established companies ("seekers") anonymously post "challenges", the selected solution gets a substantial reward. Any registered "solver" can submit solutions, and teams can be formed (teams share the reward equally if they win). The company owns the IP for all solutions, whether successful or not, and if none of the solutions are good it is possible no one would get the reward. The challenges are typically relatively technical, often involving chemistry or material science. Partners include Eli Lilly, Procter & Gamble and NASA. Part of the Procter & Gamble network.
yet2.com	A matchmaking service between the owners of IP and parties wishing to purchase IP. They assist with technology transfer and have expertise with licensing IP. Part of the Procter & Gamble network.
P&G Connect and Develop	This website lists problems that P&G would like help solving, similar mechanism to innocentive. Very technical, mainly chemical problems. Also allows for unsolicited ideas, these are reviewed by employees and feedback is given. Ideas may be forwarded on to partners if not relevant for P&G.
Intellectual Ventures	Founded by Nathan Myhrvold of Microsoft Research. It aims to solve big problems, like malaria and global warming. They acquire and enforce patent rights on behalf of individual inventors and small enterprise, in addition to their own research activities and partnerships. Although they are among the top 5 patent holders in the USA They warn that they acquire only a tiny fraction of individual inventor IP, and will only evaluate public data.
kickstarter.com	Not invention specific, they crowd-source funding for all kinds of ventures, including albums, films and art projects. Members pledge an amount towards a project, which will only be paid if their fundraising target is met. Once funded community involvement is limited, it functions more like a form of micro-venture capital.
yourEncore.com	Network of retired engineers and scientists to be tapped by potential clients. Part of the Procter & Gamble network.
Ninesigma.com	"Open innovation network" that offers consulting services to companies wanting to implement open innovation. Part of the Procter & Gamble network.
Company Specific websites	eBay, Apple, McDonalds, LEGO, Microsoft all discourage unsolicited ideas. Other companies may accept them, but typically retain IP rights, even for failed ideas.

Table 7: Summary of online open innovation tools

Interacting with the current tools

My perspective on the tools profiled above is that although they offer an inventor the advantage of participation in a product development process that is more sophisticated than what they could achieve themselves, the companies still retain dominance over the individual.

In most cases, the company has a disclosure advantage: they are allowed in some cases to remain anonymous, and they can make the problem statement as vague or specific as they wish. Once an individual submits an idea, they relinquish their intellectual property rights (unless they already hold a patent), even if the idea is not successful in the competition. Theoretically, it would be possible for a company to retain these ideas for unrelated use without compensation after the contest ended. Whether that practice would be legal is unknown and would depend on the user agreement, but in an intellectual property lawsuit the company would have a significant advantage over an individual.

The problems posed and solutions offered range from technologically trivial (e.g. headphone cable containment is a popular category on quirky.com) to technologically sophisticated (e.g. polymer chemistry on innocentive.com), with almost no middle ground. Some sites are very appealing to a lay person, others to people with very specific technical knowledge. However, the middle group of inventors with moderate to high technical knowledge are left out in most cases, and the sites are highly audience specific, to the point of exclusivity.

The explicitness and intent with which an individual or company must apply to the process is also a limiting factor for these tools. For an individual, they must seek out a platform, manually search the posed problems, explicitly decide that they have something to offer and then make a submission. Those four “decision points” limit the pool of available solutions: qualified people may not be aware of a particular competition on a particular site and they may not be aware that their idea is a match even if they do see the problem. The potential cognitive load on a company is similarly high, they must explicitly articulate their problem, choose a portal, arrive at a valuation and sort through ideas.

The future of open innovation: the role of data

I think that the current open innovation tools are just in their infancy, the technology is currently relatively primitive compared to other online services. The key element that will move the online open innovation tools into the future will be data and the way that it is applied to curate content and manage networks. The critical function of data is its power to overcome information asymmetries and bone fides issues, both of which are the enemy of a functioning idea market.

The idea of data as a valuable entity is gaining prominence: presently within popular culture there are ongoing, fierce debates over whether Facebook owns your data and what Google is doing with it’s user data. Just a few years ago this information would have been considered useless, or too unwieldy to manage effectively. Presently the idea that data and insights have a commercial value is real, but there is still ambiguity around how that value will be quantified and traded, and how the monetization of data will change product development.

The ideal open innovation participant

As mentioned previously, there are some companies that are ill-suited to open innovation for cultural reasons or their product does not lend itself to modularity or ease of communication. Similarly there are some typologies of individual inventor who would thrive in open innovation circumstances, and others that would not. An academic inventor would be the ideal candidate, as they have stability in their academic position and may have limited time or incentive to pursue commercialization. They are preferentially exposed to new information and would be excellent sources of foresight information; existing Delphi surveys typically target academics. Academics are a primary source that IBM's open innovation initiatives currently cultivate, the academics benefit from access to IBM's research centres and IBM benefits from their insight (Gassman and Enkel, 2004).

Garage inventors could potentially yield the largest gains from open innovation, as they currently have the most difficulty commercializing their inventions. However, among garage inventors there is likely a subset that would chafe at the idea of giving up a large percentage of their profits to industrial partners. If a garage inventor has overvalued their ideas relative to implementation and is expecting a large windfall for their "million dollar idea" then participation in open innovation could be difficult.

Similarly inventors with existing ties to companies interested in their work, such as employees of Google or IBM, would not have much to gain from open innovation as an individual. They already have established bona fides, they can easily get an audience with a commercialization partner and they are working with peers who could easily give feedback; these are the primary functions of open innovation. However, if they chose to invent outside their current domain they could benefit from open innovation.

An optimized tool for individuals

The best outcome for an individual inventor's participation in an idea market or open innovation would be one that combines the feedback and information contained in a foresight tool with a low-risk financial model. This would address the issue of diversity in foresight data for individuals as described in Chapter 2, and address the financial issues described in Chapter 3. A model such as this would also benefit corporate participants, as they would have reduced search costs and greater diversity of ideas, since a system that is fair and trustworthy will presumably maximize participation.

The best analogy for such a system that I can think of presently is Facebook. It's ironic given the number of intellectual property problems the company has faced, both with respect to its founders and its user data, but I think that the platform offers some interesting parallels in functionality. To be perfectly clear, I am not suggesting that Facebook in it's current form is the correct media for an open innovation tool, but rather that it forms a convenient analogy. In the following section, I will describe the functionality of a Facebook-esqe open innovation portal, I will call this proposed portal "Brainbook" for convenience.

Relevance seeking

Overall, the major strength of Facebook is the way that it oscillates between letting a person choose what is interesting and relevant and allowing for serendipity through curation. It is possible to seek out a specific piece of information relatively easily, but the vast stream of information presented to every user is filtered by an algorithm that accounts for implicit and explicit preferences.

An open innovation tool that incorporated this functionality would address one of the major challenges faced by open innovation: the high search costs. All of the current tools require an individual or company to know explicitly whether a particular idea fits with a particular problem. The emergence of natural language tools and the ability of an algorithm to detect sentiment could allow for ideas and applications to be matched in a less obvious way. The same way that Facebook targets ads to your location or interests, Brainbook could target opportunities to people based on their current idea output or past work. Since Facebook knows people "you might know", a parallel system would be able to identify people who are working on related problems, or people who could help you with an aspect of your work that is beyond your expertise.

Facebook currently prioritizes photos in the news feed because they create more "click-through", which is good for creating traffic and hence ad-views. As a result, Facebook now has face-recognition abilities, and the management of visual data is becoming increasingly automated. The next step could be interpretation of non-text data, posted drawings and models could be analyzed, enhancing the ability of Brainbook to find a match between idea and application.

Facebook also prioritizes things that generate a lot of comment activity. This valuation is partially explicit on the part of the user through preferences, and is partly the result of the Facebook algorithm. Similarly, I envision that natural language tools would allow Brainbook to seek out ideas that are particularly unique or controversial, which according to Könnölä et al (2007) is a sign of an emerging disruption, while at the same time filtering for relevance.

Disclosure

Facebook currently knows who has looked at what, and for how long. It can also identify if two people met at a particular event, if they become friends a given period of time after that event. These features seem sort of inconsequential, until you think of their potential application to the disclosure problem within Brainbook. The issue of whether a company came up with an idea independently or after viewing an inventor's work would no longer be a matter for a lawsuit, the digital DNA of an idea would be relatively clear. The same way that people can be tagged in photos, ideas could be tagged or attributed, allowing for an equitable division of revenue. It would be easy to apply this capability to other creative endeavors, such as books or music, with plagiarism lawsuits becoming a relic of the past.

Foresight

Facebook and other social networking tools currently have applications in short-term forecasts of customer behaviour (The Economist, 2011). Aggregating "likes" and status updates across the network could form a robust trend scanning tool or automated Delphi-like survey within Brainbook. This would allow inventors access to a broad spectrum of ideas in the same way that large-scale customer research informs corporate decisions. This could partially mitigate the potentially large gap in market knowledge between inventors and the companies they approach, and could persuade a skeptical company that there is latent customer desire for a proposed product. The current integration of Facebook with external partners (e.g. Twitter and FourSquare) suggests that it is possible to incorporate data from outside a network, enhancing Brainbook's prediction ability further.

The commenting and message functionality would allow for improvements to a product to be suggested earlier in the development of a project, reducing the chance of a complete prototype flopping and addresses the collaboration advantage described in Chapter 2.

Bona fides

Facebook also addresses the bona fides issue, at least partially. Facebook forces users to identify themselves, in some cases requiring an authenticated email address from an institution to access some resources. Like all online tools, impersonation is possible, but authentication enhances trust and could allow for more open discussions on Brainbook. Disclosure would continue to be an issue, but privacy settings would allow potential collaborators to be selectively open with a subset of their "friends" and adjust this openness over a project's trajectory.

On Facebook there exists a continuum of users, from those who post and respond to posts on a minute-by-minute basis, to those who post rarely, if at all. The reasons for levels of activity range from prioritization to concern over privacy issues. I would hypothesize that by allowing users to self-select their level of involvement, Facebook enabled a much larger network than they normally would have. I would suggest that a portal such as Brainbook pursue a similar strategy: allow paranoid inventors and companies to join and use it as a foresight tool (passive uptake of other's data without their own disclosure), but also incentivizes participation.

Part of the incentive to participate could come in the form of quantified credibility. By posting particularly relevant ideas on a regular basis, or by connecting collaborators, an inventor could achieve more credibility within the community, similar to the way one becomes a "mayor" on FourSquare, or gaining credibility for having a large number of re-tweets on Twitter. Brainbook's quantification of who produces original, helpful ideas could help the algorithm match people with similar levels of engagement, or enable companies to work with someone more confidently, in essence replicating the function of citations in the academic world.

Reducing Risk

Facebook also allows for the tracking of multiple message streams at once. In Brainbook this would let individuals track the value of their ideas, both instigated (ideas posted) and responded to (additions via feedback). This tracking could take the form of a portfolio, the same way that people track stock portfolios, an algorithm could track the value of contributions. This would mitigate some of the decision traps outlined in Chapter 2 and allow inventors more objectivity.

A system map

The data flows in the Brainbook system would be as shown in Figure 8, below:

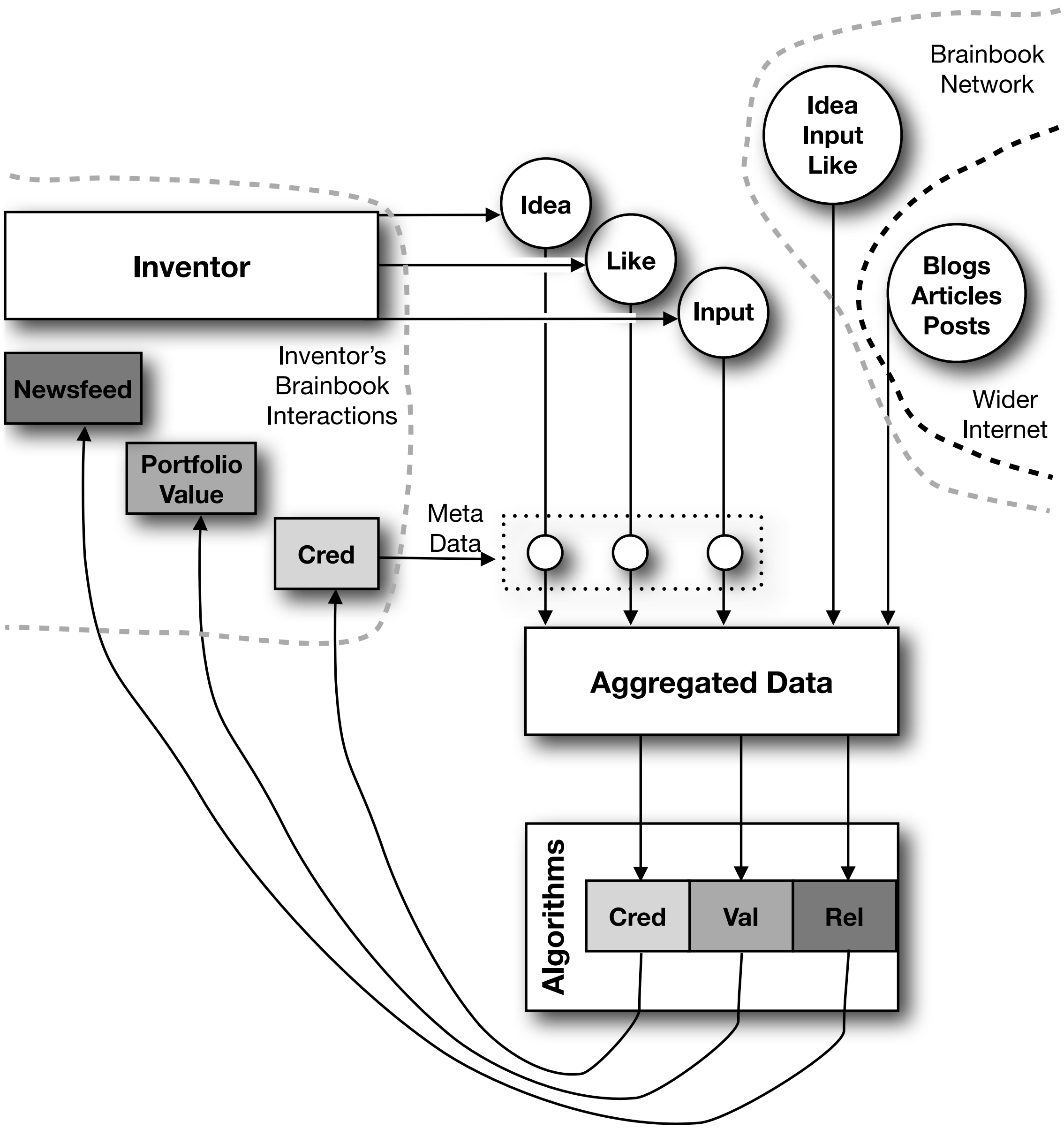

Figure 8: Brainbook data map - The interactions for a single inventor are shown. Ideas, likes or any input stream are tagged with the contributor's "cred" meta data by the credibility algorithm. Contributions are then compared with the aggregated data from elsewhere in the network and the wider internet and assigned relevance and value. The relevance algorithm is user-specific, and reflects implicit and explicit preferences, this dictates what a user sees in their Newsfeed.

Caveats

Although the arguments above suggest that the ideal open innovation platform, Brainbook would have a lot in common with Facebook, there are still a few potential challenges. One would be the interaction with the offline or private network world. Verbal or telephone disclosures wouldn't be captured, neither would information gleaned from print sources or observation; tacit information in general could be a challenge.

The other problem would be that of trust in the algorithm to allocate contributions fairly. How much an idea is worth relative to implementation or a critical revision would be a hotly debated issue, particularly for an idea that turns out to be "the next Google". This could be addressed simply with some rules of engagement, but with intellectual property laws in different jurisdictions varying wildly it could be a challenge to enforce and may not have much more practical effect than a handshake or "gentleman's agreement".

There is also the problem of ethics. Some engineers or scientists have very definite views on what they will and won't work on, it is not uncommon for engineers to refuse to work on a project that pollutes water, for scientists to refuse to work on something that causes global warming. An open network approach to innovation would make maintaining these kinds of personal boundaries more difficult, unless there was some kind of explicit consent mechanism.

Solving the valuation problem

The feedback and search efficiencies of a Facebook-like system address many of the issues facing individual inventors and the companies that wish to work for them. The one truly difficult issue remaining is valuation: what is a particular idea worth?

It's a complex, multivariate question: it would depend on the industry, the available resources of the organization developing it, the uniqueness, the quality of implementation, when the idea emerges in the trajectory and so on. Like disruption, it seems obvious post-hoc, but would be highly uncertain even after commercialization.

In conventional venture capital situations, the earlier one invests, the more favourable the terms, for example Mike Markkula became an early co-owner of Apple for the bargain price of $250,000 (Carleton, 1997). The stock market functions in a similar fashion, buying a mining company's stock when it's in exploration yields a higher profit than when it has progressed to production, because as an investor you have exposed yourself to more risk. One option for valuation of ideas would be one like a stock market: an idea is worth whatever the market will bear on that particular day. This idea is consistent with current economic models and venture capital processes.

However, I think there is another alternative. Now that ideas can be tracked and contributions to those ideas can be quantified, why not delay payment until *after* it is commercialized and adopted. Once sales figures are known, as are the tooling, distribution and marketing costs, it would be possible to arrive at a perfect valuation. The inventor could develop a prototype with an advance against their share of the eventual profits, and then wait for the remainder. It wouldn't be a huge windfall all at once, and the inventor's yield might be less than self-commercialization, but it would be equitable and minimize risk for both parties. Companies could spend less on defending against intellectual property suits, and would worry less about overspending on poor ideas or untrustworthy partners. The risk would be distributed over more people, all of whom would have an incentive to maximize success. The valuation metric would be intensely debated and argued over, potentially becoming the subject of lawsuits the way that patent violations are now.

Stakeholder Value

The previous section laid out the ways in which Brainbook or a similar open innovation tool could benefit individual inventors. The potential benefits for these individuals and additional stakeholders are outlined in the section below:

Individual Inventors

Summarizing the points made earlier in this chapter, the most notable benefits for an individual are as follows:

1. *Foresight and feedback services:* Access to an aggregated, algorithm-curated database of Delphi-like information, in addition to automated checklists and individual-to-individual feedback would represent a major advance relative to current informal trend scanning practices by inventors.
2. *Validation of Bona Fides:* Quantifiable, reliable metrics regarding one's capabilities make it easier to identify collaborators and create trust with partners.

3. *Extension of capabilities:* Working with an industrial partner enables more complex technical problems to be solved, without the limitations of one's own funding or prototyping abilities.
4. *Disclosure security:* Digital tracking may ease some of the discomfort associated with early disclosure by acting as insurance against theft.

Academic Inventors

Although the academic inventor is technically a subset of the independent inventor, their stakeholder priorities are slightly different as a result of their funding situation and academic obligations. Their benefits, in addition to those specified for all individual inventors, are as described below:

1. *Quantification of impact:* Academics applying for research funding may benefit from an additional way of quantifying the importance of their work, since an objective measure could persuade skeptical granting agencies.
2. *Alternate funding model:* Research that is too controversial for government agencies, or is by nature necessarily inter-disciplinary would benefit from less restrictive funding models, which would be facilitated by a portal such as Brainbook.
3. *Prevention of duplication:* If peers begin to indicate their prospective research directions on Brainbook, it would be possible to avoid duplicating another researchers' experiments, resulting in faster, more progressive work.
4. *Student opportunities:* Brainbook could offer students the chance to develop their projects faster, and further than in a traditional one or two term project, potentially with funding from industrial partners.

Industrial Partners

The current open innovation tools are constructed in a way that favours the industrial partner, but expanding participation and trust could yield even greater benefits. The benefits of Brainbook relative to existing open innovation tools are as described below:

1. *Foresight and feedback services:* Current foresight data collection practices are relatively labour intensive and have a long time horizon. Brainbook's algorithm and pool of experts could give access to a more flexible and responsive data set.
2. *Reduced "crackpot" risk:* Quantifiable, reliable metrics regarding an individual's capabilities provide some insurance against misappropriation of capital, and the digital tracking prevents frivolous patent lawsuits.
3. *Lower interaction costs:* An algorithm that manages the valuation and match-making aspects of open innovation would dramatically reduce the labour associated with implementing open innovation techniques.
4. *Faster progress, fewer failures:* Brainbook would be a way of simulating lead-user or focus group testing prior to full scale manufacturing, with the objective quickly catching flaws and resolving issues.

Government

Both the Canadian and US governments have made innovation a priority and are major funders of both basic research, through grants, and applied research, through tax incentives. Brainbook presents numerous opportunities for the government, in fact they may be a natural host of such a portal. The chief advantages of government either sponsoring of supporting a portal such as Brainbook are as follows:

1. *Foresight:* The government currently produces periodic research strategy documents meant to guide granting agencies and other participants. These

documents could be compiled in a more timely fashion and with more diverse contributions using the Brainbook data set.

2. *Quantification of research value:* Quantifiable, reliable metrics would make it easy to see which research groups are most productive, and which ones require intervention.
3. *Fewer bankruptcies, more tax revenue:* Individual and small business success means more tax revenue for the government.
4. *Less strain on the patent system:* Brainbook would provide feedback to inventors indicating if their work overlapped prior art or doesn't meet the patent criteria. This would reduce the number of unsuccessful patent applications, making the whole patent system more efficient.

Conclusion

The current open innovation tools and techniques do not fully leverage current data management strategies. To create a robust, thriving market for ideas, these tools must overcome issues around relevance, disclosure, bona fides and valuation. I suggest that the ideal open innovation tool would mimic the functionality of Facebook. The idea that all of the technology required to create a functioning idea market not only exists, but has been user tested by millions is an exciting one.

Conclusions

Future Directions

The idea of Brainbook or a similar open innovation portal is compelling and aligned with current trends. The overarching strategy is to follow an implementation plan similar to that of Facebook; an initial launch among lead users with limited functionality, followed by a phase of refinement and finally opening the network to all participants. The algorithms would be constantly evolving, and new applications and functionality could be phased in in the same way that the Facebook platform has evolved since it's initial launch.

A rough implementation plan is summarized below:

Initial steps:

- Find a host or sponsor to fund the initial work.
- Design a user interface for beta launch.
- Develop validated criteria for the Valuation algorithm based on previous inventions.
- Lobby patent agencies to accept Brainbook inputs as proof of invention.

- Coordinate with other social networks to allow seamless integration
- Populate database with current patent filing information.

During Beta launch:

- Invite lead users to participate in Brainbook, strictly as a Delphi-like foresight tool.
- Use the pilot data to refine the user interface, and start to construct the Credibility, Valuation and Reliability algorithms.
- Solicit the cooperation of thought leaders, such as major industrial partners, government agencies and notable inventors.
- Develop social media strategy to leverage connections of lead users and maximize uptake by innovation community.

Prior to main launch:

- Finalize the code for Valuation, Relevance and Credibility algorithms.
- Design invention self-evaluation applications to run within Brainbook.
- Release software development kit so that external applications may be written for the platform.
- Solicit additional members via social networking and publicity.
- Launch fully functional Brainbook portal.

Conclusions

This project set out to investigate the ways in which an inspired, educated person could commercialize an invention without doom. Initially, I investigated the hypothesis that the "doom" was the result of inventor-specific cognitive biases that resulted in decisions contrary to logic. However, despite that being the stated conclusions of many of the business-focused source material, a more thorough examination of their data collection methodologies and more recent USPTO data refuted some of the pervasive myths regarding the individual inventor.

Although individual inventors may be more optimistic or overconfident than their industrial counterparts, there is ambiguous evidence regarding whether it affects their choice of patenting domain or commercialization decisions. In contrast, I propose that these apparent "irrationalities" may be in response to market forces such as advantageous development conditions or lack of interest from potential industrial partners. These market forces are often driven by an information asymmetry or communication failure, whether that information is scientific, foresight or market-related.

These asymmetries can be partially remedied by judicious application of foresight techniques. Chapter 2 outlines the role of foresight and the ways that the current informal practices could be augmented with foresight frameworks. Although it is a challenge for individuals to achieve sufficient diversity of data during trend scanning, one of the chief advantages of a portal such as Brainbook would be the aggregation and evaluation of foresight data from a wider range of participants.

Chapter 3 evaluates the role of risk in financing of invention, and draws parallels to the funding of basic scientific research. I identify the key factor differentiating these two funding activities is the presence of bona fides for academic scientific researchers, providing a form of guarantee for the funder. Establishing these bone fides for non-academic inventors would have a beneficial effect for individuals seeking to commercialize an invention while minimizing the risk to their personal finances. The portal Brainbook would provide a mechanism for this, in addition to providing market information to aid funding decisions and a mechanism for incremental funding.

Chapter 4 outlines the current state of the art of open innovation. I identify high search costs and biased outcomes for the industrial participants as being a hinderance to further development of these tools. The ideal way to overcome these issues would be a portal such as Brainbook, which simultaneously addresses the previously mentioned challenges faced by inventors and offers benefits for the associated stakeholders, such as improved trust, faster progress and reduced information asymmetry. These benefits surpass the project's original goal of dodging individual "freezie doom" and propose a mechanism to leverage the abilities of all invention-minded people, whether they are tackling the small problem of frozen treats or the big problem of global warming. The outcomes of a functioning, fair idea market are not only good for the immediate stakeholders, they are good for society as well.

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