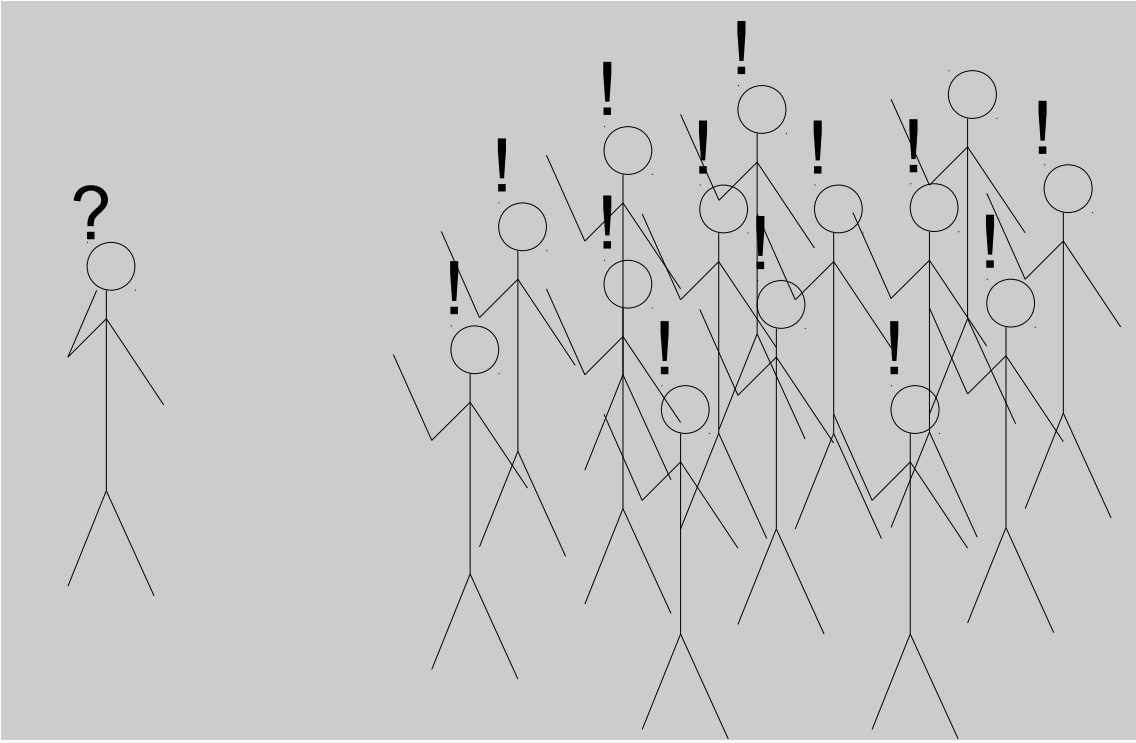
Radical and incremental solutions by marginal solvers in a broadcast search



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Radical and incremental solutions by marginal solvers in a broadcast search

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New business, innovation and entrepreneurship

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Preface

This thesis is the endpoint of a journey that lasted more than two years. A journey of learning, discovery and new insights. Although I truly expected to major in operational excellence, the views, theories and materials offered in the new business, innovation and entrepreneurship major were so inspirational that I decided to follow this route.

I could not have completed this journey without the help, support and patience of those around me and that is especially true for this thesis.

In the first place I want to thank Jan van den Ende for his guidance and enthusiasm. Helpful too were his reviews, in which he was quick, thorough and direct. He also took the time to discuss my ideas and questions and offered valuable insights from which this thesis benefited greatly.

A special debt of gratitude goes to Mark Boons. When the first data collection fell through, he was kind enough to share data he had available with me. Although not yet complete, it gave me a good start to finish this thesis. I also enjoyed the discussions we had on the matters relating to this thesis and the valuable feedback he gave.

Others that have helped me along the way are Jan and Haske Marijnissen, who brainstormed with me about possible crowdsourcing initiatives. My classmates, who made the past two years unforgettable and specifically Patrick Morcus, whose drive and enthusiasm are infectious, Jantien Westerveld and Hester IJntema with whom I had great discussions and a great time. René Koedam and Danny Vullings who were there when I needed to not think about the hard work. Wim Sluijter and Rinel Marijnissen, my parents, who made much of this possible in the first place.

Most importantly, I want to thank Anne for her support throughout these past years. It has not always been easy on you and I could not have done it without your understanding, patience and love.

Thank you all.

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Abstract

For many firms innovation is a core method for gaining competitive advantage, but the speed of innovation is steadily increasing. Luckily, the spread of cheap internet has contributed to new ways in which firms can innovate. One of these methods, broadcast search, a form of crowdsourcing, can be a powerful tool to solve specific problems that firms are not able to solve themselves.

Although crowdsourcing in general and broadcast search in particular are gaining traction as viable business strategies, they are not yet fully understood. In broadcast search, for example, it is known that more distant solvers (also called marginal solvers) are more likely to propose high quality solutions, but it is not yet clearly understood why that is. One possibility is that more distant solvers, unencumbered by the customs and heuristics of a given field may be able to pose more radical solutions, at the very least from the perspective of the seeker (the problem owner).

Although the relationship between the distance of a solver, the radicalness and quality of their proposal has not yet been researched, the literature on radical innovation does indicate that radical innovations are generally perceived to be of a higher quality, even if this perception is often implicit. The literature on marginality (or being distant to a given field) shows that marginal individuals make radical contributions.

This thesis combines these insights and investigates if, in a broadcast search, more distant solvers come up with more radical and therefore higher quality ideas, using data taken from three challenges of the Battle of Concepts website.

The data from these challenges reveals three important things: first, there is a significant, u-shaped relationship between the distance of a solver and the radicalness of their answer. Second, There is a significant and inverted-u-shaped relationship between the radicalness of an answer and the perceived quality. And third, the distance of a solver has a relationship with the quality of an idea and this is moderated for their level of education, meaning that for a higher education, the effect of being distant is less pronounced and more straightforward. This last relationship was only found for one of the challenges.

This leads to the following conclusions: solvers with a greater distance to the problem field come up with better and more radical solutions. The radicalness of their

solutions may be part of the reason why these solutions are indeed perceived as better. The curvilinear relationship found between the different variables indicate that there are optimal points, both for the distance of solvers and the radicalness of their proposals. Too distant solvers are less able to come up with good solutions and too radical solutions are not necessarily better. Lastly, the level of education of potential solvers mitigates these interactions, making the relationship between distance, radicalness and quality more straightforward.

There are some important limitations to these findings. Most important of these is the fact that for two of the challenges that were part of the full data set, the results were not confirmed. Secondly, the proposals were coded by an expert panel, who were not part of the firms that instigated these challenges. This may have influenced the outcome of this research. Lastly, although these challenges are already a few years old, at least two of the seeker firms have not implemented the proposed solutions.

There is still much that can be researched in the field of broadcast search. The findings of this thesis may be useful as indicators for further avenues for research.

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1. Introduction

1.1 Cause

In the past few decades there has been a shift from the traditional, closed model of innovation, the roots of which can be traced back to Thomas Edison and his research laboratories, toward more open forms of innovation. Championed by Von Hippel (2005) and Chesbrough (2008), this form tries to incorporate outside innovation into the firm.

One of the hallmarks of open innovation is the inclusion of customers and end-users in the innovation process. This, aided by the proliferation of cheap internet and the ever expanding availability of free information, is leading to a new way of innovating. In it, all who are interested are invited to contribute to a firm. Also known as crowdsourcing this new way of doing business was first defined by Jeff Howe as follows: *"Crowdsourcing is the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call."* (Howe, 2006)

The way Howe defines crowdsourcing, means that any and all tasks can, in principle, be delegated to the crowd. For this thesis the focus will be on the possibilities and the implications of crowdsourcing innovation.

This specific form of crowdsourcing is dubbed crowd wisdom by Howe (2009). Two broad approaches can be distinguished in the way companies try to attract a crowd. The first is an open call for innovative ideas, also called "idea jams" (Howe, 2009). Anyone with an interest in the firm, brand or product can contribute. After assessment, sometimes by the same crowd, companies then try to implement the best of these ideas. Examples include Dell's Idea storm and Shell's Gamechanger programs.

The second is what Jeppesen, Lakhani and others are calling "broadcast search" (Jeppesen & Lakhani, 2010) (Lakhani & Panetta, 2007). In this case, specific problems or innovation challenges are "broadcast" to a crowd of interested individuals. These individuals then self-select if they are interested and/or qualified to propose a solution. They are most commonly known as "solvers" (Jeppesen & Lakhani, 2010) (Boudreau, Lacetera, & Lakhani, 2010) (Lakhani & Panetta, 2007).

Often the firms or organizations that broadcast these problems, called seekers in the

broadcast search model, have been unable to solve these through more conventional methods. One avenue seeker firms can use is innocentive, where broadcast searches potentially reach 120,000 scientists from diverse fields (Lakhani & Panetta, 2007).

It should also be noted that, although broadcast search reaches a large group of potential solvers, only about 30% of all challenges posted to innocentive are deemed solved by the owner (Jeppesen & Lakhani, 2010). This is unfortunate because, for many firms, taking the step to make internal problems public is a difficult one.

Broadcast search has been the subject of some research in the past years. This research has mainly focused on the incentives of the solvers (Boudreau, Lacetera, & Lakhani, 2011), the beneficial effect of diverse domain skills (Jeppesen & Lakhani, 2010) and the way these contests have been set up (Terwiesch & Xu, 2008).

While Jeppesen and Lakhani have shown that more marginal solvers were more likely to win Innocentive challenges, it is not clear why this is so. Jeppesen and Lakhani argue that solvers with different domain skills will bring new perspectives and heuristics to the problem, thus facilitating new approaches to finding a solution (Jeppesen & Lakhani, 2010). Although this is probably true, it does not yet explain why the proposed solutions are more successful.

One possibility is that more marginal solvers come up with more radical solutions. Seeker firms have often exhausted their regular channels of innovation in an attempt to find a fitting solution. This solution is therefore not obvious, at least to them. This can be illustrated by the example of the physicist who solved a chemical engineering problem posted on innocentive (Howe, 2009; Jeppesen & Lakhani, 2010). His solution, which involved the use of static electricity was certainly very new to the seeker firm and can thus be considered radical, at the very least from the perspective of the seeker.

This research will test this by analyzing the proposed solutions and the background of three different challenges posted on the Dutch crowdsourcing site “Battle of concepts” (http://www.battleofconcepts.nl). A summary of the three challenges can be found in appendix A.

1.2 Research question

All this leads to the following research question:

"How does the marginality of the problem solver influence the radicalness of the proposed solutions for problems in a broadcast search and what is the effect on the quality of proposals?"

To help answer this, the following sub-questions are proposed:

- What is marginality?
- How does broadcast search generally work?
- What are radical solutions?
- Does educational background influence the proposed solutions?
- How does marginality influence the radicalness of the proposed solution?

1.4 Research objectives

The first objective of this thesis is to add to the literature on broadcast search. Determining why the solutions of higher marginality solvers are more successful might lead to a better understanding of the mechanics that make it useful tool for innovation.

Secondly, this insight could be used in future broadcast searches. Understanding what makes successful answers could make determining successful contributions easier. It might even help in the initial stages of compiling problems for a broadcast search.

1.5 Structure of the report

This report has the following structure: In chapter two the concepts that will be used as the basis for this report will be explored. Current and relevant literature is discussed and compared, in order to build toward an answer of the research question. This chapter concludes with the hypotheses as formulated for this research.

Chapter three details the methodology of this research. Chapter four contains the analysis of the data and the answers to the hypotheses. The results are then discussed in chapter 5. This chapter also contains a discussion of the limitations of these research as well as some recommendations for further research.

2. Theory

In this chapter the three main concepts that are the basis for this thesis will be explored. What have others said about them, what research is there and how does it relate to this thesis?

First, a brief history of crowdsourcing and an exploration of the concept of broadcast search. Next, marginality will be explored and lastly an overview of the literature of radical innovation.

2.1 Crowdsourcing and broadcast search

As pointed out in the introduction, crowdsourcing is the act of outsourcing a job normally done inside a firm to "an undefined, generally large group of people" (Howe, 2006), the so called crowd. Although this thesis will focus on a specific form of crowdsourcing, a small introduction of the subject may be in order, since crowdsourcing is not yet widely known or understood.

Because all jobs and tasks can, in theory at least, be crowdsourced, Howe's definition is necessarily vague. Broadly speaking he distinguishes 5 categories: crowd creation, crowd voting, crowd funding, crowd labour and crowd wisdom (Howe, 2009).

Crowd creation is the most well-known of these. Most of the content on YouTube, for example, falls into this category. Another example is Threadless.com where t-shirt enthusiasts can upload their own designs. The most popular of these are then produced and sold. With only a few employees they their revenue surpassed 30 million dollars in 2011.

Threadless also makes good use of crowd voting. By letting the visitors vote on the designs and by letting them indicate which design they would like to buy, threadless knows beforehand that any shirt they produce will be a success. Another advantage is that, when aggregated, the crowd tends to be smarter than average. A prime example of this is used in the television show "Weekend millionaire". One of the lifelines the candidates have is to let the public vote for the right answer. When the crowd is not influenced, the highest scoring answer is usually correct.

Crowdfunding uses the money available in the crowd to fund projects that might otherwise never get off the ground. Kickstarter.com, the largest crowdfunding platform has grown rapidly in the last couple of years. Anyone with a project can pitch

their idea and gather funding without having to resort to loans or investors.

The most direct outsourcing example of these is crowdlabour. It is a literal outsourcing of tasks by companies who pay anonymous labourers for usually menial tasks. The payment per completed task is often very low, usually only a few cents. There is one area however, where this has led to surprising results. Science tends to accumulate large amounts of data, which need to be sorted and analyzed. Several projects like the Galaxy Zoo project, in which amateur volunteers studied astronomical photo's, have shown that people are willing to donate their time and intellect for projects that interest them.

The main interest of this thesis, crowd wisdom, describes the innovations that originate in the crowd. Although there are several ways this can be done, the most common and the most used is the innovation contest.

2.1.1 From innovation contests to broadcast search

Innovation contests, in one form or another, have been around for a long time. A very early example is the Longitude act of 1714, issued by the British parliament, which offered 20,000 pounds to anyone who could devise a way to accurately determine the longitude on board a ship (Stallbaumer, 2006). Against all expectations, even those of Isaac Newton, the solution was not astronomical, but lay in the construction of a clock that could keep time accurately even on board a ship.

Despite the fact that this method of stimulating innovation was often successful, firms have traditionally favored the closed model of innovation. This model, which can trace its roots back to Edison's Menlo park (Rosenbloom & Spencer, 1996 p. 19-20), relies on vertically integrated research and development (R&D) for innovation. The drawback of such a model is that spillover of R&D activities could not always be commercialized (Chesbrough, Vanhaverbeke, & West, 2008 p. 5-7).

Another major drawback of this model of innovation is described well by a statement attributed to Bill Joy, co-founder of Sun Microsystems: “No matter who you are, most of the smartest people work for someone else” (Lakhani & Panetta, 2007). In other words, knowledge is unevenly distributed and no one company has all available or even necessary knowledge at their disposal. This is not a new idea: in 1945 Hayek already pointed out the distributed nature of information (1945). In recent years

others have elaborated on that idea. Von Hippel, for example, used the term "sticky information" to illustrate the difficulty and therefore the costs involved in getting information from one place to another (1994).

But that only applies if relevant information can be found. A quick search for "innovation management" on Google scholar reveals nearly 2 million results, 25 thousand of which were published since 2011. It would be impossible for an individual or even a large firm to wade through all these papers to find those that are not just relevant, but also useful.

In recent years a more open model of innovation has emerged. Chesbrough, for example, describes a model in which innovation can be initiated from internal or external sources and where innovations can be commercialized not only through bringing a product to market, but also through licensing and spin-offs (2008 p. 2-3). Even more open is the use of lead-users for innovation. In this model, the firm incorporates innovations made by the (lead)-users of its products (von Hippel, 2005).

Crowd innovation can be seen as an extension of these models of open innovation. Instead of collaborating with other firms or lead-users, the undefined crowd is invited to participate in innovation. And contrary to the concept of open innovation, in which altruism or self-interest are often motivators, the main motivation is usually a cash prize (Terwiesch & Xu, 2008). Broadcast search is the term used to describe a form of innovation contest (Jeppesen & Lakhani, 2010; Lakhani & Panetta, 2007) in which specific problems are put to "a population of independent agents (the solvers) and then provides an award to the agent that generated the best solution" in the words of Terwiesch and Xu (2008)

2.1.2 The advantages of broadcast search

Of course, firms will usually prefer to solve their problems themselves. If this is not possible, they may choose to use their network to do it for them. Elements in this network could be suppliers, consultants or universities.

Figure 2.1 shows four general ways firms can innovate, of which the above is just one. In this

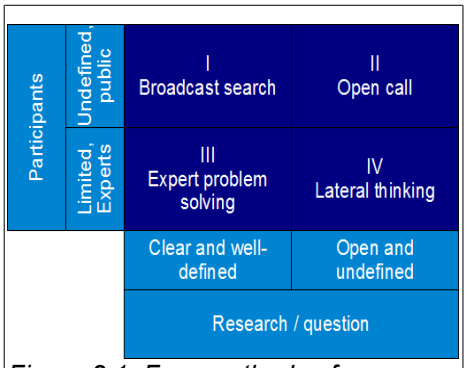


Figure 2.1. Four methods of innovation.

figure, which is based on Sluijter en de Jong (2012), the bottom half (III and IV) represent the more traditional forms of innovation, as described above.

However in some cases, this may not be enough. Either their network does not contain the necessary capabilities or capacity, but it may also be that truly novel ideas are needed. In this case, it may be an option to look beyond the traditional methods and to involve the public. In short, it may be an option to crowdsource (figure 2.1, I and II).

The open call (figure 2.1, II) is especially useful if firms wish to generate novel ideas, without having a specific question or problem to solve. While it is possible to generate a lot of ideas by engaging the public, the quality of these ideas is by no means guaranteed (Howe, 2009) and it may be difficult to select the best or most relevant ideas.

The last type of innovation in figure 2.1 is broadcast search. When firms wish to find a solution to a specific problem or an answer to a well-defined question, but they or their network are not able to provide this, they may turn to a crowd of solvers to do this for them, usually through a broadcast search platform.

A well-known example of the above is innocentive. This platform, originally initiated by Eli Lilly, connects firms that want to solve their problems with the help of the crowd, called seekers, to those who may be able to offer a solution, called solvers (Jeppesen & Lakhani, 2010). As early as 2007, InnoCentive connected 120,000 solvers from around the world to the connected seekers (Lakhani & Panetta, 2007). Currently, the InnoCentive website states that more than 250,000 solvers are active ("InnoCentive," n.d.). Many of these are scientists and students looking for a challenge.

So what are the advantages of broadcast search? As Lakhani and Panetta put it: "most of the pertinent knowledge will reside outside the boundaries of any one organization" (2007). The traditional method of increasing the sphere of knowledge, through the network of the organization, may not be sufficient anymore. The accelerated pace at which new knowledge and information comes available and the speed with which innovations become mainstream and even obsolete, mean that firms need to innovate faster and better.

As Scott Page has pointed out, "diversity trumps ability" (2008). Through broadcast

search a much more diverse group of solvers can be reached. There is a caveat though: you need to be able to reach an able group of diverse solvers to succeed. This is also where self-selection comes into play. It is the moment when potential solvers asses if they are able to make a valid contribution.

2.1.3 A definition of broadcast search

Broadcast search, then, is a means for firms to outsource innovation problems that they are, for whatever reason, not able to solve themselves. It strengths lie in the fact that a more diverse group of solvers can be reached. These solvers do need to be capable of solving the problem at hand, so it is important to reach the right group. From this group, only those individuals that deem themselves able will submit solutions, thus preventing an overload of low quality ideas.

2.2 A history of marginality

According to McLaughlin: "Marginality has long been seen within sociological theory and analysis to lead to creativity, insight, and innovation." (2001). But what is marginality? Interestingly, it is not a new concept. Already in 1928 Park described the "marginal man" as a "cultural hybrid", "[...] a man on the margin of two cultures [...]" in whom "the process of civilization is visibly going on." (1928). It should be noted that Park proposed that these marginal individuals were the best subjects to study the process of civilization and that he did not yet mention any advantages to being marginal.

These supposed advantages have become part of scientific lore (Gieryn & Hirsh, 1983; Kupferberg, 1998; McLaughlin, 2001), where the outsider is seen to have a better chance of original ideas and innovations. And this lore is understandable: when reading Bill Bryson's "A short history of nearly everything" (2004) it is hard not to notice all the marginal individuals and their contribution to the march of science. Even one of the most famous scientists, Albert Einstein, could very well be described as marginal. This however does not mean that all, or even most, progress is made by marginal individuals (Merton, 1979, p. 518 – 519). They do make good anecdotes and could therefore lead to an overestimation of the influence of marginality. Consequently the theory has not been without its critics: Golovensky, for example called it "[...] a caricature of the truth or an exaggeration of a distortion of fact." (1951).

Research into the perceived positive effect of marginal contributors has been similarly mixed. Gieryn and Hirsh name ten studies that show that marginal individuals either created or reconstituted a discipline through their innovations (1983), yet they go on to find that their own study provided no proof that marginal individuals were more likely to contribute significantly. It should be noted that their findings are disputed, and that both Simonton and Handberg (Handberg, 1984; Simonton, 1984) claim that these findings are flawed.

Still, to quote Mulkay: "There exists considerable but unsystematic evidence in support of the claim that significant innovations come disproportionately from young researchers at the foot of the scientific hierarchy and others on the margins of research networks." (1972), even if there is debate about the appropriate way to measure marginality and its effects (Gieryn & Hirsh, 1983, 1984; Handberg, 1984; Jeppesen & Lakhani, 2010; Simonton, 1984).

2.2.1 Defining marginality

It may be clear that, as with many aspects of sociology, there is still much discussion on how marginality should be defined or measured. Park, one of the first to use the term "marginal man" did so in the context of migrating individuals who found themselves in new surroundings, both physically and culturally (1928).

Others have used age (Gieryn & Hirsh, 1983; Kuhn, 1996), being new to the field (Kuhn, 1996; Mullins, 1972), being in a different technical field (Gieryn & Hirsh, 1983; Jeppesen & Lakhani, 2010) or the use of unfamiliar techniques (Law, 1973). Overall, marginality can be the outcome of societal, organizational and / or situational / individual aspects (McLaughlin, 2001) and does not need to be fixed, but can vary over time (Kupferberg, 1998).

Jeppesen and Lakhani follow Gieryn and Hirsch and McLaughlin and state that marginality relates to being in a different technical field and to social attributes such as age, education and affiliation (2010). Although being in a different technical field than the problem may constitute a clear sign of marginality, their choice of being female as a second measure for marginality may be less obvious.

Their reasoning is as follows: there is strong evidence that women are treated as less than equals by the scientific community (Etzkowitz, 2007), which leads to social

exclusion of women in science. The social exclusion equates to women being in the outer circle of the scientific establishment and thus leads to their being marginal (Jeppesen & Lakhani, 2010). As McLaughlin has shown, those at the center of their field build a framework of norms and practices, whereas those at the margins offers the possibility of developing different perspectives and heuristics (McLaughlin, 2001).

2.2.2 How marginality works

It may seem odd then that research has shown that individuals use prior experience and knowledge to solve problems (Lovett & Anderson, 1996; Sørensen & Stuart, 2000) and that this goes for individuals as well as teams. Being part of an institution and having access to its resources has even been shown to lead to higher productivity and creativity (Collins, 2000; McLaughlin, 2001). Both of these conclusions contrast with the notion of marginality.

What then, is the basis on which marginality works? In general, there are two distinct notions to describe the positive effect of marginality. The first is described as a "focused naïveté" (Zuckerman & Merton, 1971) and the second stems from the willingness of young or marginal scientists to take greater risks in order to gain recognition faster and it is their risky research that has the potential to be truly innovative (Gieryn & Hirsh, 1983; Kuhn, 1996).

For this research, the first notion is the more important one: in online contests the solvers are often anonymous and there is little potential for damage to the careers or reputation of more established individuals. There is no incentive for any solver to eschew more radical solutions if they feel these are right for solving the problem at hand, while more radical solutions may very well lead to a greater chance of winning the tournament.

It is therefore this focused naïveté we concentrate on. Gieryn and Hirsch describe it as follows: "a useful ignorance of prevailing assumptions and theories that allows them to attack problems generally regarded as impossible or uninteresting by specialists." (1983). This useful ignorance is also what allows them to "create potentially novel solutions" (Jeppesen & Lakhani, 2010).

Marginal individuals bring new perspectives to problems, perspectives a more established individual may not even consider, since they do not fit with accepted

practices in the field. These diverse perspectives and heuristics allow a physicist to solve a chemistry problem (Howe, 2009). It is also where the power of online ideas tournaments lays: by allowing anyone, including those marginal to the problem field to compete, a diverse group of solvers can be mobilized. According to Page, a diverse group of solvers will generally lead to better solutions, specifically because it will include many different perspectives and heuristics (Page, 2008). It should be noted that Page specifically meant groups working together.

2.2.3 Marginality and broadcast search

Although the notion of marginality is generally supported, both as a concept and by several empirical studies (for example: Kupferberg, 1998 and McLaughlin, 1998, 2001), there is discussion on the exact way it should be defined and measured. Still, it has a clear practical use in this thesis: as Jeppesen and Lakhani have shown, being marginal increases the chances of submitting a winning solution (2010) in a broadcast search setting.

Although Jeppesen and Lakhani used two measures for marginality, namely gender and being in a different technical field, this thesis will use only the last. Since the contests that are researched here were accesible to the general public and not just scientists, the notion of gender inequality is expected to have less of an effect. This is not to say there is no inequality outside of the scientific domain, but the effect is most likely to be less pronounced.

The focus, then, will be on the marginality of being in a different technical field than the problem. Based on the availability of different perspectives and heuristics, the expectation is that a higher degree of marginality, defined by being further removed from the technical field of the problem, will lead to more radical solutions.

2.3 Incremental and radical innovation

It has long been recognized that not all innovations have the same impact. Some innovations impact whole industries, like the early fax machine, or even the world, like the first steam engine (Gatignon et al., 2002), while other innovations merely improve existing products.

One of the first to account for the important role of innovation in the economy was Joseph Schumpeter. He also introduced the notion of "Creative destruction" (1934), to

describe the impact of highly innovative products. This impact of new technology could lead to changes in markets in such a way that it could lead to the demise of established firms.

2.3.1 Confusion about (radical) innovations

Since Schumpeter's insight much research has been has focused specifically on innovations that have a high impact. To describe these and to discern between high and low impact innovations, several different terms have been used: incremental (Green & Gavin, 1995), competence enhancing (Anderson & Tushman, 1990), really new (Song & Montoya-Weiss, 1998), architectural (Henderson & Clark, 1990) and breakthrough (Anderson & Tushman, 1990). Besides these, several other terms have been used to describe the degree of novelty of an innovation: imitative, architectural, modular, improving and evolutionary innovations (Garcia & Calantone, 2002).

Although all deal with the degree of innovativeness, few are well defined and the differences between the concepts are not always clear (Dahlin & Behrens, 2005). Garcia and Calantone alone identify fifteen constructs and 51 distinct scale items that have been used in just 21 empirical studies (2002). As a result there is little agreement on the typology of innovation types and a confusion as to what exactly has been reported on. Due to this, it can be stated that after more than 30 years of research on innovation the fundamental concepts and units are ambiguous and confused (Gatignon et al., 2002) (Green & Gavin, 1995) and that there is “widespread confusion” on what has been reported on (Garcia & Calantone, 2002). In fact, in 2000 an article on radical product innovation even states: “At present, the literature does not contain a measure of the radicalness of innovation...” (Chandy & Tellis, 2000).

This does however illustrate part of the problem: many different disciplines have researched the effects of innovation. The quote above, for example, was from the journal of marketing. Other fields include engineering, management and even organizational psychology. Many of these fields have tended to disregard research in other fields, simply because the emphasis was on different areas of innovation and its outcomes.

Interestingly, several studies have addressed this problem and each comes with its own recommendation how to solve this once and for all:

- Garcia and Calantone, 2002, describe several different constructs and propose a division of innovations in incremental, really new and radical categories.
- Gatignon et al, 2002, state that innovation should be assessed on the locus in the product hierarchy, the type and the characteristics.
- Dahlin and Behrens, 2005, propose that an innovation is only radical if it fulfills the following three criteria:
    a. The invention must be novel
    b. The invention must be unique
    c. The invention must be adopted

Aside from the differing and sometimes conflicting definitions, the constructs used to distinguish between radical and incremental vary a great deal. Some examples are:

- Order-of-magnitude change in price-performance ratio & Competence-enhancing versus competence-destroying (Anderson & Tushman, 1990).
- Launching new direction in technology (radical) versus making progress along an established path (incremental) (Christensen & Rosenbloom, 1995).
- Radical innovations disrupt a technology s-curve, incremental innovations sustain the industry's rate of improvement (Christensen & Bower, 1996).
- Radical inventions are novel, unique and have an impact on future technology (Dahlin & Behrens, 2005).
- Radical are “those foundational inventions that serve as the basis for many subsequent technical developments” (Ahuja & Morris Lampert, 2001).

Lastly, even when authors agree on the definition and the constructs, different scales are used to measure the innovativeness of the constructs. This makes comparison between the studies difficult, to say the least.

This diversity is of course understandable. Not only are several different scientific fields interested in innovation and innovativeness, innovation is a complex construct, which does not always lend itself to oversimplification. There are however, serious drawbacks to this situation. First of all, it seems as if a lot of new and groundbreaking research has been done that, on closer inspection, turns out to be a slightly different view on already existing ideas with just a different name.

Secondly, to quote Gatignon et al. “With greater clarity on units of analysis … research on innovation and organizational outcomes might be more cumulative and impactful.” (2002). In other words, if the research into innovation was more unified it would start building upon itself, instead of rehashing and renaming. The impact of the research, a greater understanding of the ways firms can innovate, would benefit not only innovative firms, but also policymakers and educators.

Lastly, for all these different forms and definitions of innovation, based on solid empirical evidence, normative strategies have been proposed (Garcia & Calantone, 2002). This makes it difficult, to say the least, to make the outcomes of research in this field useful to innovative firms. If researchers cannot even agree on a single definition, how can managers or entrepreneurs hope to judge which research is useful and up to date?

To illustrate this point, Goffin and Mitchell state the following in a book aimed at MBA students and practitioners: “This discourse is often heard in academia, but the search for an unambiguous definition is probably not a very productive one, since the degree of innovation is context dependent.” (Goffin & Mitchell, 2010 p. 14)

2.3.2 Perspectives

Upon review of the literature some common perspectives do stand out. As Garcia and Calantone (2002) point out, researchers generally measure innovativeness along different dimensions, to distinguish between those products that are highly innovative and those that are not. Two of the common break-downs are described here.

2.3.2.1 Micro versus Macro

The impact of an innovation can be different on several levels. What is a radical innovation for one firm may not be so radical for another. For example: if Dyson, who design and build vacuum cleaners, suddenly start developing a jet engine, it would be quite radical for them. For a company like Rolls-Royce, one of the largest aircraft engine maker in the world (“High Flying Performers” 2003), this would hardly be novel. The same differentiation can be made for customers of a firm.

On a higher level, a product may be innovative for a firm, but not for its competitors. The term “new to the industry” has been used to describe an innovation that is new to

all competing firms. From a customer perspective the phrase “new to the market” has been used to describe a similar level of innovativeness.

Finally there are a few innovations that transform the world. Examples include the first airplane but also electricity and the associated appliances.

Although the above is well recognized in the literature (Dahlin & Behrens, 2005), (Garcia & Calantone, 2002), (Crossan & Apaydin, 2010), there are several studies that focus only on the micro level. For example Henderson and Clark (1990) focus only on the aspect of the changes to the design of a product on an architectural and or component level. Later, Henderson (1993) adds a competence-enhancing or destroying aspect, but only at the firm level.

Christensen together with Rosenbloom (1995) and Bower (1996), in contrast, focus solely on the macro aspects. They see an innovation as radical only when it has an effect on an entire industry. Although it can be argued that this is indeed an important measure for radicalness, it leaves out the perspective of the individual firm or customer.

For this reason many researchers focus on both the macro and micro perspective. Authors like O'Connor (1998) or Sarin and Mohr (2008), establish the need to incorporate both the effect on the individual firm as the effect on the market, the industry or even the world. In a paper on research into organizational behavior House et al. state that a focus on only a macro or micro perspective “will inherently lead to misspecified theories” (1995), something that is equally true for research into innovation.

2.3.2.2 Technological breakthroughs and market breakthroughs

As US patent 3889771 (Kronogard, 1975) shows, it takes more than a technological breakthrough to be a success. This is where the distinction between technological and market breakthroughs is important. The patent describes a “universal gas turbine automotive engine. Despite being filed in 1975, only a few prototype cars with a gas turbine engine were ever built.

On the other end of the spectrum is an example from Apple: the iPod. Although it was far from the first mp3 player, it took the market by storm. In four years time it managed to capture 75% of the American market, substantially contributing to a

doubling of the stock price in the same period (Reppel & Szmigin, 2006). Although at best only an incremental innovation compared to the MP3 players available at the time, it was a breakthrough into a new market for Apple.

At least at this level, there seems some consensus: Although a few authors, mainly in the field of innovation or technology (for example: Henderson and Clark (1990), Dosi (1982) and Schoenmakers and Duysters (2010)) focus solely on the technological breakthroughs and some, mainly in the field of marketing (for example: Sood and Tellis (2005)), focus only on the marketing side, most agree that for an innovation to be truly radical, there should not only be a technological aspect, but also an effect on the outside world, usually captured by the effect on the industry or market (for example Christensen and Bower (1996), but also Van den Ende et al, (2012)).

2.3.3 Quality and radicalness

This inclusion of the effect a radical innovations has on a market or industry carries the implication that radical innovations can only be called such after they are successful, at least in some respects.

Radical innovations must also "provide substantially higher customer benefits" in the words of Chandy and Tellis (2000), or are "[...]product forms that command a decisive cost, performance, or quality advantage [...]" as Anderson and Tushman (1990) put it. Radical innovations must have a higher quality to potential users. This quality aspect is often implied, especially since radicalness is often measured ex post (Dahlin & Behrens, 2005). This inherent quality can be an important way of assessing radicalness ex ante.

2.4 Conclusion and hypotheses

As has been shown above, broadcast search is a useful tool for firms to solve problems for which they do not have the capacity or the capabilities. Due to the ease of which potential solvers can be reached over the internet and the growth of the number of platforms that offer broadcast search services, this method may become a core part of the innovation toolbox.

Jeppesen and Lakahni (2010) and Page (2008) have shown that one of the major advantages of broadcast search is the availability of marginal solvers. Solvers that are not bound by dominant paradigms and assumptions of the problem field in question.

The last element, radical innovation, can possibly be used to explain why the solutions of marginal solvers tend to be more successful. By eschewing the standard theories and practices, at least in part because of their unfamiliarity with them, they are able to propose truly novel approaches. Approaches that may therefore lead to or be qualified as radical solutions.

Radicalness can, as has been discussed, be defined and measured in many ways. There should always be a technological component, since new technology is driven by innovation, but the market should not be excluded. Inventions that have a great technological impact, but do not make it to the outside world, can hardly be described as radical. The example of the gas-turbine powered car illustrates this.

Based on the information in this chapter, the following hypotheses are formulated:

H1. The relationship between the distance of a solver and the radicalness of their proposal will be curvilinear.

This hypothesis builds on both the work of Jeppesen and Lakhani and the work of McLaughlin as discussed in this chapter. Jeppesen and Lakhani find that more distant solvers come up with better ideas (2010). In the same paper, they theorize that there may be a curvilinear relationship and therefore a point from which a higher distance, or marginality, will lead to diminishing results.

As the literature on marginality shows, there is evidence that individuals at the margins of scientific establishments can have a profound effect on the innovation in a given field. They are, is some cases, the source of radical innovation in a field. If this is true, there may very well be link between the distance of a solver and the radicalness of their proposals.

McLaughlin introduces the notion of optimal marginality (2001). To him, an optimally marginal individual is one who does have access to the intellectual core of a field, without being tied to the dependencies that are part of that field. Although his approach focuses more on institutional marginality, the notion that there is an optimal point of distance to a problem carries over well to the notion of technical marginality as is discussed here.

The expected relationship between the distance of solver and the radicalness of their answer is therefore expected to follow the same pattern, which is curvilinear.

H2. The level of education of a solver will have a moderating effect on the radicalness of their proposal. For a high level of education, the effect of being distant will be less pronounced.

That education will has a strong effect on the distance to a problem field is, of course, a given. Being distant is based on education and experience. That being said, the level of education must surely also have an effect. As Page puts it, training and experience help build our toolboxes of perspectives, models and heuristics (2008, p. 302).

If this is true, the type of training received will also have an effect on those same perspectives, models and heuristics. A vocational education (like the Dutch HBO), will offer more practical tools and models, whereas a university student may learn to build their own models.

The answer to why this is, may be found in the knowledge a potential solver has of the subject matter at hand. Those with the highest education close to the subject matter may be well informed about the latest developments in their field, but this may hamper their ability to come up with truly radical solutions. Conversely those very far from the field may be pitching (very) radical ideas because they are not hindered by the customs and paradigms of the subject field, yet still have enough general knowledge to be able to propose useful solutions.

The effect of the level of education can thus not be excluded when investigating the relationship between distance and radicalness.

H3. Radicalness has a positive relationship to the quality of an idea.

Although this hypothesis is directly derived from the findings of Jeppesen and Lakhani (2010), its roots lie in the often implicit, and sometimes explicit, inherent quality of radical innovations. As discussed in paragraph 2.3.3, radical innovations are held to be of a higher quality than existing solutions. Thus, the relationship Jeppesen and Lakhani find between distance and the quality of the idea, may be explained through the radicalness of the proposals, as theorized in the introduction. For that to be true, radicalness must have a positive and significant relationship to the quality of the proposals submitted.

In figure 2.2, the accompanying conceptual model is presented.

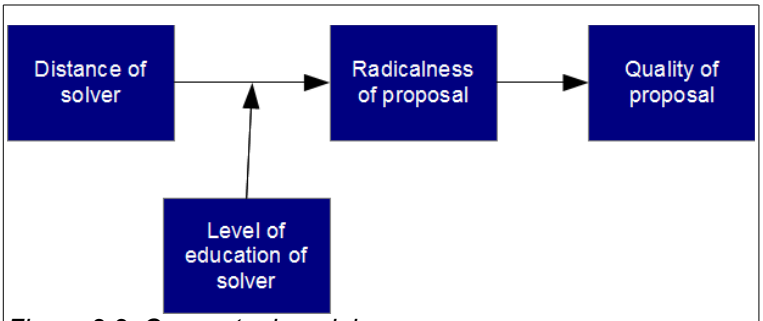


Figure 2.2. Conceptual model.

3. Research design

In this chapter the different aspects of the research are described. First, the type of research will be discussed. Secondly, the collected data and the coding of part of this data will be described. Lastly, an overview of the analysis performed in chapter 4 is given.

3.1 Research type and data collection

This research is theory based and deductive in nature. As such, it tests several concepts associated with broadcast search, namely marginality and radicalness. These concepts are tested by empirical analytical methods as described by Bryman and Bell (2007, p. 154).

The data was collected in two stages. The data for the solvers was collected by the website of Battle of Concepts when solvers submitted a solution. The data pertaining to the quality of the solutions and their radicalness was coded by myself, after all proposals were downloaded. In the next paragraph, the choices for the model, upon which the coding protocol was based will be explained. Next, the coding process will be elaborated on. Lastly, the coding protocol will be discussed.

3.2 A model for classifying and judging innovations

The discussion of incremental and radical innovation in chapter 4 forms the basis for the model needed for this thesis. The first consideration is that it should incorporate both the micro and the macro perspective. As several authors have pointed out (Crossan & Apaydin, 2010; Dahlin & Behrens, 2005; Garcia & Calantone, 2002), truly radical innovations are rare. Few innovations have the impact that transforms an industry or even the world. But to just lump all other innovations in the incremental-category, is also too rash.

Next, both the technological and the market aspect should be taken into account. Again, the problem surfaces that truly radical innovations that have a technological effect do not always affect the marketplace.

Garcia and Calantone (2002) propose a model that incorporates both these dimensions for classifying innovations. They also propose a new category for those innovations that are not radical, but are more innovative or have higher impact then incremental innovations. These should be called “really new”.

Figure 3.1 is a visual representation of their model. In this model, only those innovations that have both a micro and a macro impact on both technology and the market are radical. If an innovation only occurs at the micro-level and only has an impact on technology or the market, it is deemed incremental. All other possible combinations are "really new".

	Micro	Macro
Technology		
Market		

Figure 3.1. Matrix for identifying radicalness of innovations based on Garcia and Calantone (2002).

All proposals entered for the challenges of the Battle of Concepts website will be judged using these four categories, giving a well balanced score for the overall radicalness.

3.2.1 Judging Radicalness

Although the model above allows innovations to be classified, a mechanism is also needed to judge the impact an innovation had or will have. To do this, several methods have been proposed in the past. Of these methods, two will be discussed: the first, because it is favored by Garcia and Calantone for their model, the second because it will be used for this thesis.

3.2.1.1 The technology S-curve

The technology S-curve states that a technology develops in a roughly S-shaped fashion, starting slow, then accelerating until it plateaus. New technologies start beneath this curve and cross the performance trajectory of the old technology once (see figure 3.2).

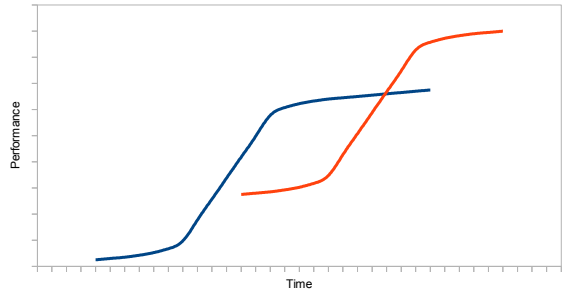


Figure 3.2. Technology S-curves.

Originally proposed by Dosi (1982) and elaborated by Foster (1985) it has since become firmly embedded in the literature on innovation and the models based on this literature.

Unfortunately there are two problems associated with this method. The first is that there is no reliable way to determine ex ante where a new S-curve starts (Dahlin & Behrens, 2005). It is difficult, if not impossible to predict which technologies are

radical and which will peter out. Although this method may have some merits in determining radicalness ex post, it is not useful for this research.

The second problem is perhaps more important. In an attempt to prove the existence of the technology S-curve Sood and Tellis (2005) researched four technology platforms and the associated innovations. Their conclusion was that technology does not show a single S-curve of performance improvement.

Although well known and still widely used, the S-curve is not usable for this thesis. Not only is it hard, if not impossible, and unreliable to determine ex ante where and when a new S-curve will begin, it would even be hard to do so after a technology has been in the market for several years.

3.2.1.2 The expert panel

This method relies on the input of experts in a given field to evaluate the innovativeness of a product. The main advantage is that experts in a given field are more likely to be able to judge the novelty and the impact of a given innovation. They are also more likely to be familiar with emerging technologies than non-experts and are thus able to compare new ideas to already existing, if not widely spread practices and products.

According to Dahlin and Behrens (2005), experts may suffer a few unavoidable biases such as the success, availability and the recency bias. The notion of biases were first introduced by Kahneman and Tversky (1972) and they describe predictable and systemic errors in judgment.

Availability bias and recency bias both cover more or less the same thing: innovations with which the expert was recently or personally involved in, will rate higher. The success bias covers the tendency to overlook those innovations that did not make it, the so called silent evidence.

However, since the expert panel will be tasked with evaluating how novel and how much impact the proposals will have, these are likely to be mitigated. They will not be asked to judge technology they may have worked on, but that which does not yet exist, or does not yet exist in their field. Who better to know what is current then an expert. Lastly, these judgments need to be made ex ante. Unfortunately, there are no other reliable methods to do this.

3.2 Coding procedure and protocol for proposals

In this paragraph, the coding process and the protocol will be discussed. First the process will be described. The coding protocol, containing all items for which was coded will be described. This chapter will conclude with a discussion on what radicalness actually means for the three different challenges.

3.2.1 Coding process

The information obtained from the Battle of Concepts website told only half the story. To accurately judge the quality of the proposals, their radicalness and the distance of the solvers, these still had to be coded.

The first step in this process was establishing a protocol which described the different measures and how they would be scored. The first step was to define these for the quality measures. These are generic in the sense that they work for all three challenges without the need of differentiation. For the measures of radicalness, this was not possible. Since the three challenges were from different problem fields, the protocol was set up in more general terms and an outline of what could constitute radicalness for each specific challenge was established. Making this more explicit beforehand would have been counterproductive, since it is unlikely that the truly radical ideas would be captured well. Radical ideas are unique and so they are hard to predict.

Distance of solver is also relative to the problem field of a challenge. Although easier to describe beforehand, the large number of possible backgrounds of solvers makes it hard to exhaustively describe the distance of all possible solvers in relation to the problem field. To make this manageable, ranges for several general categories were defined, leaving room for specific educational backgrounds within these ranges.

This coding protocol was then used to code the three challenges separately, each in three sessions. During the first session, the quality of the proposals was coded. The next session was used to code the radicalness of the proposals. Lastly, the distance of solver was coded.

Since several of the proposals were submitted by teams an additional step was needed to be taken to code the distance of a team. In this study the mean of the distance score of the team members was used for the following reasons:

- There is only a small number of teams (16,5% of solutions were submitted by a team).
- Teams are small (on average 2,5 people per team).
- Most teams consist of members with a similar background (the mean is the same or very close to the individual scores)
- Expected result of distance compared to radicalness is curvilinear, therefore the mean is an acceptable measure.

After the final coding was done, a sample of proposals, taken from all three challenges were submitted to two other coders. They coded these, per challenge, in one sitting, based on the coding protocol. The resulting codes were then compared with the scores that were already available.

In most cases the scores were either the same or varied by only one. In the case of presentation, the differences were larger. This led to a clearer description of the measure, since after discussing most of the variation could be explained by a difference in interpretation of the protocol.

For one coder, there was a great difference between the scores on cost. Since this was set up counter-intuitively (i.e. lower costs lead to a higher score), reversing the scores solved these differences.

Coding for radicalness is difficult if done beforehand. Neither the perspective of the original seeker, neither that of the market can be fully known by the coders. The most difficult of these two, the perspective of the seeker firm cannot be replicated by outsiders. By comparing with other organizations and their approach, a general idea of what would constitute radicalness for the industry and by extension the firm can be developed. This precludes innovations that are still in development inside a firm, but since these challenges were from 2010, this risk is mitigated somewhat. There is a good chance these would have been brought to market by now.

The perspective of the market is somewhat easier. Two of the challenges are aimed at consumers, the coders themselves are therefore part of the potential market. The last challenge is aimed at large public works, these are hardly kept secret. Again, the fact that the challenges were from 2010 helps the coding process.

Another potential problem lies in the coding for the quality of the ideas. Although this can be done relatively easily in general terms, the most important aspect is of course the opinion of the seeker firm. To them the chosen aspects may not have been completely relevant, as long as their problem is solved. Although the points awarded to proposals was available, for many these were 0, since only the top proposals were awarded any points. Therefore more general measures were needed, in order to evaluate all proposals. When coding for these was done, the results were compared to the points awarded. Although there were differences, those proposals with more points awarded generally also had more points for overall quality.

Despite these drawbacks, this method also had two advantages. It allowed the proposals of all three challenges to be compared to each other, since quality was measured in the same way. The other advantage is a that the proposals were rated neutrally. None of the coders had a preconceived notions on what would constitute a high-quality idea, something that may have played a role when the seekers judged the proposals.

3.2.2 Coding protocol

As discussed, all proposals are coded for the following concepts: originality, feasibility, cost, benefit, presentation and radicalness. Radicalness itself was split into micro – technology, micro – market, macro – technology and macro – market. In all cases a seven point Likert-scale was used. For all concepts the underlying rationale for the coding is explained below.

1. Originality

Originality describes how original an idea is. The score runs from 1, not original at all, to 7 a truly novel idea. Besides new ideas, new applications of existing ideas, or a new combination existing ideas. Important to note is that originality is not necessarily linked to usefulness. This is also the distinction with the notion of radicalness. For an idea to be radical it must in some way be applicable in real life. Below are some coding guidelines to illustrate how the coding worked in practice:

Not original at all: 1

Not a new idea, but used in a new situation or a combination of existing ideas:4

Completely original: 7

2. Feasibility

Feasibility is a determination of how easily a proposal can be implemented. Questions related to this topic are: Will it take a lot of time to implement? Are investments needed? In this case it is not necessary to consider how much it would cost, but how easily these investments can be met. Also important is the necessary use and development of new technology or even a new mindset for stakeholders. The harder it is to implement the proposal, the lower the score will be. Important to note is that the main difference between this aspect and the next is that this should cover the ease of implementation, regardless of cost.

3. Cost

How high are the costs involved in implementation of an idea? In the simplest of terms, how much money would it cost. Important for this point is that a higher cost will lead to a lower score. This may seem counter-intuitive, but this way all higher scores will point to a higher quality idea.

4. Benefits

If the idea is implemented, how much will the seeker benefit from this? Will it lead to more voters, real customer co-creation and better use of the space now occupied by dykes? As with all concepts, a higher score represents higher benefits for the seeker.

5. How is the idea presented?

The last of the quality measures deals with the presentation of the idea. Since the format, a powerpoint presentation, was fixed, comparison between the proposals is relatively straightforward. Aspects that are taken into account are the clarity, the substantiation and overall completeness of the proposal. Of course, lay-out and general readability are also important. An important part of this score is also determined by the question: does the proposal actually address the problem? If not, the score is automatically lower. Otherwise, a better presentation leads to a higher score.

6. Radicalness

As discussed in Chapter 2, radicalness is scored on four aspects, based on the model of Garcia and Calantone (2002) These are:

a. Micro – Technology

   How new is the technology needed to the seeker firm or organization. If a proposal calls for technology the seeker firm is already familiar with, this score would be low. An example from one of the proposals was a glass dyke, this calls for new technological breakthroughs before it can be implemented. The score in this case would therefore be high.

b. Micro – Market

   Are the customers of the seeker firm already familiar with a product, technology or service? Then the score would be low. There are no glass water management systems, so the customers would be unfamiliar with the concept, so again, this would lead to a high score.

c. Macro – Technology

   As with the score for micro – technology, but this time from the perspective of an entire industry or the world. Since large aquariums use glass to enable to let visitors see the underwater world, containing water with glass is not entirely new. However, due to the novel application, it should still be considered radical in this sense.

d. Macro – Market

   Again, this looks at the familiarity of (potential) customers. As with macro – technology, this takes the wider view of all potential users.

Important to note is that a high score on either macro measure automatically means a high score in for the corresponding micro measure. Something can not be new to the world, yet familiar to one company.

7. Distance of solver

The distance of the solvers is also coded on a 7-point Likert-scale. In all cases a higher score reflects a greater distance of the solver to the problem field.

The three challenges all belong to a different problem field:

1. 98 – Sparta - Op welke wijze kan Sparta haar klanten betrekken bij het innoveren van fietsen

   This challenge is about new ways of involving the public in the innovation of

bicycles for Sparta. Because innovation is a core component of business, this challenge is, at its core, a challenge of innovation strategy.

The scale is therefore set up as follows:

– business (administration), specifically innovation management: 1 (very close to the problem field).

– Business (administration), other areas 2 – 4.

– Technical background, 2 – 6, dependent on the exact area (technology management would lead to a lower score, for example).

– Marketing, communication, 3 – 5, dependent on exact specialization.

– Other fields: 4 – 7

2. 100 - Gemeente Utrecht - Hoe kunnen we de opkomst bij de Provinciale Statenverkiezingen in Utrecht verhogen

   This challenge is aimed at reaching and motivating voters. This too is a problem many businesses face and can be seen as a communication problem.

   Therefore, those with a communication or marketing background will receive low scores. Business administration and management studies will score 2-5, depending on the exact specialization.

3. 106 - TNO - Bedenk een multifunctionele dijk

   This challenge has a technological nature and can be seen as an engineering challenge. Although many approaches are possible, a certain amount of technical know-how would seem appropriate, if only to make an idea feasible.

   Construction engineering, architecture and water management are all considered to be close to the problem field. Business, communication and marketing are seen as distant. Technical business administration or industrial engineering are seen as moderately distant, since both contain technical elements.

3.2.4 Discussion on radicality per challenge

Since the three challenges are defined as being from different problem fields, a discussion on what constitutes a radical solution for the given problem field is necessary. Here and per challenge, this issue will be addressed.

The Sparta challenge is defined as a challenge of innovation strategy. Since that is more a process than a product, the question if technological radicalness is even possible arises. A first thing to note, is that although the challenge is at a high level a challenge of innovation strategy, the problem posed was more straightforward: How can consumers be involved in the innovation process. This can be reached in many ways, most, if not all, involving a website, which is a technical component. As such, it is imaginable that other technological solutions are proposed.

Another aspect that could potentially be radical is the way the consumers are either approached or persuaded to start innovating for Sparta. This could be through the use of technology (such as a website), but it could very well be through sophisticated marketing or communication. This can be captured by the market aspect of the model.

The following example can be used to illustrate this point: In certain high-tech industries, it is common for suppliers of complex machinery to have access to the machines of their customers for monitoring, service and even innovation purposes. If this were to be applied to bicycles, it would not only be radical from a technological standpoint (the technology to monitor aspects of a bicycle has, so far, not been used on private bicycles) it would also constitute a radical new approach to the manufacturer – customer relationship in the bicycle industry.

The reasoning for the next challenge, that of the Gemeente Utrecht, follows much te same lines. Approaching people to do something is marketing at its most basic. Still, over the years this process has seen many innovations, some technological, like banners and pop-ups on websites, others not, such as the rise of guerrilla marketing. Some of these innovations can be classified as radical, due to the impact that they had.

The last challenge, by TNO, is the easiest in this respect. The challenge calls for a technological solution. With these the model is easiest to apply, since it was primarily developed for product innovations.

3.3 Analysis and accompanying variables

The analysis of the data will be done in three stages. Here, all three stages and the corresponding variables will be discussed.

3.3.1 Stage 1: distance of solvers and radicalness of ideas

In this stage a model will be built to test for the effect the distance of a solver to the

problem field has on the radicalness of their proposals, thereby testing Hypotheses H1 and H2.

In this model, the dependent variable will be the sum of the radicalness measures (SumofRadicalness), the coding of which was described in paragraph 3.2.1.

The independent variables will be the distance of solver and the distance of solver squared (DS2) to test for the expected curvilinear relationship.

Education is the moderating variable in this model. Education depicts the level of education can either be college[1] or university.

Lastly, there are two control variables. These are team, for being in a team and gender, which is can take three values: Either 0 or 1 for male and female respectively. There are seven mixed gender teams in the data set. For these teams the gender of the submitter was used, based on the assumption that this would be the more dominant team member. All mixed gender teams consisted of only two team members.

3.3.2 Stage 2: radicalness and the quality of an idea

In this stage Hypothesis H3 is tested. The independent variable is the sum of radicalness, while the dependent variable is the Sum of Quality, which is calculated by adding all different quality aspects.

3.3.3 Stage 3: the distance of a solver and the quality of an idea

The last stage will try to replicate the findings of Jeppesen and Lakhani. Therefore, the distance of solver will be the independent variable, whereas the sum of quality will be the dependent variable.

1 College is used as the equivalent of a dutch “Hogeschool”

4. Data analysis

4.1 Descriptive statistics

In table 4.1, general information about the challenges that were researched can be seen. For all three challenges combined, a total of 163 solutions were proposed. A total of 206 solvers worked at these solutions, 66% of these worked alone, while the rest worked in teams.

39% of the solvers, for the three challenges combined, are female. The more technical challenge, that of TNO shows a slightly lower percentage of women submitting solutions than the other two challenges.

#	Seeker	Number of solutions	Number of participants	Number of teams	Average teamsize	% female	Average age at deadline	age max	age min	Average months signed up	# signed up 0 months	Average months signed up, excluding 0 months
B0098	Sparta	67	92	14	2,9	42%	23	29	19	4	46	8
B0100	Gemeente Utrecht	52	67	10	2,4	39%	23	30	19	6	10	7
B0106	TNO	44	47	3	2	36%	24	30	18	12	8	14

Table 4.1. Descriptive statistics of solvers.

Interestingly, men and women were about as likely to work in teams: 35% of men worked in a team compared to 33% of the women.

The solvers were relatively young: on average 23 years old, with the oldest solvers being just 30 years old and the youngest being only 18 years old.

Also taken into account was the length of time the individual solvers were signed up for the website. Here there is a significant difference between the three challenges: For the Sparta challenge, solvers had, on average, been signed up for 4 months prior to the deadline of the challenge. For the Gemeente Utrecht, the average was 6 months, while for the TNO challenge, the most technical of the three, solvers had been signed up for 12 months prior to the deadline of the challenge.

If we look at the number of solvers who had been signed up for 0 months, people who probably signed up specifically for these challenges, we see that 50% of the solvers of the Sparta challenge signed up for the first

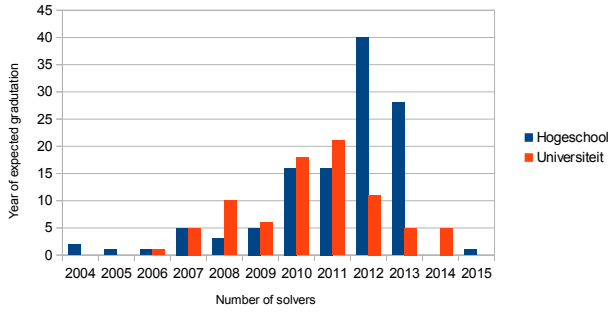


Figure 4.1. Frequency of (expected) year of graduation.

time, whereas only 17% of the solvers of the TNO challenge signed up specifically for this challenge. It is possible that this last challenge was seen as “more difficult”, due to its more technical nature, which led inexperienced solvers to not take part.

Except for one unknown, all solvers either have a bachelor degree or higher or are students at a college or university. 59% are college graduates or students. In fact, only 19% of solvers had graduated at the time of the challenge. Figure 4.1 shows the distribution of solvers over the (expected) year of graduation. Although most university students that took part were to graduate within one year after the challenge deadline, the majority of college students still had two or three years to go.

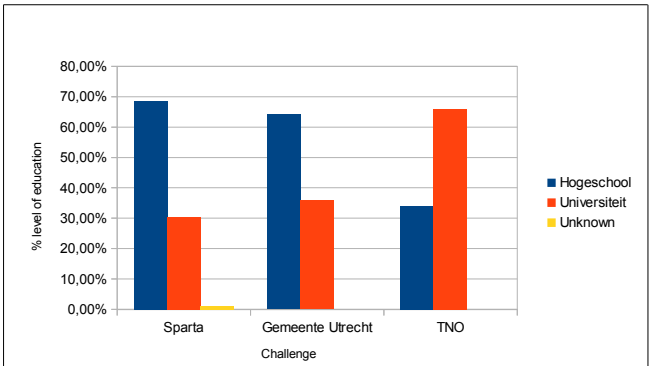


Figure 4.2. College versus university per challenge.

Although the majority of solvers are college graduates or students, something interesting emerges when we look at the different challenges, as depicted in figure 4.2. Both the Sparta and the Gemeente Utrecht challenge attracted roughly the same number of university students (30% and 36% respectively). The TNO challenge, in comparison, attracted a much higher number of university graduates and students, 65% to be precise. There is no clear indication of why this is so, but again it seems likely that the more technical nature of the challenge played a role.

A total of 81 different fields of study were named, ranging from advertising to mechanical engineering. Without further categorization, this is a relatively meaningless number, although it is remarkable that 73 of the solvers (35%) indicated that they studied communication or something related. This is by far the largest group, all other fields are more or less equally represented. Despite their large number, only 2 of those with a

#	Seeker	Battle Views	Battle Downloads	Concepts	Battle downloads as % of views	Concepts as % of downloads
B0098	Sparta	46178	991	67	2,1%	6,8%
B0100	Gemeente Utrecht	32665	608	52	1,9%	8,6%
B0106	TNO	28549	731	44	2,6%	6,0%

Table 4.2. Challenge views, downloads and concepts.

communication background entered the TNO challenge. More than half (55%) of the solvers of the TNO challenge had a technical background.

4.2 Analysis

From the data, two cases had to be removed. The solutions for these, as downloaded from the Battle of Concepts website, were incomplete, therefore no scoring was possible. This left us with 161 cases divided over the three challenges as shown in table 4.3.

#	Seeker	Number of solutions
B0098	Sparta	66
B0100	Gemeente Utrecht	52
B0106	TNO	43
	Total	**161**

Table 4.3. Number of cases per challenge.

4.2.1 Correlation

To test the strength of the relationship between the variables, the correlations between them are calculated and are shown in table 4.4. To do this Kendall's tau is used, since the original ranking (depicted by the "#" in the model) is included. An added bonus, based on Field's (2009) explanation, is that this is the better estimate of correlation, especially in small data sets. Table 4.4 shows the result of this analysis. Sum of quality has a mean of 19,38 for a maximum of 35, sum of radicalness, which has a maximum of 28, has a mean of 7,77. Distance of solver, which was rated on a 7-point scale, has a mean of 4,399.

			Correlation coefficients (Kendall's tau)				
	Mean	St.dev.	1	2	3	4	5
1. #	na	na	1				
2. Sum of Quality	19,380	1,952	-,309**	1			
3. SumofRadicalness	7,770	1,231	-,341**	,378**	1		
4. Distance of Solver	4,399	1,777	,007	-,032	-,013	1	
5. Education	na	na	-,170**	,058	,093	,127	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.4. Correlation between the variables of the model

For good measure the correlation between the original rank and the sum of the quality measures is also included. Immediately aparent is the relatively strong and negative correlation between "#" which denotes the original ranking of a proposal and the "Sum of Quality". This relationship is expected, since in the original ranking ran upwards from 1, which was the winning solution. A higher quality, therefore, correlates with a lower number on the original ranking.

There is almost no correlation between distance of solver and the original ranking or the sum of quality. Since there is an expected curvilinear relationship, this is not surprising. A curvilinear relationship would show no result.

4.2.2 Distance of solver and the radicalness of an answer

The first step in building the model is testing if the distance of solver can predict the radicalness of the answer. This is model as shown in table 4.5. Model 1 shows the control variables team and gender. These are not significant. Model 2 adds distance of solver. As expected, the predictive power is very small, only 1,1% (R^2 = ,011) and not significant. Since the expected relationship is curvilinear, the next step is to add the square of distance of solver to the model.

Radicalness of anwser						
	1	2	3	4	5	6
Moderating variables						
DS2xEDU						-,868
DSxEDU					-,235	,938
Independent variables						
Education				,075	,268	-,132
DS2			,713*	,649	,654	1,109*
Distance of Solver		-,094	-,792**	-,740*	-,655	-1,097*
Control variables						
Team	-,092	-,095	-,064	-,051	-,043	-,032
Gender	-,059	-,060	-,065	-,060	-,045	-,049
R^2	,011	,020	,038	,043	,049	,054
Adjusted R^2	-,001	,001	,014	,012	,012	,011
F-value	,911	1,076	1,552	1,403	1,316	1,253
* significant at the ,1 level						
** significant at the ,05 level						

Table 4.5. Regression model for effects of distance and education on radicalness

Although the strength of the model increases by almost a factor 2, the predictive value is still very small R^2 = ,020). However, the model does show the that the expected curvilinear relationship is indeed present, since DS2 (the square of distance of solver) is significant at the ,1 level ($p < 0,088$) and that the relationship is u-shaped.

When Education, the moderating variable, is added to the model, there is no significant effect and this model still hardly predicts the outcome, at only 4,3% (R^2 = 0,043). When, in model 4 and 5 the interaction of education on the distance of solver and the square of distance of solver are added, there is still no significant effect. The F-value is not significant, indicating that the full model is not significant either. The level of education does not influence the radicalness of an answer, for a given distance of the solver.

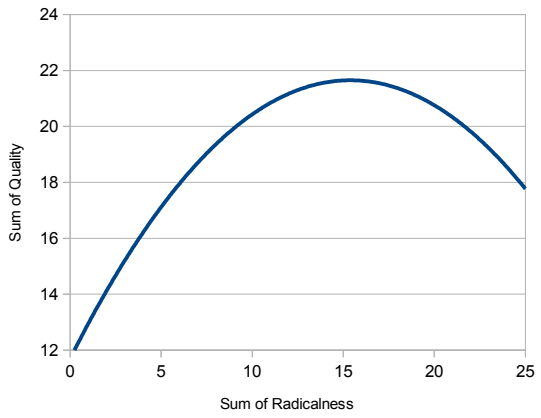
4.2.3 Radicalness and the quality of an idea

Of course, all this is only useful if a higher level of radicalness actually leads to better quality ideas. This is will be tested next. The positive and significant correlation has already been established, but how well does the radicalness of an idea predict the quality. Table 4.6 shows the model that was used to test this.

First, a simple regression was performed. Although the outcome shows a significant relationship, as expected, the predictive power can be considered medium, at 11,5%. There is however reason to assume a curvilinear relation in this case too: a more radical idea could very well be considered better, but only up to a point. When ideas become too radical, they may lose their usefulness to the seeker and thus be deemed of lower quality.

Sum of Quality		
	1	2
Independent variables		
SoR2		-1,297*
Sum of radicalness	,339*	1,603*
R^2	,115	,200
Adjusted R^2	,110	,190
F-value	20,694	19,793
* significant at the ,001 level		

Table 4.6. Regression between the sum of quality and the sum of radicalness.



Graph 4.1. Relationship between radicalness and the quality of a proposal.

To test for this, the square of the sum of radicalness (SoR2) was added to the model. Not unexpectedly, the results are significant. The negative beta for SoR2 indicates that the graph will have an inverted u-shape, as shown in graph 4.1, confirming the expectation that more radical ideas are of a higher quality, but only up to a point. More importantly, with a R^2 of 0,20, this model can be considered a good fit (Klijn, 2007).

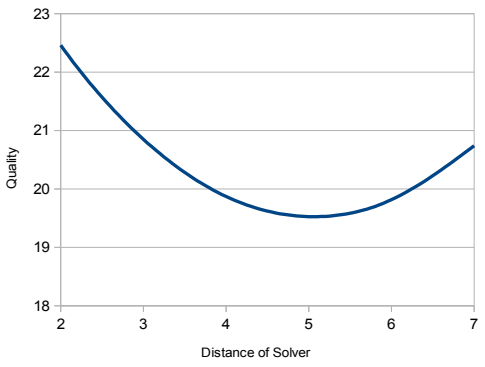
4.2.4 Distance and the quality of an idea

	Sum of quality -full dataset		Sum of quality -98 Sparta		Sum of quality -100 Gemeente Utrecht		Sum of quality -106 TNO	
	1	2	1	2	1	2	1	2
Independent variables								
DS2		-,464		1,390**		-,162		-,489
Distance of solver	-,049	,406	-,157	-1,529*	,199	,359	-,074	,408
R^2	,002	,011	,025	,074	,040	,041	,005	,013
Adjusted R^2	-,004	-,002	,009	,045	,021	,001	-,019	-,019
F-value	,390	,842	1,618	2,523*	2,070	1,035	,224	,263
* significant at the ,05 level								
** significant at the ,1 level								

Table 4.7. Regression between distance of solver and SumofQuality.

All of the above is based on the research of Jeppesen and Lakhani (2010) in which they found that solvers that were more distant came up with better ideas. This too was tested, using the SumofQuality as the dependent variable and the distance of solver as the independent. The results of this analysis are shown in table 4.7.

What is immediately apparent, is that the relationship between the distance of solver and the sum of quality is not significant in the full data set, not even for a curvilinear relationship. When the same analysis is done for the individual challenges, only the Sparta challenge shows a significant relationship between the distance of a solver and the quality of an idea and this relationship is also quadratic. Interestingly enough, this curve is u-shaped, as can be seen in graph 4.2. Initially, in this challenge at least, a higher distance will lead to lower quality ideas, before increasing for even more distant solvers. Still, it should be noted that the model is not a particularly good fit, with a R^2 of only ,074.



Graph 4.2. Relationship between distance of solver and SumofQuality

4.3 Hypothesis testing

This analysis has the following consequences for the hypotheses.

H1. The relationship between the distance of a solver and the radicalness of their proposal will be curvilinear.

This hypothesis is supported. The outcome of the regression analysis is significant for a curvilinear relationship (at p<0,058) and this relationship is u-shaped. It is worth mentioning that the distance of solver can hardly be used to predict the radicalness of an answer with a R^2 of only ,038.

H2. The level of education of a solver will have a moderating effect on the radicalness of their proposal. For a high level of education, the effect of being distant will be less pronounced.

This hypothesis is not supported. Adding education to the model shows no significant effect on the individual constructs or on the full model.

H3. Radicalness has a positive relationship to the quality of an idea.

This hypothesis is supported. There is a significant relationship between the radicalness of an idea and the quality of an idea. However, a curvilinear effect with an inverted u-shape is also found. This indicates that at first, more radical ideas are seen as having higher quality, but only up to a certain threshold. After that, more radical ideas will be deemed to have a diminishing quality. Interestingly, when taking this curvilinear relationship into account, radicalness of the proposal becomes a good predictor for the quality of an idea.

4.4 Post hoc analysis

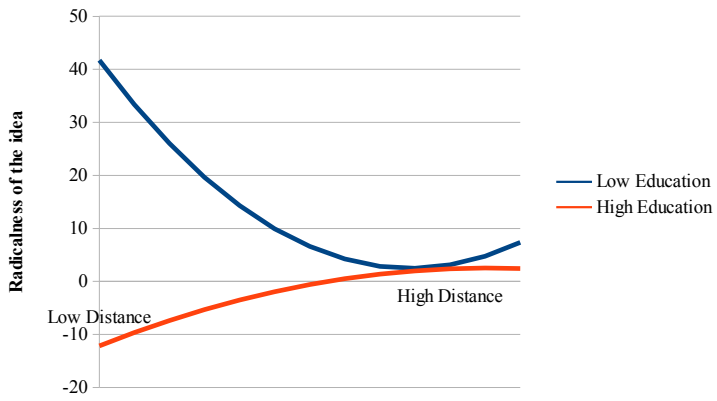
Although the distance of a solver shows a statistically significant relationship with the radicalness of their answer, the predictive power of this model is weak (R^2 = 0,051).

	Radicalness of anwser – 98 Sparta					Radicalness of anwser – 100 Gem. Utrecht					Radicalness of anwser – 106 TNO				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Moderating variables															
DS2xEDU					-4,930*					,364					,849
DSxEDU				,263	8,157*				-,646	-1,118				,103	-,926
Independent variables															
Education			,189	-,051	-3,594*			,217	,724	,867			-,155	-,236	,019
DS2		,740	,442	,503	3,044*		-,318	-,639	-,290	-,481		,349	,250	,262	-,345
Distance of Solver	-,146	-,877	-,591	-,731	-3,290*	-,011	,303	,539	,388	,563	-,161	-,504	-,417	-,485	,120
R^2	,021	,035	,069	,074	,188	,000	,003	,041	,073	,074	,026	,030	,053	,055	,059
Adjusted R^2	,006	,005	,024	,013	,120	-,020	-,038	-,019	-,005	-,027	,002	-,019	-,019	-,045	-,068
F-value	1,403	1,159	1,525	1,218	2,770	0,006	0,075	0,679	0,931	0,735	1,086	0,610	0,733	0,552	0,466
* significant at the ,05 level															

Table 4.8. Regression analysis per challenge

In table 4.8, the results of the same analysis as before can be seen, but this time split per challenge. It is interesting to note that the model is highly significant for the Sparta challenge and that this model is a good predictor, with a R^2 of 0,188.

In fact, not only is the relationship between distance and radicalness confirmed, the moderating effect of education is also significant. The relationship between the variables and the moderating effect are shown in graph 4.3.



Graph 4.3. Relationship between distance of solver and radicalness, moderated for education for the Sparta challenge, based on Dawson (n.d.).

At least as important to note is that both the Gemeente Utrecht and the TNO challenge show no statistical significance. This could indicate that the type of challenge could be important for this model. It should be noted however that by splitting the data into the three challenges, the number of cases per challenge is quite low with only 66 cases for the Sparta challenge.

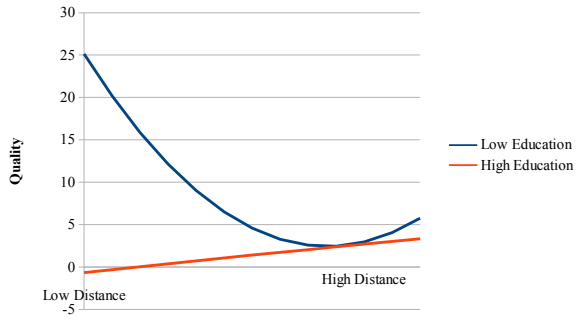
Based on the outcome above another analysis was done, this time including the measures in the original model, but using the quality of an idea as the dependent variable. In effect, the relationship Jeppesen and Lakhani found was tested, with the moderating effect of education. This was only done for the Sparta challenge, since this was the only challenge to show any effect at all. The results of this analysis are shown in table 4.9

	Sumofquality – 98 Sparta				
	1	2	3	4	5
Moderating variables					
DS2xEDU					-2,429
DSxEDU				,004	3,892
Independent variables					
Education			,155	,152	-1,594
DS2		1,390*	1,145	1,145	2,397*
Distance of Solver	-,157	-1,529**	-1,294	-1,296	-2,557**
R^2	,025	,074	,097	,097	,124
Adjusted R^2	,009	,045	,053	,037	,051
F-value	1,618	2,523*	2,211*	1,631	1,702
* significant at the ,1 level					
** significant at the ,05 level					

Table 4.9. Distance of solver and quality, moderated by education.

What is interesting about this model is that is that, when education is added as a moderating effect, R2 goes up to 0,124, even thought the model is not statistically significant. The reason it is included here is based on Field's (2005, 2009) explanation that statistical significance can generally be seen as problematic in small data sets and that the effect size should also be included in judging the relevance. Since the effect size falls comfortably in the medium rage (R2 = 0,124, R = 0,352) (Cohen, 1990; Field, 2005, 2009), it could be an indication that the effect is important, even though it is not statistically significant.

The reason to include it here is shown in graph 4.4: although the original findings of Jeppesen and Lakhani could not be replicated, since the relationship found here is u-shaped, this graph shows a possible explanation. For a high level of education, a higher distance leads to better proposals. Jeppesen and Lakhani did not test for the level of education of the solvers and Innocentive boasts about the high number of well educated solvers, with over 40% having a PhD (Travis, 2008).



Graph 4.4. Moderating effect of level of education on the quality of a proposal.Based on Dawson (n.d.).

4.5 Outcome of analyses

So far the following effects were found:

1. A curvilinear relationship between distance and radicalness, moderated by education (only in the Sparta challenge) which is U-shaped for low education and has an inverted U-shape for high education.
2. A curvilinear relationship, with an inverted U-shape, between radicalness and quality.
3. A curvilinear relationship between distance and quality, moderated for education (only in the Sparta challenge) which is U-shaped for low education and has an inverted U-shape (nearly linear positive) for high education.

This indicates that there may be a better model to explain the relationships between distance of solvers, radicalness and quality of the proposals. This model is shown in figure 4.1.

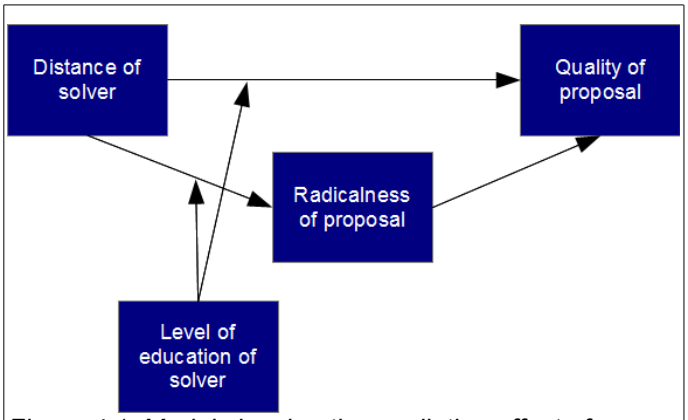


Figure 4.1. Model showing the mediating effect of radicalness.

This would mean that Radicalness is a mediating variable. To test for this the MEDCURVE model by Hayes (Hayes, 2012a, 2012b) was used, following his article on non-linear mediation models (Hayes & Preacher, 2010). Since this model does not allow for moderating factors, the model was run twice on the data from the Sparta challenge, once only for the low education group and once for the high education group. The results of this analysis are shown in table 4.10.

	Low education		High education	
	Model of mediating variable	Model of Quality (dependent variable)	Model of mediating variable	Model of Quality (dependent variable)
Mediating variable				
Radicalness of answer		3,753*		2,353
Radicalness of answer squared		-,138*		-,068
Independent variable				
Distance of solver	-4,894**	-,172	1,857***	-2,589
Distance of solver squared	,494**	,000	-,226***	,266
R2	,147	,664	,189	,275
F-value	3,267**	17,789*	2,556	1,899

* significant at p < 0,01
** significant at p < 0,05
*** significant at p < 0,1

Table 4.10. Medcurve analysis for the mediating effect of radicalness, for low and high education.

As can been seen, the model is especially strong for the low education group, but in line with the discussion on effect sizes, the outcome for the high education group is also deemed important. Following Hayes (2010) the different slopes, denoted by theta in table 4.11, are reported for a low, medium and high value of x (distance of solver), the independent variable.

	Theta	
	Low education	High education
X_{low}	-2,022	,652
X_{medium}	-1,243	-,048
X_{high}	,355	-,770

Table 4.11. Slopes for low, moderate and high x (distance).

When the level of education is low, an increase of distance for a solver close to moderately far from the subject matter will lead to lower quality ideas, through the effect on radicalness, whereas a high distant solver will show a slight increase.

For highly educated solvers this is reversed. For a low distance solver, an increase in distance will lead to better quality ideas, through the effect of the radicalness of their proposals, but for moderate to high distance solvers an increase in distance will lead to a lower quality proposal.

Simply put, for a lower education, higher distance will at first lead to lower quality ideas because the proposals become less radical. For high distance solvers the quality will increase again because proposals become more radical.

For the high education group this is reversed. As they become more distant, their proposals become more radical and are therefore of better quality. When the proposals become too radical however, which happens when distance is high, the quality starts dropping.

Graph 4.5, which was created by calculating the slope of the graph using the formulas as described by Hayes (2010), shows this indirect effect of distance on quality through radicalness.

Graph 4.5. Indirect effect of distance on quality, through radicalness.

5. Conclusions and discussion

In this chapter the conclusions, the implications and the limitations of this thesis will be discussed. The research question, as stated in the introduction will be answered, based on the research discussed in the previous chapters. The implications, both theoretical and practical will be considered next, as will the limitations of this research. Lastly, some ideas on further research will be discussed.

5.1 Overview of the results

This thesis attempts to build on existing research in the fields of open innovation and broadcast search by offering a better understanding of the mechanisms that make solvers with a greater distance to the problem field more successful.

Working from the findings of Jeppesen and Lakhani, it is disappointing to see that their findings could not be replicated directly, at least not for the full data set. When the individual challenges were analyzed, an effect could only be confirmed for the Sparta challenge and the outcome does not directly match their findings. This unfortunately casts doubt on the usefulness of the findings in this thesis. There are however some interesting aspects that should be discussed.

In the first place, radicalness has a significant relationship with the quality of an answer, as theorized in the introduction. However, the relationship is not as straightforward as originally thought. Although at first more radical proposals do have a higher quality, after a certain point, this starts to diminish. Upon reflection, this does seem logical. When ideas become too radical, they may lose there usefulness in solving a problem, either because they are not practical or because their implementation would be too expensive. It is even possible that the proposed solution is not even possible with today's technology.

Secondly, there is a significant quadratic relationship between the distance of a solver and the radicalness of their answer. Interestingly and perhaps unexpectedly, this relationship is u-shaped, meaning that solvers close to the subject matter will be able to come up with more radical ideas. As the distance of the solver increases, the radicalness of the proposals will diminish until a certain threshold is reached and the radicalness of the proposals begins to climb again.

5.1.1 Different results per challenge

Although the findings of Jeppesen and Lakhani could not be replicated using the full data set, Interesting things happen when the different challenges are analyzed. In the first place, a significant relationship between distance of solver and the quality of their proposal was confirmed for the Sparta challenge. This relationship did not follow the findings of Jeppesen and Lakhani. Instead, a u-shape was found, indicating that a greater distance leads, at first, to worse ideas, before climbing again when distance is increased further.

A possible explanation was found when the moderating effect of education was added. For a high level of education, a greater distance led to better quality ideas. Since the level of education of Innocentive solvers is high, it is possible that the results Jeppesen and Lakhani found were influenced by this.

Secondly, and again only for the Sparta challenge, the full model as used in this research is significant, also for the moderating effect of level of education. This means that a higher level of education, combined with a greater distance, will lead to more radical ideas, while those with a lower level of education will at first become less radical in their proposals, before, at an even greater distance becoming more radical again.

This could mean several things. Most obviously, the type of challenge could very well play a role. When reviewing the challenges themselves it could be stated that the Utrecht challenge and especially the TNO challenge are more an open call-type of innovation challenge, instead of a broadcast search. Other dynamics may be at play for these types of challenges, leading to the mixed results presented here.

This does however pose problems when trying to generalize these findings. Until it is clear what caused the differences, these findings are not easily applied to other broadcast search challenges.

5.1.2 The research question answered

The research question as stated in the introduction was: “How does the marginality of the problem solver influence the radicalness of the proposed solutions for problems in a broadcast search and what is the effect on the quality of proposals?”

The findings of this research indicate that marginality is a factor in the radicalness of

the proposals as posted by solvers and there is a measurable effect on the quality of the proposals. However, the interaction between these constructs is not simple and a higher marginality does not automatically lead to better solutions.

Instead, when looking at the results of the Sparta challenge in particular it seems that Distance has direct effect on the quality of proposals, but that it also has an indirect effect on quality, through the radicalness of the proposals. When taking the moderating effect of the level of education of solvers into account, the following distinctions emerge:

Solvers with a low level of education:

- Will offer better quality ideas when they are close to or far from the subject matter (the direct effect of distance on quality)
- Will offer higher quality ideas, because they are more radical, when they are close to or far from the subject matter (the mediating effect of radicalness).
- Will offer lower quality ideas when they are moderately far from the subject matter, both through the direct and the indirect effect of distance on quality.

Solvers with a high level of education:

- Will offer better quality ideas the further they are from the subject matter due to the direct effect of distance on quality.
- Will offer better quality ideas when they are moderately far from the subject matter due to the indirect effect of distance on quality, through the radicalness of their proposals.
- Will start to see diminishing results when they get more distant, again due to the indirect effect of distance on quality, through radicalness. The proposals, in other words will start being too radical, leading to lower quality.

This means that for low levels of education, the best ideas will be from those close to or far from the subject matter, while the best ideas from those with a high education come from solvers that are moderately distant.

5.2 theoretical implications

Part of the goal of this thesis is to contribute to the understanding of the mechanisms and advantages of broadcast search by investigating the relationship between marginality and the quality of ideas, since this could indicate further avenues for study.

By showing that there is indeed a link between the distance of solvers and the radicalness of their answers, in addition to a strong link between the radicalness of a proposal and the quality, at least in the context of this thesis, this research may show an interesting avenue for further study.

Maybe the most interesting aspect of the results that are described here is the confirmation of the curvilinear relationship that exists between these constructs. In their paper Jeppesen and Lakhani (2010,p. 1030) theorized about the same sort of relationship between the marginality of a solver and the quality of their idea (more specifically the chance of submitting a winning solution), and these findings support this possibility, although the results point in the opposite direction.

This research also shows that there may very well be a link between the level of education of solvers and their output, both in the quality and the radicalness of their proposals.

It may also be a start at explaining why the answers of more marginal solvers can be better, while confirming the statement of Scott Page (2008) that marginality alone is not enough. In fact, the notion of "optimal marginality", as formulated by McLaughlin (2001) seems to be supported as well, but, due to the curvilinear relationship, there may actually be two optimal points of marginality. This too could be an interesting avenue for further research.

5.3 Practical implications

With the speed and intensity of innovation becoming ever greater, companies must consider alternative ways to stay innovative. Traditional research and development, whereby most, if not all, R&D was done in house is has an important role to play alongside the different forms of open innovation that are gathering traction across many industries.

Although relatively new and perhaps still somewhat immature, broadcast search is proving to be a viable way of outsourcing those challenges can not solve themselves, due to lack of capabilities, capacity or even both. Because of the newness of broadcast search, the practical and theoretical basis on which this method rests are still relatively poorly understood.

In a practical sense this research can make three, if somewhat meager, contributions. The first is a slightly better understanding of why involving marginal solvers can be advantageous to a firm.

The second contribution is the fact that the notion of radical innovation is added to the concept of broadcast search. If seeker firms do not expect proposals that are more or less radical, they may not recognize the inherent qualities of the more radical solutions. Jeppesen and Lakhani call these the "utterly outlandish" (2010, p. 1029) solutions, but that does not mean that they are not good solutions.

The third contribution is slightly more potent and is not a direct result of the research described here. In the initial phase of this thesis an attempt was made to collect data through a website on which a real-world problem was broadcast. The details of this first attempt are added in appendix B. The reason that this thesis is not based on that data, is that the response rate was much too low to draw meaningful conclusions. This is always a risk for firms trying to obtain answers through broadcast search. There are numerous reasons why solvers may not be interested in trying to solve a specific problem and it is worth taking this into account before attempting a broadcast search.

5.4 Limitations and further research

As with all research this thesis has its limitations. These will be dealt with here first. Possible further research opportunities will then be discussed.

5.4.1 Limitations

The first limitation is methodological. Both radicalness and the distance of solver were judged by an expert panel. This can lead to several problems. Primarily, the scores given can be subject to several biases of the experts involved, like the aforementioned availability, recency and success bias for the radicalness of the proposals. However, because the backgrounds of the experts differed greatly, this is probably mitigated to a reasonable extent. The largest possible error may have come

from innovations that were available, but not yet known to the panel, leading to inflated scores on radicalness. Since the challenges were two years old, this too is somewhat mitigated: if these innovations were truly breakthrough, information on them would be available now.

The distance of solver, coded based on the information collected when solvers submitted their proposals, present another potential problem. These were judged based on the knowledge and experience the panel had with the mentioned studies. Since these covered a wide range, certain assumptions had to be made. By checking these assumptions against available information, this risk is mitigated somewhat. Here too the differing backgrounds of the panel were an advantage, further mitigating the risk of incorrect coding.

There was however no information available on extracurricular activities, work experience or additional education. Since these can play an important role in the marginality of a solver, these scores must be seen as incomplete. A better may have been a self-assessment of the solvers distance, although this too has its limitations.

Radicalness as a concept has been measured in many ways, using many different constructs and tools. It is quite possible that a different measure than the one chosen for this research will lead to different results.

Another limitation can be found in the size of the sample. With 161 cases the sample is not very large especially since the effect sizes are small ($R^2 < 0{,}09$), a large data set is needed to reliably measure these (Field, 2009).

As the post-hoc analysis shows, the effects of the distance of solvers on the radicalness of their answer differs per challenge. Although all three are broadcast search challenges, they are for different fields (technological, business and general) and, it could be argued, that at least two were more of an open call to innovate. There is a possibility that different rules apply for different types of challenges. This may be reason to not analyze them as one.

Lastly, these challenges were aimed specifically at students or recent graduates of colleges and universities. In fact 81% of the solvers had not yet graduated. Compared to other broadcast search platforms, this is quite a narrow group of potential solvers. This may very well have influenced the outcome of this research.

5.4.2 Further research

The first interesting aspect that could warrant further research are the curvilinear relationships between the constructs. Jeppesen and Lakhani (2010) already theorized about a curvilinear relationship between the marginality, or distance, of a solver to their chance of winning a challenge. This research seems to confirm that this curvilinear relationship is indeed present. It would be quite interesting to explore this relationship to find the optimal points of marginality. This could help in understanding ex ante which solvers have a better than average chance of generating useful solutions.

Secondly, the findings of Jeppesen and Lakhani could only be confirmed for one of the challenges, for which all other effects were also present. This seems to indicate that both their findings and the findings of this thesis may be limited to a specific type of challenge, specific solvers or even a very specific mix of these two factors. Future research could look at the matching between solvers and challenges to see how that effects the outcome of quality and radicalness.

Still, for this single challenge, the effects were significant, but they could not explain all the variation. This means that other measures can and should be taken into account when predicting why marginal solvers come up with better ideas. By researching what seekers see as winning qualities in a proposal, insight in these aspects may be found.

In this specific case, at least two of the winning solutions, those of the Sparta and the TNO challenge, have not yet been put into place, although TNO did invite the winners to a workshop. Future research could try to investigate what companies actually do with the proposals they get from their searches and how valuable this process has been for them.

Generally speaking, there is still much that can be researched in the field of broadcast search. This thesis has attempted to explain, in a small way, how marginality leads to better results. Possibly it can the results can give pointers for further research into this field.

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Appendix A: summary of the challenges

Sparta challenge

Op welke wijze kan Sparta haar klanten betrekken bij het innoveren van fietsen?

De Battle

In deze Battle wil Sparta inspiratie op doen om uiteindelijk een eigen co-creatieplatform op te zetten. Het platform moet onderdeel worden van de huidige site, dus via een duidelijke button op onze site te bereiken zijn. Net zoals we dat hebben gedaan bij Sparta ION club (elektrische fietsen). Zie voor meer info www.ionclub.nl.

Met het platform streven we naar twee verschillende interacties:

1. **Het delen van ideeën en behoeften**
   We zijn heel benieuwd naar de ideeën en behoeften van onze klanten, maar ook van niet-klanten. Het moet voor hen makkelijk en aantrekkelijk zijn om hun ideeën en behoeften op het platform achter laten. Dit kunnen ideeën zijn voor nieuwe zadels, wielen, ventielen, frames, boutjes, kleuren, fietsbellen, snelbinders, verlichting, noem maar op. Uiteraard moet Sparta op de ideeën kunnen reageren.

2. **Vragen stellen**
   Daarnaast hebben we de behoefte om fietsend Nederland vragen te stellen over bijvoorbeeld de nieuwe kleuren voor het komende seizoen of over de vormgeving van bijvoorbeeld een nieuwe koplamp. Bezoekers van het platform moeten kunnen reageren via het platform en andere bezoekers kunnen daar weer op reageren.

Source: http://www.battleofconcepts.nl/concepts/Sparta%20Battle_Open_Deadline_25april2010.pdf

How kan Sparta involve their customers in the innovation of bicycles?

With this battle Sparta wants to collect ideas for setting up a co-creation platform which should serve two purposes: sharing ideas and needs and asking questions.

Gemeente Utrecht

Hoe kunnen we de opkomst bij de Provinciale Statenverkiezingen in Utrecht verhogen?

(Hoe krijg je deze mensen naar de stembus?)

De Battle

Met deze Battle wil de provincie Utrecht beter inzicht krijgen in wat de inwoners motiveert om te gaan stemmen. Uit de bovenbeschreven taken blijkt dat de provincie er niet voor niets is. Wat we willen weten is: Welk belang hebben de inwoners van de provincie Utrecht bij de provincie? Met andere woorden: What's in it for me?

We willen dat je je verdiept in de taken van de provincie Utrecht en in het belang voor de inwoners daarbij. Het is de bedoeling dat je die uitkomst vertaalt naar een aansprekende boodschap waarmee de inwoners van de provincie Utrecht geprikkeld worden te gaan stemmen bij de Provinciale Statenverkiezingen.

Met welke boodschap zien de inwoners van Utrecht het belang van de provincie in en worden zij gemotiveerd te stemmen?

Source: http://www.battleofconcepts.nl/concepts/OpenBattle%20ProvincieUtrecht%20Deadline30mei2010.pdf

How can the voter turnout for the provincial elections be raised?

Which message will convince the inhabitants of the provincie Utrecht of the use of the provincial government and motivate them to vote?

Vervolgens willen we van je weten hoe wij deze aansprekende boodschap op een slimme wijze kunnen communiceren zodat we zoveel mogelijk inwoners van de provincie Utrecht bereiken. Is dat op de traditionele manier (advertentie, flyer, radio of tv), of heb jij een vernieuwend idee? Probeer je concept zoveel mogelijk concreet en visueel te maken. Stel je een advertentie voor? Laat zien hoe deze eruit ziet, waar hij hangt, etc. Nieuwe en innovatieve ideeën (wellicht afgekeken uit campagnes in het buitenland) zijn welkom zolang je maar aangeeft waarom je denkt dat het effectief is!

Jouw idee moet inwoners van de provincie Utrecht motiveren om te stemmen. Richt je concept op de groep mensen die wel stemmen bij de komende Tweede Kamerverkiezingen, maar waarschijnlijk niet gaan stemmen bij de Provinciale Statenverkiezingen. Wat motiveert ze om voor de Tweede Kamer te stemmen? En hoe motiveer je ze om volgend jaar ook voor Provinciale Staten te stemmen?

Source: http://www.battleofconcepts.nl/concepts/OpenBattle%20ProvincieUtrecht%20Deadline30mei2010.pdf

Additionally, we want to know how to communicate this motivating message intelligently, to reach as many voters as possible. The proposal should motivate people to vote and should be aimed at those people who are likely to vote in the national elections, but not the provincial elections.

TNO challenge

Bedenk een multifunctionele dijk!

De Battle

In deze Battle zijn wij op zoek naar nieuwe en functionaliteiten voor multifunctionele waterkeringen, naast de waterkerende functie. Neem bij de uitwerking van je concept een stedelijk gebied zoals het Noordereiland in Rotterdam als uitgangspunt.

Jouw multifunctionele waterkering moet ervoor zorgen dat een stedelijk gebied, ondanks de opoffering van ruimte voor de versterking van de waterkering, aantrekkelijk blijft voor de bewoners, de gemeente, ondernemers en bezoekers van het gebied. Je kunt hierbij bijvoorbeeld denken aan een waterkering met een recreatieve, economische en/of ruimtelijke functionaliteit. Bijvoorbeeld een horecagelegenheid, energieopwekking, een opslagtank voor overvloedig water of kunst. Belangrijk is dat de multifunctionaliteit een toegevoegde waarde is voor het stedelijke gebied.

De belangrijkste functionaliteit van jouw waterkering is veiligheid: de bescherming tegen water. Water moet worden tegengehouden!

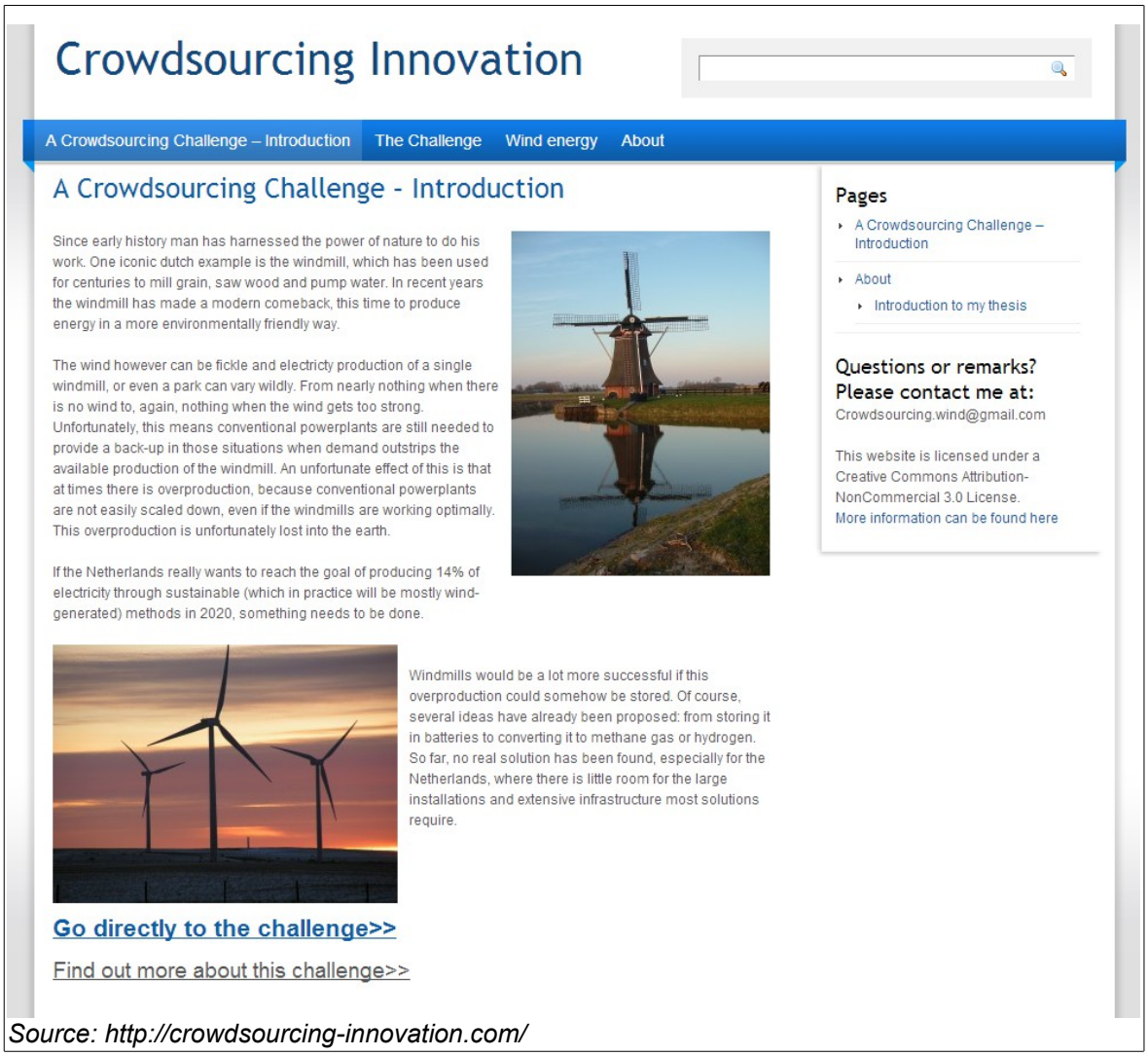
Bij het bedenken van een nieuwe functie voor jouw multifunctionele dijk kun je je laten inspireren door alle in de Battle gegeven voorbeelden. Deze voorbeelden zijn al bekend bij ons en naar deze ideeën zijn we dan ook **niet** op zoek.

Source: http://www.battleofconcepts.nl/concepts/TNO%20Battle%20deadline%2018%20juli%202010.pdf

Come up with a multifunctional dam! With this challenge we are seeking new functionalities for dikes, beside the damming function. It should make the space that is needed for this safety measure attractive in a city like environment. The most important function will be safety: the protection against water.

Appendix B: original challenge

Originally, the idea for this thesis was to organize a broadcast search challenge and to collect data from participants. To do this, the website as pictured below was set up.



Source: http://crowdsourcing-innovation.com/

It offered the opportunity to solve a challenge related to the energy production through windmills. With all the attention for and interest in clean energy production, this challenge was thought to be attractive for potential solvers.

Although more than 300 individuals visited the website between June 1, 2012 and July 1, 2012, only 5 people filled out the questionnaire and only 4 people submitted proposals. A response rate of only 1,2%.

This does point out an important weakness in broadcast search: even if a large number of people are interested in a challenge, this does not necessarily mean they will offer up solutions.