KARELIA UNIVERSITY OF APPLIED SCIENCES
Degree Programme in Design

Ilya Sokolov (1201443)

SQUID: AN OPEN SOURCE DESIGN PROJECT

Thesis
May 2016

THESIS
May 2016
Degree Programme in Design
Sirkkalankatu 12A
FIN 80100 JOENSUU
FINLAND
Tel. 358-50-358-2494

Author(s)
Ilya Sokolov

Title
Squid: An Open Source Design Project

Commissioned by
Santeri Lanér

Abstract

My main goal will be designing a futuristic bicycle concept, a bicycle that will also comprise all the necessary elements of an ordinary bicycle. At the same time I would like to significantly improve the reliability, outlook, interaction and comfort.

The only way to make this project possible in modern realities is to make it open source. Open source design represents the process of creating a tangible artifact where the design information is widely available. The design information of an open source project should be public, so anyone is able to modify, distribute, and use that design.

I created this thesis as an open source design guideline for everyone who wants to build a covered recumbent tricycle and create a community around that artifact. It has a Share-alike license, so that any enthusiast is able to modify, improve and redistribute my design. However the main emphasis was made on building an open source design community and improving the initial design concept created by me. The results that I received from research and numerous workshops are stunning and presented in the conclusion of the thesis.

Language	Pages 46
English	Appendices 2
	Pages of Appendices 4

Keywords

Thesis, open source, innovation, tricycle

CONTENTS

1 INTRODUCTION

Nowadays, there is a need for a smart, compact and energy efficient closed vehicle, which could be used in any environment. At the forefront we have protection from any possible impact starting with weather and ending with protection during a possible road accident. The idea is not only formed by the needs of society but also by understanding the current CO_2 emission situation around the globe.

We see a growing need for smart and compact vehicles that could be used widely in tight city environments. Cars are too big and economically inefficient; they cause a lot of discomfort for owners as well for the environment. Bicycles are small and perfectly fit in the city environment with their size and impact, but they are not enough protected.

By implementing this project we are creating a new smart way of transportation that will be used by different types of people worldwide. I believe that it will bring more sustainable development in the transportation sphere and permanently change traffic around the world.

It is possible to implement the idea using technologies that we possess nowadays. We had an ulterior motive to choose a three-wheel base. The tricycle is the perfect chassis for city and countryside transport, because it is compact, light and stable.

From the design point of view the main inspiration for the project lies in nature, more precisely in the depths of the ocean. There we can find a very enigmatic creature, the squid. Squids are considered the most intelligent cephalopods on the Planet. They are an important example of advances cognitive evolution of animals in general.

The intelligence of squids and their natural ability to analyze situations make them as one of the most inspiring creatures for the project.

Natural selection made the shape of a squid’s body, so it represents a great hydrodynamic and energy saving solution, which perfectly coincides with the main purposes of the project.

The main purposes of the thesis project are to:

1. Create an open source design/hardware/software project;
2. Create a design project of a bicycle successor using a tricycle base;
3. Implement a futuristic design of squid body ;
4. Experiment with energy saving and aerodynamic solutions;
5. Based on the results of the research and design work, create an open resource library;

Main tasks of the thesis project:

1. Project related research	Research of current trends in transport industry from the perspective of design and technology; Futures research of bicycle/tricycle trends; CO2 footprint research; Electric lightweight vehicles market research;
2. Creation of a design concept	Searching for a right shape by the means of sketching; Consolidation of the shape in 2D software (Adobe Illustrator): Transforming 2D Adobe Illustrator model into 3D model using 3DSMAX; 3D model rendering (creating complete visualisation scene); Building scale 3D model in 1:16 scale using 3D printing technologies;

3. Building of a first Squid prototype	Compiling a technical assignment for engineers; Building a chassis; Building up a body of Squid using carbon fiber techniques; Creating needed user interface (cockpit, steering elements, software);
4. Establishment of an open source project	Compiling a list of challenges; Receiving an open license; Create a library of resources, based on the knowledge gathered from the project; Engage same projects to participate in the process;
5. Formation of a user community	Create a community of practice based on the project; Create user/tester community to get relevant user feedback

Table 1. Main goals of Project Squid

My thesis consists of a theoretical part about open source design, methodology, visualizations, guidelines and community based research. The main scope is based on a single design project – Squid and its impact on the formation of an open source community around it.

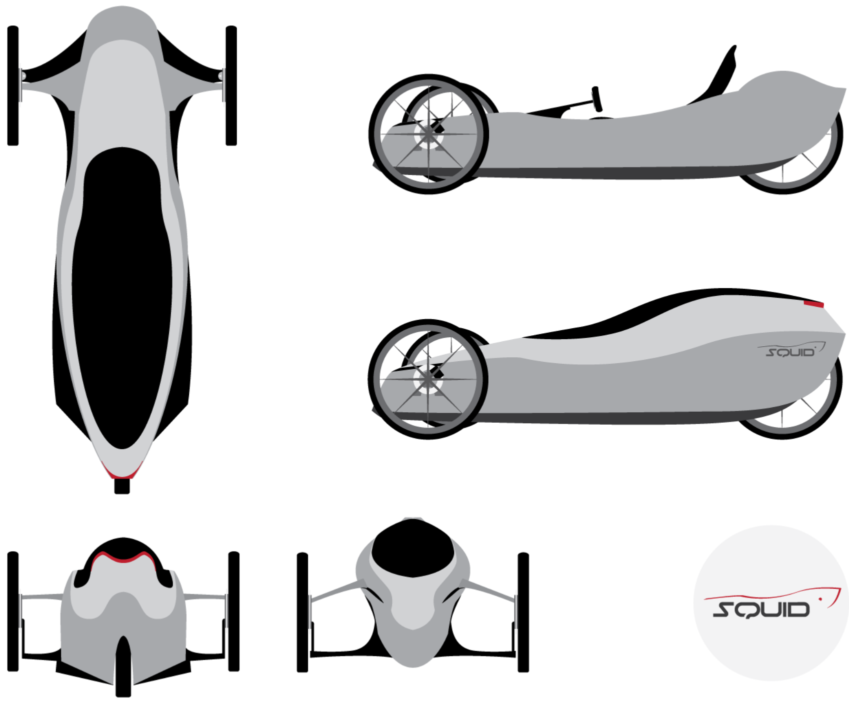
The tricycle project challenge was firstly presented to me by Jukka Niskanen, due to some previous results in bicycle creation and design. One from the departments of Karelia University of Applied Sciences had an assigment to create a tricycle with cover. This assignment has formed the basis for Project Squid. (Picture 1.)

Picture 1. First sketches of tricycle, protected by a cover. (Ilya Sokolov)

The financial resources for the thesis project and project Squid were provided by Joensuu Science Park and Draft Programme.

Concerning the investment and implementation processes, in the open source community we have created an efficient action plan and design approach. We are tightly cooperating with a great number of different specialists in pursuit of embodying the project.

The first revelation of the design concept and the design task was created soon after the formation of a clear technical assignment and was based on sketches (Picture 2).



Picture 2. First 2D drawings of Project Squid. (Ilya Sokolov)

Basing on sketches, 2D drawings and a clear technical assignment, I could start the design process. In the beginning I decided to take a look at open source and methodology.

2 FRAMEWORK

Problem, goal and the process:

There is an expression that says, “To reinvent the wheel”; it literally means to invent something that has the same value as the item that already was invented by someone. The same kind of attitude is applied to bicycle design and production. Is there a reason to make something more complicated if it needs to be simple? It always was a cornerstone of design. However, at the present time the focus of bicycle design is shifting to search for new ways of development; e.g. multiple electric bicycle concepts, multiple tricycle concepts and multiple inventions in the cycling environments. Is it possible to merge all of those into one project, a sum of all the positive elaborations? How well will this design work? Will it get a positive feedback among cyclists? – All these questions will be covered in the thesis.

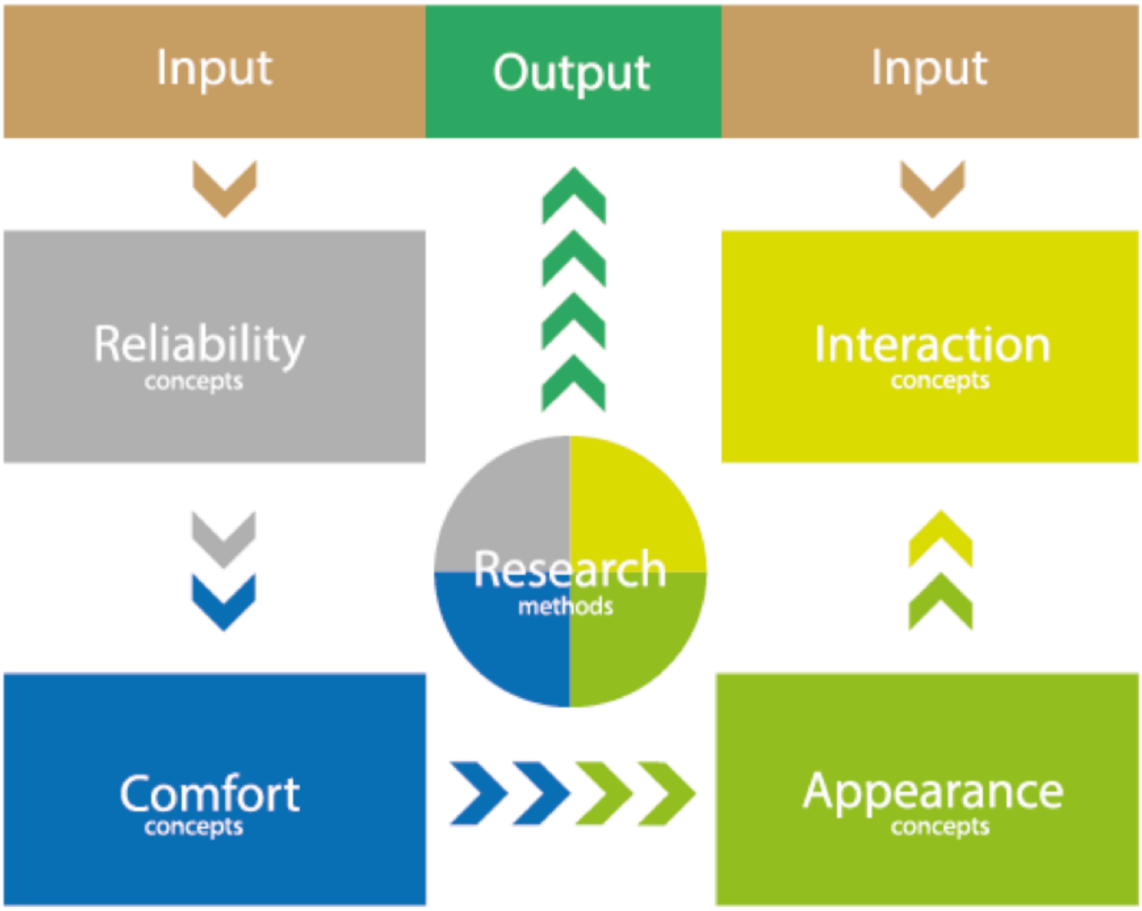
My main goal will be designing a futuristic bicycle concept, a bicycle that will also comprise all the necessary elements of an ordinary bicycle. At the same time I would like to significantly improve the reliability, outlook, interaction and comfort.

The design process will be based on the same paradigm that is given above. The order of the elements will be as follows:

1. Reliability – the technical part of the process, which will include all the necessary technical elements of a bicycle and an explanation of their reliable performance. In this chapter I will be using the methods of technical analysis and counting.
2. Comfort – the part will include qualitative research: surveys, interviews and observations. It is impossible to create a comfortable bicycle without proper feedback. Hence, I will conduct multiple researches concerning people’s opinion about comfort.
3. Appearance – this part will include visual schemes of the project. It will be entirely dedicated to visual design and bicycle as an object of

architecture. According to the recent work of Alexey Maslov, who is one of the chief designers of the unique Atom R1 low floor tram: Vehicle + Architecture = Vehitecture (R1 Atom Media Kit 2014, 3).

4. Interaction – is the interaction design part of the paper. In this part I will examine the interaction between bicycle and cyclist and the ways this will be improved. The main type of research analysis that will be used in the part is experimental analysis. By means of experimental analysis I will be able to create two groups of participants who subsequently will evaluate the idea.



Picture 3. Design process (Ilya Sokolov)

To be consistent I would like to work according to the following scheme. The first step of the scheme is receiving data for a separately taken part. The second step is applying this data for building a design concept of each of the parts. The second step is the research of obtained results and compare concepts with the previous results I received. In the chance of receiving satisfactory results the successful concept complements the final project.

I believe that the scheme of design and research process presented above will be the most rational for the project. A great benefit of using the scheme lies in the ability to simultaneously process all four threads of the process. The key problem of the research is the research itself; it includes a large quantity of different aspects. These aspects are impossible to examine using conventional methods; consequently the methods I am planning to use are more complex.

There are a great number of different notions that need to be defined. They mainly relate to values of urban design, evaluation systems whereby it is possible to evaluate the process and the result, customer satisfaction, which derives from the values, economical reasoning, design management and personal development.

The value of urban design is defined as, “a measure of the worth of something to its owner or any other person who derives benefit from it, this being the amount at which it can be exchanged” (Thomas Telford 2001, 14).

Evaluation systems will be formed according to the Monitoring and Evaluation systems creation rules pointed out in the (Marelize Görgens-Albino, Jody Zall Kusek, 2009, 11).

Customer satisfaction could be estimated to be guided by the results from the qualitative and experimental researches.

Economical reasons comprise elements that receive benefits from the implementation of the project. In my case they are the planet (environmental benefits) and people (learning and development).

My personal development, along with the implementation of the project, should not be underestimated. It will give extra knowledge and practice to me, but also to the company that I will be collaborating with.

The main ethical question that arises from the topic is in what should we invest more and on what should we be more focused: human and human development or technologies and technological development? During recent years the majority of innovative projects has been focused on technology and technological processes more than on humans and personal development.

With the Project Squid I want to try to combine those two and use technologies for personal development of a human. Moreover, I will try to reduce the carbon footprint by producing less CO_2 emissions during the work process and receive a CO_2 footprint certificate.

3 OPEN SOURCE

3.1 Open source – the future of human development

Since the main approach of the thesis is to show Project Squid from the open source design/hardware/software point of view, the main focus of the theoretical research and knowledge base is on open source.

WHAT IS OPEN SOURCE?
"In production and development, open source as a development model promotes universal access via a free license to a product's design or blueprint, and universal redistribution of that design or blueprint, including subsequent improvements to it by anyone." (Lakhani 2003, 923–943).

WHY OPEN SOURCE?
When it comes to open source and its usage in different spheres of application, it is very crucial to understand why this model should be used instead of the usual approach in cases of inventions, design and technologies. I can underline five main factors which motivate me to use an open source model instead of a more usual design approach:

1. **The desire to learn and develop fast.** If there is a lack of knowledge in a particular field, then this knowledge is gathered during the working/research process. For visionary design projects that are innovative, knowledge is the main basement for the process. Hence, the faster the needed knowledge will be gathered, the faster design project will be implemented.
2. **Open mind.** The question of open mind is not so much about the practice process but it is more about ethics and learning. Moreover, society should be ready to understand a new model like open source.
3. **Understanding the need for change.** Nowadays, we are faced with a great number of ecological problems all around the world. The unwise usage of resources by humans should be changed and it is changing in a more positive way. Unfortunately, now we came to the point of no return

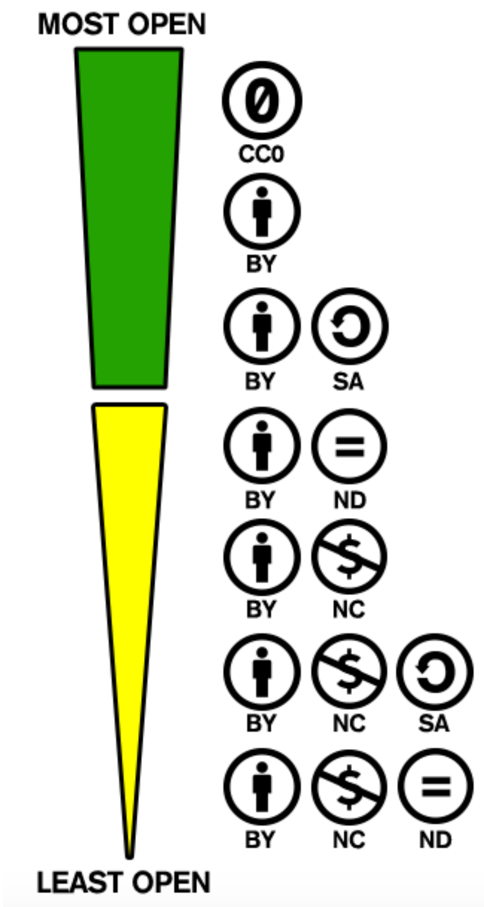
for resource consumption. This project is mainly about reconsidering our attitudes towards resource usage.

4. **Desire to make a difference.** By using an open source model we are showing an alternative way for technology development in an open, available, fast and cost-effective way. I understand the risk and opportunities by using open models in the design work and fully rely on the idea of open source.
5. **Willingness to share.** One of the main ideas and models of behavior in open source models is sharing the results, information and resources that one has engaged in with other projects in the same field without any financial benefits. Usually all open source projects act under the share-alike license, a license that requires users of a work to provide the content under the same or similar conditions as the original.

3.2 Open source licensing

Licensing for open source hardware may present some problems, depending on the nature of the design. While open source software licenses such as the GNU GPL deal with copyright, hardware often faces the issue of patents. This was one of the primary motivations for the creation of the TAPR Open Hardware License (Rubow 2008, 2) .

The most common tool for protecting and licensing open source projects of any kind is Creative Commons licensing. Creative Commons has multiple tools for licensing open source hardware, software, design projects, etc. When the project members decide on which kind of a license should be used for a particular project, it is good to keep in mind which kind of reuse should be encourage. The types of Creative Commons licences are logically structured, from most open licenses for reuse and least closed for reuse (Picture 4).



Picture 4. Creative Commons licensing diagram. (Creative Commons)

Based on the scheme we are able to see that there are seven types of the Creative Common licenses, which are:

1. **CC0 Public Domain Dedication** – “when using CC0, you will waive all copyright and related rights to a work to the extent possible under the law.” (Creative Commons official website)
    a. Europeana — Europe’s digital library using CC0 license;
    b. Figshare using CC0 licence;
    c. Open Goldberg Variations using CC0 license.

2. **CC Attribution (CC BY)** – “this license lets others distribute, remix, tweak, and build upon your work, even commercially, as long as they credit you for the original creation. This is the most accommodating of licenses offered. Recommended for maximum dissemination and use of licensed materials.” (Creative Commons official website)
    a. PLOS - Public Library of Science, uses CC BY license;

   b. Saylor.org - service for free studying courses uses CC BY license;

3. **CC Attribution-ShareAlike (CC BY-SA)** – “this license lets others remix, tweak, and build upon your work even for commercial purposes, as long as they credit you and license their new creations under the identical terms. All new works based on your will carry the same license, so any derivatives will also allow commercial use.” (Creative Commons official website)
   a. Wikipedia and Wikimedia commons uses CC BY-SA license;
   b. Arduino - open source chip, uses CC BY-SA license;
   c. The Peer 2 Peer University (P2PU) is a grassroots open education project that organizes learning outside of institutional walls and gives learners recognition for their achievements, uses CC BY-SA license;

4. **CC Attribution-NoDerivs (CC BY-ND)** – “this license allows for redistribution, commercial and non-commercial, as long as it is passed along unchanged and in whole, with credit to you.” (Creative Commons official website)
   a. Behance.net uses CC BY-ND license,
   b. GNU and FSF (Free Software Foundation) use CC BY-ND license;

5. **CC Attribution-Non-Commercial (CC BY-NC)** – “this license lets others remix, tweak, and build upon your work non-commercially, and although their new works must also acknowledge you and be non-commercial, they do not have to license their derivative works on the same terms.” (Creative Commons official website)
   a. Brooklyn Museum uses CC BY-NC license;
   b. Wred.com - photo sharing service uses CC BY-NC license;
   c. Jonathan Coulton - an independent singer-songwriter who became famous once he started sharing his music for free online under a CC BY-NC license.

6. **CC Attribution-NonCommercial-ShareAlike (CC BY-NC-SA)** – “this license lets others remix, tweak, and build upon your work non-commercially, as long as they credit you and license their new creations under identical terms.” (Creative Commons official website)
    a. MIT OpenCourseWare uses CC BY-NC-SA license;
    b. Jonathan Worth - famous photographer from London, UK uses CC BY-NC-SA license;
    c. Cory Doctorow - famous blogger uses CC BY-NC-SA license.

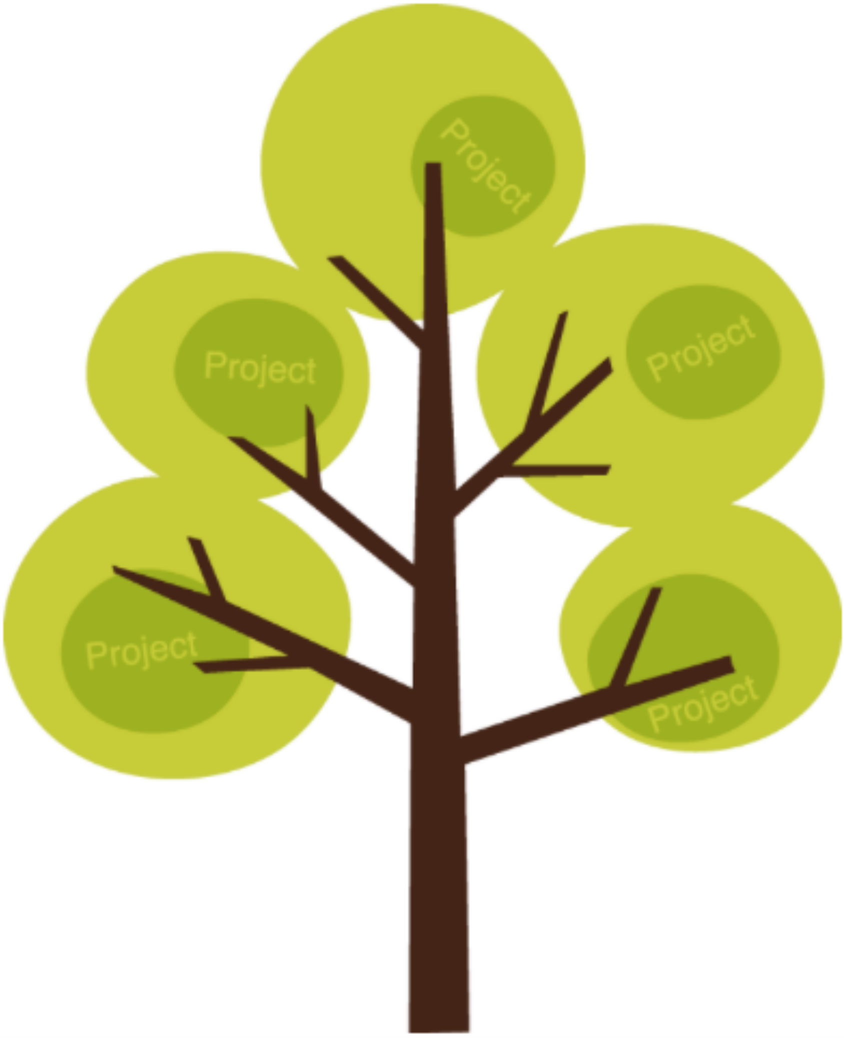
7. **CC Attribution-Non-Commercial-NoDerivs (CC BY-NC-ND)** – “this license is the most restrictive of our six licenses, only allowing others to download your works and share them with others as long as they credit you, but they cannot change them in any way or use them commercially.” (Creative Commons official website)
    a. TED Talks uses CC BY-NC-ND license;

From studying the licensing tools of Creative Commons I found out that there is a vast range of different projects that are using open-source licensing, starting from huge information resources ending with rapidly developing hardware projects. Creative Commons provides a wide range of licenses to choose from, so the choice should be based on the logic of redistributing the idea.

Open Source Project Squid is to be licensed under the CC Attribution-ShareAlike (CC BY-SA) license.

By using open source CC BY-SA type of licensing Project Squid will be protected from idea theft and at the same time will make it possible to distribute, develop and improve the idea faster than in cases of using the ordinary patent licensing.

Share-alike models in case of open source projects can be visually described as a tree with branches, where the trunk of the tree is the main project with knowledge patented under the open license. The branches of the tree are projects related to the main projects and otherwise related to its knowledge base or resources. All these elements: main project and smaller projects - are acting under the same creative open patent. However, if any of those smaller sub-projects wants to split from the main project licence and receive its own creative patent then it has to indemnify caused loss. (Picture 5.)



Picture 5. Tree of open source project. (Ilya Sokolov)

3.3 Open source community

Typically, a community of designers develops open source design. Participation is usually voluntary based, and designers do not receive any compensation for their work. In addition, the design is made available to the public.

Development of open source projects goes hand in hand with organizing an open source community around the project. In fact, the more challenges and tasks are provided by the project the more active community members are. Open source community is usually separated into the following member groups:

- Core group
- Active group
- User group

Open Source Innovation (OSI): OSI is characterized by freely revealing the information on a new design with the intention of the collaborative development of a single design or a limited number of related designs for market or non-market exploitation. (Raasch, Herstatt & Balka 2009, 383.)

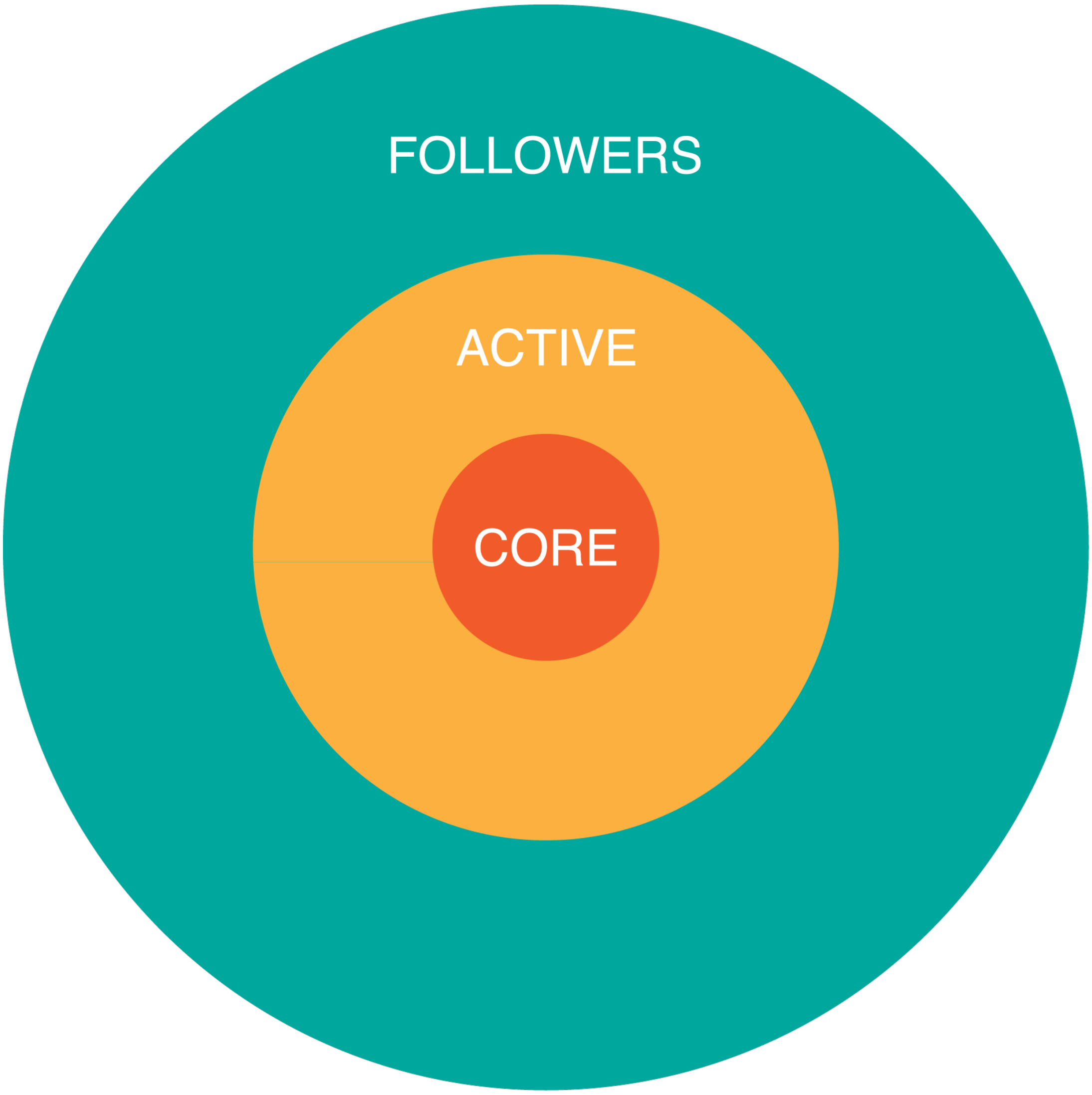
Open Source innovation model has four essential rules:

- Authors of an open design redistribute their concept or idea to an indefinite number of collaborators, without compensation
- Collaborators of an open source design process share results of their work with the clear aim to contribute in the joint process
- There is always one major open source project that is separated into the smaller design tasks
- The final aim of the open design project is to be integrated in another project or be acknowledged

The user group is one of the most crucial groups in the open source design community. Every design needs to be improved. The only way to do it is by means of the user group inside and outside the community. It is usually done by collecting relevant feedback and proving the concept or improving its parts.

An active group is a group of contributors interested in developing, improving and implementing the project. It consists of active people, directly benefiting from implementation of the project. For example they can be designers, engineers, commercial contributors, etc.

The core group consists of idea owners and managers who are responsible for organizing working processes inside the community. The core group usually consists of people experienced in management and project-related spheres of knowledge (Picture 6).



Picture 6. Open source community structure. (Ilya Sokolov/Ilpo Pohjola)

3.4 Open source development and motivation

"Open source hardware is a thing - a physical artifact, either electrical or mechanical - whose design information is available to, and usable by, the public in a way that allows anyone to make, modify, distribute, and use that thing." (Rubow 2008, 1).

The open source hardware design process consists of the following processes:

1. Open interface - the interface to the hardware must be explicitly made public so the hardware can be used freely.
2. Open design - the design of the hardware must be made public so that others can implement it and learn from it.
3. Open implementation - the tools used to create the design should be free so that others can develop and improve the design. (Rubow 2008,1.)

The sources of motivation for participants could be logically aligned with these processes. In this thesis I will try to systemize all knowledge that we have in one simple model below.

Sources of motivation:

- Internal;
    - Intrinsic motivation;
    - Altruism;
    - Community identification;
- External;
    - Revenues from products and services;
    - Human capital;
    - Self-marketing;
    - Personal recognition

4 BICYCLE DESIGN, TECHNICAL ASPECTS

4.1 Bicycle of the future

“More than three centuries ago, the distinguished French mathematician Jacques Ozanam spelled out the theoretical advantages of a human powered carriage in which can drive oneself whenever one pleases without horses. Its owner could freely roam along the roads without having to care for an animal and might even enjoy a healthy exercise in the process” (Herlihy 2006, 15). When I take a look at the past and present of the bicycle I always remember this statement. It gives a sufficient description of cycling as a process and a bicycle as a main part of this process.

There is a man and a machine whereby a man is able to move in time and space with a speed far exceeding his own. It is a little mechanical gimmick that helps a human being to trick Mother Nature. “The Greek mechos means a device designed to deceive - i.e. a trap - and the Trojan Horse is one example of this. Ulysses is called polymechanikos, which schoolchildren translate as the crafty one. The word mechos itself derives from the ancient MAGH, which we recognize in the German macht and mögen, the English might and “may. Consequently, a machine is a device designed to deceive; a lever, for example, cheats gravity, and mechanics is the trick of fooling heavy bodies.” (Vilem Fusser 1999, 17.)

The main challenge that I faced during the design process lay in the possibility of the creation of a new development concept for the cycling and bicycle industry. The concept of the development of a bicycle of the future should have bigger value than previous concepts and be in the same range with Vilem Flusser’s statement above. A bicycle of the future should help a human to easily overcome natural circumstances such as rain, ice, frost, and wind as well as social circumstances such as theft, human errors, and accidents.

4.2 Bicycle. History of development

It is impossible to cover such a specific topic without the historical background. Before I started to review the engineering and design aspects of a bicycle there was a strong need to reveal how the evolution of a bicycle proceeded. One of the best sources of the veridical bicycle history is *Bicycle: The History* by David V. Herlih. It describes the history of cycling from the 17th century until today and even looks into the future. The author even discusses electric bicycles and their future: “Will electric bicycles prove a boon or a bane to traditional cycling? On one hand, electric bicycles could encourage more people to leave their cars behind and head out on the road with a two-wheeler, buoyed by assurance that they can use the auxiliary means of power whenever their will to pedal wanes. On the other hand, the persistence of an onboard electric motor arguably undermines the spirit of cycling and detracts from the bicycle’s charm and simplicity”. (Herlihy 2006, 410.)

A different kind of approach can be found in another bicycle history source – *The Bicycle Book* by Bella Bathurst. The book is a collection of great stories about bicycles and inventions. Compared to the previous source The Bicycle Book does not describe the development of the bicycle, but represents only historical facts. Those facts could be used in further process because of their interestingness and exclusiveness.

There is a need to deeply analyze not only the history of the bicycle in general but the history of bicycle design in particular. “With more than a billion machines produced so far, the bicycle ranks among the world’s most numerous vehicles. Yet the automobile has received much more attention. Indeed, few areas within the history of technology have been as neglected as the history of the bicycle.” (Hadland & Lessing 2014, 11.) It is a truthful statement, taking in account the fact of how the automotive industry has developed compared to the bicycle industry. Moreover, it is an indicator of design trends and history. *Bicycle Design: An Illustrated History* is a combination of the two previous sources. It could be used in the design research process of some specific part of the bicycle. Besides, it gives a broad view on the design and technology of different bicycles and inventions.

4.3 Bicycle technology

The technical literature concerning bicycles is a vital part of the research. I would like to monitor the changes that have happened in the technological approaches. Hence I have started with predecessor of all contemporary bicycle-engineering literature – *Bicycles and Tricycles: A Classic Treatise on Their Design and Construction* by Archibald Sharp. The book was firstly published in 1896 and represents complex technical literature including terms, diagrams, equations and counting. It is a first known source of bicycle engineering and mechanics.

I realized that with time the literature about bicycle mechanics has become less complicated e.g. "One of the first lessons we learn from bicycling is that more effort is required to ride fast, or uphill or against the wind (than to ride at more moderate speed on the level in calm conditions or with the wind at one's back)." (David Wilson 2004, 123) The statement is empirical knowledge, which is possible to obtain from a cyclist's experience.

However, in the earlier sources even such empirical statements were described with complex formulas. Over time cycling has gained a lot of popularity among usual people who do not have a degree in engineering. That is why contemporary bicycle mechanics literature is easy to grasp. In 2004 Enslow Publishers published a book called *Bicycle Science Projects: Physics on Wheels* by Robert Gardner, which represents cyclists scope at a bicycle engineering.

With the help of the sources given above I was able to widen my technical approach. It is logical that I obtained knowledge in the engineering of a bicycle merged with its history. Unfortunately, without this knowledge it is impossible to understand modern inventions and trends in the bicycle industry.

4.4 Bicycle technology

After a solid historical, technological and design basis was laid in the understanding of future concepts I was ready to observe the modern trends and methods of the analysis of these trends. “Electric bicycles are one of the fastest growing segments of a global bicycle markets, appearing precisely because they use a motor to accentuate or replace altogether the act of propulsion by pedaling - their status as hybrid vehicles.” (Luis Vivanco 2013, 24.)

As for recumbent bicycle, it seems to fit the definition above in the broadest terms, tough its unique handlebar position, its differently sized wheels, the enlarged shape of the frame, the orientation of the seat, and the placement of the cranks and pedals defy easy categorization.” (Luis Vivanco 2013, 25.) All of these designs need to be tested and evaluated. *Reconsidering a Bicycle* by Luis Vivanco could be a great source for inspiration and current information, but it should be carefully surveyed.

There are a great number of methods in which new designs could be evaluated beforehand. In my future work I would like to use set monitoring and evaluation systems carefully. “A Monitoring and evaluation system gives decision-maker an additional management tool by providing feedback on the performance as a basis for future improvement” (Görgens-Albino & Kusek 2009, 2).

In terms of evaluating the already happened improvement or design I will be using a different type of analysis approach. I have chosen the future-oriented qualitative research. “Futures research and innovation (processes) complement each other. Since innovation is aimed at the future, the application of futures research can help organizations improve their innovation process. Furthermore, it can be assumed that the type of innovation is related to the type of futures research. “The more radical an innovation is, the longer its lead time and the greater the uncertainty of the innovation process will be, which means futures research should be of a more explorative nature.” (Patrick Duin 2006, 59.) According to the statement the future is not singular, but complex.

5 DESIGN PROCESS

5.1 Squid – tricycle of the future

Nowadays, there is a need for a smart, compact and energy efficient closed vehicle, which could be used in any environment. At the forefront we have protection from any possible impact starting with weather and ending with protection in road accidents.

If we take a closer look at cycling, we can see that it has a lot of advantages:

- Healthy lifestyle;
- Zero emissions;
- No traffic jams;
- Almost no expenses;
- Not so much need in technical maintenance;
- The cheap price of a bicycle itself.

At the same time cycling has its own disadvantages, which are usually the reasons why someone needs to buy a car. They are:

- A cyclist is not protected from weather, such as wind, rain, snow, cold, etc;
- A cyclist is not protected from road accidents. Even a small collision could have a significant impact on a cyclist's health;
- Long distance commuting is problematic and slow by bicycle.

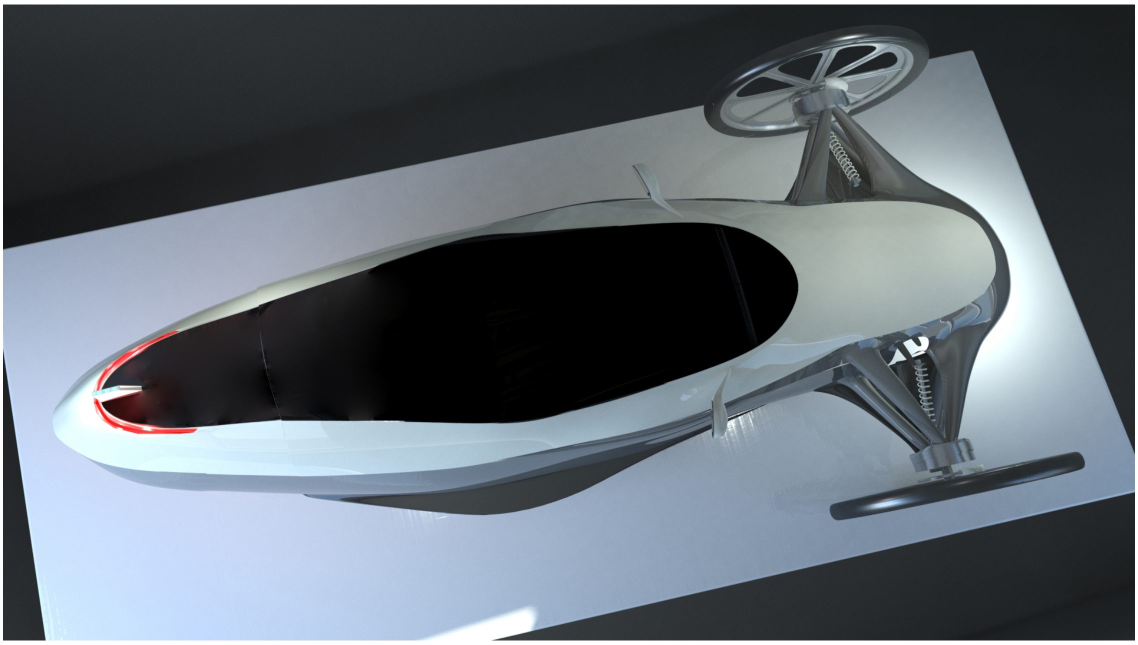
By implementing Project Squid I am creating a new smart way of transportation that will be used by different categories of people worldwide. I believe that it will bring more sustainable development in the transportation sphere and permanently change to traffic around the world.

It is possible to implement the idea using technologies that we possess nowadays. I had an ulterior motive to choose a three-wheel base. The tricycle is the perfect chassis for city and countryside transport, because it is compact, light and stable.

There are two ways of applying the hybrid base into practice:

- Two wheels on the front, one wheel on the back – The stable and fast construction that is used in the majority of recumbent trikes around the world;
- One wheel on the front, two wheels on the back - Slightly faster but less stable construction that is usually used in the motorcycle tricycles.

After a detailed analysis of the Project Squid chassis I have realized that first option is more prospective and stable then second one, so we have chosen it as the main approach to the chassis construction. It also should be mentioned that the front wheel base will be pretty narrow, starting from 80 cm and ending at 100 cm. (Picture 7.)



Picture 7. Squid – top view (Maria Mosunova/Ilya Sokolov/Dmitry Fedorov)

I saw a growing need for smart and compact vehicle that could be used widely in tight city environments. A car is too big and economically inefficient; it causes a lot of discomfort for the owner as well as being environment harmful. A bicycle is small and perfectly fits in the city environment with its size and impact but it does not offer enough protection.

That is why I have started to search for a kind of vehicle which is something between cars and bicycles; hence it will have advantages of cars and bicycles. At the same time Project Squid will have more advantages in future development compared to cars and bicycles. The wide usage of advanced technologies will transform a simple tricycle into a smart vehicle. It is no more a vehicle, but an extension of the body. Moreover, it will cover and protect drivers.

- The convenient design will protect the driver from environmental and weather impacts. So he/she will be able to dress in anything he/she wishes without the fear of freezing or getting wet;
- The Squid tricycle will be created by using a hybrid base, which means an electric engine combined with a classic pedal rod. To make it more efficient, we will be able to create a system of intelligent charging. (The tricycle will work on a Lithium ion battery, which consists of thousands of clusters. Electric power from the active zone of the battery will move the vehicle, while the recuperation system will charge the inactive zones of the battery. A smart computer control unit plays the most important role in whole process by analyzing processes and recharging clusters in a more efficient way);
- The Squid tricycle is about sensitive technologies; it is all about interaction with the user. Every user of my product/service will be able to communicate with the vehicle and any person he/she wants while driving it. It opens a vide horizons of work while riding.
- A touch screen embedded in the steering wheel will make the communication and driving process more easier;
- A comfortable and adjustable seat will let the driver rest until the end of a ride (If the driver will want to get out, of course);
- The light and simple construction will be easy to maintain and take care of. It provides great maneuverability in city traffic with the ability to use cycle paths, sidewalks and roads.

Design development of Project Squid consists of constantly developing steps:

- Idea (concept) generation;
- Sketching of the new idea;
- 2D visualisation using Adobe Illustrator software;
- 3D visualisation using 3DSMAX software;
- Rendering;
- 3D printing;
- Prototyping;
- Improving of the prototype.

All of the steps presented above are to be developed within an open source design model. Open source is the working model for Project Squid. In Project Squid there will be:

- Open hardware
- Open design
- Partly opened software

Project Squid will be registered under the UE open patent, which means that any organization or person can use all the information, technology, and knowledge to make his/her own projects. However, all technologies created based on Project Squid's opened patent are considered as "Share-alike", and they can only be used under the same patent. If a company/person wants to receive a separate patent for its project, product, technology, etc. it is only possible by financial compensation to the Project Squid open patent hold.

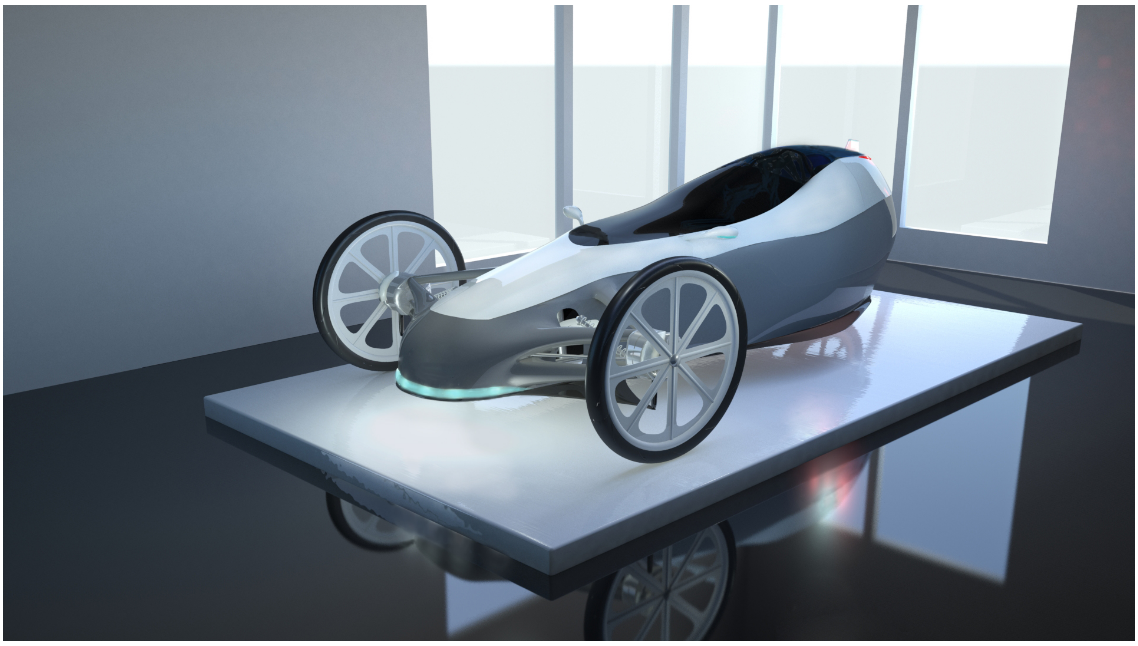
5.2 Squid specifications

There are four main platforms to embody Squid:

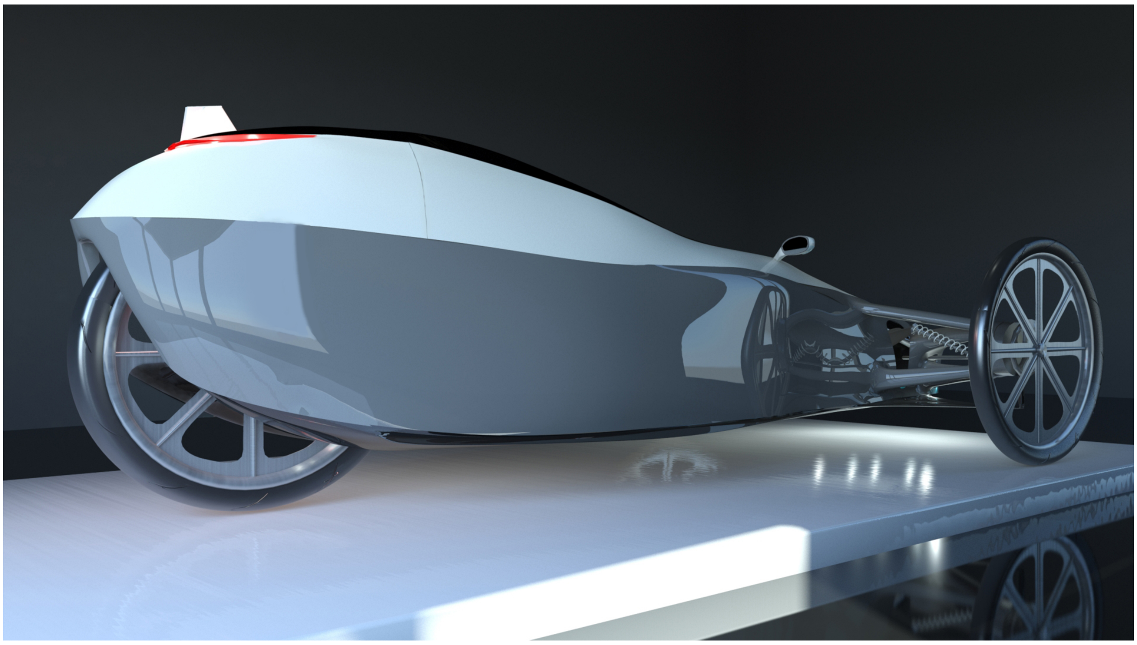
- **Hybrid recumbent tricycle: (Bicycle based)** that is positioned as an electrically assisted bicycle. Hence it is fully legalized into the bicycle category and being used under the same legislation; (Picture 9)
- **Electric tricycle: (Bicycle based)** that is positioned as a fully electric moving tricycle. Its speed characteristics (250W/25km/h) and dimensions

should also be legalized under the same category. (It should be verified) (Picture 8.)

- **Moped car tricycle: (Moped based)** which is positioned as a three wheel based moped. The electric motor's maximum power is restricted to 4.0 kilowatts (5.4 PS; 5.4 bhp). Mopeds are allowed to carry one passenger with the driver if the moped is registered as having two seats. (Wikipedia, Moped, 2016)
- **LM7 car: (Car based)** Squid produced under this mark is positioned as a lightweight car. The weight of the LM7 car should not exceed 400 kilograms, while its size should be verified. However its speed is limited only by traffic signs.



Picture 8. Squid 1.0E – electric motor powered Squid. (Maria Mosunova)



Picture 9. Squid 1.0H – hybrid powered Squid. (Maria Mosunova/Ilya Sokolov)

Detailed description of Squid platforms specifications:

Squid 1.0E

Size - L:200cm W:120cm H98cm

Chassis - tricycle (two wheels on the front, one wheel on the back).

Engine - electric hub motor in rear wheel hub. (250W/25kmh)

Cockpit - closed cockpit for one person.

Base - fully electric (without pedal force). Two pedals placed in the front of cockpit are only for accelerating vehicle and stopping it.

Batteries - in the bottom of the vehicle multisection Li-ion batteries.

Squid 1.0H

Size - L:200cm W:100cm H140cm

Chassis - tricycle (two wheels on the front, one wheel on the back).

Engine - electric hub motor in rear wheel hub. (250W/25kmh)

Cockpit - closed cockpit for one person.

Base - hybrid (with pedal force).

Batteries - in the bottom of the vehicle multisection Li-ion batteries.

Steering - wheel with brakes and accelerator placed on the steering wheel. (Alternative tricycle steering handlebars)

Squid 2.0E

Size - L:240cm W:120cm H100cm

Chassis - tricycle (two wheels on the front, one wheel on the back).

Engine - electric hub motor in rear wheel hub. (250W/25kmh)

Cockpit - closed cockpit for two persons.

Base - fully electric (without pedal force). Two pedals placed in the front of cockpit are only for accelerating vehicle and stopping it.

Batteries - placed in the bottom of the vehicle multisection Li-ion batteries.

Steering - steering wheel with touch screen and control buttons.

Squid 2.0H

Size - L:240cm W:100cm H140cm

Chassis - tricycle (two wheels on the front, one wheel on the back).

Engine - electric hub motor in rear wheel hub. (250W/25kmh)

Cockpit - closed cockpit for two persons.

Base - hybrid (with pedal force).

Batteries - in the bottom of the vehicle multisection Li-ion batteries.

Steering - wheel with brakes and accelerator placed on the steering wheel. (Alternative tricycle steering handlebars)

Squid T

Size - L:240cm W:100cm H140cm

Chassis - tricycle (two wheels on the front, one wheel on the back).

Engine - electric hub motor in rear wheel hub. (250W/25kmh)

Cockpit - closed cockpit for two persons.

Base - hybrid (with pedal force).

Batteries - in the bottom of the vehicle multisection Li-ion batteries.

Steering - wheel with brakes and accelerator placed on the steering wheel. (Alternative tricycle steering handlebars)

Squid M

Size - L:220cm W:140cm H100cm

Chassis - tricycle (two wheels on the front, one wheel on the back).

Engine - electric hub motor in rear wheel hub. (4KW/45kmh)

Cockpit - closed cockpit for one person.

Base - fully electric (without pedal force). Two pedals placed in the front of cockpit are only for accelerating vehicle and stopping it.

Batteries - in the bottom of the vehicle multisection Li-ion batteries.

Steering - steering wheel with touch screen and control buttons.

Squid LM7 TESVEKA Hybrid (Picture 7)

Size - LM7 class dimensions.

Weight - 400kg maximum.

Chassis - 4 wheel

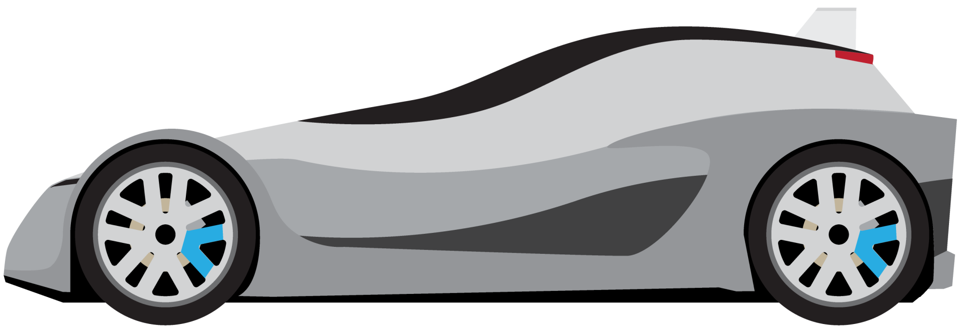
Engine - electric motor placed on the rear of the car (RWD).

Cockpit - closed cockpit for two persons. Driver seats in front of a passenger.

Base - fully electric (without pedal force). Two pedals placed in the front of the cockpit are only for accelerating the vehicle and stopping it.

Batteries - placed in the bottom of the vehicle multisection Li-ion batteries.

Steering - steering wheel with touch screen and control buttons.



Picture 7. LM7 Tesveka Hybrid prototype. (AI Illustrator - Ilya Sokolov)

Prototype production schedule 2016-2017:

Squid 1.0E and Squid LM7 TESVEKA hybrid - Spring, summer 2017

Squid 1.0H - Autumn 2018

Squid 2.0H - Winter 2019
Squid T - Spring 2020
Squid 2.0H and Squid F - Summer, autumn 2022

Detailed explanation of parts and technologies used in the process:

Body: Carbon fiber base with carbon fiber frame and fiberglass top part combined with polycarbonate glass. Carbon fiber protected cockpit.
Chassis: Metal fishbones, shock absorbers covered by carbon fiber shell.
Steering: Steering wheel, steering rack, tie rods, steering tips
Wheels: Front: two wheels 22”, Rear: one wheel 24”
Windshield: Polycarbonate curved glass with aluminum frame.
Light elements: Polycarbonate protected led-lamps with lenses and reflectors.

5.3 Squid open source community and its’ impact on the project

Especially for the needs of the Project Squid, Joensuu Science Park has helped me to create an open source design community – “Future Traffic – Now”. With the help of Joensuu Science Park and the open source community E-cars – Now, we organized a series of events concerning Project Squid and its implementation. The first event took place on the 29th of October 2015 in Joensuu Science Park.

The event was focused on things that are forming the future of traffic:

- Emission free traffic: now and tomorrow;
- Energy efficiency: technology and batteries;
- Building electric vehicles: converted cars, motorcycles and bicycles;
- Open software & hardware business models;
- Connecting all interested sides in developing future traffic.

The program of the event was separated into three main parts:

- Speakers’ presentations;
- Exhibition;

- Workshops.

We were able to attract a lot of interest about the event in the local press and local communities. The Karjalainen newspaper issued a big article about the event that was opened by the regional mayor – Kari Karjalainen. (Karjalainen 26.10.2015). With the support of various organizations Future Traffic – Now was able to attract more than 80 participants and experts from the electric vehicle industry. These are the themes that were presented at the event:

- Now! (and then) - Lessons learned from an open hardware project that was to revolutionize the auto industry / Jiri Räsänen, e-Cars – Now! Community
- Open Source as a Business Model / CEO, Jussi Hurskainen, Arcusys Oy
- Using Open Hardware in R&D / CEO, Henry Palonen, PalonenLABS
- Working with NASA - how to develop epic solutions / Heikki Immonen, Karelia AMK
- Squid – Open hardware Electric tricycle project / CTO, Ilya Sokolov, ISTLE Bicycles

The exhibition was represented by:

- eCagiva Electric Motorcycle;
- Renault 50 Volt;
- Voltti-auto, an Electric VW Transporter by Ula-Sähkö;
- Electric Bicyles by Karelia AMK;
- Electrobike Helsinki;
- ABB.

It took me three weeks to prepare and facilitate all the workshops. I separated the participants into teams of 6 people or more. The teams consisted of designers, engineers, managers and a presenter. Each team chose an assignment that they would like to work on. Teams had 60 minutes to work on a chosen idea. Every team had professional assistants who helped them with the challenge. After the working process, each team presented their solution to the problem or challenge in a 5-minute visual presentation. The presentations were also done by gathering the results on post-it -notes from the “workshop wall”, and every one had the opportunity go and check them before each team gave their summaries. After the presentation experts gave professional feedback on the topics.

We gathered the results of the workshops on post-in-notes. Post-in-notes showed me following:

- What was learnt;
- Answers to the questions and challenges;
- How the work of the community should be organized after the workshop.

All workshops were separated into the following topics:

- SQUID: Technical problems
- SQUID: Design problems
- SQUID: Open hardware as business model
- SQUID Building local and global community
- SQUID: Infrastructure & user community
- Driving electric: Possibilities and difficulties

Especially for the workshop I had gathered the best experts from different spheres of activity who could contribute to the workshop work process:

- Jiri Räsänen: Jiri is skilled in open source community building, society, the big picture (history, future), and also charging solutions for electric vehicles;
- Teijo Makkonen: Teijo is skilled mainly in building converted electric cars;
- Ari Pikkarainen: Ari is skilled in building a converted electric car and teaching the basics of electric vehicle conversion;
- Henry Palonen: Henry is skilled in building electric vehicles, EV technology, programming, embedded technology, testing and 3D printing;
- Ilpo Pohjola: Ilpo’s main skills are: communities of practice and start ups;

- Santeri Lanér: Santeri's main skills are: community building, society and the big picture;
- Daniil Illarionov: Daniil's main skills are: business administration, management.

5.4 Conclusions from work of the open source community

These are the results and ideas regarding the workshop:

Concept idea:
The concept might consider some solutions regarding a trailer, specifically a two-or three wheeling trailer stroller (single and two-seater children carrier stroller). Alternatively it might be a child's place (or two) inside of SQUID (family-friendly model of SQUID). Passenger (children) safety must be taken into consideration

Technical features of SQUID concept idea:
Implementation of heated air ventilation into the SQUID model designed for countries with cold climates (for instance, Nordic countries). Consideration of a ventilation and air purification system in the SQUID model developed for a polluted megalopolis (Asian countries). Air-conditioner for SQUID models oriented to tropical countries.

Vision Design of SQUID:
Joints of the elements/parts of the body of SQUID should be designed and attached in consideration of pressure drag.

Prefabricated elements of the shell of SQUID:
The scale of the prefabricated elements of the shell should meet the body's volume and requirements according to mechanical production (consultation with the experts is required). Advantages: replacement of worn-out or destroyed parts/elements is easier and less expensive than a cast body where the replacement of the entire shell would be needed. Disadvantages: prefabricated system of the body is less vandal-proof.

Cast body of SQUID:

Advantages: a high degree of anti-vandal functionality compared to a system containing prefabricated elements of the body. A material of high resistance is required. Assembly costs might be less expensive.

Disadvantages: Damaged shell means the replacement of the entire body, which is a cost issue.

Marketing strategy:

Online money transfer (such as PayPal, Azimo money transfer or Yandex money for the Russian market) might be taken into account for a certain group of customers.

Carbon footprint:

Obtaining the carbon footprint certificate is a key to the Nordic market (it is applicable to the entire world: Asia, USA, Australia and so on). All relevant information regarding the benefits and requirements of the carbon footprint is available via hyperlinks provided in the references.

6 CONCLUSION

It is difficult to anticipate the future and accurately determine future trends. Instead of predicting what will be happening after a while, it is more logical try to define the ways the bicycle industry is developing and then compare them with the modern trends. I was able to obtain approximate models of possible future development. However, this was not the core concept of my research. As a designer I would like to create a bicycle that will comprise all successful technical solutions and has a sufficient level of comfort.

The inspiration from my design process came from works of Vilem Fusser, who was a great design theorist. Through this research I tried to show the possible means whereby a human is able to trick nature even more.

When I created an open source project I did not expect that there would be so much interest around it. I was able to gather a lot of interested people with different kinds of expertise in the project core and active groups. Those people were working because of different motives, but I coordinated them all. The main lesson that I have learned from the open source design process is: as long as we had challenges to work on, the members of the community were interested to contribute.

I directly connect the success of Project Squid with open the source model that was selected by me from the beginning. The research process, design process, implementation process and improvement process is proceeding faster in the case of using the open source model.

It is hard to say and draw future plans regarding the implementation process of my design. What I am capable to do at the moment is to prepare an open design guideline for enthusiasts and companies, which has been this thesis text.

During the design process I had a lot of opportunities to experiment with energy saving and aerodynamic solutions. The initial design has changed from the starting point of the project. It happened just because Project Squid needs to be energy efficient to prove its name.

Based on the results of the research and design work, we were able to create an open source library. This thesis is nothing but a guideline for enthusiasts who want to create open source communities and build similar open source design projects.

The project has extensive future potential. It may become one of the most widely used means of transportation, because everyone, including the elderly and disabled, could use it. It may as well become a bank of the future, using widespread cycle network and a system of plastic key cards (these could be bank cards).

For Project Squid I have planned a new marketing and design approach. I understand that traditional ways of thinking and spreading out ideas are not relevant any more. That is why I will be using a revolutionary service subscription scheme. It assumes that clients will not need to own these tricycles to ride them. To become user of the system the client will need to be subscribed to it and hence have a key card. Then user of the system will be able to ride any spare vehicle according to his/her subscription balance. I am also planning to build a wide network and expand it as widely as possible.

Concerning the investments and implementation processes, I have created an efficient action plan, a design approach and an open source design guideline book, which is this thesis. I am currently tightly cooperating with a great number of different specialists in pursuit of embodying this project.

REFERENCES

1. Alexander Hars, Shaosong Ou. 2001. Working for Free? – Motivations of Participating in Open Source Projects
2. Cornelius Raasch, Cornelius Herstatt, Kerstin Balka. 2009. On the open design of tangible goods
3. David Herlihy. 2006. Bicycle. The history
4. David Gordon Wilson, Jim Papadopoulos. 2004. Bicycling Science
5. Görgens-Albino & Jody Kusek. 2009. Making Monitoring and Evaluation Systems Work: A Capacity Development Toolkit
6. Kenda Earns Carbon Footprint Certification: An example of Carbon footprint certification in bike market (7.11.2015)
7. Lakhani, K.R.; von Hippel, E. 2003. How Open Source Software Works: Free User to User Assistance
8. Luis Vivanco. 2013. Reconsidering the Bicycle: An Anthropological Perspective on a New (Old) Thing
9. Nordic Environment Finance Corporation: Carbon Finance and Funds (6.11.2015)
10. Patrick Duin. 2006. Knowing Tomorrow: How Science Deals with the Future
11. R1 Atom Media Kit. 2014
12. Rubov. E. 2008. Open Source Hardware
13. Thomas Telford. 2001. The Value of Urban Design
14. Tony Hadland, Hans-Erhard Lessing, Nick Clayton. 2014. Bicycle design: An illustrated history
15. Vilem Fusser. 1999. Shape of things. Phylosophy of Design

https://www.sciencedaily.com/terms/cephalopod_intelligence.htm https://en.wikipedia.org/wiki/Moped

http://www.myclimate.org/?gclid=CMb8jfyF_MgCFYILcwod4JUDiQ

https://money.yandex.ru/new

https://creativecommons.org/examples/

http://www.biketaiwan.com/resource/article/9/619/article-26.pdf

http://www.nefco.org/financing/carbon_financing?gclid=CKq1w8mJ_MgCFYHDcgodpq0Arw

Appendix 1

Workshops follow up:

Workshop: Project SQUID - Industrial design challenges

- Moderator – Ilya Sokolov
- Beginning
  - Ilya gave some in-depth info about Squid-project.
- Questions and challenges
  - **User interface challenge:** How to get in? Think of a convenient way to get inside the Squid without using ordinary car doors;
  - **Parking challenge:** How to park your Squid? Think about how parking and charging of Squids could be organized
  - **Tourism challenge:** How could we improve Suid interface so it could be used in tourism? Think about the way how to make Squid more attractive for tourist use.
- Missions:
  - Build a convenient vehicle arround user;
  - Create an infrastructure for Squid in a city environment.

Workshop: Project SQUID - Business challenges

- Moderator - Daniil Illarionov
- Beginning
  - Daniil gave some in depth about creative marketing and business approach for a creative field Startup
- Questions and challenges
  - **Marketing challenge:** How can we sell more? Think about the best marketing approach for the Project Squid if its' price ranges from 10000€ to 20000€;
  - **Business concept challenge:** How can we create a strong business? Think about a business model for Squid which is most suitable for European (Scandinavian) business environment.
- Missions:

  - Make Squid available for everyone;
  - Build business from a creative idea.

Workshop: Project SQUID - Engineering and Programming Challenges

- Moderator – Henry Palonen
- Beginning
  - Henry and Petteri told participants more about workshop-related topics: Adaptive suspension; recuperation and batty technologies.
- Questions and challenges
  - **Suspension challenge:** How to make Squid adjustive? Think about a way how can we build an adaptive suspension. So wheelbase could change its' parameters according to the need of environment (bicycle lane, motorway etc.)
  - **Recuperation challenge:** How to save more energy? Think about the way to recuperate energy from moving, braking etc.
  - **Battery challenge:** What kind of batteries should we use in Squid? Think about the most reasonable way and place to mount battery elements on Squid. Also think about their structure and type.
  - **Electric motor challenge:** Where they usually mount an electric motor on a tricycle? Think about the most reasonable way to mount an electric motor on a tricycle.
  - **Programming challenge:** What kind of programming skills are needed in a project like squid? What different kind of services there could be on board the Squid and in your pocket as mobile apps? What kind of know-how we need in community about programming? What kind of learning possibilities there are? Is there business opportunities? How to use the knowledge in Squid-project?
- Missions:
  - Make Squid more technological advanced;
  - Create legacy/knowledge for other Squd-like projects.
  - Make EV more user-interactive by means of the softwarte

Workshop: How to build an EV conversion

Moderator: Santeri Lanér.

- Experts: Ari Pikkarainen and Teijo Makkonen.
- Beginning
    - Ari and Teijo told “making of” stories of Voltti car and 50volt car.
- Questions
    - Why do we need to build an EV conversions? What are the benefits, as a vehicle, project or learning process?
    - How to use the knowledge from Voltti and 50volt projects to build something new?
    - What would be interesting projects? Could these projects be doable by the Future Traffic Now - community?
        - Road vehicles;
        - Out-roads vehicles.
    - How to combine business, education and hobbyist in the project?
    - How to get funding for projects?
    - Future of Voltti and 50volts - can we find ways to take the projects further by the help of the community?

Workshop: Building the momentum - how to make a real impact with the community?

- Moderator: Ilpo Pohjola.
- Experts: Timo Tahvainen and Jiri Räsänen
- Beginning
    - Ilpo told more info about the community
        - Where community was;
        - Where community would appear in one year;
        - What help did we need.
- Questions
    - Ideas how to build up the momentum? What should be done?
    - Who should be involved in the community? How we can attract those people?
    - How can different organisations help?
        - NGO’s, education organizations, city etc.

- What kind of projects we should have?
- How to combine business, inventors, hobbyist and education in the projects?
- How to make business spinoffs / startups from the projects?

Appendix 2

Pictures that were not included into the main text (Maria Mosunova)