

# Exercising Creativity 2012



**Dr. Daniel Collado-Ruiz**  
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**EDITORIAL**  
**UNIVERSITAT POLITÈCNICA DE VALÈNCIA**



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Editors:  
Daniel Collado-Ruiz  
and  
Hesamedin Ostad-Ahmad-Ghorabi

EDITORIAL  
UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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Hesamedin Ostad-Ahmad-Ghorabi

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# Prologue

*Do you consider yourself creative?* This was the first question to the participants of the Summer School on Creativity Engineering 2012 held at the Vienna University of Technology. The answer to the posed question seems easy, either one is creative or not. But for many participants this was not the case. Instead of a simple yes or no answer, many counter questions arose. Questions such as *What is creativity?*, *What activities are considered to be creative ones* or *How can one measure a creative performance?* were just some of the concerns. These concerns were an essential reason for the participants to come together in this Summer School. From July 2nd to July 20th 2012, participants had the opportunity to explore the topic of creativity and develop their creative ideas to successful business models. The results of their work are presented in this book. At the end of the course, the question was posed again; some participants re-evaluated their answers - to the better.

I want to take the opportunity to thank all the people who made this event possible and a valuable experience for all involved parties. This year, I was very happy to have a team of international lecturers and participants from all the world. With lecturers from Germany, Spain, Japan and USA, and participants from Russia, Iran, Slovenia, China, Columbia, Germany, Egypt, USA, Austria, Uruguay and Belgium, this year's summer school was again and truly a multicultural and interdisciplinary event.

Thanks to Daniel Collado-Ruiz from Universidad Politècnica de València - Spain, Charles Pezeshki and Chia-Chi Hu from Washington State University - USA and Jutta Jerlich from Nagoya City University - Japan for co-lecturing and supporting the students.

Thanks to INNES Vienna ([http : //www.innesvienna.net](http://www.innesvienna.net)) and SICENG GbR ([http : //www.siceng.org](http://www.siceng.org)) for all their efforts "behind the scenes of the summer school" to make the summer school happen.

Hesamedin Ostad-Ahmad-Ghorabi

Head of Creativity Engineering Summer School



# Editorial

Following the motto of the summer school *from a creative idea to the successful marketing*, this book presents the work and findings of the participants of the Creativity Engineering Summer School. They were asked to develop an idea and stepwise substantiate it. Instead of an oral or written exam at the end of the school, participants had to work in groups for a particular idea of their choice, use the contents taught during the course to make the idea tangible, and come up with a concept that is almost ready for implementation.

The expectation of most participants about developing an idea may have been just generating an idea. But there is more about an idea than its birth phase. In one of our lectures it was pointed out that being named a pure *inventor* is actually not a compliment. A pure inventor has good ideas, and may come up with new products or services, but what would the idea be worth if it cannot be marketed, hence successfully realized?

Obviously, the aim of the summer school was to go beyond daydreaming, even though daydreaming may constitute a source for new or creative ideas. Beyond daydreaming, the purpose was to find all efforts, strategical moves and activities that would make those dreams come true.

In order to follow the path from idea generation to idea realization, there is a need to understand several mechanisms that have an effect on this transition. The first set of mechanism is all those processes in a particular individual that influence creativity. These processes need to be analyzed on psychological level in order to understand where the source of ideas lies, how ideas can be developed and how to increase the potential of being creative. You can imagine that once a creative personality is trained, the performance of a creative individual will differ when put into a team. This will also be true if all team members have creative personalities. Teambuilding mechanisms and group dynamics effect the creative performance. Understanding such mechanisms is critical to ensure creativity.

Now, imagine a well attuned and creative team: put it into an organization and its performance regarding creativity may not be as good as in the team. Organizations

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have to be innovative in order to survive. Innovation, according to our definition, includes all efforts and processes that can be marketed successfully. A creative idea in an organization is one that is innovative, hence can be marketed.

To cover all different aspects of creativity in the process of idea generation to idea realization, the course program was divided into three main parts:

1. Individual creativity
2. Creativity in teams and
3. Creativity in organizations

Human traits in creativity were discussed through the lectures for individual creativity. The role of intelligence, personality and cognition in creativity were explored. The relationship between idea generation mechanisms and the aforementioned human traits was studied.

The second part of the summer school included cultural awareness training and an introduction to business models. A big portion of the course was dedicated to problem solving, which was explored from psychological point of view and from a project management point of view.

We were lucky to have two guest lecturers, Professor Charles Pezeshki from *Washington State University* (WSU) and head of *Design Clinic* at WSU, and Chia-Chi Hu, a psychologist working at *Washington State University*.

The third part of the course included idea generation in teams, idea analysis and an introduction to business plan development.

All throughout the course, a strong emphasis was put into group dynamics. If we were talking about creating a relaxed but motivated environment in creative teams, it would just not be coherent to neglect this fact. Every morning we had warm-up sessions to have people fully active. We had the students play some number games, or do some music or theater improvisation. The main reason behind this was to get people in an active and creative mood. If you start by a creative and motivating activity, discussions become much more fluid just afterwards!

We are happy to introduce in this book four projects developed by the participants. All ideas were generated through the summer school and were further developed and prepared for being implemented.

Additionally, ideas were presented by each of the participants on the last day. Focus was given to the quality of the presentation and the engagement that the students have with the audience. For that reason, a workshop on how to prepare effective and motivating presentations was carried out, to avoid bulky text-intense psychology-neglecting unplanned presentations. Basically, the motto was *thing*

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*think think* about everything involved: the content, the different channels, your movements, your tone of voice, your questions, or even your jokes.





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## Part I

# Conceptual background



# Chapter 1

## Introduction

Collado-Ruiz, D. <sup>1</sup>, Ostad-Ahmad-Ghorabi, H.<sup>2</sup>

Creativity attracts the attention of most disciplines. It has been a basic feed for artists, necessary for innovation, strategic for product or technology development, and a key factor in project or process management. This chapter deals with the nature of creativity, with what it is and how it appears to happen.

### 1.1 What is creativity?

What is creativity when put in the spotlight? Most societies have long liberated it from its godly nature, but still project on it an aura of mysticism. Merriam Webster's Dictionary defines creativity as *having the power to create, or exerting the act of creation*. This fact of creating something new is probably one of the reasons for perceiving it in such an obscure way.

The last decades have seen creativity become the subject of rigorous scientific interest, after the work of J.P. Guilford. Even if this arena does not fall for a common definition, there are some strong points of agreement: *creativity involves the generation of ideas that are novel and appropriate*.

There is no discussion about the need for creative ideas to be original or new. If I need to illuminate the road in front of a car, using a lightbulb does not

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seem particularly creative. Maybe at Edison's time it could have been something unexpected, but nowadays we see this solution every day.

Novelty of ideas can be assessed at different levels. Ideas that seem novel at hand can have been thought by others some time before. They are creative to us, because we do not know – in our field, or in our context – of their existence. Other ideas, however, are genuinely new and have never been explored. M.A. Boden distinguishes between what she defines as psychological and historical creativity, respectively (also called p-creativity and h-creativity).

However, an original idea does not necessarily mean a creative one. If we are trying to clean the living room by spilling acid all over it, it is a very original way of doing it, but not practical at all. If you ask somebody whether that is creative, they would just categorize it as crazy. For an idea to be creative, it must also be appropriate for the problem at hand.

Both concepts combine seamlessly when defining what a creative idea is, and people that have creative ideas are considered creative people. Some other literature adds the parameter *surprisingness*, out of a very interesting phenomenon: when seeing or having a creative idea, people tend to feel motivated and encouraged to continue exploring it. Not surprisingly A. Maslow pointed out creativity as representative of autorealization. However, since this is a *post-hoc* assessment rather than *ex-ante*, the only appropriateness and novelty will be used hereon.

The environment in which one operates is also relevant as to the creativity of the output, in different levels. M. Csikszentmihalyi points out that the performance of very creative individuals depends on three different factors: the person, the domain and the field. Being predisposed is one out of three. Being knowledgeable about the *domain* is also very important to avoid reinventing the wheel, to know where the answers might be, or to be able to ask the correct questions. Understanding how the *field* works is also important, to make sure ideas are successful beyond mere theory. It ensures appropriateness beyond novelty. It contributes to the materialization of the idea.

## 1.2 How are we creative?

Beyond measurement, research has provided great insight in the way the mind works during the creative process. Albeit the incompleteness of models, psychologists have figured out patterns that shape the way people behave while having an idea.

One interesting question is *how much time does it take to generate an idea?* The reader would do good in taking some time to think about the topic, and the answer is not short of a riddle. Some people would consider it to be instant, referring to

the so-called *eureka moment*. Other people would answer it could take a lifetime to have that great idea you are looking for. Other would more safely and evasively say it depends. And to some extent they would all be right.

The process for generating successfully a good idea requires of some mental processing, but such processing tends to happen in the background to some extent. Reflection happens in a non-sequential way. Solutions seem to pop out of the blue. This has been called by E. de Bono *lateral thinking*, as opposed to *vertical thinking*. The latter is used to express rational and sequential problem solving processes. The way we solve it is rather defined, and every step is logically linked to the previous. There are no surprises, the procedure is clear, and there is one answer to the question.

Lateral thinking, on the other hand, faces problems that do not have *the* ultimate solution, but rather better or worse solutions. It is necessary to explore alternatives, so the process is more chaotic, takes surprising turns, and does not follow a specific path. If you knew the path you were supposed to follow, you would already know what the solution is going to look like!

The difficulty with this is that we need to break loose of our rigid mental structures, our semantic network. If you think about drinking coffee, you most probably think about drinking from a cup. You have seen hundreds – or even thousands – of coffee cups in your life. Thinking about drinking it out of a bottle is less ordinary, and it would require you to challenge that semantic network a bit. It takes some more time, and some more exploring, to come up with concepts involving this.

This is called rigidity, and it is related to the process neurons follow to retain information. When we go through a path, and it is positively reinforced – that means, we get what we wanted to get – then this path becomes more likely to be taken again. If you drank coffee from a cup, and it worked, why explore more? Our brain prefers to dedicate time to focus on tasks where we see more potential for improvement, or greater challenges. Such greater challenges normally also challenge our creativity, they force us to explore paths that we had not crossed before.

The effect of crossing such new paths is associated with this perception of novelty, the amusement provoked by creative ideas. That is one of the main reasons why creativity is so important in advertising, or why we laugh at jokes. Exploring new paths "tickles".

Sometimes, these new ideas are so positively reinforced, that we think *why didn't I think this before?*

Due to this level of parallel thinking, the brain needs some time to process and explore ideas. That is why many people say it takes much time to get to the ultimate idea you are looking for. And that is also one of the reasons why good



ideas many times come to you in the shower or on the bus. That is why G. Wallas – and many experts after him – map the creative problem-solving process to the following steps:

**Preparation:** The question is posed and defined, and different constraints are pointed out.

**Incubation:** It involves internal restructuring of the patterns in our brain. It is a non-conscious process, and the time required depends on the problem and the idea to be generated.

**Intimation:** A pattern arises that seems to make sense. The idea is not yet generated, but some parts of it already start being coherent. People have the feeling that *they are getting somewhere*.

**Illumination:** The idea jumps to conscious level. This is the so-called *eureka moment* after Aristotle's expression of joy in solving a problem. It is very dependent on the environment: the person needs to be relaxed, and the environment needs to be favorable to new ideas.

**Verification:** The new idea is tested to ensure it meets the expectations.

One important trait of this process is that, albeit the sequential description, it happens in parallel for the different patterns and ideas. Because of the nature of this incubation, some people recommend *walking away* from the problem to let the brain rearrange. Others speak about creating a relaxed atmosphere to ensure that illumination happens. Others swap problems, so the first problem seems easier when you get back to it. Others provide random stimuli so that the patterns during incubation are wider. The ways of using the knowledge on this process are numerous.

### 1.3 Creativity and the person's traits

Studies of creativity are mainly framed in the discipline of psychology, and much of our understanding comes from other insights gained in this field. At the end of the day, a creative person is a person and a creative behavior is a behavior. And they all have mental processes behind them.

In particular, the aforementioned processes related to vertical and lateral thinking relate much to the concepts of conscious and unconscious. Creativity seems to fall, after evidence on the process, on this second level of behaviors, of which we are not fully aware.

In particular, traits of a person can strongly influence the way they come up with new solutions. Differences in intelligence may have an obvious influence on the

patterns that the person has been capable of developing. Personality traits as to how problems affect us – and how we affect problems – may also. This section explores those two concepts somewhat more in depth.

### 1.3.1 Intelligence and creativity

What do we understand by intelligence? When surveying non-experts, one of the most common answers is a combination of problem-solving, verbal and social capabilities. F. Galton was one of the first to try to measure intelligence, using sensory acuity as a proxy. But it was not until much later when C. Spearman started measuring different non-correlated "intelligences". All in all, there seems to be a strong link to the capability of guiding thought, to face challenges in an active, interactive and reflective way.

The question that arises then is... is creativity part of intelligence? Or the other way around?

According to J.P. Guilford's structure of intelligence, creativity is a set of facets of intelligence. In divergent production, some creative abilities are spotted:

- Sensitivity to a problem: ability to recognize problems.
- Fluency: ability to produce rapidly various ideas, associate words or organize words in a sentence.
- Flexibility: ability of adapting, be it by need or spontaneously.
- Originality: ability to produce ideas that are new.

R. Sternberg and T. Lubart, to the contrary, conceive intelligence as a trait of creative people, but as only one part of their creativity. They complement intelligence with other necessary traits, such as knowledge, thinking style, personality, motivation and environment. From intelligence they take some traits that are necessary: being good at generating solutions, being critic with one's ideas and selecting only the most competent ones, and being involved in applying those ideas in reality. The link to knowledge is particularly interesting. Too less knowledge hinders creativity, but too much knowledge naturally provokes rigidity. This is a potential danger for creativity.

When assessing both of them as independent terms, it is interesting to analyze the overlap. Descriptive studies show that creative people tend to have above-average intelligence, and particularly that outstandingly creative people in history have had very high intelligence assessments. However, the opposite is not necessarily true: highly intelligent people cannot be proven to be particularly creative. When correlation is directly studied, the correlation is weak and depends strongly on

the subset that is measured. The correlation seems strong on the lower part of the scale, though: people with a low intelligence are lowly creative, in an almost proportional way. Above average, creativity seems to imply intelligence but not the other way around.

### 1.3.2 Personality and creativity

Personality refers to the particular combination of psychological traits – such as emotions or attitudes – of an individual. It follows a unique combination for each particular person.

Some people speak about creative personalities, as that of someone who is consistently creative. But what traits influence this? As happens with intelligence, the term *personality* itself holds some disagreement as to what it encompasses. Aristotle tried long ago to infer human character from physical attributes, and Hippocrates associated bodily fluids to personality traits. Since then, focus has been rather put on the persons traits directly. G. Alport and H.S. Odbert found almost 18.000 words in the English dictionary to describe personality, with some 4.500 being trait-like words (adjectives). R. Catell then reduced this into 16 personality factors, namely *warmth, reasoning, emotional stability, dominance, liveliness, rule-consciousness, social boldness, sensitivity, vigilance, abstractedness, privateness, apprehension, openness to change, self-reliance, perfectionism* and *tension*. For each one of them, the level can be high or low, the latter not being necessarily negative. For example, low warmth would describe somebody who is formal, reserved or impersonal.

These factors have been further seen to be correlated, in five more global factors. Although this synthesis was done before, it was popularized by L. Goldberg as the *Big Five*. These factors are:

1. Extraversion
2. Agreeableness
3. Conscientiousness
4. Openness to experience
5. Neuroticism

Psychologist using the humanistic approach have pointed out the importance of understanding why an individual behaves the way it does. They pointed to the issues of *self, self-actualization, health, hope, love, creativity, nature, being, becoming* and *individuality*.

Creativity only started to be paired with personality – in the scientific arena – in the early 1980's. F.X. Barron related it to aesthetic sensitivity, broad interests, attraction to complexity, independence of judgment, intuition, high energy level, self-confidence, and creative self-concept. Later G.J. Feist described them as autonomous, introverted, open to new experiences, norm-doubting, self-confident, self-accepting, driven, ambitious, dominant, hostile, and impulsive. He pointed out in the *Big Five* model that *extraversion* and *openness to experience* had a particular relevance.

It can be seen that the relation between personality and creativity is a two-sided arrow: personality traits influence creativity, and creative performance can influence personality traits. What seems surely clear is that some personality traits can be creativity blockers. Intolerance, low willingness for new experience, or restricted fields of interest constitute arid soils for creative tasks.

## 1.4 Conclusions

As has been seen, creativity is a field in which much has been said, but still much remains to be said. Since it applies to so many disciplines, and to so many contexts, the points of view are bound to be diverse. However, having knowledge on the different concepts presented in this chapter will hopefully give the reader a competitive edge when facing creative tasks. Knowing how your creativity works can let you get more out of it. It can teach you to be more creative.



# Chapter 2

## The birth of a business idea

Collado-Ruiz, D. <sup>1</sup>, Ostad-Ahmad-Ghorabi, H.<sup>2</sup>

Having *the* idea is not a random occurrence. Not only can a proper setting be nurtured, it needs to be worked through to make sure it is successfully implemented. This chapter presents a process that can drive teams towards that final success.

### 2.1 Setting the target

A good idea may *happen* in various different situations: while you are thinking of a problem, while you are *not* thinking of a problem, while you brush your teeth, while you are sitting in the bus, or while you are looking outside the window. And sometimes they happen while you are daydreaming.

We all have more or less experienced the daydreaming situation, where we start to give thought to a particular topic. Daydreaming is usually a comfortable situation, where we find ourselves very creative in giving thought to all the details around a particular idea. This liberated attitude is good for developing first ideas, either for a specific predefined problem or just out of the head. But you can imagine that by just formulating those first ideas, a realization is not possible.

The same comfortable situation should be present in an idea-generation session, such as a brainstorming. In brainstorming, a lot of different ideas that pop into ones mind are formulated. However, brainstorming normally has an initial problem

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definition. Hence ideas are not developed randomly for any purpose, but for a specific one. A clear definition of the purpose is needed.

The initial ideas may serve as a pool of resources for defining the *goal*. The goal is a formulation of the direction that has to be taken, independently of how the particular solution will look like. The goal definition states where you want to go, not how you want to get there.

Once it is defined, objectives need to be declared. When all objectives are met, we can consider we have reached our goal. Therefore, we can interpret the objectives as an overview of *how* the goal should be reached. Some of the initially daydreamed or brainstormed ideas can be, after some evaluation, retaken to attain the objectives.

## 2.2 Environmental analysis

To develop an idea in a systematic way, it is important to know what you may find in the path. Inspired by product development processes, the next natural step to generating the idea would be to fully understand the environment.

Students of the course were asked to analyze the entire environmental setting of their project idea. This includes to get to know among others the competitors, customers and users, as well as other stakeholders and sources of information such as laws or regulations.

The terms *customer* and *user* have to be better distinguished. A customer is someone who pays for a product, and is not necessarily the one who uses it. Think of toys: the customers are mostly the parents who pay for the product. The users are – most of the time – the kids, who play with the toys.

*Competitors* are all parties who have implemented a similar idea. It is important to envision the selling proposition of each competitor, e.i. why they stand out. This can give an overview on potential niche markets, or on crafting one's Unique Selling Proposition (USP). Understanding competitors and their behavior gives an understanding of why a customer or user would pay money for the product.

The term *stakeholders* refers to all parties that are interested in the course of the process or product. Investors or shareholders are examples of such a case, as may be consumer associations or governments.

Another aspect that influences the realization of an idea, or a project in general, are existing or upcoming laws and regulations; they constitute constraints that have to be obeyed, and it is important to anticipate them.

Having an overview of the potential resources one can access is also important. Such resources include budget, networks, manpower or any other physical resources such as an appropriate workplace.

## 2.3 State of the art

When you have an idea, you might not be the first one or only one to have had it. Before developing all details of the idea, it is very important to get to know what is already out in the market. This helps to save time, money and energy you put into your idea, and also avoids later frustration. The state of the art analysis gives an overview of what is out in the market at a particular moment.

In case of a new product or a particular innovation, it would be a good idea to conduct a patent research. This will help to find out whether the ideas have already been realized and whether the implementation is already protected.

From the moment you have an idea to the moment you implement it, much time can pass. It is important to bear this in mind, as in the meanwhile someone could have implemented something similar. While implementing the idea, it is also important to further analyze and track what is going on. This process is called *monitoring*. In case of patents for example, the time between applying for a patent until it is made public is up to 18 months. Even if a state of the art is conducted, the latest patents researched have been applied 18 months before, and it is not possible to find out which patents are currently being processed by the responsible authorities. Monitoring is then an important strategy to stay up to date with the latest outcomes.

One more note: even if the state of the art analysis shows that a similar idea is already available, it does not necessarily mean that your idea should not be further processed. It becomes critical to have a clear vision of your Unique Selling Proposition.

## 2.4 Idea generation

Once the whole context is well known, it is time to solve the problems that have risen, that have been perceived in competitors, or that have been detected in customers. It is the time to be creative! For this, it is proposed to use creativity techniques.

The selection of the technique – or even the decision of employing a technique or not! – is left to the team. Nevertheless, some suggestions are made. In particular, a technique that stands out when trying to deal with creative problem solving and team dynamics at the same time is *the Six Thinking Hats*, proposed by E. de



Bono. Due to its strong focus on group dynamics, its success relies strongly on the facilitator's skills.

There are many different ways that a problem can be faced. We can try to see different faces to it. If we do it spontaneously, we have the risk of trying to see all of them at the same time! For example, if we decide what car to buy, and we are contemplating a small city car, we may be thinking at the same time about how convenient it will be to park it in the city, how we could be more comfortable in long trips if it were bigger, how we may solve this problem by renting a caravan during those special occasions, and whether you need to take a solution before your vacations in August. Of course, for the final decision we want to include all factors, but... how to do it without going insane, or without prioritizing whatever we intuitively thought of last?

The principle behind the Six Thinking hats is the following: *when facing a problem, there are six possible mindsets that we can use*, each represented by a hat. Structuring these mindsets is bound to give better solutions, since we can allocate and dedicate time conveniently. Additionally, we let each one of those hats reason completely before going into the next step.

This becomes particularly relevant in teams, and even more so in teams with complex dynamics. Aligning the way people are thinking will avoid conflicts, and will let people focus on the task instead of in potential mindblocks.

The six hats are the following:

**White hat:** It represents facts and data, and it responds to the way of thinking in which we are trying to gather or share as much information as possible. If we have some information that is relevant to solve the problem, through this hat we mention it to the team or note it down. If we have some doubts on information, with this hat we raise the question to the rest of the team, or we try to find that information.

**Green hat:** It represents novelty and freedom of thought. Judgment is canceled temporarily, and the more original an idea the better. The goal is to explore very different things. If it has not been proposed yet, the green hat is supposed to say it!

**Yellow hat:** It represents optimism and positive logics. It focuses on advantages and strong points. When speaking about a problem or a situation, through this hat we see the opportunities.

**Black hat:** It represents criticism and negative logics. What could go wrong? What is bad about an idea? When dealing with a problem, through this hat we are able to see the difficulties that we are going to encounter. When facing a solution, this hat shows us the risks.

**Red hat:** It represents emotions and feelings, and is the one that lets us channel the *gut feeling* for a particular idea or issue. The red hat allows us to express an opinion that is unjustified or seems illogical, but that we have nevertheless. Intuition is a very important asset, and through the red hat we are able to let it out to speak.

**Blue hat:** It focuses on the process, and coordinates the session. Through the blue hat we do not speak about the problem, but rather about how we are solving it. With this hat it is possible to decide whether to continue or stop the meeting, whether the level of detail of a solution is enough for the purpose of the task, etc.

The fact of wearing a hat – or some visual reference – is actually pretty relevant. They constitute a visual aid of where in the process the team is, and the perfect excuse to act the traits of the hat that would normally be perceived as negative: the white hat is nosy or brings up external topics without solving the problem, the green hat is silly, the yellow hat is naive, the black hat rants about other's ideas without constructing, the red hat does not justify opinions, and the blue hat just does not care about the problem!

This method forces everybody to take each one of the roles, and to avoid people getting stuck in their natural roles. But the "imposed" roles need to be structured in a convenient way. There is no strict rule regarding this order, and it is always better to leave some degree of flexibility for the facilitator to adapt to the team's results and mood. Admittedly, there are some good ideas regarding the order. Starting with a blue hat to set the goal of the session, or a white hat so that everybody understands the problem, seems coherent. From that point onwards, the order should depend on how the process is going. The facilitator should be good with the blue hat! Sometimes it is good to put the green hat on to explore some alternatives, or to put the black hat on to define the challenges in the problem. If the team's motivation is at stake, putting the yellow hat may build up the confidence so that people see themselves solving the problem. If there are motivational problems, it's a good idea to start with the red hat.

To finalize, it is convenient to end with a blue hat, speaking about how to proceed from this point onwards. This general good practice has a hat of its own, so it is good to remember to end with blue. It will ensure that participants see the benefits of the meeting, and assess whether it was productive or not.

After applying this technique, or of having a creativity session in any case, the group should have a conceptual design of what they wish to deliver to reach their goals.

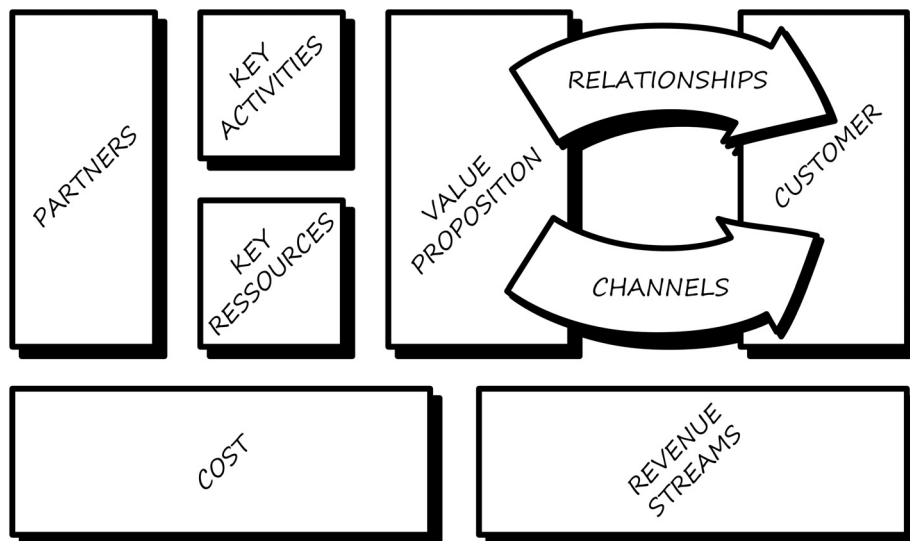


Figure 2.1: The business model canvas, by A. Osterwalder

## 2.5 Conceptualization of the business

Creativity sessions deliver raw ideas. In order to turn them into tangible business solutions, additional factors need to be considered. What is the final value proposition? How will the business get in contact with its customers? Who and how are they? What activities will the company do? With whom? All these questions need to be answered to fully define the business model.

A. Osterwalder developed an ontology of topics to develop in order to do so, and further structured them as what is known as the *Business Model Canvas*. The canvas holds the nine topics that need to be discussed in depth. Figure 2.1 shows how these elements appear in space.

The order in which they are discussed depends on the business that is being developed. Some businesses start by figuring out the different relationships they have with their customer, because that is where they innovate. Others find a creative way of getting revenue (thus making the service cost-effective for the user, or even free). In conventional businesses (or those that sell a specific product or service) there is some level of structure that can be followed. This is a way to avoid dependencies in the process. The elements to be considered, and in a convenient order, are as follows.

**Value proposition:** Why do customers buy the product or order the service?

One of the key matters to consider in a business is what value it gives to society, or to a part thereof. It is the key description of the company, strongly related to its mission. In the case of innovative businesses, it is important for it to be unique, and therefore it is also related to the Unique Selling Proposition (USP) mentioned before. The reason for advising this topic to be covered first is because it strongly shapes the rest of the business, and most specially the importance of each topic. Having a too weak value proposition will probably make the business model very weak itself. Having a value proposition that spreads along many topics will be an enormous challenge to communicate to potential customers.

**Customer:** In most areas of business, it is strategic to understand your customer.

At the end of the day, without customers there is no business! In this section of the canvas, a thorough analysis should be carried out as to who will take advantage of the value proposition, and what their context is. Their interest, consumption criteria, or even everyday life, become protagonist at this point. It is sometimes advisable to go out and ask potential customers, to gain a better understanding. As was considered before, beware of the difference between customer and user, since it may be quite relevant at this point!

**Relationships:** The way to engage with customers does not only depend on knowing about them: it is also important to plan how to communicate and relate to them. Whether the relationship is constant or sporadic, whether there is a pure efficiency reason or rather an emotional attachment of the customer with our product, or even the feedback we get from them, fit this part of the model.

**Channels:** In order to get our products or services out, they need to get to the customer. Relationships are intangible, but at some point we need to deliver something tangible to them. It is also important to plan ahead how we will be doing this, since it has an influence in how the product or service is consumed.

**Key activities:** What do we need to do in order to run the business? There are many activities that take place, but some of them will be critical for the company's success. At this point they should be spotted and prioritized, to know the purpose of actions and how they relate to the rest of the model.

**Key resources:** In order to carry out the activities, some resources need to be put in place. They could be physical resources, financial, or personnel. Understanding which ones are key in the business allows us to understand the level of investment needed, or the risks associated to resources.

**Partners:** All companies are part of an environment in which other institutions operate. In very rare cases does a company start up – or later work –

dissociated from the rest. Having partners is most of the time key to success. At this point, the strategic partners should be decided and the way to interact with them should be defined.

**Revenue streams:** At the end of the day, the company needs to make money! At this point, different strategies for gaining that benefit can be explored. Some companies are innovative at this point. In what range are the prices expected to be, or for what sort of services is the customer going to pay, are important things to keep in mind when filling in this part of the canvas.

**Costs:** Related to the different resources and activities, the company will have associated costs. Accounting for them – specially for the key ones, the ones that are mainly going to shape the way the company performs – is important when defining a model, so that it is possible to assess whether some resources, activities, or parameters might be excessive for the revenue.

The position of the different items in the canvas is not casual: the central part constitutes the core of the model, the offering that the company does. The right part focuses on the market and how the link with it is established. The left part is rather internal, and focuses on what is going to be running "in the background", as well as what is critical from the foreground. Finally, the bottom part focuses on financial aspects, keeping as well some level of homogeneity on the left and right parts.

## 2.6 Risk assessment

Plans normally assume some standard conditions. We assume a relatively uniform environment. However, we all know that the environment very rarely reacts exactly as planned. There are many factors that may change, and that provokes risks for our project.

A risk can be understood as a possible change in the predicted environment that can compromise the results of our project. From that definition, there are some very important points that are worth developing on.

Firstly, it is a *possible* change. That means there is no certainty that it will happen, but it may. If we know it will happen, then it is no longer a risk: it's a challenge! This implies that risks will have a *probability* associated to them, or at least a level of likeliness.

Secondly, it is a change in the *environment*. It is not something that the project team can decide on. If it were, then it would not be a risk, just something that has not been done yet! Therefore, risks require some level of monitoring to keep track of whether the possibility has materialized or not.

Thirdly and finally, it may *compromise the result* of our project. It could decrease the quality, delay our project, or constitute an extra cost. In a broader conception, it could compromise our relation with some stakeholders. That is why we need to watch out for them! Of course, different risks will have different impacts, and in particular different so-called *severity*. There are many ways of measuring severity, including subjective assessments, but one common way is relating them to the money loss in case the risk materializes itself.

There are different levels of detail in which risks can be assessed. In some projects, or at a very preliminary stage of the project, sometimes it is enough to list the risks and leave the rest for subjective assessment. If there is more time, or at later stages of the project, it is important to make an assessment of probability and severity. A simple way would be to assess it in a subjective scale. If there are more stakes, assessing the actual probability and severity (in % and currency units) is a good idea.

For example, if you are organizing an outdoor event, you have the risk of it raining, or of there being a typhoon that impedes people from going to the place where you are holding it. The first is more likely, but rather less severe. The second would normally be very unlikely, but extremely severe.

Once the risks are known, the strategy to follow regarding them should be set. Obviously, most reactions have a cost associated to them, so it is important to study whether it pays off to act in a particular way or another. The possible strategies are:

**Accept** and ignore. This means not doing anything, and obviously implies no additional budget. Nevertheless, if the risk comes to happen, the full severity is assumed.

**Transfer** to an external stakeholder. Normally, this would imply an insurance company, that would put a price to the insurance and then assume the consequences if the risk materializes.

**Mitigate** and reduce the effect. Sometimes, measures can be taken so that if the risk happens, it is not so severe. In the case of the outdoor event, you can organize a venue just in case, and have a bus company be prepared in case you need to take the people there. It will have its costs, but you make sure the event can take place and people do not get wet, limiting the severity.

**Avoid** completely. This implies making some change so that the effects of the risk have no influence in the project quality. In the outdoor event, it could imply installing a tent so that people will be covered, even if it does not rain.

For the level of detail in which ideas are developed here, normally there would not be a strict numerical assessment. Nevertheless, if severity is measured in currency

units, you can assess the magnitude of the risk as the multiplication of severity with probability. If that magnitude is higher than the cost for eliminating, mitigating or transferring it, it would be important to invest in it.

It is also important at this point to develop, if the project steps forward, a contingency plan in which to include what variables are monitored – to see if the risks come to happen – and what reactions are expected if they seem to indicate that the risk is happening.

## 2.7 Closure and further steps

Once all the previous topics have been assessed, the team should have a competent and complete vision of the business model concept. This point is however not the end of the race, but rather the beginning!

At this point is when the team should start executing the different tasks, actually engaging with the partners, and getting financed the different resources. Although the purpose of this book, and of the Creativity Engineering Summer school, is not to follow up on this in the official curriculum, it is important to consider this when structuring the process.

All groups in the Creativity Engineering Summer school were presented with the concepts in this chapter, and they developed their own ideas up to the point of presenting competent business models the last day. The description of their business models take the form of the chapters on Part III.

## Chapter 3

# Developing the business concept

Jerlich, J. <sup>1</sup>

There is an abundance of ideas in the world, but many never make it from someone's mind to an actual product. The reason for this is that an idea has to survive in a rather complex environment and be adopted by the market to become a successful product or service.

Looking at the business potential of creative ideas adds an entire new level of factors to be considered to the development process. If one seriously thinks of taking an idea to the market, it is essential to know what tasks and issues you may find along the way. To best understand the myriad of questions that need to be answered to bring a product or service to the market and position it well within the competition, it is best to work in a systematic way.

This chapter clarifies the three most common tools to eventually develop an idea into a business plan. But before that, it is important to understand what the determining factors responsible for success or failure are, to understand the sense behind the tools.

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### 3.1 Success factors

In order to look at a project idea in a structured way, multiple questions need to be answered. Beyond the preliminary study of the environment addressed in Section 2.2, there are a number of elements that must be monitored. Some almost indispensable question groups to be addressed are the following:

**Industry and market:** Depending on the project idea the industry and market needs to be defined. Thinking about the product or service to be developed is the core question and starting point in the development process. The important questions are: Who are my target customers and clients? Who is the competition and what do they offer? Is my product or service substituting another product or service already on the market? What are the entrance barriers keeping me from entering the market? Are there any kinds of dependencies on others? Suppliers? Competitors? Qualified staff?

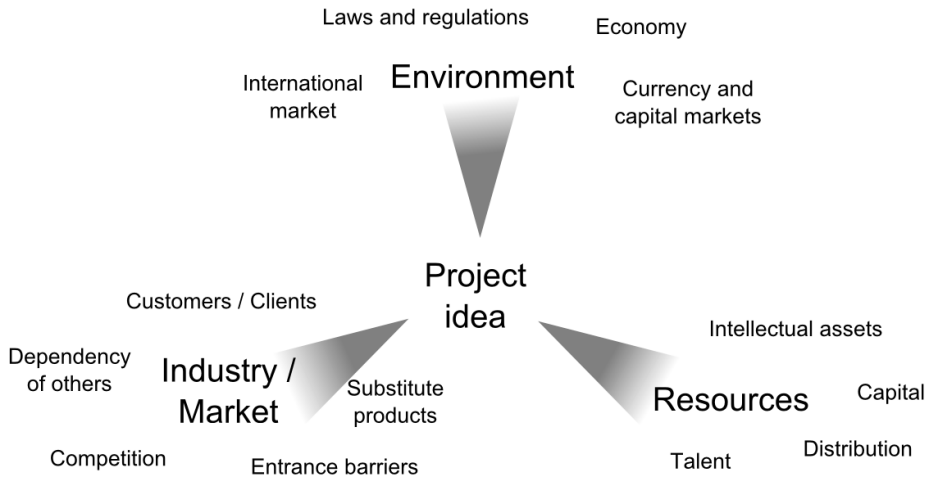
**Resources:** In order to develop and produce a new product or service, resources are needed. What kind of talent is required? How will the product or service reach the target market? Which distribution channels are useful? Do not forget about intellectual assets as copyright and patents to secure your project idea. Getting a good picture of the capital and financial investment needed to develop your project idea is one of the most important tasks in the development process.

**Environment:** The environment the product or service will be positioned in is important. What are the economic factors having a potential influence on the market? Are there any laws and regulations governing the target market? If yes, which laws and regulations exist and how can the product or service comply with them? Are international markets exercising an influence on the product development process? To what extent are currencies and capital market developments affecting the product?

However, as important as it is to think in a structured way, it is important as well keep an overview of the problem at hand. Important elements should be captured. Questions and parameters are not stand-alone, but rather interdependent: all questions are linked to other questions.

For example: Are international markets exercising an influence on my product development process? In times of globalization this question will result in a *yes* in one way or the other. The following question therefore has to be: *how is this influencing the capital investment I need?* Another follow-up question could be: *how does this influence my decision on where to start my business?*

All answers are implicitly making decisions, and determine how the product or service should be designed, or how it will be adapted to the conditions in the industry and of the target market.



**Figure 3.1:** Success factors influencing a business idea

## 3.2 Three tools to know

In the field of business, numerous tools have been developed and used throughout the years. Some look at a broader perspective and some focus on a narrower – yet more detailed – view. All of them offer a way to gain insight into the project and its implementation plans.

Based on the need one is facing, the best suited tool can be selected. In most cases, the best fit is made of a combination of them. In addition, sometimes using a particular tool will be necessary to address certain stakeholders that you want to involve in the project, like qualified experts, banks, investors that should fund your project, etc.

Finally, consider that to ensure success, people from all different areas must coordinate: business, marketing, engineering, design, etc. These tools provide a shared common language to create the best fit product for the target market.

In business development, three tools stand out as references, each for their particular objectives:

- The *Business Model Canvas*, or more broadly speaking, *business model thinking*.
- The *Marketing Plan*.
- The *Business Plan*.

Looking at the three concepts a little closer reveals their differences in terms of content, target (reader) and use. As a matter of facts, it also reveals that they each feed on each other's information! It is important to understand the business model to develop a marketing plan, and it is critical to have a marketing plan to develop a business plan. The following sections detail these differences.

### 3.2.1 Business Model Canvas

A business model describes the rationale of how an organization creates, delivers and captures value (economic, social, or other forms of value). The process of business model design is part of the business strategy. Business models are used to describe and classify businesses in an entrepreneurial setting, but also by managers inside companies to explore possibilities for future development

The Business Model Canvas is a visualization of business models, and was introduced on Section 2.5. The main purpose of this tool, as was proposed to be used there, is to help the project team to capture the project idea from all sides.

### 3.2.2 Marketing Plan

The marketing plan – sometimes also called *marketing mix* – is a written document that presents the vision of how the product or service reaches its customers. Actually, *marketing mix*, as coined in 1960 by E.J McCarthy, is probably the most famous marketing term! Its elements are the basic, tactical components of a marketing plan.

When practically implemented in a work situation, the marketing plan describes all concepts, down to the individual action plans for each department of the company. It is a tool designed to help the project team to plan the marketing side of a project idea from all aspects.

Also known as the Four P's, the marketing mix elements are *price*, *place*, *product* and *promotion*:

**Product** features are details about the product or service: color, shape, characteristics, technical features, etc. It comprises functionality, quality, appearance, packaging, brand, service, support, warranty. In also includes consideration of the benefits customers receive from using the product or service. It is evident that the answers to those questions will be totally different if describing a service.

**Price** is not always as obvious to define as it seems to be. There are many ways to price a product: think about list prices and discounts, financing, leasing options, payment period, credit terms. Also think about who is the party



**Figure 3.2:** Elements of a marketing plan

actually paying the price for your product. Are users and customers the same?

**Place**, also known as channel or distribution strategy, is the mechanism through which goods and/or services are moved from the manufacturer – or service provider – to the user or consumer. Important keywords to consider here are locations, logistics, distribution channels, internet, mobile, etc.

**Promotion** includes all of the tools available to the marketer to communicate with their potential customers. The terms Advertising, Public Relations, Message, Direct Sales, Sales, Media, Budget are related to this topic.

B.H. Booms and B.J. Bitner developed the concept of the Four Ps into Seven Ps. The three additional Ps stand for *physical evidence*, *people* and *process*. They were introduced particularly to be able to introduce some of the critical facts that affect the service industry.

**People** are the most important element of any service or experience. Services tend to be produced and consumed at the same time; therefore aspects of the customer experience are altered to meet the 'individual needs' of the person consuming it, and strongly depend on the person delivering the service.

**Process** has to be considered separately, since it is the key means used to achieve the service outcome, and therefore critical for success.

**Physical evidence** is an essential ingredient of the service mix. Consumers will make perceptions based on their sight of the service provision. Unlike a product, a service can not be experienced before it is delivered. This creates an

element of risk for the customer when choosing the service. Uncertainty can be reduced by helping potential customers *see* what they are going to buy. Physical evidence reassures that the company is going to deliver its promise. It is important for the evidence to be appropriate to the expectations of the customer. For example, a medical service will need to be delivered in more formal way than a haircut.

The marketing plan should clearly describe all the elements explained above, so that all people in the company know how to align with the marketing strategy.

### 3.2.3 Business Plan

The main target of a business plan are investors or lenders, for them to be able to decide whether to invest or not. The reader of this document is therefore assumed to be someone who does not know any details about the project idea and the people behind it. It is essential to add information about the innovators or company founders. The core part of this document is the presentation of the financial plan and the associated investment needed to realize the project.

Common headings of a business plan are as follows:

- Executive summary (Project Synopsis)
- Product/Service description
- Market analysis
- Marketing
- Team & Management
- Financial plan (3-5 year forecast)

Some critical information to include in the business plan, in one of the aforementioned sections, is the company's goals and strategy, the business idea and concept, the customer benefit, information about industry and competitors, how the marketing and distribution is intended, the company's organization and management, and the resources and investment needed.

A business plan usually contains a SWOT analysis. The document is designed in such a way that the reader – and potentially the future investor or lender – can easily comprehend what your product or service will bring to the market. A good advice is to make the content very visual: make sure you use clear graphs and pictures!

Developing the business plan includes many different tasks: developing the business model, creating a marketing plan, documenting, calculating the finances, etc.

It is very easy to get sidetracked, to use wrong assumptions or to forget about important elements. Parallel to the information collection process, it is critical to include feedback loops. Interdependencies and links have to be considered, but it is very easy to forget them.

There are a lot of common pitfalls that can be avoided if thinking about it beforehand. The following list presents some advice on how to prepare oneself to develop a business plan:

- It is tempting to roll up your sleeves and plunge right into the details of your business: evaluating products, studying market segments and sizing up your competition. Do not forget to start with creating your vision and a coherent set of values for your company. Develop a mission statement and use it to define short-term goals and priorities. Once you have a clear road map, planning your journey with more confidence becomes possible.
- A budget is not the same thing as a plan. The budget should be the product of all the other elements in your plan. If you do not have a clear understanding of your industry, customers, competitors and market conditions before you develop a budget, the numbers will not likely reflect reality.
- Take the time to learn about your customers, and build your business plan around their needs and desires.
- Do not underestimate the competition. Your competitors are actually a great source of information about what works and what does not.
- Be prepared to take risks. Creating a business involves risk; so it is crucial to understand and manage the risk. This is why a good business plan anticipates possible challenges and includes a variety of scenarios for meeting those challenges.
- Use the different point of view everyone brings to the table. You need to study the plan objectively and point out possible weaknesses that might have been missed.
- Build in flexibility to allow for unexpected changes.
- Focus on what makes you unique. Learn from your competitors' strengths, but also learn how to identify their weaknesses and use them to improve your own business plan.
- Planning is hard work, and there's no guarantee it will make your business succeed. But a good plan is still the best way to turn your vision into a realistic business.

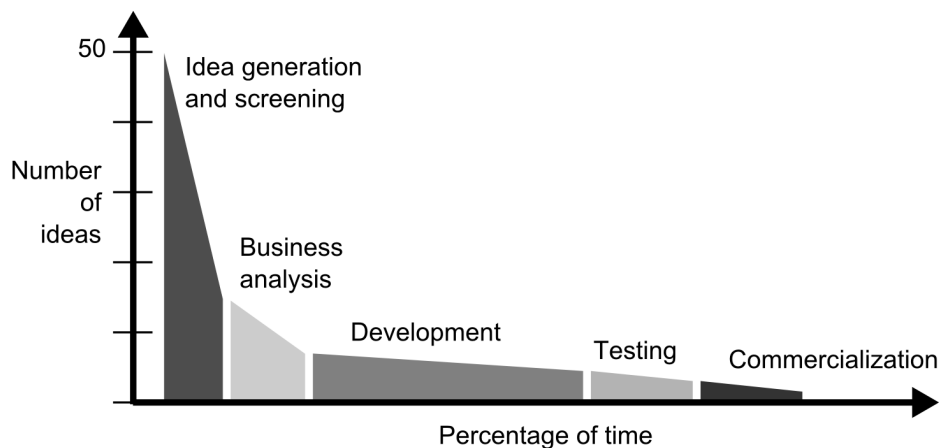


Figure 3.3: Mortality of New Product Ideas

Taking into consideration all the above, it is possible to create a document that will help entrepreneurs communicate with their investors. Of course, it is important to bear in mind that a plan is just a plan, and it is important to stay tuned to changes in the environment. That is why investors take such a close look at the entrepreneurial team!

### 3.3 Reasons for failure

Even when following all recommendations, there is still a risk of failure. After all the hard work is done, the product or service still has to be accepted and bought by target customers. After winning the trust of the first customers, and hopefully satisfying them, this should attract new customers. At best customers return and become repeating customers. The time that this process takes determines for how long financial resources have to be invested until the first cash flows back to the company.

To gain some perspective, Figure 3.3 shows how many success stories can be reported in comparison to the numbers of ideas created. Statistics show that 80% of new products fail. In today's competitive world where the capability to adapt to continuously changing markets determines the survival of companies, this fact confirms that Innovation and Product Development is a big challenge.

This becomes tangible when remembering products that came to the market but disappeared again. A paradigmatic product is the Palm Pilot from 1997. The design is not so far away from today's smart phones. It paved the way for better products.

Others, like the Lohner-Porsche Mixte-Hybrid car from 1898, were just way ahead of their time. Surprised? Yes, the first hybrid car was designed in 1898. The 18-year-old genius Ferdinand Porsche designed it for the Lohner Coach Company. Unfortunately its lead-acid batteries weighed more than those of a Prius, and the automobile maxed out at 60 miles per hour. Lohner canceled production after selling only 300 units in eight years.

In 1981 Xerox made waves by introducing a computer with a mouse, Ethernet networking, and a graphic user interface with icons and folders. It was quietly phased out around 1988. But it is a fact that Xerox invented the graphical user interface many years before Apple and Microsoft made it the standard everybody knows and uses today.

So why do new products fail? Some fail to offer unique customer benefit. Others are not what customer really want. A common reason is that market potential, competition or speed of market change is underestimated. When product development takes longer and cost structures change during that time, it can close down a business. There are cases where a rush to the market without a well developed marketing plan can be the cause for a new product not be accepted on the market. It can be as problematic to move to slow, as it can be to move to fast.

### 3.4 Reflections and conclusion

This chapter has presented a number of marketing and business tools and concepts, but furthermore it has brought up a myriad of questions that need to be answered by the idea-development team. The experience of working in this area is especially valuable for engineering students, who have mostly had little contact with such topics during their studies.

The tools described may seem complex already, but its real complexity only becomes truly patent when going through the process of actually using the tools. Each question that gets answered reshapes and changes the original idea. Furthermore, it might even force feedback loops, in which the team is forced to revisit a previous questions. Are the assumptions still valid after the change? Practitioners find that it is many times not the case.





## Part II

# Guest chapters



## Chapter 4

# Acknowledgment from the editors

This year we succeeded in having Professor Charles Pezeshki from Washington State University (WSU) as guest lecturer. Chuck is Professor at the School of Mechanical and Materials Engineering at WSU, director of Industrial Design Clinic and founder of the Global Design Clinic where he is responsible for including and structuring CAD across Mechanical Engineering Design curriculum. In this role, he has conducted many design projects for companies such as Boeing Company or Siemens Corp. Since its inception the industrial design clinic has increased its yearly donation rate from the range between 30 to 50 thousand dollars, to that of 150 to 180 thousand. In this years summer school, Chuck presented his experience in working with big companies, about communication barriers and the barriers one faces when attempting to transfer an idea to someone else. In the following guest chapter, Chuck will talk about thinking patterns, relational modes of individuals and societies, by referring to spiral dynamics. We believe that the study of this chapter will help the reader better understand the complexity of communication and perception in an individual, an organization and bigger societies.



## Chapter 5

# Creativity and performance

Pezeshki, C.<sup>1</sup>

One of the most interesting aspects of understanding creativity and performance is how the organization of relationships will impact the final design of any product. From Wikipedia, Conway's Law is an adage named after computer programmer Melvin Conway, who introduced the idea in 1968. It states that "organizations which design systems ... are constrained to produce designs which are copies of the communication structures of these organizations".

My experience has shown this also to be true. As my career of a professor of design has progressed, and I have worked with an increasing number of companies, it is very clear that the design of many products produced by many different lines of business will share important commonalities dependent on the social structure of the organization. It is no surprise, for example, that the design of a contemporary, commercial airliner resembles a hierarchy, as a relatively rigid hierarchy is the organization that designs it. Equally as important is the fact that a relatively rigid hierarchy - the Federal Aviation Administration in the United States - is the primary interface with the outside world that the designers must both work with and satisfy. My observations have shown that rigid hierarchies happen to be a relatively optimal form for managing fine detail, and attention to detail is what keeps airliners in the air without crashing. So this is not at all a bad thing.

It then follows that relationships, and how they are formed, will have a relatively large effect on how a design is generated, as well as how much innovation and unpredictability is created in the design process. Dependent on the field and the

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context, this can also be a good or bad thing. Divergent thought and multiple concepts can be an extremely positive force on new product design. However, standardized practice is profoundly important to design reliability, and so context is extremely important. One expects a hose fitting to fit on a pipe.

If relationships are important, then how does one understand relationship structures and how they apply in the context of design? There are numerous models for understanding organizational forms. For the purposes of this paper, we will discuss one, called Spiral Dynamics.

## 5.1 Spiral Dynamics

In the '50s, a different approach toward understanding relational dynamics was pioneered by C. Graves, a professor at Union College, and further advanced by D. Beck and C. Cowan, students of Graves and authors of the book *Spiral Dynamics*. Graves, originally performing research to validate Maslow's Hierarchy of Needs in a relational context, found that Maslow's Hierarchy was incomplete. He found that societies and individuals traversed well-defined relational modes dependent on the challenges faced by those societies at their particular moments of crisis. Further, these modes were split into two dominant forms - *I* modes, where some aspect of an individual was expressed, and *We* modes, where individuals sacrifice their well-being to the larger good of the group. These levels were color-coded for ease of discussion, though the colors do not have any independent meaning.

In increasing complexity, the different relational modes, what Beck has coined the *psycho-social DNA* of a society, are, from lower on the Spiral, to highest:

1. Survival (I - Beige) - characterized by individual survival needs (water, food, shelter).
2. Tribal/Magical (We - Purple) - characterized by group-shared rituals and belief structures, but no strong leadership structure.
3. Authoritarian/Egocentric (I - Red) - Groups of people organized roughly into a hierarchy, with an individual or groups of individuals occupying stratified positions of power and privilege in the group, as well as independent decision-making authority.
4. Legalistic/Absolutistic (We - Blue) - Groups of people organized into hierarchy that, like the authoritarian structure, occupy stratified positions of power and privilege, but are subject to a body of law that applies to all, and restrains individual power and decision-making capability.
5. Achievement-oriented/Entrepreneurial (I - Orange) - Societies that follow this relational mode, or have some of this feature embodied in their structure

are the first to value highly independently formed relationships, and use trust as an evaluative tool in deciding relational formation. Instead of a rigid hierarchy of people or laws, group structure is dependent on achieving a goal or some level of culturally desirable performance.

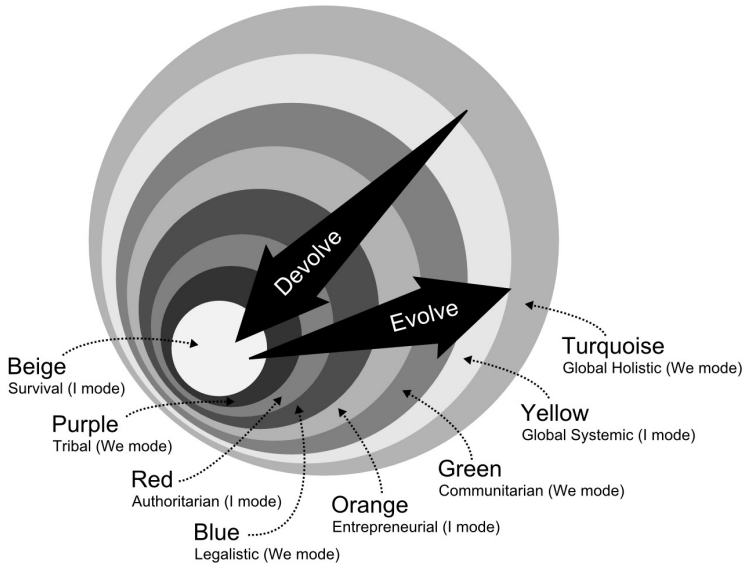
6. Communitarian (We - Green) - People-oriented societies that highly value each individual in the society, and are based around egalitarian principles and laws that enshrine the individuals' rights in the context of the group.
7. Global Systemic (I - Yellow) - Recognizes the relational dynamics present in all lower levels and opportunistically combines these to achieve higher goals and purposes.
8. Global Holistic (We - Turquoise) Combination of various Yellow 'I' mode thinkers devising larger systems that span larger expanses of cultural relational dynamics and incorporating these together to achieve goals on a global level.

Figure 5.1 is one potential representation of Spiral Dynamics theory. It is important to remember that though individuals and societies can and do traverse up and down the Spiral as situational needs dictate, a given individual or society can only use relational modes at or below the maximum developmental stage of the individual, or in aggregate, a society. Thus, a society that has developed into a communitarian model can still use authoritarian structures (there are still prisons in Sweden), but societies that have only developed to the authoritarian level cannot have intrinsic communitarian organizations that can stand independently. A king may have a relief society for poor people, but poor people will still stand in diminished status in that society, and their privileges are still dependent on the largess of the king, an individual at the top of a hierarchy. If the king is displaced, such aid organizations may also necessarily be displaced.

This is a very important notion to understand when using Spiral Dynamics at all, because there is a tendency in the larger community to identify certain issues with certain Spiral levels. Spiral Dynamics does not inform on specifics. Rather, it informs on meta-level relational approaches to issues. As in the above example, taking care of the poor can occur at virtually any Spiral level. But the approach to taking care of the poor will definitely involve the relational level that a given society has evolved to.

And indeed, part of the problem with using Spiral Dynamics is that Spiral Dynamics as a field is relatively poorly developed. There is a sparse rigorously peer-reviewed literature documenting its ramifications, and because of many people seeking alternate spiritual perspectives, it is often co-opted by many either as a tool to hierarchicalize ostensible human enlightenment, or serve as a springboard for alternate out-of-the-mainstream religious practice.





**Figure 5.1:** Spiral dynamics: levels and evolution

This is unfortunate, because the insights of Spiral Dynamics as applied to preparing engineers for design practice actually come from lower on the Spiral. For example, consider the problem of defining the 'global engineer.' One might posit that a true 'global engineer' must have a dominant v-Meme structure that is characterized by 'Global Holistic' or Turquoise. This is a misinterpretation. An individual only needs to make an individual difference in a small part of an organization that may have an international division, which does not require an all-encompassing view of the world to make that change. A well-practiced engineering design process can do just this.

In fact, one can use the Spiral and understanding the various colors and combinations of relational modes to interpret corporate culture and build bridges among organizations with different relational modes.

## 5.2 Basic Relational Dynamics

A complete discourse on Spiral Dynamics is beyond the scope of this short chapter. However, there are a couple of interesting notions that come out of the Spiral that apply. First is the fundamental dichotomy of relational importance that characterizes a breakpoint in social organizations. This is the balance between

the importance of externally defined relationships versus independently generated relationships.

Externally defined relationships are ones humans associate with titles, such as 'Professor' and 'Doctor'. External relationships are defined by larger society, and as such are usually the result of a large investment of time in a certifying organization, or are familial. If there is no ethical or professional malpractice, once a title is achieved, it cannot be taken away.

Independent relationships are more varied, fundamentally defined by individuals between each other, and data- and circumstance driven. In an independently defined relationship, humans make their own decisions on who is to be believed, or trusted based on both external behavior and interaction. Titles and external definitions may play a role in initial credibility, but longer-term validation is dependent on performance.

Organizations characterized more by the Authoritarian/Red v-Meme, and Legalistic/Blue v-Meme that are status-based are more likely to have externally defined relationships and hierarchical in form. Achievement-oriented/Orange v-Meme or Communitarian/Green v-Meme organizations that are more performance-based or human-focused depend more on independently defined relationships, and can have any number of relational structures.

For example, in a performance-based company with a flatter, more human-centered organizational structure, if a Ph.D. formed a relationship with the janitor, and that relationship resulted in the savings of one million dollars, would be positively approved and they would likely receive a bonus. In a more rigid hierarchy, such as a university, if a professor formed a friendship with the janitor, who was obviously below the professor in status in the hierarchy, and saved the institution the money, the comment would likely be 'what is a professor doing talking to a janitor?'

### **5.3 Applying Spiral Dynamics logic to the Creativity Engineering class**

Since one of the primary goals of the Creativity Engineering Course is to spark creativity among student participants in the class at the TU-Wien, Summer 2012, independent group organization was placed with a premium. However, in order for students to develop those independent relationships, as well as the accountability that would be required in order to guarantee performance, a number of social integration exercises were conducted. A sample of these would be:

1. In the initial icebreaker class, students were forced to learn each other's names, as well as conduct personal interviews between individual participants.

2. The largest national contingent of students in the class (11 out of 22) came from one university in Beijing, China. These students were independently encouraged to work with other students, who came from an assortment of countries, including Germany, Austria, the Ukraine, Colombia and the U.S.A.
3. Students were socialized in many different venues, from attending an open reception for all international students attending the summer program, to visiting nightclubs in Vienna, to visiting Budapest together. Friendships were developed that carried back into the classroom environment.
4. Students then were allowed to self-organize around various product concepts. A process was given that the students were expected to follow, including generation of a business plan, specification, multiple design concepts and a final project presentation.

If self-organization is believed to be a cornerstone of group creativity and divergent thinking, then the Creativity Engineering class certainly demonstrated this. The range of ideas that the students committed to in their final projects show the breadth of diversity of the class. Students worked on everything from a biomimetic sub, to a small consumer-oriented hydroponic system for growing home vegetables, a method for accelerating parking on crowded city streets, and a device to recharge cell phone batteries while walking.

Contrast what might have been expected in a more hierarchical design environment. Students would have been given a particular class of problem and expected to conform their solutions inside a much narrower range of answers, such as re-designing a chair, or building a better wrench. Both classes of problems have an appropriate place in filling societal needs. But the more free-form, unconstrained approach definitely leads to more creative range.

## 5.4 Student development in the context of Spiral Dynamics

The relational level development of the students participating in the Creativity Engineering summer course was split between final year undergraduates and graduate students from engineering programs. As such, they primarily have been embedded in the rigid hierarchies that characterize the educational process, where titles and externally defined relationships are pre-eminent. Additionally, students had been expected to engage mostly in algorithmic thinking, where single answer and good/bad dichotomies predominate.

Algorithmic thinking is only a component of true creative design thinking, which, in the case of product design, is more characterized by Orange/Green v-Memes.

Design thinking prizes multiple options for solutions, with a graded optimality associated with different design solutions. Because of this, students had to evolve their cognitive style to fulfill the goals of the Creativity Engineering class. The students were also all engineering students in accredited degree programs, and as such, were used to well-defined problems with well-prescribed initial conditions. None of this was true for the design projects the students picked. All the projects involved the students defining the initial specification themselves, as well as the scope of the project.

In order to force the issue of transforming the groups into being self-reliant, the group of instructors in charge of the course intentionally left one week for students to engage in mentored group work. No professor posed as an expert in any of the specific project areas. Rather, instructors served as process experts and idea stimulators outside the individual groups. This formed self-reliance among the students in the group that grew as the week went on.

Additionally, by dismantling the authority associated with the various titles possessed by the instructors, the students were driven to do independent research on the subject areas and make educated guesses that they had to evaluate for truth. Students turned to real-world analogues to their projects to base their own designs in reality. They were also encouraged to confront the real time lengths associated with development cycles, and the challenges associated with acquiring money to support salaries during processes that may take multiple years that do not produce revenue. All of this fed into relational evaluation and who in the group was trusted regarding certain parts of the project.

## 5.5 Conclusions

Organizational theories such as Spiral Dynamics can help develop both students and the direction of curriculum in classes such as the Creativity Engineering course offered by the TU-Wien summer university. Understanding exactly the social and organizational dynamics at work can help with improving such a course, and continuing the process of creative modification of future efforts.



Part III

Project work



## Chapter 6

# U-farm-2: Bio-organic home mini farm

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*Keywords: Bio-organic planting, Healthy food, Home-owned mini-farm, Home produced food*

### Abstract

*A self-sufficient autonomous mini farm for natural fresh food production.* This somewhat futuristic concept will help produce part of the foods needed by people living and working in indoor places like homes, offices, schools, kindergarten, etc.

With the help of this proposed plant box it is possible to grow vegetables, plants, and flowers. It consists of a small closed electrical resin cube with a monitoring system, filled with soil and seeds. It uses the energy of the sun as well as electricity for heating. This concept addresses the urban farming problem. With something like this, it could be easy for people living in bigger cities to grow their own food. The main drivers for the design are producing something useful and occupying a minimum home space.

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## 6.1 Introduction

In modern times, people are more concerned about their health every day, they want to live a healthy lifestyle. Besides sports, satisfaction with education, employment, family and friends, there is very important field that cannot be neglected - what we eat. *Mens sana in corpore sano*, the famous quote, means healthy soul in a healthy body. Healthy food presents an important part of maintaining healthy life.

Nowadays the food production industry is adding increasing amounts of chemicals to food. The increase of gene modified food leads to consumers being uncertain about the real value of the produced food. Some even have problems to distinguish between real naturally produced food and industrial artificial food. Natural food markets are on the rise. Home produced food presents the right answer to meet customer needs. This project, U-farm-2, presents a self-sufficient natural food production system, a mini farm concept, under the motto *You can do it yourself!*.

## 6.2 State of the art

Nowadays, food provenance is a big issue, so the modern kitchen is concentrating on ideas that can produce healthy ingredients for our families to consume. For many urbanites, natural food is their path to freedom. Consumers are more aware than ever, and have serious concern about the journey that food goes through in order to end on our plate. With so many horror stories out there, it is very hard for consumers to trace the origins of ingredients.

When benchmarking the idea, our group came across various competitors in the home plant production sector. As our competitors see the mini plant boxes as part of the furniture, but the aim of this project goes beyond: we want to present our product to the customers as a pet. The fun of planting should be an enjoyable experience for our customers. Another very important difference in comparison to competitors is the educational function for children and students. Through the research we found out that most competitors products are mainly integrated in luxurious furnitures. For that reason the price of their product is much higher than what we expect for our product. The three strongest competitors will be presented in the following paragraphs.

**Philips biosphere home farming:** As an answer to urban farming problem, Philips has come up with a unique, self sufficient and autonomous farm concept, with an opportunity to grow part of the foods, needed by a family, within the confines of their urban dwelling. The basic plan of the system would be divided in different levels. The upper two tank levels would be allotted to plants. Next level would contain algae, followed by a tank con-

taining fishes and shrimps. The last layer would have organic garbage from the kitchen wastes, for methane gas production and water purification. In our point of view this product is too expensive, complex and still not available as mass product.

**Plan T mini greenhouse for indoor plantation:** Plan T is a mini greenhouse, in real terms, which can easily be installed within the confines of your home. It will function like a greenhouse and will also allow you to take care of it with ease. It will grow herbs and short shrubs within it. It holds a lot of similarities to the concept presented here, but our product will have a joint easy carrying function. Also the price of this product is higher than for the U-farm-2 product.

**Window agriculture:** The vegetable window pot, also known as window agriculture, uses the basic way of making effective use of freely available solar energy in any window opening, to develop a small garden in your home. All you need to do is stick transparent plastic containers, containing soil and plant of your choice, to the window with the help of a double sided tape. Depending on the size of your window and your plastic container, you can grow plants, ranging from small herbs to vegetables and fruits. In comparison to our product this one does not contain the monitoring systems and is too simple for our target market.

The main focus of our project is to produce natural food in the optimal growing environment in small planting boxes. We also want to offer our customers the fun of planting; like a hobby. Adding an educational perspective to our product is another aim of our project.

## 6.3 Methods and tools

For generating our ideas and reveal the project we used different methods and tools. Firstly we applied the six thinking hats to generate ideas (presented in Section 2.4). After the decision of which valuable features are important for our product, we started to work on our business model. For the business model we used the Business Model Canvas (presented in Section 2.5) in which we identified our key activities, parameters and stakeholders. After defining all the aforementioned activities, we established the marketing plan for 4P's (presented in Section 3.2.2). With this we already identified our marketing strategies for special target groups. We also conducted the SWOT analysis for identifying the strengths and weaknesses of our product on one hand, and on the other hand opportunities and threats for market launch of the product.

## 6.4 Concept description

### 6.4.1 Idea generation

As our initial step we applied the method of six thinking hats. The following text details the process followed and the ideas brought up in each sequential step.

First, we gathered data and information under the cover of *white hat*:

- There is a lack of fresh bio-organic food on the market.
- More people want to be sure about food production process.
- Healthy issues are arising due to the ever more unhealthy food with high part of additives and other chemical compounds.
- Consumers have trust issues about genetically modified food.
- Home production of vegetables and other ornamental plants are occurring.

Afterwards, we brainstormed a variety of ideas for our product by using *green hat*:

- Self-sufficient mini farm.
- Easy-to-carry small boxes with plants.
- Control system for measuring and controlling current condition in the planting box: controlling temperature, nutrition, water etc...
- Monitoring system for measuring conditions in the planting box.
- Big box with inclusion of small boxes.
- Integration of plant boxes into the furniture.
- Plant boxes made of glass.
- Natural seeds production.
- Usage of natural materials for glass house design.
- Planting without soil.
- Optimal growth conditions in small glass boxes.
- Usage of variety of accessories by which people can consider their home growing plants as their hobby and a fun activity.

After the green hat we used *black hat* to reduce our ideas. We agreed to remove following ideas:

- Integration of control system due to high designing costs.
- Integration of plant boxes into the furniture because we want to accelerate the easy carrying function of our product.
- Natural seeds production, since we do not poses additional knowledge for seeds production (outsourcing of this function).
- Plant box made of glass, since there are plenty of other more attainable materials on the market.
- Planting without soil because we want to be as natural as planting can be.

For the remaining ideas we applied the *red hat* where all of us we confirmed a good gut feeling about all of the ideas.

Finally, we looked for positive arguments for our ideas by using *yellow hat*:

- Self-sufficient function of mini bio-farm can be achieved with designing plant box with monitoring system.
- Easy carrying function can be achieved with congregation of small plant boxes into a big box.
- Monitoring system should use symbols for friendly usage and should obtain user guide.
- Optional usage of recyclable materials for plant box design.
- Optimal growing conditions in the plant box can be achieved with creating appropriate environment (monitoring system).
- Offering of variety of accessories for plant boxes in order to achieve assimilation of our product into the living environment of our customers.

The *blue hat* was used during the idea generation process to establish a positive working environment among our group members.

### 6.4.2 The Business Model Canvas

Upon the facts from the six thinking hats method we developed the Business Model Canvas, as follows:

**Value Provided:** U-Farm-2 is designed to let people grow their own food. With limited space, our project cannot support the daily food demand of a family. However, people can enjoy growing plants in U-Farm-2. It also constitutes a great education tool for children. Our main values provided are: production of own food at home, minimal space occupation, easy carrying, fresh healthy food, variety of choices, faster growth due to optimal conditions, fun of planting, educational aspect for children to watch plant growing process.

**Key Partners:** Our company has a tight relationship with the agriculture industry, which includes soil, nutrition or seed manufacturing industries. We recognize following stakeholders as our key partners: seed producers, farm tool companies, research institutes and investors. Meanwhile, in order to promote it, NGOs are also our key partners.

**Key Activities:** For the project's development, the key activities would be: literature research, customer research, key requirements, characteristics of the product, designing process, depicting the appropriate material, monitoring system development and prototype development.

**Key resources:** Our main resources are: time, material, people, seeds, nutrition, soil and water.

**Costs:** The cost of our project mainly occur during manufacturing. Other costs are: material, seeds, stakeholders, R&D, resources, salary, marketing, logistics, distribution and services.

**Customer Relationship:** Except for the traditional way of promotion, like TV, newspaper or the internet, our project will cooperate with NGOs to highlight our environment-friendly features. Meanwhile, a forum of customer will be established to promote our product on the internet. Other types are: our own advertisements, application to the bio-organic network, internet sale (e-business), customer service and user guide.

**Customers:** Our product focuses on people who live in apartments in urban area because they barely have a chance to be close to nature. The target group is presented with people in urban areas, people who want to live a healthier life and people who are sensitive to what they eat. Another market segment is represented by schools and kindergarten. Here, we want to highlight the educational function of our product.

**Revenue:** We will have our own store and will sell U-Farm-2 in supermarkets. The box is not our main revenue, we earn more by selling accessories, like seeds, soil and nutrition. We will earn revenues from: store sale, distributors, internet sale, customer service and accessories.

### 6.4.3 Design concept

After properly defining the business model we decided to start designing our product. Our product will be a cuboid (the top and bottom can be moved out) with a height of 50cm, width of 30cm and length of 30cm. It is transparent and designed to fulfill following requirements:

- It will be easier to join some U-Farm-2s together with a cuboid shape.
- It should not take too much space, the size  $30cm \cdot 30cm \cdot 50cm$  is acceptable and easy to carry.
- The bottom can be moved out so it will be easier for customers to clean the walls and the bottom.

The product has a part we call *slide system* consisting of a protuberant or concave line. Two of the adjacent sides equip with the protuberant lines and the other two sides equip with concave lines. The slide system is designed to join the U-Farm-2s together as customers want. There is a handle on the top part of the cuboid, with which consumers can easily take a U-Farm-2 with themselves. On one side there are two sensor chips attached to the inner wall. The one below the soil line detect the moisture and the pH value of the soil. The one above the soil line measures the temperature and illuminates the U-Farm-2. The user interface is designed to show the result of the monitoring system, informing consumers about the state of the U-Farm-2. Taking into consideration that our target market comprises people from all over the world, everything is graphical on the pane, as presented in Figure [refFig:UFarm2:ControlPannel](#).

The user interface is fixed on the top. For each parameter (moisture, temperature, luminance and pH value) ranging out of the normal range, the figures on the panel will keep twinkling. To transport the U-Farm-2, the product will have a handle. The handle is covered with different design and constitutes an important accessory to our product. This component is made of canvas so that consumers can decorate it the way they want. The cover also protects the plants when moved around.

## 6.5 Detail description

### 6.5.1 Marketing plan

The following section presents the marketing mix, as explained in Section 3.2.2. We will address our key customers trough different distribution channels and will distinguish marketing strategies for two different target groups. One will be schools and kindergartens as part of educational aspect of our product. The other will be people who want to produce home made fresh food in general. In our opinion,

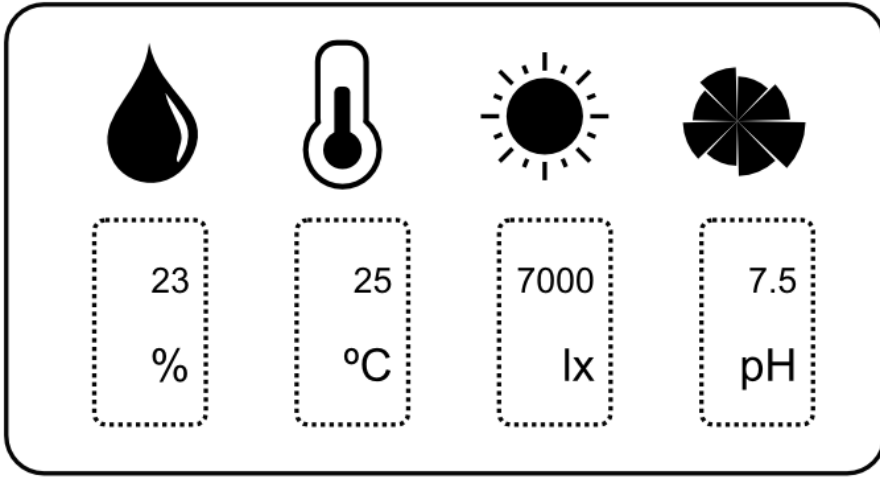


Figure 6.1: Proposal for graphical control panel

marketing campaigns with different NGOs constitute also a powerful marketing tool. This campaign can increase the level of consciousness of people to realize how important is to know, what we are eating.

**Product:** The key functions of our product and the features it has to satisfy are listed in Table 6.1. Our customers will be using our product mainly in indoor places like homes, offices, kitchen, balcony or terraces. It will look like a transparent box so that the plant inside can be seen, and customer can combine small boxes to get a big box. The shape of each box is a cube of size  $30\text{cm} \cdot 30\text{cm} \cdot 50\text{cm}$ . The big outer box can be of  $62\text{cm} \cdot 62\text{cm} \cdot 50\text{cm}$ . The box can be decorated with accessories of different colors, different photos (symbols) and different covers. What differs most from competitors is easy-carry, bioorganic attributes, and an educational aspect for children and students. At the same time, we provide multiple choices of accessories for the customers while the cost are less in comparison to current products in the market.

**Price:** The total price of our product is 19.90 EUR, which is carefully calculated by cost control and market research. In the market, similar products with bigger boxes cost around 160 USD each. Our targeted price seems competitive and attractive. A major part of our profit is from selling accessories, so we can make the product itself much cheaper. Because of accessories selling policy, the customer price is sensitive. For the box itself, small change of price will be ok. But to our accessories, customers will be sensitive. In

order to make our product accepted sooner by the market, we'll have some discounts or gifts for the people who buy at least 4 boxes, like 69.90 EUR per 4-box-pack. There will also be discounts during fairs, exhibitions and the school holidays. Students and children can also have a 10% off for educational purposes (there will be education edition for the special usage).

**Place:** The product will mainly be sold in stores, online shops and fairs. Stores will be supermarkets, grocery stores, farm tool stores and our own stores as well. We also want to establish internet sales through B2B and B2C websites. We can access the distribution channels through the farm tool shops, through investors, through our support partners or NGOs. Sales are necessary. For example, special discounts for customers with discount cards are considerable. We will also attend trade fairs and make online submissions.

**Promotion:** We can get across our marketing messages to our target markets through shops, internet, supermarkets, bioorganic organizations, billboards in the city, flyers, newspapers, online advertisement, advertising with other bio-organizations (NGOs) or through direct marketing. The target market is people living in apartments in big cities, schools and kindergartens. Schools' journals and notice boards are also a desirable way to promote our product. Our product can be used in both summer and winter, so there will not be any timing problem for the release. As for the promotion time, it depends on different market groups. For schools, the perfect promotion time is a month before semester and after semester; for people living in apartments, the promotion time will be anytime and holidays. And the best time for the launch is in Christmas when people buy lots of presents.

### 6.5.2 SWOT analysis

This SWOT analysis presents different views of the product launch in the company and in the market, to anticipate and possibly avoid problems.

- Strengths:
  - Fresh home produced food.
  - Natural planting.
  - Easy carrying.
  - Minimal space occupation.
  - Controlling the growth process.
  - Faster growing due to provision of optimal conditions.
  - Planting like a hobby.



Key Functions	Features to satisfy customers' needs
Bio-organic	Using bio-organic seeds
Easy-to-carry	Using light material and firm handlers
Cheap	Using cheap material and simple design
Customer service	Service centre, warehouse, and website support
Reliable	Using resistant material, interface and connection parts have to be very firmly connected
Flexible (can be used everywhere)	Light, with flexible wheels at the bottom
Friendly user interface	Graphic display with no words in particular languages, to be readable by customers from all over the world
Easy cleaning	Can be opened from both top and bottom
Beautiful look	Simple look with embellished accessories (small board with names)
Easy maintenance	Easy to disassemble, redundancy for function of critical components, spare parts
Fast learning with easy-to-read instructions	Instructions with graphic display

**Table 6.1:** Key functions and features of U-farm-2

- Offering various accessories.
- Small plant boxes with special slide system to design different forms.
- Monitoring system to control the growing process.
- User guide in companion with monitoring systems for different sorts of plants.
- Weaknesses:
  - High cost of materials and monitoring system.
  - Outsourcing of natural seed production.
  - Lack of primary capital.
  - Not enough money for major marketing campaigns.
- Opportunities:
  - Worldwide applicable product.
  - Special market: schools for educational purposes.
  - Cooperation with NGOs for a good cause campaign.
  - Finding a possibility to integrate our product into furniture.
  - Development of the control system that can create perfect conditions for growing (especially appropriate for people who are often away from home).
- Threats:
  - New competitors may arise.
  - Market targeting - possibility of not choosing proper marketing strategy.
  - Customers could see our product as too expensive.
  - Some activities should be outsourced and can present very high rise in costs.
  - Prices of materials can rise and can really affect price of the final product.

## 6.6 Summary and outlook

The U-farm-2 project contributes to users having their own mini-farm at home. Our group decided to work in the field of natural home food production because we want to be convinced about our foods' origin. We also want to launch our product also to the market and offer it to the various consumers.

At first our group generated several ideas about what our product should look like. For this part of our project we used the six thinking hats method. We found this tool very useful to gain common objectives about our future product. After successful implementation of this method, we were able to build the Business Model Canvas to define our key resources, key partners, key activities, provided value, costs, revenues, customer relationships channels and target customers. In the next step, we prepared the marketing plan, defining product features, price specifications, place and promotion activities.

Main key added value of our project is: *Natural planting by having fun!* In accordance to this, an important segment will be accessories for kids and students as well as for other users to decorate their mini farms individually.

In the future we want to research the field of hydroponics and aeroponics, which can present promising way of future planting in homes. Hydroponics means growing plants using mineral nutrient solutions in water, without soil. On the other hand, aeroponics is a method of growing plants in an air or mist environment without the use of soil or on the aggregate medium. Further research activities on this field will contribute towards new findings. Therefore our main focus lies in teaming up with universities and versatile institutes to gain special knowledge and participate in joint projects.

# Chapter 7

## E-Heels

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*Keywords: Charger, Green energy, Kinetic energy, Mobile phones, Shoes*

### Abstract

Our project develops a product that uses human walking kinetic energy to recharge phones; it provides sustainable and green energy in an easy way. The device can solve the problem of batteries running out when no plug is available, which is very frequent in smart phones, given their high power consumption. We propose two concepts to harvest energy: piezoelectric and capacitor based, both approaches give enough energy to perform a call within less than 30 minutes of movement. The designed device is to be attached to the shoes (inside or outside depending on the used concept) and will benefit from the energy generated by the walking movement. Pressure against the floor, for the piezoelectric devices, and feet vibration, for the capacitors, are the working principles behind the concepts. We develop a business model in order to make profit from the design device and decided to have cell phone companies as partners and customers. SWOT and risk analysis are also performed. In addition, we do market research, regarding both, competitors and users. The results of a user survey that we have conducted are quite promising:

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63% of phone owners would buy a portable product to be able to recharge their phone anywhere at any time. Our conclusion is that we have a product with much potential, and a project worth of investing in.

## 7.1 Introduction

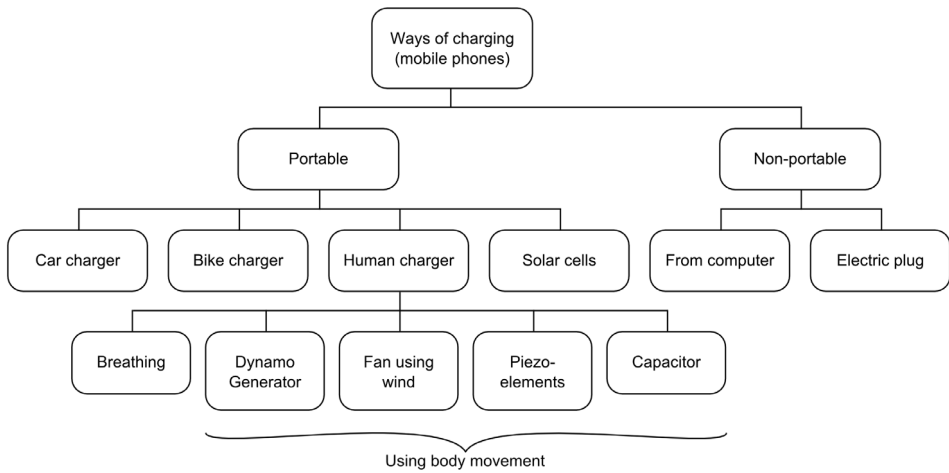
In the century of digital technologies nobody can live without connection, mobile phones, computers and all related items. So it is very important to support our devices with energy all the time. That's why portable chargers are a need nowadays.

E-Heels is a product that will fulfill a need already present in people's daily life. People are on the move, but they still have their electronic devices with them and need energy to power them up. Movement is the cause and the solution to the energy needs. Where plugs are not available, the movement of the human body is able to generate enough energy to feed up a mobile phone until grid power is available again.

E-Heels stands for electronic heels; we are planning to call our company in the same way, e-motion, to define our position on the market.

## 7.2 State of the art

Figure 7.1 summarizes different ways of charging a cell phone that can be found in the market. As our device is portable, we will describe only devices using portable ways of charging as our possible competitors. We consider those using alternative energy sources, for example, solar panels. This alternative source is used nowadays as a portable part of different devices; also, it is simple and cheap enough (average price of solar panel charger is about 15-20 USD). The focus of our product is using body movements; therefore from the scheme in Figure 7.1 we take into consideration other existing devices, which have mechanisms to derive energy from body movements. Those devices are breath and fan chargers with a small turbine or fan, working with our breath. Other devices use piezoelectric elements where energy is produced from pressure on a special element. Other devices are dynamo generators which generate renewable energy by harvesting motion. Another possibility are capacitors which work by mechanical vibrations. Those devices are still not widely spread on the market and most of them exist only on conceptual level. It is difficult to estimate a price for similar devices because this market of chargers is relative new.



**Figure 7.1:** Different existing ways of charging mobile phones already offered in the market. From the human charger concepts, the three leftmost ones (breathing, dynamo generator and fan using wind) exist only as prototypes, and the two rightmost ones (piezoelements and capacitors) are included in the proposed concept

However, to have a rough estimate where the price of our device can be positioned, we have investigated devices that use similar components and parts. We believe that the price should not be more than 80-100 EUR.

### 7.3 Methods and tools

The development of the idea involved different methodologies and tools according to the different stages of the project.

We alternated whole group, subgroup and individual work throughout the process. In general, big decisions (e.g. definition of the business model) and task identification were discussed together within the six of us. To work in the different defined tasks (e.g. market research and analysis), subgroups of two or three people were defined. To execute small and very specific tasks (e.g. drawing of a discussed concept) and to document, we mostly used individual work.

To generate new ideas and solutions for the implementation of our project we used brainstorming. It allows all the members expressing themselves, with no hard constraints on the applicability of the solution or details on the actual design. Then, some analysis of pros and cons was necessary to choose the most viable ideas, before starting to research and sketch the selected concepts.

To decide and design the business model we used the Business Model Canvas, as presented in Section 2.5. The six thinking hats method (see Section 2.4) was also useful; for example, we were discussing for a while and could not make our minds on one big decision in our business model involving partners and customers. So we took the two options we were handling: sell our product to individuals or to big cell phone companies. After a round of yellow (positive), white (facts), black (negative) and red (emotional) hats, we were able to take a consensus decision.

To define our company's marketing strategy and identify potential risks, we used SWOT analysis.

To better understand what users expect and will be eager to buy, we developed a closed questionnaire consisting of 10 multiple choice questions. This questionnaire was distributed online among other participants of the Vienna Summer University 2012 and was also used to perform interviews in the streets (mainly in Karlsplatz subway station in Vienna, Austria). A total of 100 forms were filled, which allowed us to describe a tendency in the market with a reasonable error and confidence interval.

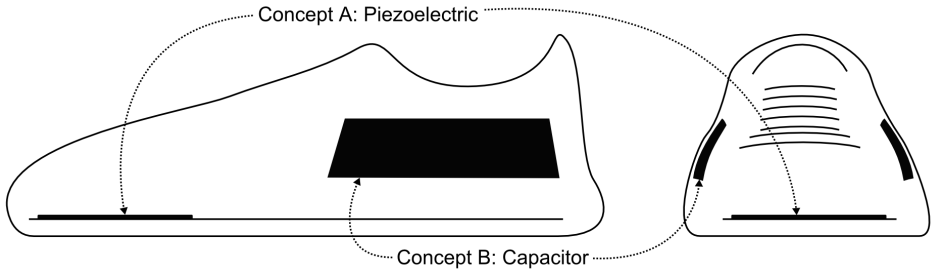
## 7.4 Concept description

### 7.4.1 Concept A: Piezoelectric

The word piezoelectric means electricity produced by pressure, thus piezoelectric materials are those materials like ceramics (PZT), bones, crystals, and Polymers (PVDF) that produce energy when they are under pressure. The use of piezoelectric materials in the E-heels project is due to the useful energy that can be produced because of the pressure people do against the floor at each step of a regular walk.

The way to introduce this mechanism into shoes is through a shoe insole. The piezoelectric film will be installed inside the insole and will be connected to a harvesting circuit to use it to recharge the mobile phone. This idea lets users introduce or remove the device in any shoe they want to wear, as many times as needed. The piezoelectric film is less than 10g and about 7cm long, 3cm wide and approximately 2mm thick. Figure 7.2 shows a sketch of the concept.

The electric charge of a regular mobile phone battery is around 900mAh and the electric charge of a smart mobile phone battery is around 1400mAh (3.7V, approximately 5Wh) but the electric charge of the smart shoes would be an average of 10mA. That means that in order to fully recharge a regular battery one would need to walk for almost two days (for a typical smart phone battery it would be 3 days). Therefore, the mechanism itself is not designed to fully power up a mobile



**Figure 7.2:** Graphical representation of both concepts when applied to a shoe

Parameter	Value
Width	10mm
Length	9mm
Device thickness	200 $\mu$ m
Total volume	1cm <sup>3</sup>
Output power	116 $\mu$ W

**Table 7.1:** Important parameters of the product

phone battery but it is designed to give enough energy to let the user make a phone call or finish a non complicated task on it.

#### 7.4.2 Concept B: Capacitor

The basis of the electrostatic energy conversion is the variable capacitor. The variable capacitance structure, which will be fabricated with MEMS technology, is driven by mechanical vibrations and oscillates between a maximum capacitance and a minimum capacitance. If the charge on the capacitor is constrained, the voltage will increase as the capacitance decreases. If the voltage across the capacitor is constrained, charge will move from the capacitor to a storage device or to the load as the capacitance decreases. In either case, mechanical kinetic energy is converted to electrical energy. Some important parameters of the concept are shown in Table 7.1.

The optimal power output is 116 $\mu$ W/cm<sup>3</sup>. However, the output is dependent on the volume of the device. If we set the volume to be 10cm · 1cm · 4cm = 40cm<sup>3</sup>, and we install two of this per shoe (as shown in Figure 7.2) the output will be 9.28mW. This means that if one wants to use this device to fully recharge by cell phone, it will take 22 days:

$$Time = 4.9Wh / 9,28mW = 22 \cdot 24h \quad (7.1)$$



Consequently, when implementing this concept, it is also very difficult to fully recharge a smartphone battery. Nevertheless, our goal is to be able to guarantee the user the ability to perform one call, and this is achieved.

## 7.5 Detail description

### 7.5.1 Business model

#### *Value provided*

The proposed device particularly addresses business people who work out of the office, travellers and mobile phone users that run out of battery quite often and do not have a nearby electrical outlet. E-Heels provides them green energy anytime, anywhere, to recharge not just their small and portable electronic devices. It allows them finishing their mobile call or finishing a simple task on their smart phone. E-Heels is portable, hence attachable to shoes.

#### *Key Partners*

The E-Heels device should match pretty well with the user's phones. It is thus convenient to work hand in hand with the companies that have experience in marketing and designing this kind of devices. This will help us to develop the an attractive and purchasable device. Any mobile phone producing company can be our key partner. Mobile phone manufacturers and also mobile phone batteries manufacturers are going to be key partners for us to improve our design.

Finally but not less important the consultancy companies in the electronic field. These partners will have a close relation with the mass production of the devices.

#### *Customers*

At this point, it is important to clarify that E-Heels users are not the customers for this our company. Our company will only have business-to-business customers.

This channel of distribution is due to the decision to establish a direct connection with the companies that are controlling the mobile phones market so as to take advantage of their distribution network and their experience selling this kind of devices and their better and strong financial situation.

Since we have already defined our customers we need to take into account that most of them have a global market. This means we will also need to cover a global market because it will be demanded by our customers.

### ***Customer relationships***

We will reach the final users through our customers. In other words, we will built trust and establish a warm communication with the final users being partners with well-known brands.

### ***Channels***

Since our customers are mobile phone companies, our channel of distribution is indirect and it would be the distribution network that the customer's company already has.

### ***Key Activities***

The main activities at the beginning are related to the design of the device; they include the development of prototypes, the testing methods, the materials selection and the quality improvement.

Other key activities are are building the relationships with the key partners and the promotion of the device.

### ***Key Resources***

Our main resources are the money that will be obtained by raising funds from investors, banks, and governmental organizations and the human resources as engineers, industrial designers and lawyers.

### ***Costs***

The costs of our project development are:

- Design device costs (prototypes, testing methods, device manufacture)
- Salary for staff
- Advertisement, promotion costs
- Manufacture costs (mass production)

In addition, the company is willing to offer an after sale service that will generate costs but also will intensify the relation between the company, the users and the customers.

### *Revenue*

The company of the E-Heels device will obtain its revenue from two different sources. The first one would be from selling the product to mobile phone companies and the second one would be the commercialization of a patent of the device itself.

## 7.5.2 SWOT analysis

Based on the proposed concepts and our defined business model, we executed a SWOT analysis of our project.

**Strength** usually refers to the aspects that our product exceeds the equivalents from other opponents. However, our product is the first in the market, so here "strength" means how the innovative idea might bring new experiences to customers in a different way from traditional ones. Because the principle of the power generation is based on vibration, it is considered as a green device and an effective alternative for energy supply. As smart cell phones are increasingly used, people are eager to recharge the batteries with the help of the device once running out of power. Anyway, it can be considered as an accessory of shoes, hence, it is portable and simple. Moreover, since our group is composed of six young members, all of whom are optimistic and enthusiastic, it is fresh and full of energy to face any challenges.

**Weakness** is the negative but inevitable element that we have to clarify during the entire procedure. The energy generated by our product is low due to the limited space and low frequency of vibration for power generation. As the device is attached to shoes, sometimes it would be fragile under harsh environment. Besides that, our product may be expensive so that some people may not willing to pay for it. Since our product could be directly sold to big companies, we lose the intimate contact with customers. More importantly, we have no money to guarantee that our company would operate smoothly.

**Opportunity** is the chance or potential advantage which we may gain. Obviously, we can apply for several patents according to those creative ideas or methods during the design process. As big companies are the key partners, it is prone for us to establish good association with them. Consequently, we can benefit from the potential cooperation. Once we have our own brand and certified intellectual property, we could broaden our market.

**Threats** are factors that may undermine our company's profits as follows: firstly, since we are the first one to realize the conceptual design and put it into market, it is possible that no customers are willing to buy the product. Secondly, it would be difficult for our company if any competitors show the same results or even better. Finally, the complicated device might fail in being produced as expected.

### 7.5.3 Risk management

The threats identified, are the risks our projects must manage. We analyzed severity and frequency.

**Risk 1 - No costumers:** Given our inexperience in the market we assume this risk is possible and its severity is catastrophic. We decided to avoid this risk by performing a users survey that should show us (before starting the actual production of the device or even the prototype) whether people are willing to use and /or pay for a device like the one we are projecting. Results of the survey are shown in the next section (market research). Anyway, some risk persists, so we planned to partner with a solid cell phone company that already has presence in the market and an image people trust; consequently transferring the risk to them.

**Risk 2 - Better competitors:** This risk may have an important severity, but from the benchmarking we conclude that is unlikely to happen. No counter-measure is taken, the risk is assumed.

**Risk 3 - Production problems:** We think this risk has a medium probability of occurrence, but a high impact in costs and time to market our product. We decided to transfer this risk, delegating the manufacturing of our device to a third party company.

### 7.5.4 Market research

We interviewed people in the streets of Vienna, Austria. One hundred questionnaires were filled by men and women from which 52% were male and 48% female. Some 60% were aged between 16 and 26, 30% aged between 27 and 36 and 10% were between 37 and 46 years old.

The first interesting result is that everyone of the interviewed people has at least one phone, and in second place, that the majority (more than 2/3) possesses a smartphone. This is significant for our project, because smartphones are much more power-greedy than regular phones, consequently needing more frequent battery rechargements. In fact we found out that 83% of the smartphone owners are willing to buy a device to be able to recharge their phone anywhere at any time,

in contrast with only the 60% of owners of regular phones that will pay for this kind of device.

When asking how much money people are willing to pay to have this device, 35% were willing to pay up to 10 EUR, 36% up to 30 EUR, 5% up to 50 EUR and 2% up to 100 EUR. Some 22% of the interviewed are not willing to pay extra money. However, as the device is not yet in the market, is difficult for the general public to precisely evaluate money figures, this question was just intended to have a general idea.

## 7.6 Summary

During our project we discussed very much about our idea and researched among all similar devices. Moreover we searched for useful ways in order to generate electricity from movement, among many of them we choose two physical concepts, vibration and piezoelectric. We also interviewed about 100 persons to realize whether our prototype is practical or not. Eventually, we conclude that we have a very interesting and actual idea about portable chargers. To launch this project, we need to get in contact with potential investors, banks, and organizations (e.g. those who help start-ups), that can help us with the initial steps of starting a business and provide money. It is also necessary to seek the contact to those companies that are interested in our device. It is thus necessary to arrange meetings with cell phone companies and producer of devices for mobile phones.

## Chapter 8

# Crab-parking: a smart, auto-parking system

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*Keywords: Parking system, Big toe*

### **Abstract**

The aim of this project is to develop a smart auto-parking system to solve the problems of parking a car in big cities of China. We call the system "crab-parking". We have added one extra wheel, named big toe, into the car to make it move horizontally to finish the parking. Our main focus is the Chinese market. SWOT analysis and six thinking hat methods turned out to be a good approach to further develop our idea.

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## 8.1 Introduction

With the increasing number of cars, it is becoming more and more difficult to find a space to park a car, especially in some big cities in China. According to the Beijing Traffic Administration Bureau, the total number of vehicles in Beijing was already 5.04 millions in March of 2012 but the legal parking space is less than 2.5 million. Parking a car in the relatively small parking slots in Beijing requires lots of skills and experience. It may take about 3 minutes to finish the parking; and even more time will be spent when parking a car in downtown Beijing. Some hotels and restaurants employ people to guide guests to park cars; salary of those parking guides is up to 250 EUR per month. Private parking areas are rare and very expensive. A usual parking process requires much fuel, since a lot of braking, starting and driving activities are involved. To solve these problems and to make parking easier, we came up with three ideas for parking a car:

**Crab-parking:** The idea is that we can make the four wheels of a car turn 90 degrees. When parking a car, it could just move horizontally like a crab, that is why it is called crab-parking.

**Moving floor:** Moving floor is used in parking area, when one stops his car on this moving floor, it will move horizontally to help you complete the side-parking.

**Big toe:** The "Big toe" is an additional wheel which is installed horizontally in the middle of the back wheels. It will retract in the car and won't touch the ground when you don't use it. When you activate it, it will move down and touch the ground, making the back wheels go up and leave the ground. Since the "big toe" is installed horizontally, it can help the car to move horizontally to finish parking.

## 8.2 State of the art

### 8.2.1 Market analysis

We have designed a questionnaire with 4 questions to survey the needs of customers and market.

We confronted people in Beijing and Vienna with the following four questions:

1. Do you have any troubles when you try to park your car in rush hour? (yes/no)
2. Which car is the most difficult to park? (MPV/SUV/Van/small car)

3. How much time do you spend for side-parking? (10secs/10-60secs/1mins-2mins/2mins-3mins/3mins-5mins/≥5mins)
4. Would you pay extra money for a smart parking system? (yes/no)

The results of the survey show that drivers from Beijing have more parking troubles than people in Vienna and they are more willing to pay extra money to buy a car with the smart parking system. We can conclude that big cities like Beijing in China are key markets. The survey result also indicates SUV is the most difficult car to park. So we plan to develop a smart parking system with Chinese SUV leading manufacturer Great Wall Motor to make their products more competitive in China.

### 8.2.2 Competitors analysis

There are three main products in the market to solve parking problems.

**Intelligent Parking Assistant (IPA):** It is a semi-automatic Intelligent Parking Assistant system installed on cars like the Lexus LS460L or Benz B-200. The system uses ultrasonic sensors to detect parking spaces, and can combine cameras to identify the stop line. The system is not only capable of measuring the length of the parking spaces, but also provides motorists with the best parking proposal. The drivers just need to confirm the target parking space on the display and control the speed of less than 4 km/h. The vehicle will adjust the steering angle to help the driver park into the target location. The IPA system automatically ends the operation when the vehicle is parked in the parking space. There are some disadvantages in the IPA system. The operation of IPA system is complicated. Although the automatic parking system uses intelligent control to park the car into specified position, and drivers need to follow technical procedures that are somewhat complicated, and spend more time to park a car. Furthermore, this system is quite expensive. The average price of this device is 2000 EUR and it is only used in some luxury cars.

**Dimensional garage:** It is a mechanical garage which is used to store vehicles. The garage is controlled by a electronic device. The driver only needs to stop at a certain position, then the garage will move the car to the right place. It should be said that the mechanical garage can really save a lot of parking space. But in China, the proportion of this dimensional garage is only 2% to 3%. We have concluded 3 reasons for it. First of all, if you consider the land price in the city's area to build this large dimensional garage, then it is not economic. Using this garage means that drivers may have to pay more money for the parking, compared with normal parking area. Many drivers will not choose to use it. Secondly, the owners of the cars may need to wait



for a long time before they can get back their cars. Thirdly, some drivers worry about the chassis and tires, they may suffer when touched by the steel structures. Because of these reason many people choose not use this service.

**Concept car:** The Japanese industry brand NTN (New Technology, Network), has released a car allowing a 90-degree rotation of the tire. The car is currently exhibiting a variety of performance tests. The mechanisms also allows the tire to a 45 degree angle tilt, to swivel body, so the car can easily turn around in a narrow space. This concept is similar to our idea of crab parking. We think the biggest challenge is that this idea will change the structure of the vehicle a lot. Some changes may definitely have side-effect on normal driving.

## 8.3 Methods and tools

From the three possible technical solutions, and after applying the six thinking hats and SWOT analysis, big toe was selected to be the option with the biggest market. The following sections explain the results and thought process to get to this conclusion, and give insight on the market for such a business.

### 8.3.1 SWOT Analysis

In order to predict the strategic position of our product in the market, we choose the SWOT analysis. The analysis helps us to dedicate our product possibilities and drawbacks to make better decisions concerning strategical positioning, financial risks and technical problems.

- Strengths:
  - A new parking idea.
  - More parking reliability.
  - Large potential market needs.
- Weaknesses:
  - The cost of studying and test is high.
  - The complicate systems, including software, mechanical structure and materials.
  - The reliability of the sensors.
  - The communication with engineers and sponsors.

- Opportunities:
  - Market drivers: limited parking space and increasing cars.
  - Drivers who often face difficulty to park their car.
  - Avant-garde crowd who would like to try new designs.
  - Adding market competitiveness to companies with limited parking spaces.
- Threats:
  - Cooperative risks.
  - Crash with other cars, mechanical or software failure.
  - The accuracy of sensors is not reliable.

### 8.3.2 The six thinking hats

With the application of the six thinking hats, more details can be listed and taken into account, thus helping us to further study what, when and how to put our idea into product and join the market.

**White hat:** gathering data, facts and questions:

- The quantity of cars in Beijing and Tehran.
- The quantity of parking space in Beijing and Tehran.
- The average time of side-parking time in Beijing and Tehran.
- The average cost of parking in Beijing and Tehran.

**Black hat:** listing negative things or threats; logically killing ideas.

- Electromagnetic sensors need a slow movement of the car.
- The time to put down the "big toe" and lift the car should be carefully calculated.
- Reliability of the sensors.
- Colliding with other cars during parking.
- Possible problems with mechanical or software failure.
- There is no guaranty that people will be attracted and pay the additional expenses for the system.
- Help from the government is not guaranteed.
- Competitors with similar ideas.

**Green hat:** creative points or new ideas.

- "Big toe", an automatic and moveable wheel, is installed horizontally between the two back wheels and shall be used to lift the car and ease parking.

- Electromagnetic parking sensors and ultrasonic sensors are chosen; four are installed at the back of the car and others are uniformly distributed at the other three side.

**Red hat:** feeling about our idea and product

- Amazing, cool, exciting, positive.
- Making parking enjoyable and comfortable.

**Yellow hat:** the positive statement on our amazing product, logical.

- The short supply of parking space makes our product attractive, which will help us to get the time value of money and then we get the greatest possible use of funds.
- Discounts for large companies will help to keep our big clients.
- The government interest will be attracted by the fact that our systems help to save space in cities.

**Blue hat:** process based on strict scheduled time.

## 8.4 Concept description

### 8.4.1 Big toe dimension

The size of the big toe has to be adapted to the car it is installed on. For a typical SUV car for example, with tire specifications of 235/70 R16, a big toe with specification 235/70 R17 will be appropriate.

The wheel is made of rubber. Radial tires can contribute to a better control of the car, so the design of stabilizing ply of the wheel is important. It must have good flexibility, and be made of a fibrous material with good mechanical characteristics.

A benchmark with existing tires show that, for the example of a SUV car, the weight of the big toe will be around 10 kilograms. The Big toe will be placed in the middle of the two back wheels of the car.

### 8.4.2 Big toe function

For the proper working of the system, a radar detector is installed. The radar will measure the distance and the angle between itself and the objects around. The necessary operations to park the car will be calculated by the digital system in the car. Big toe is able to adjust the direction of the car; the driver only needs to control the speed of the car. The big toe system will be activated manually by the driver.

To lay down the Big-toe, a pneumatic transmission system is needed. When the driver pushes the button, pressurized gas activates the system and generates the needed mechanical energy to lift the car. The advantages of this pneumatic transmission system are the following:

- The working medium in this system is air, which is easy to get and can be released directly to the atmosphere; it is easy to handle.
- The viscosity of air is smaller compared to liquid, so the loss of energy is less. Also it is not necessary be concerned about transmitting lead content into environment.
- The system has high adaptability. It can work normally in the circumstance of flammable, explosive, dusty, strongly magnetic, or vibrating environments.
- In comparison with a hydraulic transmission system, this system does not need a single hydraulic source and a liquid backflow system. Furthermore, this system is not vulnerable to liquid leakage. Additionally, the accuracy of hydraulic components is not high, so there is no justification to worry about the deterioration of the working medium.
- When compared with battery-based system, pneumatic system are more durable and lower in price.

### 8.4.3 Crab-parking software

The software of Big-toe is the key control part of the system. When the control button is pressed, the parking procedure is activated. The sensors start to work, information is collected and is sent to the core processor which is embedded with an intelligent algorithm. The software will output the dynamic pictures and the best parking route will be displayed on the screen. If the driver confirms the parking, the software will send commands to lay down the Big-toe wheel. After this movement, Big-toe begins to roll at low speed until the car gets in the predicted position. When parking is finished, Big-toe will be hidden.

### 8.4.4 Test and experiment

To test our system, we need to team up with a car manufacturer which has the appropriate systems. We will choose a SUV car to firstly install our system on, because we believe that those kind of cars are particularly difficult to park due to their size and dimensions.

The tests include normal performance tests (speed test, accelerate test, brake test, climb test and so on), operation tests, software tests and big toe tests. Some damage experiments should be done to show the reliability of the car carrying a Big-toe.

### 8.4.5 Parking sensors

Parking sensors are proximity sensors for road vehicles which can alert the driver to unseen obstacles during parking manoeuvres. The whole system is sometimes referred to as Park Distance Control. Parking sensors generally fall into two categories: *electromagnetic* and ultrasonic.

Electromagnetic parking sensors rely on the vehicle moving slowly and smoothly towards the object to be avoided. Once the obstacle barrier is detected, the vehicle will momentarily stop on its approach, and the sensor will continue to give signal to show presence of the barrier. If the vehicle then resumes its manoeuvre an alarm signal gets triggered, and becomes more and more intense as the barrier approaches. Electromagnetic parking sensors are often sold as not requiring any holes to be drilled, offering a unique design that discretely mounts on the inner side of the bumper preserving the 'new factory look' of the vehicle.

Ultrasonic parking sensors, also known as transceivers, both send and receive signals. The ultrasonic sensors are currently available in several brands of cars, with a variety of brand names such as Parktronic and Parking Aid. Some systems are also available as additional upgrade kits for later installation. In our paper, we will refer to ultrasonic parking sensors only. Parking sensor systems use ultrasonic proximity detectors embedded in the front and/or rear bumpers, to measure the distances to nearby objects at low level. The sensors measure the time taken for each sound pulse to be reflected back to the receiver.

Depending on the speed of the vehicle and the distance to an object, the system will warn the driver by visual and/or audible means about the risk of collision. The feedback to the driver will generally indicate the direction and proximity of the object.

Rear sensors are activated when reverse gear is selected and then deactivated as soon as any other gear or neutral is selected.

Front sensors are generally activated by pressing a button and then automatically deactivated when the vehicle exceeds a certain speed; this is to avoid nuisance warnings in slow moving traffic.

The most common form of feedback to the driver in a car with parking sensors is audible "beeps" or tones. Generally, the frequency of the beep indicates the distance from an obstruction; with the beeps becoming faster the closer the vehicle moves to an object. A continuous tone may be heard when the vehicle is extremely close, often warning a driver to stop immediately to avoid collision.

Some systems use visual aids additionally or instead of audible tones, such as LED or LCD readouts to indicate the distance from an object. The direction and

distance to the object is indicated by the location and strength of the warning symbols.

Since the system relies on the reflection of sound waves, it may not detect some items that are not flat or large enough to reflect sound, for example a narrow pole or a longitudinal object pointing directly to the vehicle.

Some objects such as skips (UK) or dumpsters (USA) may have flat surfaces that are angled from the vertical. These objects can behave in "stealth mode" by deflecting the return sound waves away from the sensors causing them not to be detected.

Ultrasonic sensors, being exposed to the elements and not being solid-state devices, frequently do not last the life of the vehicle and may require replacement after a number of years. Most PDC systems have a fail-safe mode which detects a malfunction and alerts the driver that the system is not working and that he/she should not rely on it when reversing. Typically this is done with a long continuous tone as soon as reverse gear is engaged.

The ease of replacing sensors varies; on some vehicles the rear fender (bumper) needs to be removed and the sensors may also require spray painting to match the rest of the car, making this an expensive proposition. On other cars the sensors are mounted on a separate piece of black trim which can be easily removed for maintenance.

Although the sensors are ultrasonic and the majority of their output is beyond the range of human hearing, it is possible to detect a completely failed unit by putting the vehicle into reverse gear (with the ignition on, but, for safety, without starting the engine) and listening closely to each of them. A working sensor makes a rapid clicking sound; a sensor that does not click, or is noticeably quieter than the others, is likely to be the cause of a malfunctioning PDC system .

## 8.5 Detail description

In the following paragraphs key insights are presented for the better understanding of our idea. We developed the idea by using SWOT analysis, Business Model Canvas and Six Thinking Hats.

### 8.5.1 Business Model Canvas

Through business models canvas, we can create a better understanding of the idea detached from emotional aspects and put our conceptual idea into business.

- Value Provided:
  - Safe parking.
  - Time and fuel saving.
  - Parking space saving.
  - Turning round easily.
- Customers:
  - Drivers.
  - Car companies.
  - Cities with limited parking space.
  - Governments.
- Customer Relationships:
  - The relationships with customers should be described as "warm", which means their needs will be carefully understood and realized with our product.
  - Personal assistance will be available through local representatives or certain websites.
  - Communication platforms will be created, allowing people to talk with technical engineers or car companies.
  - All feedbacks will be seriously analyzed to improve our product.
- Channels:
  - Shown and installed in reference places.
  - Available to mechanics for installation, and for car manufacturers for it to be available since the car is sold.
  - Advertisement on some selected television channels, video, magazines and newspapers.
  - Billboard on crowd parking space.
  - Web media to communicate, sell and get feedback.
  - Promotion in car companies or parking space.
  - Models exhibition.

- Key Activities:
  - Research of the structure of car.
  - Automatic jack.
  - Functional sensors.
  - Control software.
  - Structure design.
- Key Resources:
  - Technical engineers, including automotive, computer, structure and economical engineers.
  - Government support.
  - Social investor.
- Key Partners:
  - Parking companies.
  - Material supply companies.
  - Sensor manufacturing companies.
  - Software companies.
  - Governments.
- Costs:
  - The cost of special materials and sensors.
  - Tests and experiment.
  - Advertisement.
  - The cost for website building and maintaining.
  - The salary of the engineers.
- Revenue:
  - 10% of the car's price for personal or 8% of the car's price for large companies.
  - The government reward for saving parking space to city construction.



### **8.5.2 Marketing Plan**

Our product is a high-tech product which demands high-end solutions. Based on the 4P's method, we have established our marketing plan. Product awareness should be carefully built. We will create two platforms, one is digital marketing and the other is physical marketing.

As to the former, a website will be built to take advantage of the possibilities that digital marketing offers. Advertisement will be released on the website and will be linked to web media (online magazines and newspapers). Other mass media should be properly used, such as selected TV channels, radio and direct marketing shots. At the same time, interactive features can be realized on the website communication platform. This will help to understand what our customers think about our product and how we can improve it and gain the trust of our customers. As to the latter, we will provide model cars, which offer direct experience to customers in car stores/points. To expand the social marketing, we will also hold lectures and conferences in parking spaces, associations and companies through PR.

## **8.6 Summary and outlook**

Through the project we understood that the same product may have completely different markets in different countries. In China, parking is a serious problem and people need a smart parking system more than people in Europe. So there is no question that big cities in China are our key market. We have to grasp this market. In a first step, we will seek cooperation with Chinese car companies. We believe that people's driving habit will change significantly once Big-toe is installed on a car. The experiences from the Chinese market can then be used to entrance other markets and to approach more car companies and different types of cars.

# Chapter 9

## EcoRay

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*Keywords: Exploration, Manta, Ocean, Oil*

### Abstract

In the last few years the world has suffered from several oil spill incidents. The most famous is the "DeepWater Horizon" oil spill in the Gulf of Mexico in 2010 which is the largest accidental marine oil spill in the history of the petroleum industry. Eleven men working on the platform were killed and seventeen were injured. The spill caused extensive damage to marine and wildlife habitats and to the Gulf's fishing and tourism industries.

In our project we develop the idea of "EcoRay", a company that is specialized in locating and tracking oil spills all over the world using MOSD1000, an unmanned underwater vehicle that resembles the manta ray in shape. It utilizes bio mimicry and technological advancement in the robotic industry.

The company's vision is to protect the oceans from oil spill damage and to facilitate oil spill removal, keep the oceans clean and explore the oceans.

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## 9.1 Introduction

With the increased consumption of oil in the world today comes an increased need to drill and produce more oil. Inevitably, a result will be more oil spills and the increased need to map and track these oil spills, especially when oil companies use detergents to disperse and sink the oil. The oil spill clouds produced by these detergents in the deep sea threaten ocean wildlife and cause unknown damage to the environment. This is the genesis of the need for the EcoRay.

## 9.2 State of the art

### 9.2.1 Previous Autonomous Underwater Vehicles (AUV) and Remotely Operated Vehicles (ROV)

The following sections describe different AUVs and ROVs that currently exists, which could be considered inspiration or competition for the product at hand.

#### *Sentry*

Sentry carries a superior science sensor suite and enjoys an increased science payload enabling it to be used for both mid-water and near-seabed oceanographic investigations. Sentry produces bathymetric, sidescan, subbottom, and magnetic maps of the seafloor and is capable of taking digital bottom photographs in a variety of deep-sea terrains such as mid-ocean ridges, deep-sea vents, and cold seeps at ocean margins. Sentry is uniquely able to operate in extreme terrain, including volcano caldera and scarps<sup>1</sup>.

#### *Seaglider*

Seagliders fly through the water with extremely modest energy requirements using changes in buoyancy for thrust coupled with a stable, low drag, hydrodynamic shape. Designed to operate at depths up to 1.000 meters, the hull compresses as it sinks, matching the compressibility of seawater<sup>2</sup>.

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<sup>1</sup><http://www.whoi.edu/main/sentry>

<sup>2</sup><http://www.apl.washington.edu/projects/seaglider/summary.html>

Parameter	Value
Depth capability	4500m
Dimensions	Length 2.9m; Width 2.2m; Height 1.8m
Weight	1250kg (2750lb) without extra science gear
Operating range	50-100 km, (27-54 nautical mile) depending on speed, terrain and payload
Operating speed	0 – 1.2m/s (0-2.3 knots)
Propulsion	4 brushless DC electric thrusters on pivoting wings
Energy	Lithium Ion batteries, 13kWh
Endurance	up to 24h survey time
Recharge time	10h
Descent/Ascent speed	~ 40/55m/min, 2400/3300m/hr (7800/11000ft/hr)

**Table 9.1:** Specification of the Sentry

Parameter	Value
Body size	1.8m
Diameter	0.3m
Wing span	1m
Maximum depth	1000m
Maximum range	4600m
Glide angle	16 – 45
Batteries	Lithium primaries, 24V

**Table 9.2:** Specification of the Seaglider

Parameter	Value
Diameter	20cm
Length	213cm
Weight (Dry)	52kg
Buoyancy	0.4kg
Dive Angle	18 – 25
Depth Rating	1.500m
Endurance / Range	Up to 6 months/4.800km
Speed	Variable, 19 – 35cm/sec typical
Energy	17.5MJ of total energy; Lithium primary batteries
Propulsion	Hydraulic buoyancy pump
Navigation	Compass, GPS and depth sensor; Way-point boundary navigation

**Table 9.3:** Specification of the Bluefin Spray Glider

### *Bluefin Spray Glider*

The Bluefin Spray Glider is a deep-diving, buoyancy-driven autonomous underwater vehicle. The Spray collects water column data profiles using a pumped, conductivity-temperature-depth (CTD) sensor and other instruments. Deployments of up to 6 months can be achieved with a single set of batteries<sup>3</sup>.

## 9.2.2 Biomimicry

### *AquaRay*

Analysis of various types of movement through water has established that rays are perfectionists in submarine ‘flight’ and gliding. The up-and-down motion of their flanks in water closely resembles the flapping of a bird’s wings in the air. This wavelike movement perfectly combines maximum propulsion with minimum energy consumption. The streamlined form lends graceful movement to the manta ray, in particular, and makes it a veritable submarine acrobat.

AquaRay is a remote-controlled fish with a water-hydraulic drive unit; its form and kinematics are modeled on the movement patterns of the manta ray<sup>4</sup>.

Bionic fluidic muscles serve as actuators. These largely consist of hollow elastomeric tubes with integrated woven aramide fibres. When the fluidic muscle is

<sup>3</sup><http://www.bluefinrobotics.com/products/spray-glider/>

<sup>4</sup><http://www.festo.com/rep/en/corp/assets/pdf/Aqua.ray.en.pdf>

Parameter	Value
Overall length	61.5 cm
Dry chamber	41.0 cm
Overall width	96.0 cm
Dry chamber	31.0 cm
Height	14.5 cm
Weight	10 kg
Torso	fibreglass-reinforced plastic
Maximum speed	1.8 km/h
Minimum flight duration under full load	30 min.

**Table 9.4:** Some technical data on the AquaRay

filled with air or water, its diameter increases and it contracts longitudinally, giving rise to smoothly flowing elastic movement.

### 9.3 Methods and tools

To get to our initial product idea, we made use of the six thinking hats, as is presented in Section 2.4. Afterwards we analyzed our idea and analyzed our choice of model. That is why we tried inverted thinking to find out if the choice of form was optimal for the task. We analyzed the problem by starting from the service we wanted to provide; we discovered that a manta has a very good shape when the fluid resistance and surface area of the sensors is considered<sup>5</sup>.

One of the assumptions of our service was that people would know or even care about the product. To validate this assumption we sent two of our German speaking (lower threshold) group members onto the street to ask normal citizens some of these crucial questions. The survey gave us positive feedback considering our assumptions.

### 9.4 Concept description

The EcoRay distinguishes itself from its competitors by using energy efficient means of diving and moving. Propulsion is achieved through the use of biomimetic characteristics of the movement of the manta ray. The EcoRay does not use a propeller. Some of the advantages of this design are that it will not get stuck in the oil cloud and that it will need significantly less energy for its movement. For diving, the manta will make use of a synthetic equivalent of spermaceti oil; a fluid that

<sup>5</sup><http://www.mantatrust.org/threats/natural-predation/>

Parameter	Value
Weight	180 kg
Wingspan	2m
Length	1,2m
Height	0,3m
Maximum speed	14 kph
Max flight duration	24h
Density of spermaceti@30C	857,3 kg/m

**Table 9.5:** Specifications

changes density as the temperature changes, thus you only need a heating element to regulate the depth. As you cool the fluid it will change state and becomes a solid; the density rises and the dive of the manta will be completely passive (e.g. a brick). As soon as you reach the right depth, the heating element will kick in and the manta will stay stable at that depth<sup>6</sup>.

By using this kind of diving method we are able to use a lot less energy than the other available technologies. As a consequence of the lower power consumption, the manta is able to stay underwater for longer periods of time and will be able to map the oil cloud faster than currently possible.

For the detection of oil, the manta will use a fluorometer<sup>7</sup>. Since this kind of detector requires the oil to pass through it, the manta will move in a spiraling movement around the bulk of the oil cloud. The speed of the mapping process can be further reduced by using multiple mantas in a swarm.

Our service is the tracking and selling of live detailed maps of oil clouds. These maps are consequently sold to a partner company which specializes in oil recovery. Since the oil companies need to pay 150 million dollars as a premium to insurance companies, we could negotiate with the oil companies to recover the oil for them together with our partner company so they would save money on insurance costs. Otherwise we could also negotiate with the insurance companies to clean the oil for them at a lower cost than they would have if they were to clean up the oil themselves.

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<sup>6</sup>"Physical properties of spermaceti oil in the sperm whale", Malcom R. Clarke; mar.biol.ass.U.K (1978)58, 19-26. [http://sabella.mba.ac.uk/2029/01/Physical\\_properties\\_of\\_spermaceti\\_oil\\_in\\_the\\_sperm\\_whale.pdf](http://sabella.mba.ac.uk/2029/01/Physical_properties_of_spermaceti_oil_in_the_sperm_whale.pdf)

<sup>7</sup><http://www.tech-faq.com/fluorescence-spectroscopy.html>

## 9.5 Detail description

### 9.5.1 Business model

The business model would be as presented below:

- Key partners:
  - Universities.
  - Software companies.
  - Environmental groups.
  - Public.
  - Bionic learning Network.
  - Recovery Firms.
  - Insurance Companies.
- Key Activities:
  - Oil spill mapping & tracking.
  - R&D.
  - Demonstrations & Expositions.
  - Maintenance.
  - Marketing & Sales.
  - Raising Public Awareness.
- Value Proposition:
  - Oil spill mapping&tracking.
  - Ocean life exploration.
- Customer Relationship:
  - Demonstrations.
  - Expositions.
  - Conferences.
  - Business to Business.
- Customers:
  - Oil companies.
  - Insurance Companies.



- Key Resources:
  - Time.
  - Money.
  - Human Resources.
  - Software Engineer.
  - Biological Engineer.
  - Database/Server.
- Channels:
  - Business to Business.
  - Active contact.
  - Internet.
  - Expositions.
- Costs:
  - Salaries.
  - Operation costs.
  - Maintenance.
  - R&D.
  - Prototype.
  - Public Relations.
  - Workshop+Base.
- Revenues:
  - Selling the service of removing the oil spills.
  - Selling gathered information.

We will offer our service to the Insurance companies, who offer insurance for oil spill clean ups. Our service will allow them to make a profit without requiring them to do any work themselves. We will approach the insurance companies with our service and will try to acquire a subcontract with them. Of course we also offer our service directly to the oil companies for oil spills which they did not get insurance for.

### 9.5.2 The Challenge

The MOSD has the purpose of detecting and mapping deep sea oil clouds. We will provide detailed maps of oil clouds to oil companies and environmental organizations. We are the only company addressing this deep sea spill issue currently, and we want to remain the major stakeholder by innovating ahead of potential future competitors. Within 3 years from start of development we want an MOSD1000 in commercial operation, mapping oil spills and removing them with the help of an Oil Removal Company.

### 9.5.3 Situation Analysis

#### *Company Analysis*

**Goals:** Build one working MOSD1000 within 3 years and arrange a product demonstration in the Gulf of Mexico within 3 months after completion of the prototype. Furthermore we should establish our promotion channels by the end of the first working year. These channels include a website, videos on youtube and 2 or more publications in science magazines, which will make us known to the broader public, as well as influence the public awareness of oil clouds. Within the first working year we want the National Geographic Company to develop a feature film or television series based on our Company and our work mapping deep sea oil clouds and removing them.

**Focus:** Our main focus is tracking oil clouds and mapping their size, location and movements and to give the information to our partners to remove the oil. A secondary focus is gathering oceanographic data in order to further explore the ocean. In addition to our tracking focus, we need to focus on raising public awareness of the crisis of the deep sea oil clouds.

**Strengths:** We are a multicultural engineering company that consists of 5 international students possessing multidisciplinary outlooks on technological solutions. Since we are a startup company, we are adaptable to oncoming challenges and able to make changes quickly.

**Weaknesses:** Since we are a new startup, we do not have much experience producing products, especially in the oceanographic area. We also require high initial capital, and have limited resources pooled initially.

### *Customer Analysis*

Our potential customers consist of 6 Oil companies (British Petroleum, Royal Dutch Shell, Exxon-Mobil, Chevron, Total and Conoco-Phillips) and Insurance Companies (who offer insurance for oil spills - these are our main customers) Because of public awareness of the deep sea oil clouds, oil companies will want and possibly need our product in order to:

- Increase their public image.
- Meet government mandated oil clean up requirements.
- Recover the spilled oil (1 Million Barrels of oil alone, still in the Mexican Gulf).

Meanwhile, the environmental protection organizations are working to increase the public awareness of oil spill damage and to accurately map the damage.

Currently oil companies do not have a large incentive to map and clean oil spills, but when public awareness increases, they will have to polish their image. Also, when they become aware of the money floating in these clouds of oil, they will have a large incentive to recover the oil.

### *Competitor Analysis*

**Market position:** We do not have competitors yet, so we can form the market.

**Strengths:** Because there are no competitors, we do not have to position ourselves in a unique position.

**Weaknesses:** Because there are no other competitors, there is not currently a large market, but it is developing.

**Market shares:** Some other companies are providing an oil spill detection system (slick guard oil detections buoy). But these can't move around and are only able to do static detections. Thus, they are not a true competitor, and we hold the entire market share.

### *Collaborators*

We have the potential to collaborate with universities, environmental organizations, the public and investors. Universities and environmental organizations will be able to provide knowledge and are potential funding sources. The public will be used to increase pressure on oil companies to clean the deep sea oil clouds, and investors are essential as a source of funding.

Our two main collaborators will be an oil removal company, which will use our information in order to remove the oil we find and a company who has established the "Bionic Learning Network", which works on biomimicry of animals, especially that of a manta.

### *Environment*

The results of the macro-environmental PEST analysis:

**Political and legal environment:** The legal issues of Unmanned Underwater Vessels (UUV) are diffuse as the definition of 'vessel' has wide interpretations. One important part of defining a vessel is its purpose of transportation. As our product just carries sensors, and not military devices for example - the regulations for vessel are not imposed on us. However the boat operating the remote control will have to fulfill the regulations of the The International Regulations for Preventing Collisions at Sea (COLREGS). Another regulation that has to be taken into account is that in international straits and archipelagic sea lanes research or survey activities have to be in consent of bordering nations.

**Economic environment:** The oil sector is feeling the effects of the current economic crisis, and as such has canceled some research projects. This could pose a problem to our product, however our product is set to be relatively inexpensive.

**Social and cultural environment:** The current trend in the public is an increase in environmental awareness. By utilizing and fostering this awareness, we can help the oil companies realize the need for deep sea oil cloud cleanup.

This we confirmed by conducting a survey on the streets. We asked the following questions:

1. Are you aware that an oil cloud of 1 Million barrels is floating around in the Gulf of Mexico?
2. We are working on a project to map out these oil clouds and to cooperate with firms to retract it out of the water. Would you be willing to support this project socially?
3. Would you be willing to support this project also financially?

The results of the survey were very supportive of our cause. Question 1 was answered with Yes by 70%, Question 2 was answered with a yes by 95% and Question 3 with a yes of 75%

**Technological environment:** Currently, our biomimetic concepts are the most innovative in the market. In this aspect we have a strong vantage point, because we are able to go where no robot has gone before. Recently some researchers discovered massive clouds of dispersed oil up to 48 km long by 11 km wide and approximately 30 m thick. The National Oceanic and Atmospheric Administration (NOAA) has started projects to measure the impact of these clouds on subsea ecosystems. Because of this higher interest we might possibly be able to get the NOAA to hire our services.

### *SWOT Analysis*

A SWOT analysis of the business environment can be performed by organizing the environmental factors as follows:

**Strength:** Our service is relatively inexpensive compared to current exploration products on the market and our competitors are nonexistent. As public awareness of the problem of oil clouds grows, so will our potential market. We are also an innovative startup company that has access to university research and projects.

**Weakness:** Since we are a high-tech company, we have a high initial capital cost for research and development, and we are a new company with limited initial knowledge and limited resources.

**Opportunities:** We have an opportunity to increase public awareness of the deep sea oil clouds, which will increase our market potential. In future, we can expand to new markets such as oil spill cleanup, military applications and oceanography. Along with this oceanography, we can discover new resources, creatures and treasures.

**Threats:** We have several threats to our business, placed here in decreasing risk: Small size of the market (coupled with public apathy), competition from software developers, technical failures, the worldwide financial crisis, and dangers present in the deep sea.

## 9.5.4 Market Segmentation

### *Oil Companies*

Oil companies are companies that drill for oil, specifically those involved in deep sea oil drilling. We predict that oil companies will constitute 20% of our market. Oil companies need our product in order to meet government mandated cleanup regulations, increase their public image, and reclaim the spilt oil. They will receive

an accurate and periodically updated three dimensional mapping of the deep sea oil clouds. For us to deliver this service, we will need to regularly update the maps. We reach the oil companies through active business to business sales, i.e. we will travel to their business to sell our service. The oil companies are not price sensitive.

### *Insurance Companies*

Insurance Companies (the other 80% of the market) are now offering an insurance premium for oil spills. This premium is approximately \$4280 for each barrel of oil that is spilled into the sea. By offering our service to the insurance companies, they can make a profit of \$1280 per barrel spilled into the sea, without having to do any work themselves. We will try to establish cooperations with these companies, so that when any oil spills need cleaning up we automatically get the contract from them. This way we hope to secure a steady stream of contracts and income for us.

## **9.5.5 Marketing Strategy**

### *Product*

Product decisions should include:

- Product name: MOSD (Manta Oil Spill Detector)
- Quality: Very high
- Biomimicry: manta-like movement and fluid trimming of depth make up for higher maneuverability and higher energy efficiency
- Long work-time under water, because of high efficiency will result in a faster execution
- Price: should be under 100.000 USD for the first working model and maintenance cost should be as low as 40.000 USD/year. A small risk assessment shows that a breakdown during operations would cost about 62.500 USD in lost revenues. To reduce these risks the components have to be very durable.

### *Service*

- Value to Consumer: 1.280 USD per barrel of oil removed from the sea cloud.
- Cost to Consumer: 3.000 USD per barrel of oil removed from the sea cloud.
- Customer use: The customer saves money through us and they drastically improve their tarnished image
- Competitors: There are several companies in the market of oil removal, but they are all potential partners as well.
- Maximum cost to us: 6.000 USD per 24 hours of operation
- Name: EcoRay

### *Pricing*

- List price: 3.000 USD per barrel of oil removed from the sea
- Payment terms: 50
- Financing options: Monthly payments (but at a slightly higher price)

### *Distribution (Place)*

- Buyers will not look for our products, we will come to them. Since our potential customer base is so small, we have the time and the need to approach them to sell our service.
- We do not have channels to distribute, we will be the distribution channel.
- We will need to have sales representatives who go direct to our customers. They will also attend trade fairs (though none exist for our specific product) and will need to make demonstration videos of our product in operation.
- We do not have direct competitors, but we can learn from companies that currently clean up oil spills, also learn from other spill mapping companies, though they have slightly different markets.

### **Promotion**

- For the service we offer, direct marketing is highly important. Therefore we will address companies directly and give a short presentation via a phone call. This however will only happen after we have already tested a beta version by a small company that is not necessarily one of our important target clients. By doing this, we can already provide attractive test results. However, we will not do this kind of promotion during summer or in December in regard of holidays and therefore little attention.
- There will be a website showing our company's mission, advantages and product data.
- Via a youtube video we will get peoples' attention and interest. It will explain our product and show the manta swimming in deep seas detecting oil spills.
- An important step will be to present expositions considering oil spills and maritime engineering. Also conferences and seminars like the International Oil Spill Conference of the ICCOPR, the AMOP Technical Seminar on Environmental Contamination and Response, the Interspill 2015 and the Spillcon 2013 will make up for an important part of our promotion strategy.
- A good contact to journalists who write about environmental issues in the daily press or in specific science magazines will be established.
- In addition, we will try to be invited to talk shows facing environmental issues and oil spills in the oceans.

### **9.5.6 Short and long-term projections**

This section includes forecasts of revenues and expenses as well as the results of a break-even analysis. Within 3 years, we project that we will have a MOSD1000 in commercial operation, and at that point begin to receive revenue from operations. As long term projections, we want to further explore the potential of the MOSD1000 in other markets. We want to diversify into oceanographic exploration and possibly plastic vortex mapping and cleaning.

The finance plan will look like this. In the first three years, the figures would be:

- Costs
  - Salaries: 310.000 USD
  - Prototype: 500.000 USD
  - Workbench + Base: 200.000 USD



	Year 1	Year 2	Year 3	Year 4
Costs	500.000 USD	500.000 USD	500.000 USD	1.500.000 USD
Income	0	0	0	30.000.000 USD
Profit	0	0	-200.000 USD	28.500.000 USD

**Table 9.6:** Financial overview

- Public Relations: 50.000 USD
- Modifications on the prototype: 100.000 USD
- Funds
  - Grants: 1.000.000 USD
  - Public Support: Not accounted for
  - Bank loans: 200.000 USD

On year four, the figures should already be as follows:

- Fixed costs
  - Salaries: 310.000 USD
  - Base + Workbench: 100.000 USD
  - Public Relations: 50.000 USD
  - Maintenance: 40.000 USD
  - Backup Tools and Equipment: 500.000 USD
- Variable Costs
  - Operation Costs: for 24 hours of operation: 10.000 USD; for 20 days of operation: 200.000 USD
- Income
  - Barrels per day: 3.000
  - Price per barrel: 3.000 USD
  - Income for 20 days: 1.500.000 USD

Table 9.6 shows a summary of these figures for the four first years.

## **9.6 Summary and outlook**

The future is expansive for EcoRay and the oceanographic field. As we envision an exploration and mapping of, inevitably, the entire ocean, we want to be on the forefront of this exploration. We also want to, and it is imperative, that we clean and reverse the damage that has been wreaked on the oceans. One way to do this is to facilitate in the cleaning and recovery of the oil spilled, and currently floating, in the oceans. We have identified a vital role in this cleanup process and are eager to fill this position. In order for us to realize our product, we need to secure intense funding, and need to attract individuals with knowledge that we are currently lacking in our company, such as marine biology and software development. In review of our project, our biggest challenge will be developing our prototype. The mechanics that we want to explore and develop does not have a large library of prior research for us to build upon; biomimicry is a nearly virgin field of research. Our business plan is unique and very innovative, and is a strong point for our company. It is the technological innovations that will prove to be our largest challenge. As the market of oil recovery has currently a maximum value of 2 Billion USD, we have looked into other possible markets for our manta.



**Part IV**

**Closing**



# Chapter 10

## Closing and conclusions

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The previous chapters show the results of the projects of the students from the Summer School on Creativity Engineering 2012. All discussed ideas were addressing current needs in an individual's life or environmental problems. What is interesting is that without pushing the students in this direction, three out of the four projects deal with sustainability and environmental topics: be it healthy and organic food, generating energy or cleaning up oil spills. This clearly indicates the awareness of students to sustainability topics and their wish to push forward technologies that align with the endeavor of a sustainable future with increased quality of life.

Good food is the basis for health, any efficient activity and creative performance. This opinion is also shared by one group that has come up with the idea of providing a possibility to grow own food; even in cities and apartments. Educating our children where food comes from is a first step to re-connect with nature again. The product presented for farming own food covers all important aspects also needed for a creative performance: experiencing, learning, having fun and feeling joy.

Some groups detailed their ideas and have given thought to the technological implementation. So did one group who had the idea of producing energy by movement, in particular energy to reload batteries for phones by walking. The proposed product can be implemented in shoes and by walking, energy can be produced and used for charging batteries of electronic devices. The authors state

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that this product is the basis for developing more efficient devices to produce green energy, simply by moving and walking.

Another group detailed their ideas about cleaning the oceans from oil spills and at the same time making money. The idea and business model of the manta robot that is able to spot oil spills shows that it is possible to make money by cleaning the oceans and at the same time to explore it.

On the other hand, some groups have spent more time on developing the idea rather than making a business model of it or to give full detail attention to technological implementation. A group of students coming from cities where parking a car is a serious problem, have given thought to how cars can be parked more efficiently. Their approach is providing a system to be installed on cars and assists in parking. The group analyzed different available systems and indentified the pro and cons of each solution and tried to postulate an ideal solution, where the advantages of each idea were brought together in a single product.

All these projects are the result of three weeks of intense lectures, workshops and hard work on the student's side, and much of that can be seen in the previous chapters. This book is the conclusion of that hard work. Nevertheless, this book is not the end, but rather the beginning. Documenting a project - as has been done here - is the first step to making it happen, to turning it into a reality. In this regard, it is delightful to hear that one of the Summer School alumni from 2011 further developed a project firstly developed during the Summer School on Creativity Engineering 2011 and has won some competitions for start-ups in Austria as well as the second price at Virginia Tech Global Partnership Challenge.

We believe that in a few years from now it will be possible to look back and see how much of what is stated in this year's book comes to happen, be it by the students of the Summer School on Creativity Engineering, or by anybody reading this book and getting inspired by its contents. If you are such a person, please let us know!

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