



CHALMERS



A Mobile Application for Public Transport - How can gamification be used to promote the use of electric buses for a sustainable future?

Master of Science Thesis
in the Interaction Design and Technologies Programme

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Launcher icon for the Android application created in this thesis, see section 4.

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Abstract

Chalmers introduced a new challenge-driven lab, called Challenge Lab (C-Lab), in year 2014. We (two master students) and ten other students are the test pilots for this new type of education at Chalmers. The first part of this thesis is about the entire C-Lab process, where the C-Lab team met with different stakeholders in three sectors of society; the public sector, the private sector and the academic sector. This gave us a broad sustainability basis to help us form our own sustainability-related research question. When the research question was found we started the second part of the thesis.

How can gamification be used to promote the use of electric buses for a sustainable future?

This part is based on our education as Interaction Designers, where we use an iterative design process, making both low-fidelity and high-fidelity prototypes, involving users in the testing and evaluation process in the creation of a gamification service for public transport.

Keywords: Challenge Lab, Interaction Design, Augmented Reality, ElectriCity, sustainable public transport, gamification, stakeholders, Android, Google Play Services, mobile development, Wikitude SDK

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Glossary

C-Lab - The Challenge Lab

MLP - Multi-level perspective

IxD - Interaction Design

AR - Augmented Reality

ElectriCity - Open innovation project for electric buses

Eclipse - Development tool

Wikitude SDK - SDK Platform for Augmented reality

OS - Operating System

Google Play Services - Cloud platform for making games, leaderboards etc.

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1

Introduction

Since the beginning of human history man has used earth's resources to improve living conditions and due to the fast population growth and the ever growing economy with increasing energy and material demands, earth has reached significant boundaries. Today earth's resources are restricted, the natural assimilation capacity is limited while at the same time land area is becoming a restriction.

However, the world woke up to some extent because of the Rio Declaration on Environment and Development (United Nations General Assembly, 1992) at the United Nations Earth Summit, seeing the unsustainable growth in many sectors of human life, among others; mobility and transportation. One causing factor to this is the global population explosion. The world population reached 7 billion in 2011, a growth of nearly 3 times from only 60 years ago, as can be seen in Figure 1.1.

The population increase is commonly explained by technological revolutions; the tool making revolution, the agricultural revolution and the industrial revolution. These revolutions allowed humans access to for instance more food, resulting in larger populations. The growth is however slowing and future growth is mainly in Asia and Africa (United Nations, 2003).

Man has always moved around from one place to another and has transported materials and goods to improve living standards. Near the end of the 20th century the belief in an everlasting growth in mobility and transport started to fade (Greene and Wegener, 1997).

One of the reasons behind this are the energy shocks in recent decades and the rush of strong military superpowers to control energy resources. Especially oil has been in the global spotlight. The global urban transition has made transportation a necessity to be concerned about, as can be seen in Figure 1.2. This calls for new ways of thinking, attitude change, technology innovation and IT applications to solve sustainability issues.

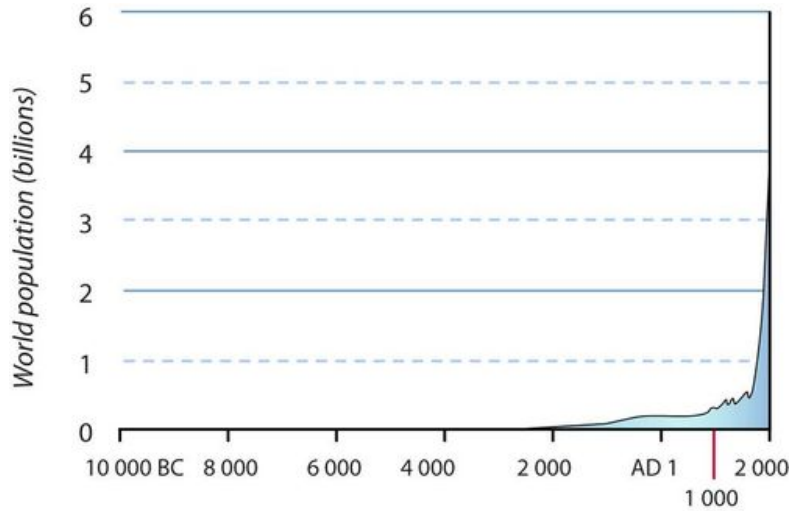


Figure 1.1: Graph of human population from 10,000 BC-2000 AD (CK-12, 2014)

The top 20 mega cities by 2025 will be:



Figure 1.2: Top 20 Megacities by 2020 (Frost & Sullivan, 2010)

Already in 2007, about 72% of the European population has had the trend of living in urban areas. Urban areas today have a growing need to change the transport system while facing huge challenges of easing congestion and reducing CO₂ levels, noise and air pollution; as well as addressing social concerns (Commission of the European Communities, 2009).

Since 2009 more than half of the world's population resides close to urban areas and in 33 countries, 80% of the population or more live in urban areas. Urban growth has exceeded governmental expectations of building infrastructure which is fundamental for urban residents. Because of this, one in three urban residents live in poor neighborhoods or in informal settlements (World Health Organisation, n.d.).

The result of these developments has been and still is that humans are using up the resources of our planet to an extent which is not sustainable. The amount of vital renewable and nonrenewable resources per person is currently declining fast. This fact, explained by World Population Balance (n.d.) is causing *massive social and environmental problems, such as political instability, loss of freedoms, vanishing species, forest destruction, desertification, garbage, urban sprawl, water shortages, traffic jams and accidents, toxic waste, oil spills, air and water pollution and increasing violence and crime.*

Measures being taken, according to WWF's Living Planet Index, to natural systems such as ocean freshwater, health of forests etc. are on a downward spiral by 35%, in the earth's ecological health, ever since 1970s (World Watch Institute, n.d.).

Above all, humans have far too long taken the photosynthesis for granted, the generator for our nutrients, fresh air, clean water and renewable fuel in its different forms. In urban planning too little thought has been given to improve a sustainable environment for nature's own regeneration capacities. Resources must be distributed fairly and efficiently, much like the green city concepts today aim to do, since it is no longer just about reducing fuel consumption and carbon emissions. To meet basic human needs, nature must not be impoverished by over-harvesting or in any other form of ecosystem manipulation. It is a fact that humans move around and that mobility will never disappear, which means that the means of transport, for either products or travellers, clearly have an impact on the environment. Approximately a quarter of the environmental impact is caused by the energy consumption of the transport sector (POWER, n.d.).

The terms sustainable mobility and transportation came into use after the world woke up to the pressing need for sustainable development. Since then, a lot of world forums have been created under UN leadership (Commission on Sustainable Development, CSD) in order to increase awareness of sustainable development. The European Commission adopted the Action Plan on Urban Mobility (Commission of the European Communities, 2009) for sustainable urban mobility in order to guide communities towards sustainable actions.

The EU Council of Ministers of Transport defines a sustainable transportation system as one that:

1. *Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.*
2. *Is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development.*
3. *Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rate of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise (Litman, 2008)*

A lot of research and work has gone into establishing the non-sustainable present development, but solutions to counteract the unsustainable development has been slow so far. Awareness of these consequences is certainly one factor that should be addressed even stronger in the future. Nevertheless, the emerging information technology is still a vastly untapped tool to implement a sustainable future where a population of about 10 billion people is able to meet their own needs, within the planetary boundaries without compromising the ability of future generations to meet their own.

1.1 Background

1.1.1 What is Challenge Lab?

The Challenge Lab is a pilot run created by Chalmers for targeting the transport sector of Gothenburg, to direct a sustainable workflow with 12 master program students to act as change agents for complex societal challenges that the transport sector faces today.

The Challenge Lab (referred to as C-Lab) will engage the public, local, international, societal factors of the present and future through collaboration with stakeholders from the academia, industry and public sector. In the transdisciplinary C-Lab group, teams have been formed to meet these challenges within sustainable development in complex systems. The first challenge that C-Lab has taken on is: Sustainable Mobility and Transport.

The C-Lab group aims to inspire change in complex matters, in order to fill up the void often created by common strategies for infrastructure, resource shortages, industry clusters, urban developments, land use and energy for the society.

The C-Lab team connects; initiates and searches leverage points within the system in order to bring companies, the public sector and academia together - to then suggest solutions to take all sectors in society forward.

"A new type of thinking is essential if mankind is to survive and move toward higher levels"

(Einstein, 1946)

1.2 Aim and objective

Our starting point in C-Lab will be to develop an understanding of how an interdisciplinary team can interact with stakeholders to create a sustainable world that will not deplete us from our natural resources. This part of the thesis will describe the C-Lab method, more commonly known as the C-Lab process, how the research question was defined and finding where to intervene in the transport system of Gothenburg.

Including this, the project section will describe how information technology can contribute to the needs of the everyday traveler for a sustainable society in the transport system. By acting locally we have the long term view that the public transport system in the Västra Götaland region will not only act as a role model in Sweden, it will also show the rest of the world where it needs to be.

The hope with this project is that it will attract more commuters to use public transport and bring social awareness towards sustainability with the help of a mobile application through gamification. The main focus will be to develop a prototype of how the app would work in a gamification setting, with the help of user testing and how it could promote sustainability for the ElectriCity project. We have based our research question on: A mobile application for public transport - How can gamification be used to promote the use of electric buses for a sustainable future?

1.3 Scope and limitations

The thesis is limited to evaluate what the current situation is in the transport and mobility area of Gothenburg together with delivering an insight of different parameters that affect global sustainability challenges. The thesis does not provide a full theoretical background to all the components of C-Lab, but focuses on the tools used and the C-Lab method itself.

Other key areas ranging from what information was gathered in the C-lab process and our own findings which supplement the second phase will also be added.

For the project phase user tests will be held to assess the gamification values from expert users as well as everyday users of the prototype. The prototype of the app is intended to be part of the ElectriCity project that will commence in 2015.

1.4 Outline of thesis

This thesis is divided into 7 chapters which are as follows.

Chapter 3 describes the outside-in perspective in C-Lab with methods, tools and frameworks used to produce results that are found in this iteration. The research question is formulated by the C-Lab when finding a target area for the project during this phase.

Chapter 4 describes the inside-out perspective through leadership modules, self-leadership, dialogue tools and the MLP perspective with transitions and design thinking.

Chapter 5 explains the gamification project at hand, defined by the research question.

Chapter 6 discusses the findings and results from the user studies within the gamification project and reflects on the C-lab process as a whole.

Chapter 7 describes the conclusion of the project and the gamification research.

Chapter 8 finalises the thesis with recommendations for C-Lab and future work.

2

Outside-in Perspective

This chapter will explain the global challenges the world faces today and gives an outside-in perspective on the sustainability issues gathered in C-Lab.

2.1 The C-Lab process

The C-lab process had a long preparation phase where literature studies, theories, tools, methods and stakeholders were gathered to help identify global sustainability issues and find leverage points in the system. The first weeks started with understanding the challenge and having an outside-in perspective on the global situation. Specifying what a sustainable future is can only be achieved if we understand what the current situation is and how complex the matter is. To help us define what a sustainable future is, we used a method called backcasting (Holmberg, 1998) which became an iterative tool for the global sustainability criterias. We also mapped the groups' sustainability goals with the help of a compass which was divided into four different sustainability areas to see where the shift was most affected. Another tool we used as well was the Funnel, showing where increasing demands and decreasing supply meet each other and adding this to research of current unsustainable trends.

The inside-out perspective on the other hand was meant to support the core values of the team and use the given dialogue tools to further strengthen the group internally and externally. The leadership, self-leadership and the dialogue tools were not only tools to inspire and envision, they were also there to help the teams improve and to interact with the different stakeholders (finding out their agenda) as well as keeping the communication flow open in the C-lab group.

Including this, different system theories were introduced during the C-Lab phase,

such as the multilevel perspective that transitions sociotechnical systems from niche to regimes, together with innovation systems to understand how the transitions occurs.

Lastly, to characterize the system and define the leverage points (hot spots) we used design thinking to formulate the project idea for the thesis. Figure 3 shows the overview of the C-Lab process for working with complex sustainability issues.

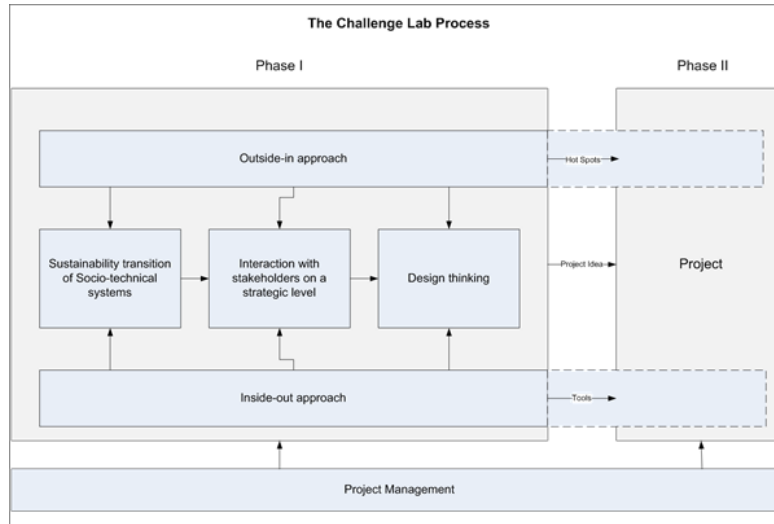


Figure 2.1: The C-Lab Process

2.1.1 The Compass

In the very beginning of the C-Lab process we used a sustainability compass to identify 4 different areas of where the sustainability challenges lay. This was done in order to see where the shift was most affected. To help us map them, every challenge was named according to the directions of the compass. N for Nature, E for Economy, S for Society and W for well-being.

Nature refers to the health of the environment and the sustainable caretaking of the ecosystem with natural resources. Economy refers to the product and service system that the user requires or simply wishes to have. Society refers to the departments, structures and collaborative actions of people in which societal systems are built upon. Well-being refers to monitoring the individual happiness and health standards of people. Its four sectors is a way to map indicators and challenges for sustainability issues, to find the sector with the biggest potential for sustainable change, which is inspired by the work of Daly (1973).

The measurements of the compass were done by first having a brainstorming session where the C-Lab group wrote down sustainability issues that would show which area had the most challenges to make a change in. The sustainability issues were listed for each

direction of the compass, for example some challenges might have been solely in the well-being section, and those were listed in the west side of the compass. If some challenges were interrelated or did not have a specific group then those sustainability issues were placed in between the compass markers. This tool is based on AtKisson (2008) sustainability compass, but does not necessarily follow all the steps in the process of identifying the challenges.

The findings of the compass can be put into perspective with the following question:

What affects the current system and what is needed to overcome these issues to make a change?

N for Nature

In this section the C-Lab group mapped out challenges such as:

Fossil fuels, global warming, reducing environmental impact, increased pollution due to transportation, substance quality, air quality, kg of GHGs, particle concentration, radioactive waste, ecotoxicity etc.

Surprisingly this section was the one with the least listed sustainability issues, however the challenges this section faces are interlinked with the society section where one could say; in order to put nature back into kilter a societal change is needed first.

E for Economy

In the economical part one can see that this section is much influenced by the supply and demand aspect of resources. These are the economical challenges listed:

Resource scarcity, vehicle cost, GDP, feasibility of innovative technologies, product competitiveness, supply chain, market demand, utilisation of resources, supply of public transport, manufacturing costs, income, emission costs, taxes, infrastructure lifetime, sustainable investments etc.

S for Society

The largest change needed in the compass was seen in the society section, since it encompasses a very broad spectrum of sustainability issues. Realising this, the other compass directions can be seen as a view of sublevels for the society section. These are the listed society challenges:

Collaboration between nations, social equality, behavioural change, adaptation, global consciousness, increasing population, cross cultural interaction, commitment by politicians, urban planning, population density, areal growth of cities, wealth distribution, happiness index, trust vs value, public transport scheduling, living standards etc.

W for Well-being

The well-being section in the compass can be seen as something very personal and apparent that most people tend to forget about. Nevertheless, evaluating what people actually want is an important part of a sustainable system. These are the listed well-being challenges:

Comfort, coverage of transport system, personal security, punctuality, technology adaptability, time spent, recreational possibilities, satisfaction, personal equality etc.

2.1.2 Backcasting

Backcasting can be seen as a strategic approach for sustainable development (Holmberg, 1998). It is a tool that starts its planning with a desired future and how to reach that imagined outcome to be carried out into the present. It does not predict the future, instead it asks the question what is needed today to reach that outcome?

This type of reasoning does not limit itself to just forecasting some outcomes, instead it envisions and adds creativity to implement projects of today for the future.

Defining criteria for a future sustainable situation as a guide for today's measures has proved superior to traditional forecasting for strategic planning (Rob  rt et al., 1997).

Complex systems will always need a transdisciplinary approach and utilising backcasting with sustainability principles, can give a better understanding of what the constraints are, in order to operate within these current trends. To clarify this, backcasting can be especially useful when:

- *The problem to be studied is complex.*
- *There is a need for major change.*
- *Dominant trends are part of the problem.*
- *The problem to a great extent is a matter of externalities.*
- *The scope is wide enough and the time horizon long enough to leave considerable room for deliberate choice* (Dreborg, 1996; Holmberg and Rob  rt, 2000).

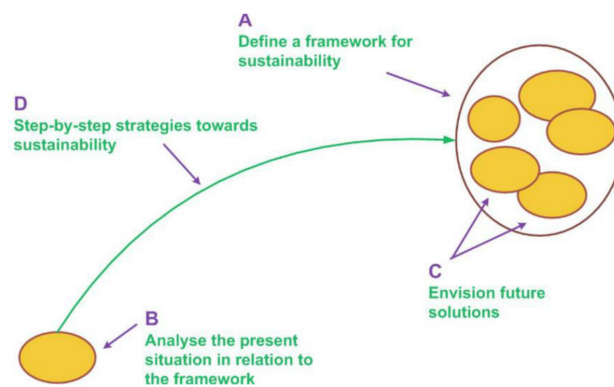


Figure 2.2: The Steps in Backcasting (Holmberg, 1998)

Figure 2.2 shows the different steps in backcasting. However, sometimes it might not be easy to get large groups to agree to a common vision or a future scenario. At times scenarios may be too specific and when that happens creativity and innovative ideas get limited during the process.

Strategic sustainable development depends on the principles of backcasting, for example these so called sustainability principles should represent something that can be agreed upon and be based on scientific facts. If these principles are not taken care of then society is unsustainable. To have a sustainable society, these principles have to be attended to in order to achieve an outcome on principle level.

Since the framework is constituted by principles, it is only useful for the overall structuring of relevant questions, thoughts and measures. There will always be a need for more knowledge to make the framework function efficiently during the transition towards sustainability, for instance in order to make appropriate priorities (Holmberg and Robèrt, 2000).

These are the steps to follow when defining important criterias for sustainability. This method is concerning the criteria of a sustainable future.

Defining criteria for sustainability:

1. *Subject to increasing concentrations of substances extracted from the earth's crust.*
2. *Subject to increasing concentrations of substances produced by society.*
3. *Impoverished by over-harvesting or other forms of ecosystem manipulation.*
4. *Resources must be used fairly and in the most efficient way so that the basic human needs can be met on a global scale (Holmberg, 1998).*

Step 2 analyses the current activities and competences by describing the situation in relation to the criteria for sustainability. Step 3 envisages the broad future with its possibilities for a sustainable society without being too detailed. Step 4 then finally identifies strategies that can link the current situation together with the sustainable future (Holmberg, 1998).

2.1.3 Global challenges - The Funnel

"The funnel is a tool to visualise current trends, where many aspects of the society are growing. At the same time the planetary boundaries puts a limit to the capacity. The combination leaves a constantly decreasing gap"

(Robèrt et al., 1997)

As stated above, in order to visualize global trends, the funnel is a tool that consists of six different areas called population, economy, material and energy intensity, resource

restrictions, assimilation capacity and finally land area. Including this, it brings together the resembling trends, to generalise the focus area of sustainability. The funnel tool was divided into groups of two, where each group analysed one trend with the help of literature studies and gathered the results on a wall, to be a constant reminder of the unsustainable development worldwide.

Population

The human population has grown exponentially in the last hundred years. History shows that before the industrial revolution the population has grown slowly despite high birth rates, due to high infant mortality, wars and plagues. During the time before the industrial revolution the population was well below 1 billion inhabitants. In 1927 the 2 billion mark was passed, in 1987 5 billion and in 2011 7 billion (BBC News, 2011; Worldometers, 2014). There are various projections for the future, to where the population might reach, however the United Nations gives a projection of about 10 billion by the year 2100.

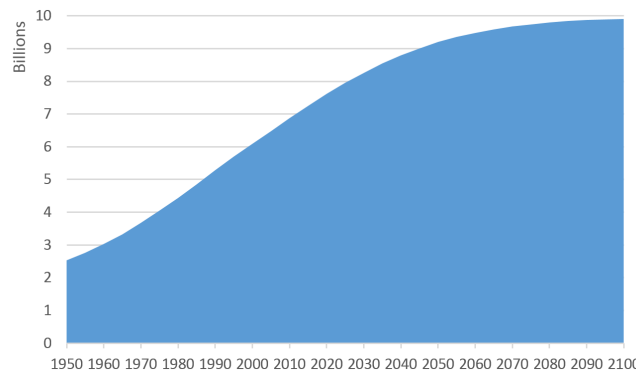


Figure 2.3: World population projection (United Nations, 2012a)

Since 1950 the conditions for dramatic population growth existed, i.e. greatly increased food production as a result of an agricultural revolution. The industrial revolution brought access to better products and consumer goods for mass production. However, a less cited aspect of population growth is the much improved sanitation and great advances in medicine. More newborns survive and people simply live longer. Before these medical advancements were made, around 70% of children died before becoming procreative while today about 95% of newborns in industrial nations come of age (McKeown, 1988). It is also worthwhile to note the much improved educational system, because of which the population growth rates have started to decline. See Figure 2.4.

The population explosion could not have materialised without strong growth towards urban living. In 1800 only 3% of the world's population lived in cities (The Economist, 2007). The forecast by 2030 shows that about 5 billion people will live in cities, which is an increase of more than 60% for urbanised areas (Leighton, 2013). This can also be

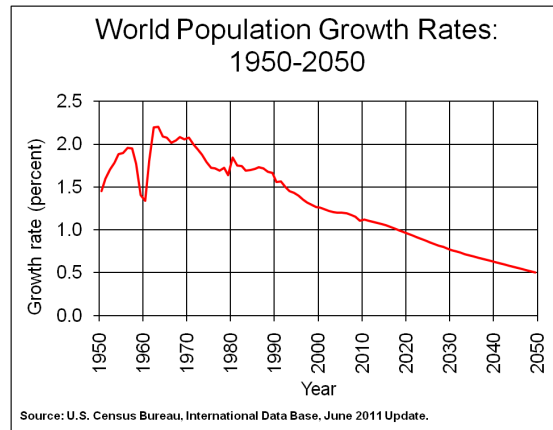


Figure 2.4: World population growth rate 1950 – 2050 (US Census Bureau, 2011)

seen in Figure 2.5.

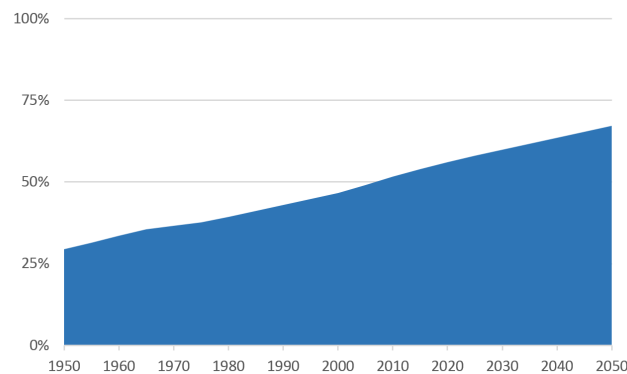


Figure 2.5: Percentage of urban population in the world (United Nations, 2012b)

The urbanisation trend has grown strongly in the developed world as well as in China and India. In the future the urbanisation increase will take place primarily in the poorest continents of Asia and Africa. Unfortunately more than one third of the urban population live in towns which are in fact slums. This gives breeding grounds for social problems and crime (Davis, 2003).

The population density in the whole world is by far the highest in Asia and second highest in Africa, the two areas with the strongest population growth. This can be seen in Figure 2.6.

The explosion of the world's population has called for a definition of the earth's carrying capacity. It has been debated what the carrying capacity of the world is, but definite research is still missing in this area. Because of resource depletion and increased western world abundance, estimates are continuously set lower. Some have suggested a plan B approach of stabilising the present.

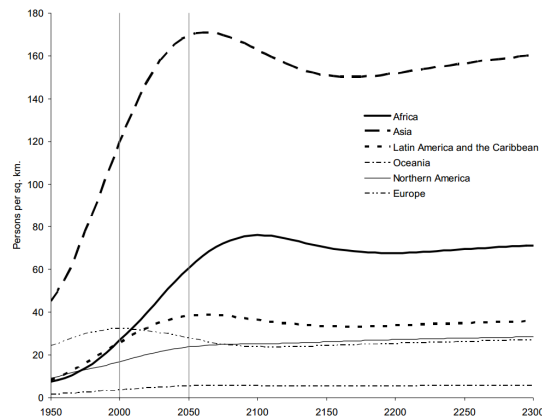


Figure 2.6: Density, major areas: 1950-2300 (United Nations, 2004)

“The Plan B goals—stabilising climate, stabilising population, eradicating poverty, and restoring the economy’s natural support systems—are mutually dependent. All are essential to feeding the world’s people. It is unlikely that we can reach any one goal without reaching the others. Moving the global economy off the decline-and-collapse path depends on reaching all four goals”

(Brown, 2011)

However, Pearce (2009) states that the main threat to population is the over-consumption in wealthy nations. Since Earth’s carrying capacity is still disputed, the fact remains that the bio capacity available per person has dropped significantly, from 3,2 gha (global hectares per person) in 1961 to only 1,8 gha in 2008, a drop of nearly 50% as seen in Figure 2.7 The graph also shows the average per person resources demand, reflecting on both the level of consumption and the efficiency with which resources are turned into consumption products.

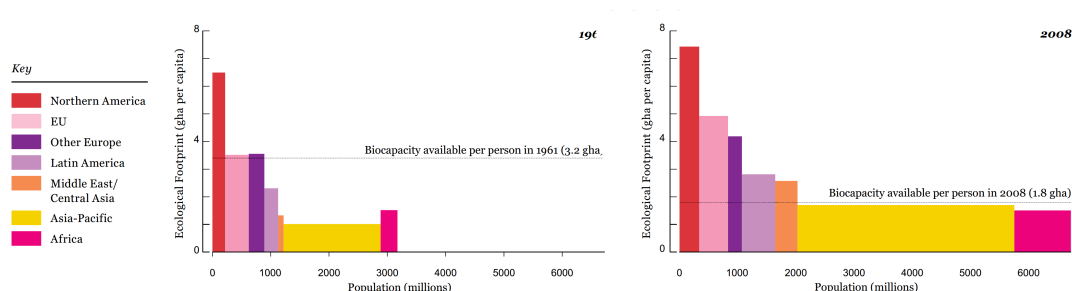


Figure 2.7: Ecological Footprint by geographic grouping, in 1961 and 2008 (WWF, 2012)

Economy

The traditional measure of economic activity is GDP or Gross Domestic Product. The Economist (n.d.) defines the GDP in a simple and understandable way as a measure of economic activity in a country. According to Callen (2012) *GDP measures the value of final goods and services – that is, those that are bought by the final user – produced in a country in a given period of time (say a quarter or a year)*. GDP is important because it gives information about the size of the economy and how the economy is performing. GDP does not take into account unpaid work or black market activities. It does not account for depreciations of machinery and buildings that are used in production.

It is important to understand that GDP is not a measure of standard of living or well-being of a country. Many times GDP per capita is used to compare countries regarding success, but external costs such as environmental damage, noise damage, depletion of nonrenewable natural resources are not taken into account. The quality of life may be deemed only for the elite, averages do not give the correct comparisons for countries. For this purpose the United Nations has developed other measures, such as Human Development Index. This index ranks countries based on life expectancy, literacy, and school enrollment in addition to GDP Callen (2012).

The world economy has grown every year, except for 1 year during the last 52 years as shown in Figure 2.8.

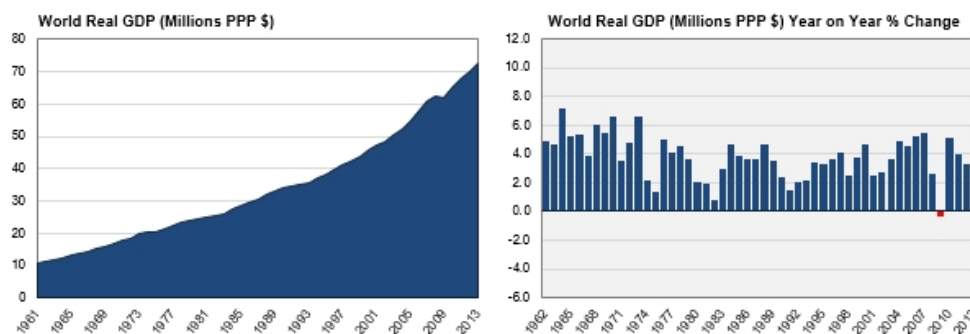


Figure 2.8: World Economy Growth 1960-2012 (Global Growth Tracker, 2014)

Around 1960 to 2012 the GDP growth per annum was 3,6% when GDP per Capita growth was 1,9% according to Global Growth Tracker (2014). The population is growing faster than the economy. However, the charts tell us how important humanity has considered economic growth, as a basis for improving living standards.

The share of GDP in the world has developed very differently in the different continents. Europe, the Americas and Asia seem to have their fair share. Africa is hopelessly left behind.

The real GDP per Capita (PPP \$) level is very low in Africa but also for Asia in comparison to Europe and Americas. In the year 2012 Real GDP per Capita (PPP \$)

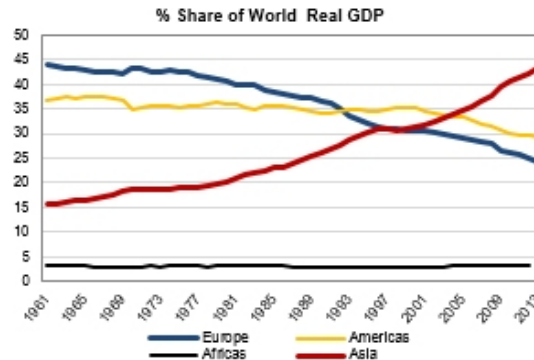


Figure 2.9: World Economy Growth 1960-2012 (Global Growth Tracker, 2014)

was roughly:

Europe \$24.000

Americas \$22.500

Asia Pacific \$7.500

Africa \$2.300 (Global Growth Tracker, 2014).

All continents in the world are expecting growth for the coming decade, with political leaders around the world designing policies and actions to achieve growth at any cost. According to The Conference Board (2014) economic growth is slowing but still growing, in 2014 3,5%, in 2014 to 2019 3,1% and 2020 to 2025 2,4%. Growth per region is displayed in the Figure 2.10.

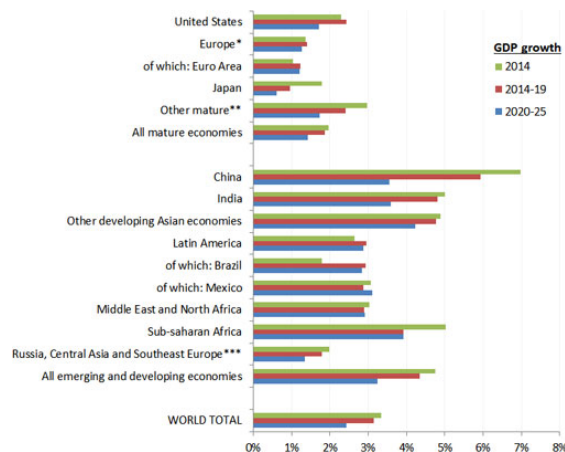


Figure 2.10: Global Outlook for Growth of Gross Domestic Product, 2014-2025 (The Conference Board, 2014)

Figure 2.11 highlights the fact that high GDP goes hand in hand with unsustainable public sector indebtedness and ageing populations, as is the case in Japan and most

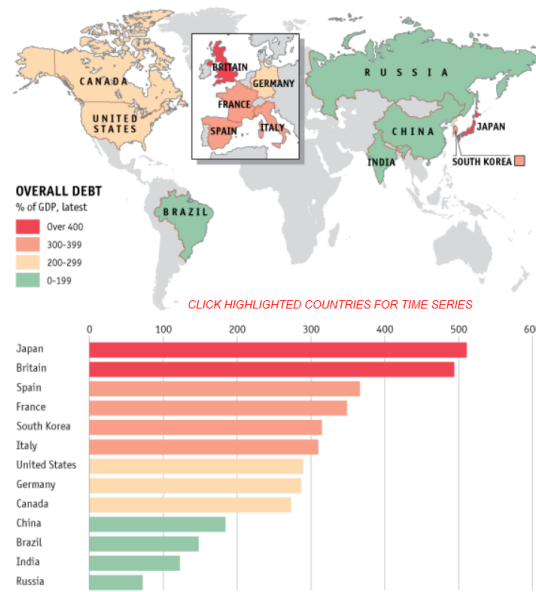


Figure 2.11: Global overall debt in % of GDP (The Conference Board, 2012)

European countries. High GDP also takes the economy towards a service economy as can be seen from Figure 2.12. The service sector's share of the world's added value has grown significantly in the recent decades when the industry and agricultural sectors have declined.

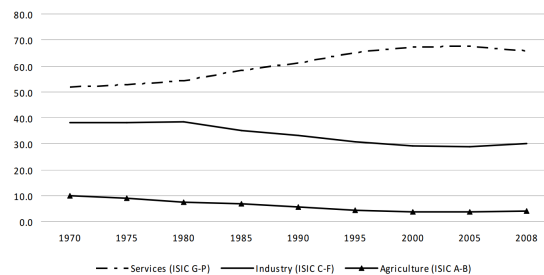


Figure 2.12: World value added by sector (United Nations, 2010)

All three sectors of economic activity are driven by market economy forces. Therefore economic profit is the driving force, with less notice given to sustainability aspects or a fair distribution of wealth globally. Economic activity has led to heavy pollution, environmental degradation and social inequality. Economic activity is closely linked to CO₂ emissions as shown in Graph().

According to The Carbon Brief (2013) China's emissions in 2012 were 3% higher than in 2011. Emissions in the US were down four percent on 2011 levels, and in the

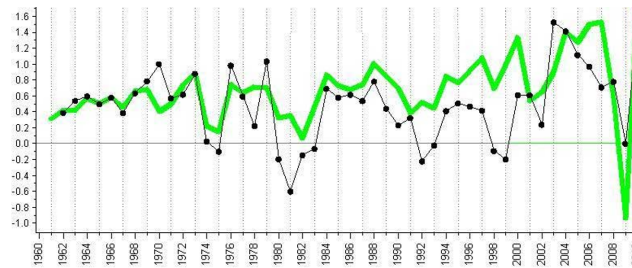


Figure 2.13: Annual growth of world GDP (green line, trillions of USD) and annual change of estimated CO₂ emissions (black line, millions of kt) (Tapia Granados et al., 2012)



Figure 2.14: The highest emissions came from China, the US, and the EU (The Carbon Brief, 2013)

EU they fell by 1.6%.

The three regions of North America, the EU and Asia with nearly 1/3 each of world's GDP are the greatest polluters of our environment. A healthy world with sustainable economic activities and a fair distribution of global wealth is not foreseeable in the near future.

Material and Energy Intensity

The strong population growth during the last century and technology advancements to produce goods, in combination with demand for higher living standards has forced humanity to rethink how goods are produced and what energy input is acceptable. Concepts like “energy efficiency”, “material and energy intensity” have been widely discussed in United Nations forums.

According to the World Energy Council, energy efficiency has a broader meaning than mere technological efficiency of equipment; it encompasses all changes that result in decreasing the amount of energy used to produce one unit of economic output (e.g. the energy used per unit of GDP) or to achieve a given level of comfort. Energy effi-

ciency is associated with economic efficiency and includes technological, organisational and behavioural changes (Peck and Chipman, 2007).

Material efficiency is a widely used concept in industry. It is defined as *the amount of a particular material needed to produce a particular product* (Peck and Chipman, 2007). There are three components in material efficiency; reducing the input amount used to produce a product (generally called lightweighting), waste reduction and recycling.

Energy intensity on the other hand is defined as *the energy required to produce a material from its raw form, per unit mass of material produced* (Gutowski et al., 2013).

Out of the primary energy used for production of materials worldwide, approximately 60% was used to produce only 4 materials; steel 32%, cement 12%, paper and cardboard 10%, aluminum alloys 8% (Gutowski et al., 2013).

Energy intensity consists of mainly two steps, harvesting and refining. In the old days this process was rather simple as it was for example harvesting timber or stone. Refining was mixing and heating bricks and cement. Nowadays the process is much more complicated with metals and minerals. The production processes includes mining, crushing, washing and separation from the surrounding material. Today the refining process itself produces carbon dioxide gases as well as the energy used (Gutowski et al., 2013).

Industry is one of the largest energy consuming end-use sectors in the world today. The consumption of delivered energy to industry in the OECD (Organisation for Economic Co-operation and Development) countries was 30% in 2003. The forecast of energy usage in the industrial sector is to grow 2,4% per year through to 2030. The expected growth in the developed countries is 1,2% and 3,2% in current developing countries (Peck and Chipman, 2007).

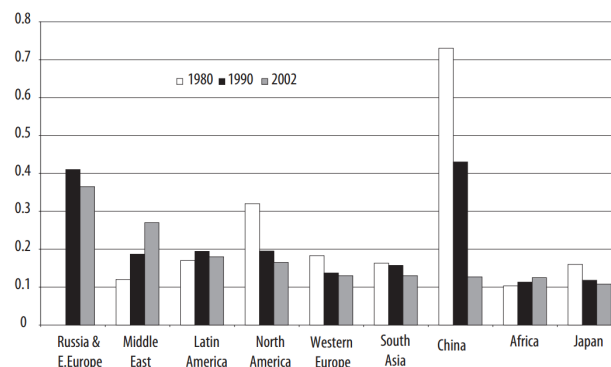


Figure 2.15: Regional variation in industrial energy intensity (Peck and Chipman, 2007)

The trends in industrial energy intensity are clear. Global energy intensity is expected to decline at a rate of between 1,5 - 1,9% per annum between 2003 and 2030, depending on economic growth (Peck and Chipman, 2007). China and North America are making significant progress. The EU-15 negotiated regulations have had a major impact in

reducing the energy use in heavy consuming industries such as primary metals, non-metallic minerals and chemicals, as can be seen in Figure 2.16.

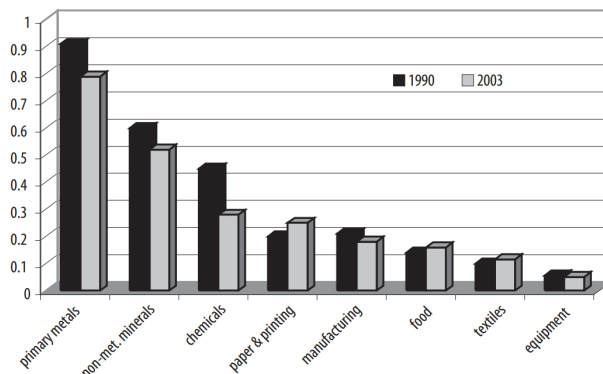


Figure 2.16: Energy intensities by subsector in the EU-15 (Peck and Chipman, 2007)

The broadest and best known way to improve material and energy intensity is a set of governmental policies in the production- and consumption cycle that promote recycling of used or waste material back into the production system. Many recycling processes for industrial materials are already commercially in place (Peck and Chipman, 2007).

A lot of effort has been put into improving material and energy intensity. This has been achieved by economic realities and economic incentives. However, with the expected growth in population and economy, action is needed to overcome the unsustainable development.

Resource Restrictions

The industrial revolution starting back in the late 19th century brought about one of mankind's greatest changes in the use of raw materials, product development, use of land and water. An increasing population with ever increasing demand for products and services was supported by the invention of mass production. The technical development with machine replacing man, together with rail, vessel and car transport making goods available from distant locations, made earth's resources accessible to satisfy the ever increasing demand for products and new innovations.

In the last 25 years there has been a steady growth of global resource extraction. As can be seen from Figure 2.17 the growth is from 40 billion tons in 1980 to 58 billion tons in 2005, an aggregate growth rate of 45%. The growth rates were uneven for the main material categories. Metal ores increased by i.e. more than 65% (WRF, 2008).

With the heritage from the colonial time, the western world was used to the idea, that raw materials cost nothing or very little and this perception held true practically through the 19th century. The price of raw materials was volatile but at a declining trend as shown in Figure 2.18.

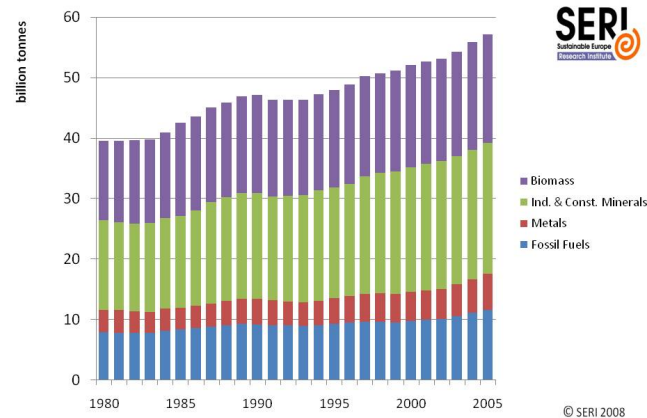


Figure 2.17: Global used extraction of natural resources in four categories (WRF, 2008)

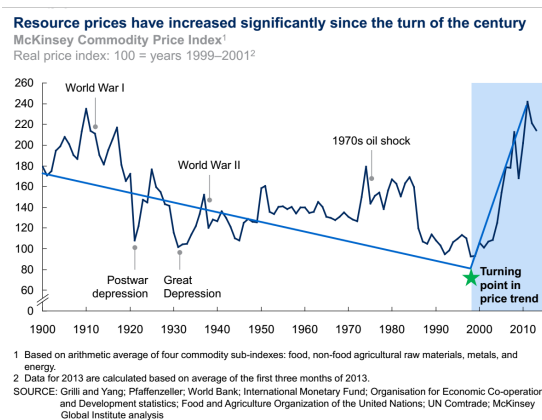


Figure 2.18: Resource price trend (McKinsey Global Institute, 2013)

In the beginning of the 21st century the trend changed. Ten years earlier the geopolitical situation had changed completely with the fall of the iron curtain. The world opened up to global market interaction, together with the advances in IT technology. Hence, the western world started to invest in the developing world. The price trend of raw materials was broken and the prices more than doubled with the increasing demand and industrialisation of Asia, namely China and India. Raw materials markets have encountered great volatility due to short term factors such as droughts, floods, labour strikes or export restrictions, but mainly because of less availability at old prices. Increased supply is brought out at a higher cost, as is the case with oil, mining and copper discoveries (McKinsey Global Institute, 2013).

Global growth means growing energy usage. The International Energy Outlook 2013 forecasts that the world's energy consumption will increase by 56% between 2010 and

2040. See Figure 2.19.

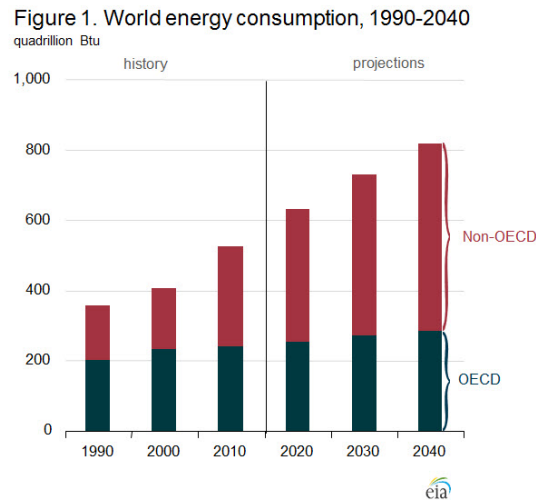


Figure 2.19: World energy consumption (Energy Information Administration, 2013)

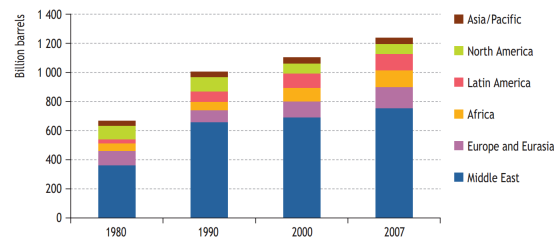
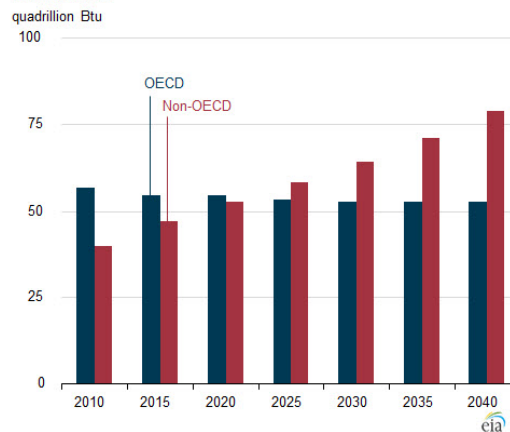
Energy consumption is rather stable in the OECD countries. The non-OECD (developing) countries are driven by strong long-term economic growth with energy consumption increasing as much as 90% in 50 years, while the energy consumption increased only 17% in the OECD countries in the same timespan.

Fossil fuel continues to account for almost 80% of world energy sources through to 2040. Fossil fuel consumption growth is estimated to be 1.7% per year, when renewable energy and nuclear power are the world's fastest growing energy sources, increasing 2,5% each.

The industrial sector is by far the biggest consumer of delivered energy. The 2040 estimates are that the world's industrial sector is still consuming over half of the global delivered energy. With today's policies of carbon dioxide emission restrictions, IEO expects the emissions to increase from 31 billion tons in 2010 to 45 billion tons in 2040. There is therefore a pressing need to reduce carbon dioxide emissions (Energy Information Administration, 2013).

Oil has been at the centre of geopolitical tensions in the last two decades. Before 1990 there were a couple of "oil shocks" which changed the world's attitude towards energy and specifically towards oil. BP Oil states that total proven oil reserves stand today at 1,220 million barrels. This can be Figure 2.20.

The transportation sector's growth in energy use is the strongest in the Non-OECD countries due to high population, economic growth and immature transportation sectors. The growth is expected to be 2.2% per annum from 2010 to 2040 Chart 2.1.3.24. The OECD energy consumption for transportation is estimated to decrease by 0.1% per year. This is due to slow economic growth, improvements in energy efficiency and stable or declining population levels (Energy Information Administration, 2013).

Figure 9.3 • Proven remaining oil reserves by region, 1980-2007 (end-year)**Figure 2.20:** Proven remaining oil reserves by region, 1980-2007, BP (2008) as cited in (International Energy Agency, 2008)**Figure 131.** World transportation sector liquids consumption, 2010-2040**Figure 2.21:** World transportation sector liquids consumption (Energy Information Administration, 2013)

Government policies especially in OECD Europe and Japan have led to declining transportation energy use. The European Union's latest directive from 2012 regarding car emissions can be mentioned as an example. By 2015 new cars are not allowed to emit more than 130 grams and vans no more than 175 grams carbon dioxide per kilometre. By 2020 the emissions are to be reduced to 95 grams for cars and 147 grams for vans (Energy Information Administration, 2013).

Assimilation

Whether you're talking about ideas or nutrients, assimilation describes the act of taking something in and absorbing it fully (Assimilation Definition, n.d.).

As has been described in the previous chapters, humankind has, over the last hundred years largely increased the impact on the environment. This takes the form of air pollution, water pollution, noise pollution, soil degradation and destruction of ecosys-

tems.

However, nature has an assimilation capacity to counteract humanity's emissions and pollutants. The most common emission is the carbon dioxide emission which is mostly generated by converting fossil fuel to energy. Before the industrial revolution started on a larger scale, nature's "own emissions" like forest fires, decay and peat, generated around 277 ppm. Today's concentration of CO₂ in the atmosphere is 393 ppm, an increase of 42%. The trend since 1980 with strong industrial growth, is pointing firmly upwards, without disruptions, which one would normally expect from nature during such a long period, see Figure 2.22.

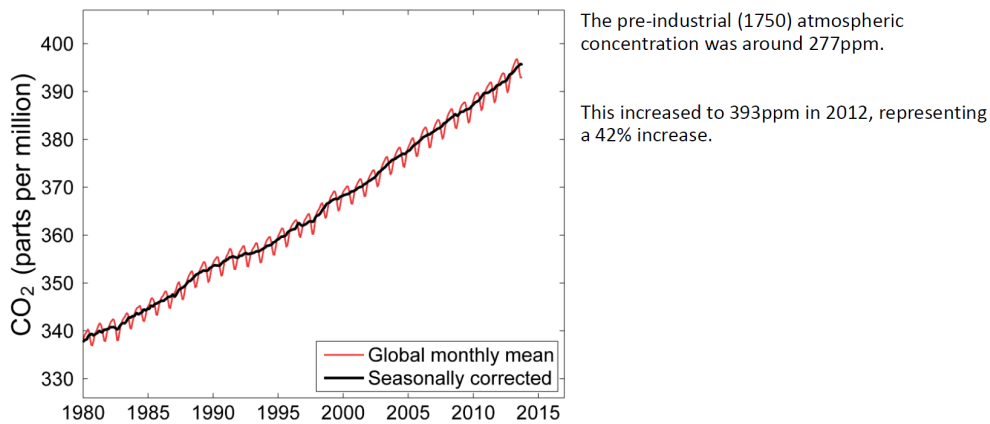


Figure 2.22: Atmospheric CO₂ Concentration 1980-2012 (Quéré et al., 2007)

The emissions are assimilated with declines of nature, which consists of land, ocean and atmosphere. The carbon source and sink development gives an overview of today's developments, see Figure 2.23.

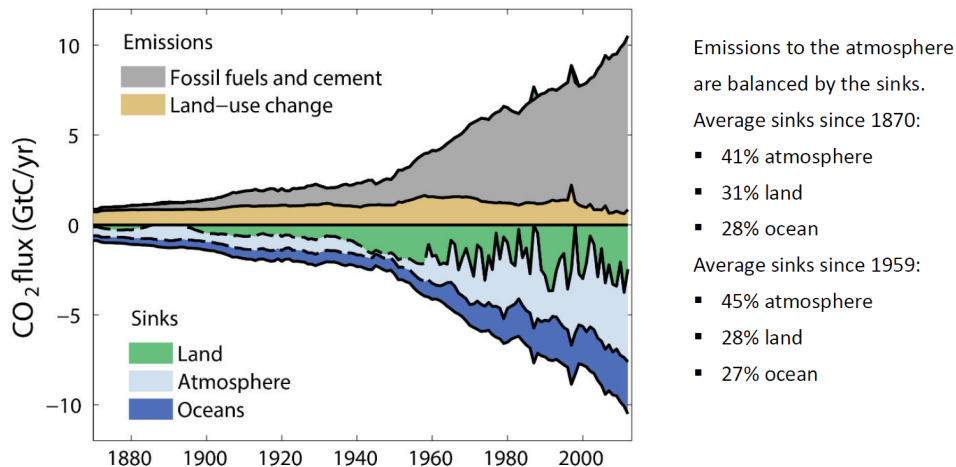


Figure 2.23: Carbon sinks over time (Quéré et al., 2007)

According to Rockström, Johan et al. (2009) mankind is making an impact on many aspects of our planet. He points out that many planetary boundaries have already been crossed and many others are close to being crossed.

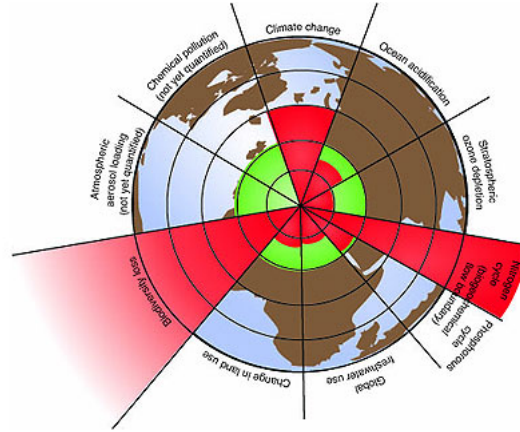


Figure 2.24: Planetary boundaries (Stockholm Resilience Centre, 2012)

The green colour represents safe operating space for the nine planetary system boundaries. The red colour represents the present situation, with three of the boundaries already crossed; the bio diversity loss, the nitrogen cycle of the biogeochemical flow boundary and the climate change boundary. As with many of nature's environmental issues, human knowledge is insufficient as is admitted by Rockström, Johan et al. (2009) regarding atmospheric aerosol loading and chemical pollution. These two impacts have not yet been defined (Rockström, Johan et al., 2009).

To correct humanity's behaviour towards more sustainable systems created by nature, Rockström, Johan et al. (2009) proposes limits to 7 assessed sectors:

1. *Climate change: CO_2 concentration $< 350ppm$.*
2. *Ocean acidification: mean surface seawater saturation state with respect to aragonite 80 per cent of pre-industrial levels.*
3. *Stratospheric ozone: < 5 per cent reduction on O_3 concentration from pre-industrial level of 290 Dobson Units*
4. *Biogeochemical nitrogen: and phosphorous cycle: limit industrial and agricultural fixation of N_2 to $35 Tg N yr^{-1}$ and annual P inflow to oceans not to exceed 10 times the natural background weathering of P .*
5. *Global freshwater use: $< 4000 km^3 yr^{-1}$ of consumptive use of runoff resources.*
6. *Land system change: < 15 per cent of the ice-free land surface under cropland.*
7. *Rate of biodiversity loss: annual rate of < 10 extinctions per million species.*

Hopefully the planetary boundaries thinking will impact humanity to take resolute decisions to follow nature's cycles towards resilience. *Resilience is the long-term capacity of a system to deal with change and continue to develop. For ecosystems such as forest, this can involve dealing with storms, fires and pollution, while for a society it involves an ability to deal with political uncertainty or natural disaster in a way that is sustainable in the long-term* (Stockholm Resilience Centre, 2007).

Land Area

Land use is based on the functional dimension for different human purposes or economic activities. *Typical categories for land use are dwellings, industrial use, transport, recreational use or nature protection areas* (OECD, 2005).

The total ice-free land area is 159 million km² and is all in use today (Hooke et al., 2012). Figure 2.25 outlines the land use in the major sectors.

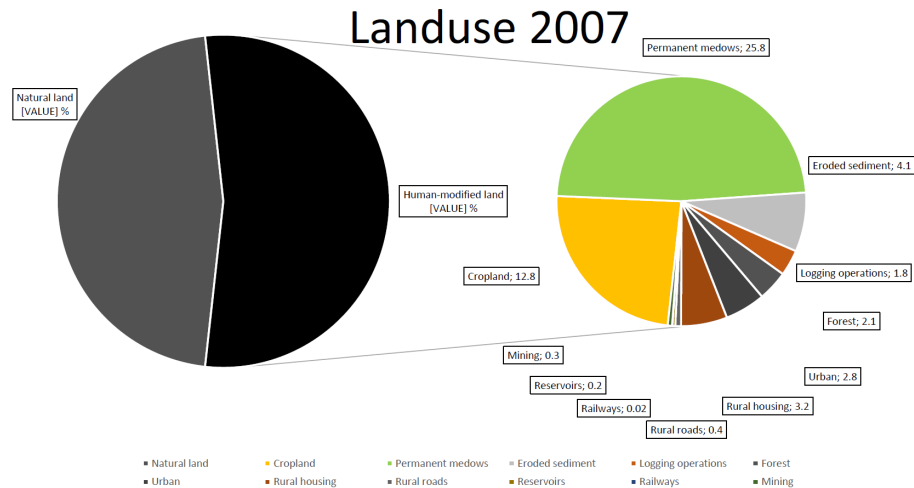


Figure 2.25: Land use in year 2007 (Hooke et al., 2012)

The figure shows that about half is natural land and the other half has been directly modified by man. Out of the 46.5% natural land, 18.7% is highly unsuitable for agriculture. This includes mountainous areas, arid regions and tundra. Left untouched are 28 % of natural forest. This means that two thirds of the useful land available have been modified by humans (Hooke et al., 2012).

In recent decades, however, increasing population and socio-economic pressures on land, water and genetic resources that underpin the provision of food and other valuable environmental services are cause for concern. This worry is well founded given that food production should roughly double by 2050 to satisfy the projected global population of 9 billion people. Agriculture already uses two thirds of the freshwater resources withdrawn for human use. Irrigated crops are also providing already 40% of total cereal harvest.

Additional land suitable for good production is scarce, while pressure to produce more food on marginal areas can lead to degradation and poverty (FAO Statistical Yearbook, 2013).

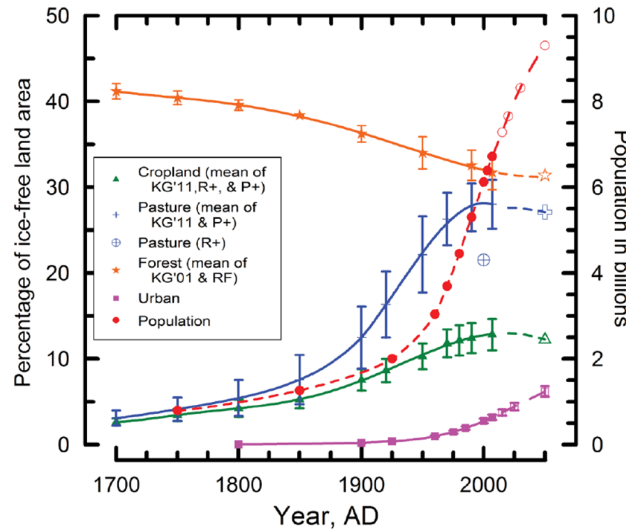


Figure 2.26: Changes in land use through time with extrapolations to 2050 AD (Hooke et al., 2012)

By tradition, land use has been a local issue for communities and private owners. As a consequence of the population explosion, worldwide changes to farmlands, forests, waterways and air have been driven by the need to provide food, fiber and shelter to today's 7 billion people.

Global croplands, pastures, plantations and urban areas have grown in recent decades. This has caused large increases in the use of energy, water and fertilizers and a subsequent loss of biodiversity. The changes in land use have enabled humanity to increase food-, industrial materials- and consumer goods production by activating the earth's resources for immediate needs. Nevertheless, these actions potentially undermine the capacity of ecosystems to sustain food production, maintain fresh water and forests resources, regulate climate and air quality and eliminate infectious diseases.

3

Inside-out Perspective

The inside-out perspective section explains the self-leadership, leadership modules, dialogue tools, Multilevel Perspective: Transition of Socio-technical Systems (MLP) and design thinking of the C-Lab group.

3.1 Self-leadership

In order to find the depth of engagement and motivation, one must first understand the different types of extrinsic motivations, which is motivation based on external rewards (Brown, 2010). According to Ryan and Deci (2000), there are four levels of extrinsic motivation ordered by increasing level of self-determination (see Figure 3.1):

1. **External regulation** - the first type of motivation and the least self-determined. It is based on incentives and consequences, you do something in order to receive a reward (you do something only to get the benefit attached to it). Behavioural change.
2. **Introjected regulation** - when behavioural changes occur without or with little motivation, increasing self-esteem or avoiding guilt could be a reason for this.
3. **Identified regulation** - when behaviour is intentionally changed in order to get a sense of meaning.
4. **Integrated regulation** - the last and most self-determined type of motivation. Does not involve behavioural changes as this represents the deepest values and beliefs. (Not to be confused with intrinsic motivation because satisfaction comes from extrinsic satisfaction, rather than the task itself).

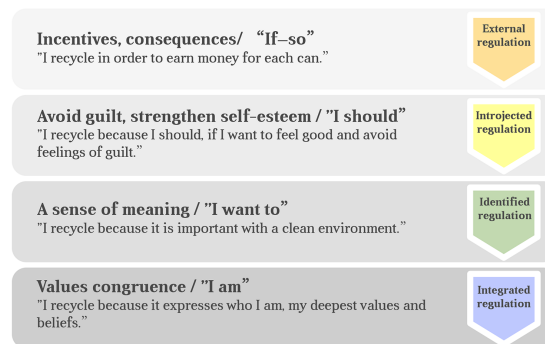


Figure 3.1: Levels & depth of motivation and engagement (Ryan and Deci, 2000)

Before this seminar the challenge lab team was asked to take part in an online survey by ValuesOnline (2014). This was done to find the team members' own values and were presented to the team in a meaning map. The map consists of three cycles, foundation, focus and vision, which represents the past, present and future. These values could be sustenance, traditions and respect in cycle 1, independent, humour and cooperation in cycle 2 and challenge, solidarity and knowledge in cycle 3. The highest ranking values in each cycles is called core values, but they should not be trusted completely because the core values can differ with each time you do the survey.

The team members were then asked to select three values from each cycle and in groups of three, practice active listening with one person telling a story from his/her life where the specific value presented itself. Another team member was asked to listen to the stories without interrupting and without asking any questions in order to fully focus on the story-teller. The third person was an observer that not only should listen without interrupting, but also to observe the whole situation and keep track of time.

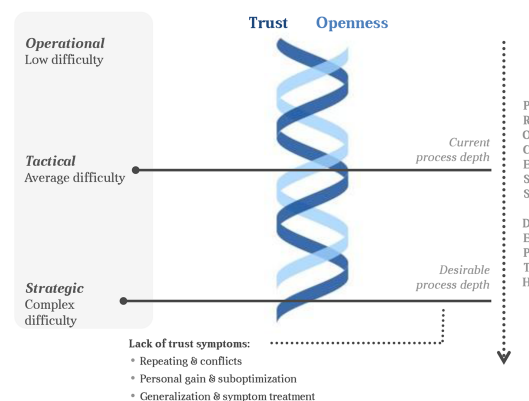


Figure 3.2: The Openness and Trust Spiral model (Wendelheim, 1997)

The Openness and Trust Spiral (Figure 3.2) is a model (Wendelheim, 1997) that is used to explain how trust and openness has to work together for the group to handle

complex issues. There are three levels of difficulty, low (operational), average (tactical) and complex (strategic), these levels represent how deep the trust and openness between the members of a team has to be in order to take on different tasks.

When working in a team with people with different qualities, it is important to understand how to use their strengths. von Martens (2014) presented an exercise, see Figure 3.3, that shows how to take one strength and exaggerate it to get an overdone strength that was used to find a positive opposite, which became a complementary strength. Then exaggerate the complementary strength to get a challenge and the original strength became the positive opposite of this challenge.

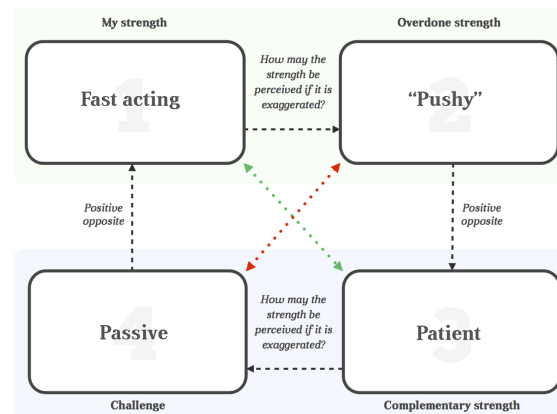


Figure 3.3: Exercise: Balancing your strengths, von Martens from (von Martens, 2014)

Lastly, the team members were asked to pick their favourite part of the day and share it with the others. This exercise is called "Pearl of the day" and is used to increase the community feeling and end each day on a good note.

3.2 Leadership

In the end of the first week we had a seminar with Göran Carstedt, *President of the Car Division at Volvo France, President of IKEA North America and Senior Director of the C40 initiative at the Clinton Climate Initiative (formerly at IKEA, Volvo, MIT, Society for Organizational Learning, and Clinton Climate Initiative)*, with the title "Leadership for Sustainable Development". The seminar was about how to create leadership that is relevant to our times, co-creative and which has an outside-in perspective.

He talked about that the leaders need to change their logic and start creating change in order to get a more sustainable future. They need to move from their old logic which is based on things, to a new logic which is based on knowledge and ideas. For example, move from hierarchies to networks, from bosses to facilitators, from teaching to learning and instead of trying to conquer nature, one should be in harmony with it.

This is not the easiest task. It will be hard and cost more than keeping on going with the situation today. But it is needed.

"I think there are good reasons for suggesting that the modern age has ended. Today, many things indicate that we are going through a transitional period, when it seems that something is on the way out and something else is painfully being born. It is as if something were crumbling, decaying and exhausting itself, while something else, still indistinct, were arising from the rubble." (Havel, 1994)

Which relates to Nietzsche in that if we have a goal to strive for we can put in the extra labor and resources in order to reach that goal.

"If we have our own why in life, we shall get along with almost any how." (Nietzsche, 1889)

To create our desired future with this new way of thinking, we have to use backcasting from sustainability principles, have cross-border collaborations that change the rules of the game and shift our attention and measurements to optimising wholes – not parts; what is important – not what is measurable, long term consequences – not only short term results. It is hard to measure what is important because it varies between cultures and people. Kennedy (1968) once said "GDP measures everything, except that which makes life worthwhile". But in 2009 France's President Nicolas Sarkozy proposed the Happiness Index, which tries to measure France economic progress with the help of these indicators:

1. **Work-life balance** – what is the ratio of number of hours worked to leisure time?
2. **Traffic congestion** – buying petrol may help the economy but sitting in a traffic jam increases pollution.
3. **Mood** – people will be asked to record how much time is spent feeling happy or sad.
4. **Chores** – do people have enough time to carry out child care, cleaning and DIY?
5. **Recycling** – living a more sustainable life reduces the impact on the planet.
6. **Gratification** – is life filled with short-term gratification or more fulfilling long term satisfaction?
7. **Insecurity** – are people feeling financially secure and safe in their homes?
8. **Gender** – are men and women treated fairly in the workplace and home?
9. **Tax** – does everyone get their money's worth from the government?
10. **Relationships** – do people have time to see friends and relatives regularly?

One of the biggest companies in the world, Wal-Mart, has been doing a lot to reduce their impact on the environment. They have three main goals for sustainability; to be supplied 100% by renewable energy, to create zero waste and to sell products that sustain people and the environment (Sustainable WalMart, 2014). Carstedt presented to us a quote from Lee Scott, Wal-Mart CEO, that explains why sustainability is important in any company:

"A company that cheats on overtime and on the age of its labour, that dumps its scraps and its chemistry in our rivers, that does not pay taxes or honour its contracts will ultimately cheat on the quality of its products. " (Carstedt, 2014)

3.3 Dialogue tools

According to Isaacs (1999) there are two types of conversation; defending and suspending. Discussion and debate are part of the defending conversation, where parties want to defend their opinion and resolve the issues by beating down the opposition, see Figure 3.4. This is how politics work in today's society. The other type, suspending, is when parties listen to each other without resistance and interruption. This would be the foundation of what becomes reflective dialogue, when you listen to the different opinions, underlying causes, rules and assumptions can be explored, which leads to a deeper framing and question of the issues. To get to a generative dialogue, the parties must explore new possibilities in order to solve problems collectively.

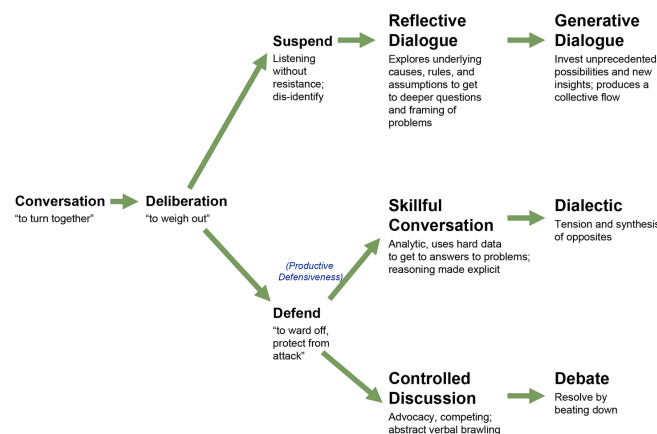


Figure 3.4: Discussion vs. Dialogue according to Isaacs (1999)

Using dialogue tools, an organization can become collectively intelligent by following a simple double looped model. This model, see Figure 3.5, explains how listening and observing creates understanding, trust and collaboration when a disruption hits the organization. This will in turn create increased participation, which leads to innovation and creativity and ultimately ends in excitement that closes the loop.

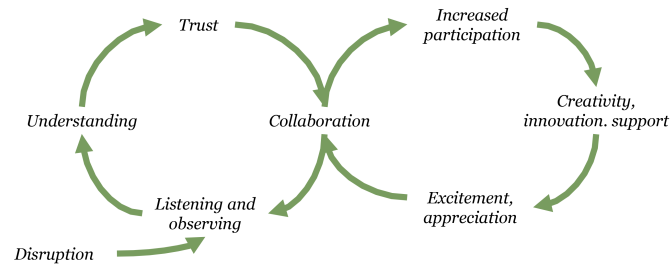


Figure 3.5: Reinforcing double loop using dialogue tools (Sandow and Allen, 2005)

When not using dialogue tools, the disruption becomes a base for misunderstanding and separation, which overflows into the second loop to redundancy, see Figure 3.6. Redundancy in an organisation always leads to increased costs and decreased resources, which creates opportunities for other organisations to become competition. When an organisation is faced with competition it will lead to fear amongst the employees and that fear will create more separation, thus closing the loop.

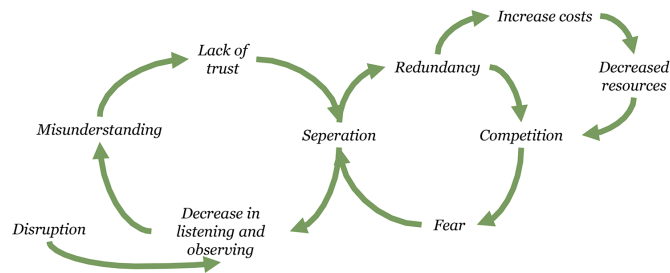


Figure 3.6: Separation in organizations and its impact (Sandow and Allen, 2005)

There is a tool that Sande (2014) presented that is called "circle and triangle time". This tool is used for setting up timeframes for when to collaborate, create and learn and when to make decisions. In the circle time, dialogue is used to create alternatives and address questions containing energy. It is also important to respect the diversity of the group and make everybody involved part of the co-creation. The other time, triangle time, is when it is time for decision making, where the team members have clear roles and choose the paths and priorities the specific project will take. Here it is important to have acceptance and loyalty in order to reach decisions and continue with the project or to start a new cycle with another circle time.

When using dialogue as a tool to communicate better within an organisation, it is a good idea to define some rules. Start with a listening rule, in which the participants must listen without resistance in order to understand better. The next rule would be respect, where respect of others opinions and understanding is the key and trying to find how everything fits together. Then comes the suspend rule, here participants has to take a step back to understand what is taken for granted and suspending the flow of thought. Finally, voicing is when each participant speaks from their deepest self, expressing their



Figure 3.7: Circle and triangle time (Sande, 2014)

core values.

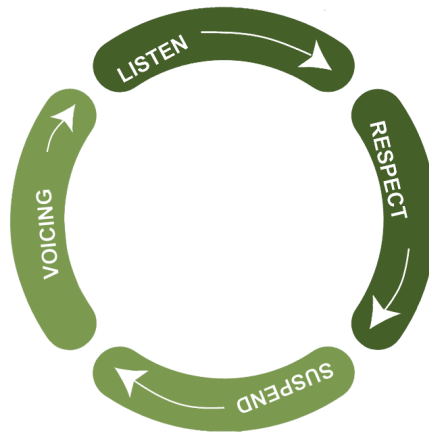


Figure 3.8: Definition of the dialogue rules (Sande, 2014)

To reach a transformation in an organisation, a multi-perspective approach could be implemented, where strategy, structure and culture work together. Strategy is used to create goals and visions to lead the organization in the right direction. The structure is the foundation of the organization that allows collaboration and trust to flourish. This is generated by policies and rules within the organisation to create understanding among the employees. How people act and think around others is covered in culture, which shows itself in values and collaboration. To communicate, act and reach decisions is vital to reach transformation through a multi perspective approach.



Figure 3.9: Multi-level approach to transformation (Sande, 2014)

3.4 Multilevel Perspective: Transition of Socio-technical Systems

A few decades ago innovations were merely new or better tangible products to be marketed with highest possible profit in mind. Little thought was given to consequences or impacts to the environment, society or human personal wellbeing. Increased education, more available information and constantly developing technologies have given the individuals more power to ask for sustainable products and more recently global sustainability for the whole processes in bringing products and services into the consumers use. *This means that new products should not only be “new and improved” but also “new to improve” the society in which they function* (Joore, 2010).

There are those who say that the society is functioning drastically differently today, to the extent of a “Third Industrial Revolution”. We need less and less physical products and more and more experiences. Today society is pronouncing “prompt access” rather than “ownership” and innovations need to be “solutions” instead of artifacts. *The rise of the Creative Economy is drawing spheres of innovation (technological creativity) business (economic creativity) and culture (artistic and cultural creativity) into one another, in more intimate and more powerful combinations than ever* (Joore, 2010).

A framework has been developed, Multi-level perspective (MLP), to analyse the interactions between industry, technology, markets, policy, culture and civil society (Geels, 2002). The MLP is about transition processes in society (Geels, 2002). In the MLP the transitions are described as the result from the interplay of multiple developments at three levels: niches or radical innovations, socio-technical regimes and a socio-technical landscape. The three levels can be seen in Figure 3.10.

Niches create novelties and radical alternatives. The novelties are created by pioneers, entrepreneurs, social movements or other relative outsiders to the existing systems. Niches normally face a struggle to be accepted, because they cause changes in the existing stable regime. Niche - actors expect their creations to be replacing or to be adopted by existing regimes. This happens only sporadically because there are many obstacles, such as final cost, functionality, compliance with regulations or lack of infrastructure. *Nevertheless, niches are crucial for transitions, because they provide the seeds for systemic change* (Geels, 2002).

The socio-technical regime is in fact the existing way of performing, with strong

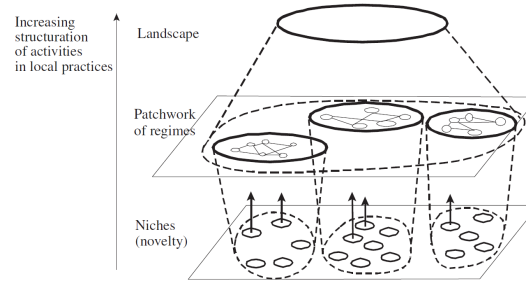


Figure 3.10: Overview of the Multi-level perspective (Geels, 2002)

actors in the network. They are all in a circle that use existing technologies, regulations, user patterns, infrastructures, and cultural discourses. Regimes also include users, policy makers, special-interest groups and civil society actors. Step by step, small developments occur in the regimes because of lock-in mechanisms and path dependencies (Geels, 2002).

The socio-technical landscape is something around us and something we are part of, it consists of the structures of our society; such as legislation, economic structures, cultural values, political ideologies, beliefs and concerns which are beyond the control of individual actors. Changes in landscape are very slow because they mostly depend on demographic trends and cultural and political awareness (Geels, 2002).

3.4.1 Transitions

Transitions in society are difficult to understand. What is the reason or the reasons why a certain transition took place? However, the MLP implies that there is no single reason(s) for transition. Instead there are many processes going on at the same time and transitions come about through the interaction between the processes at different levels: *niche - innovations build up internal momentum, changes in landscape level create pressure on the regime, destabilisation of the regime creates windows of opportunity for niche - innovations* (Geels, 2002). See Figure 3.11.

Niches are the creators of transition technologies, but alone or without support from the outside they seldom pass the window of transition to form a new regime. The niche technology needs to link up with the different levels to reinforce each other (circular causality). That may take place with unexpected linkages, lateral alignments or thresholds and tipping points (Geels, 2002). Multi-level commitments are mostly backed by social groups and there is no guarantee for transitions to succeed. Niche-innovations may fail. The following period can be to build up more support for the next attempt or to fail completely. Tensions in existing regimes may also remain small. Therefore the window of opportunity for the transition technology to break through may not be open. According to Geels (2002), there are different ways to break through the socio-technical regime, which are: *Niche accumulation, Technological add-on or Hybridisation*.

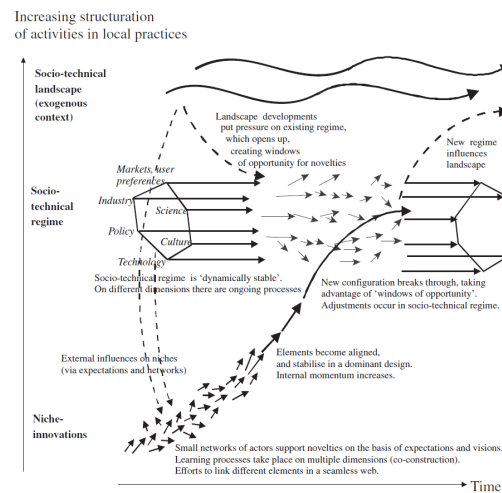


Figure 3.11: Multi-level perspective on transitions (Geels, 2002)

The step from niche to regime level does not happen overnight. Shifting from niche to mainstream application involves a lot of experimentation, learning and adjustment during the development period. Above all the formation of the stakeholder network is most decisive for niches to succeed. (Geels, 2002; Van den Ende and Kemp, 1999)

Many new technologies are developed without proper information about the market conditions. New technologies develop at the same time with users and markets. In order to make a breakthrough for a niche application easier, it may be wise to decide for mechanisms of add-on and hybridisation. This means that the niche links up with an already existing infrastructure. The niche will not compete with the old application but end up in symbiosis between the two technologies (Geels, 2002).

The easiest way for a niche to enter regime level is to take part in a sector with strong growth. Growth sectors will constantly need additional resources and the dominant technology may face novelty problems or shortcomings which need to be addressed or replaced (Geels, 2002).

Technological transitions seldom occur suddenly from one regime to the other. Step by step development of each and every aspect is normally the likely way. However, at a certain point cascade effects might occur as change of one element requires update in other elements of the regime and also finally a change in the landscape. The breakthrough of niche technologies is also dependent on processes in both the regime and the landscape (Geels, 2002).

3.5 Design Thinking

Design thinking can be seen as a multilevel framework tool (Örjan Söderberg, 2014) that was used for creating ideas, projects and products in the C-Lab. To better understand the complexity of sustainability challenges and what they require, design thinking was used as an approach to characterise the system. Sustainable development is realising the importance of existing technologies and that most of the problems we are facing today are usually trends with lock-in effects and path dependencies. Realising that the hot-spots in the system are sensitive areas and that the force applied to them is rather small, they still result in a big change of the system (Meadows, 1997). Having both the theoretical background and the interaction with stakeholders, C-Lab was able to identify some of the leverage points needed in the system that could adopt change, hence each group would then write down problem descriptions, functions and identify user needs to the selected projects.

The figure down below lists a schematic overview of the design methodology used by the Challenge Lab. The multilevel design model is closely related to the research by (Joore, 2010) who also describes the different levels of where a product could interact.

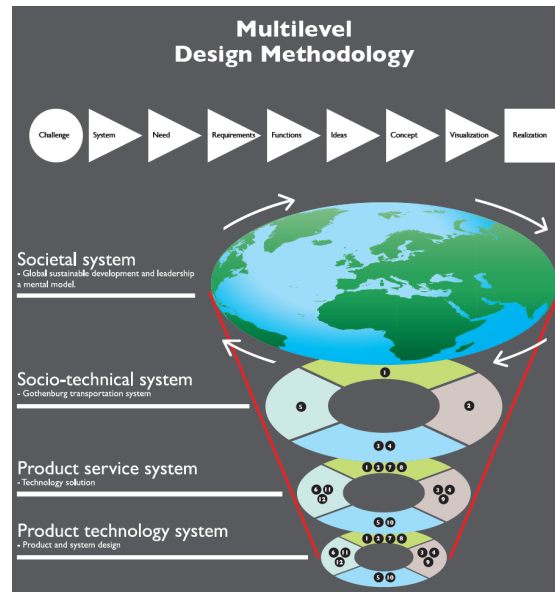


Figure 3.12: Multi-level Design Methodology (Örjan Söderberg, 2014)

The societal system analyses the problem area based on preferences regarding social order and aims to explain what is ideal for a new societal situation. Its development process leads to a future vision for where societal change is needed.

The socio-technical system adapts the design process on making a proposal for a chosen system, in our case the transport system of Gothenburg. To identify the needs

of this system; stakeholders, users, services and the environment must be taken into consideration. In addition to this, it should be mapped what the current system fulfills, what it demands and what regulations there are for the different actors in the system.

The product service system defines the chosen area at hand and deepens the understanding of the specific stakeholders' agendas. Concept iterations and system requirements are analysed. It results in the design of a new product-service system.

The product technology system focuses on semiotics, target groups and manufacturing. Analysing the users' needs, creating concepts from ideas and evaluating them, is part of making an applicable product. It results in the design of a new product or technology.

4

Project

4.1 Background

The public transport area covers a wide range of actors within the industry, academia and public sector. Targeting a competence area of public importance will not only change transportation practices, it will also utilise IT solutions for mobile devices that will support sustainable innovation areas of a near future. The ever-growing need to think creatively about sustainable development is something that is needed globally. Creating a sustainable transport situation in Gothenburg is no easy task, but as many sectors can agree, if you act locally, more will follow and inspire others to act.

However, the problem occurs if everyone is waiting for a change, because then the change arrives late and therefore no longer being of use. This is one key issue that we wish to address, the unseen potential in acting locally with information technology. As the need of the everyday traveler changes, so does the need for information technology in society. Our system's approach is towards targeting something concrete for the public transport sector, combining this with analysing user studies, evaluating design concepts and finalising an app prototype, will result in the design of a new product-service system.

What particularly caught our interest was the ElectriCity project, since it focuses on how to get commercial actors together with open innovation, to generate a sustainable future for public transport and bring it up to another level.

[...] to develop and test new services and products that contribute to a more attractive public transport system [...] and to produce new business models for sustainable mobility in the city that can be scaled up outside the demonstration arena (Ohlin, 2014, p. 5 & 11).

During the “An electrified city” seminars (Gothenburg, 2014) we also met different

stakeholders and heard them set up goals for the future. Here are some of the goals stated in the seminar from Västtrafik (2014):

- *By 2025 the number of public transport trips will be doubled from 2006, to 380 million. Last year's number was 282 million.*
- *In 2025, at least 95% of public transport will be carried out by renewable energy. Last year's number was 77%.*
- *By 2025 Västtrafik will use 25% less energy per passenger km compared to 2010. Last year's number was 8%*
- *By 2025 public transport's emissions of NO_x and particles per passenger kilometer have decreased by at least 60%. Last year the numbers were 30% and 15% compared to 2009.*
- *By 2025 public transport's emissions of NO_x and particles per passenger kilometer have decreased by at least 60%. Last year the numbers were 30% and 15% compared to 2009.*

Sustainable gamification practices can change behavior. One particular example of this is Recyclebank, where 97% of the participants survey says that the game increases their knowledge about the environment while making them more likely to take green actions as a result of participating in the game challenges (Xu, 2011).

Therefore, we found the need to explore this area further to see if a digital gamification service could actually increase environmental awareness as well as get users travelling more often with the electric bus. As stated above, knowing that ElectriCity's project aim is to generate a sustainable future with open innovation solutions around the new electric buses and other services, we agreed that this would be our niche area to focus on.

The niche area came to be a bus app that is meant to limit the use of normal bus cards, meaning that bus card manufacturing would decrease and there would be no need to buy new bus cards monthly from refill shops. The app should not only help decrease the demand of resources when manufacturing bus cards it should also be user-friendly, fun to use, creating a "buzz" on the bus stops, hence getting more people to want to use the electric bus.

In the design process for the ElectriCity app project, the main client became Västtrafik, since the app was intended as a ticket system for the electric buses that commence in 2015. Other relevant stakeholders involved in the ElectriCity project are: City of Gothenburg, Volvo Group, Göteborg Energi, Lindholmen Science Park and Johanneberg Science Park.

In the ElectriCity project we first met up with project leader Gunnar Ohlin of Test Site Sweden, who directed us to get in contact with the right people at Västtrafik,

getting Västtrafik to know about our idea briefly via e-mail. Since the deadline of the thesis project was nearing its end and the representative from Västtrafik was busy, we decided to present our app prototype to Västtrafik, among others, in the Visual Arena at Lindholmen Science Park.

Looking back at the C-Lab process, if we would not have had the stakeholder meetings we would not have realised how important behavioural change is in society in order to inspire others to act. Our core perspective on sustainable development has changed somewhat, but our true inner values have remained the same, therefore one could say that “the real change lies underneath the surface” in both design and in sustainability, if you choose to pay close attention to it.

4.2 Theory

4.2.1 Interaction design

The research area of interaction design is heavily focused on satisfying the needs and desires of the majority of users who will use a product (Cooper et al., 2007). If you compare this to other disciplines like software engineering, then their area of expertise is heavily focused on only designing for technical stakeholders. What clearly makes interaction design a design-field is the user-centered design perspective, balancing user needs with technical viewpoints and design perspectives to create new solutions for interactive products and services.

Other fundamental focus areas for interaction design are user experience, human-computer interaction and software development (Cooper et al., 2007).

Knowing that user-centered design (UCD) is an approach in interaction design for including users in the design process with the designers (Psomas, 2007), this could be a good starting point to talk about. Key points in having good integrated UCD methods are keeping the users updated on the design and that it will deliver on the requirements made by the client or stakeholder.

One could further improve this by also having workshops with users, meeting up with other focus groups or as mentioned above, with stakeholders where they will share their knowledge, future visions, competences and experiences instead of asking directly or telling how an idea of a product or service will be. The reason to do this, is because one should preferably observe the users by the help of existing mediums to fully understand what the user wants. Here is one example from 2.1 Objective of usage observation by Kanis and Rooden (2005, p. 9):

The aim is to gain insight into user activities in terms of what, how and why, in order to apply these insights in usage oriented product design. Observation may involve existing product(s)/situations; simulation with the help of concepts, drawings; models, partly functioning; prototypes.

Other interrelated processes in the interaction design process that could be beneficial with UCD methods, are ideation sessions, user-scenarios, usage of a non-user, demoing and prototype testing methods. These are but a few UCD methods that could be relevant for use in any kind of interaction design process. As Nielsen puts it in the following paragraph, the more UCD methods you use, the safer you are from overlooking design flaws.

Several studies have shown that usability inspection methods are able to find many usability problems that are overlooked by user testing but that user testing also finds some problems that are overlooked by inspection, meaning that the best results can often be achieved by combining several methods (Nielsen, 1995, p. 377).

User experience and usability

User experience in a nutshell is how people feel when they interact with a system. These systems can be digital artifacts such as websites, games, software services or as in this research, an app with gamification purposes to increase bus commuting numbers and sustainability awareness. Generally speaking, user experience is closely related to a form of HCD, whether it be digital products or another form of new technologies (Gube, 2010). The end user is the target group and the interaction between them and the designers is important, which is also what Nielsen and Norman (n.d.) defines as user experience.

"User experience" encompasses all aspects of the end-user's interaction with the company, its services, and its products.

Nowadays the goal of user experience is not only making efficient and productive systems in working environments, but also creating systems that are *satisfying, enjoyable, fun, helpful, motivating, aesthetically pleasing, supportive of creativity, rewarding and emotionally fulfilling* which is something Preece, Rogers, and Sharp (2007) talk about in their user experience goal section. The primary aim of designing interactive products is the user's experience. The feel of the interactive product is declared subjectively through what the end user's perception is. As Kuniavsky (2010) points out here in the following section, the focus and the sum of end users' perceptions of a product will determine the user experience.

The user experience is the totality of end users' perceptions as they interact with a product or service. These perceptions include effectiveness (how good is the result?), efficiency (how fast or cheap is it?), emotional satisfaction (how good does it feel?), and the quality of the relationship with the entity that created the product or service (what expectations does it create for subsequent interactions?) (Kuniavsky, 2010, p. 14).

Interaction designers' work is specifically close to the user experience, leading designs into evaluating how the user's perception of a system is. The goals can also be set into sub goals of a process that involves a function to find out whether the system is pleasant and easy to use. For example, as in this research, charging up the e-ticket for travel with the electric bus can be seen as a sub-goal for finding out if the procedure of users using

the payment methods function in the app is easy and efficient to use.

Special methods that one could use for a good user experience is user interviews, gaining detailed information about their experience and expectations of the design or release of a product. A cognitive walkthrough could also be an option, where a dedicated group of evaluators walk through the design, discussing usability concerns through the use of an early prototype or paper prototype to define the requirements. Both methods could improve the view on how the user thinks, interacts with the product and in that way not oversee potential functionalities of the design itself. The design could get better with the cooperation of end users, which is something Kuijer and Jong (2011) talks about in this section.

Human-centred design (HCD) aims to get a better ‘match’ of a designer’s anticipations with the real world by doing research about and/or closely cooperate with people expected to be future users of the product. (Kuijer and Jong, 2011, p. 2-3)

Usability on the other hand is defined by the ease of use and the learnability of a product. Ranging from apps, websites, gadgets, machines and tools, usability can be found ordinarily in the broad spectrum of everyday products that people interact with.

Usability refers to properties of a design that characterize the ways in which we do something specific with a given thing, system, tool, etc. – those properties that characterize use for something. It usually refers to qualities of use such as easy to learn, efficient in use, robust in use, different sorts of use experience, etc. (Hallnäs and Redström, 2006, p. 53).

When defining ease of use, it comes from usability used in design processes, which are defined by *Learnability, Efficiency, Memorability, Errors and Satisfaction* as Nielsen (2012) puts it.

This means the intended use of a product can be measured how understandable it is, how quickly the user is able to use the product if its function is easily repetitive. Also finding errors in high and low fidelity settings may give a better view of the users’ interaction with the product itself. Fluent interaction on how pleasing, satisfying it is to use will determine how successful a product will be. This is not only limited to digital products, any everyday product can be met with usability. However, finding an exact measurement for user satisfaction is quite difficult to measure, since all people have different requirements of a product. To summarise this, an interactive product should be enjoyable, easy to learn and efficient in use. When optimising the design of a product, in regard to user behaviour, users will adapt them more quickly in their homes as well as in their public activities if you consider these usability practices.

To recap, usability is generally regarded as ensuring that interactive products are easy to learn, effective to use, and enjoyable from the user’s perspective. It involves optimising the interactions people have with interactive products to enable them to carry out their activities at work, school, and in their everyday life. (Preece et al., 2007, p. 14)

What mainly sets user experience apart from usability is that their goals are different.

User experience is about how the users relate to the interactive product itself, their concerns from their perspective, while usability is more objective oriented in defining how useful or productive a system is, from its own perspective. Both differ in the way of how they are used or achieved through different means. Usability deals with efficiency and achieving a specific usability focus, while user experience deals with how aesthetically pleasing a product is, proclaiming in that way the quality of the product or service.

Recognizing and understanding the trade-offs between usability and user experience goals is important. In particular, this enables designers to become aware of the consequences of pursuing different combinations of them in relation to fulfilling different users' needs. Obviously, not all of the usability goals and user experience goals apply to every interactive product being developed. Some combinations will also be incompatible. (Preece et al., 2007, p. 18-20)

4.2.2 Gamification

Information technology has brought completely new tools to perceive, understand and react to the environment. IT has also changed the way people communicate, building up a continuous connection to the web. *The nature of intelligent environments has transformed with the impact of Web 2.0 and social media over the past years. The conceptualisation of the user has changed from being a cog in an organisational machine to a partner in a system interaction and an ultimate consumer, and more recently to a content creator and a task performer* (Liu et al., 2011, p. 1).

Nowadays, the individual has access to instant information about a lot of his or her environment like never before, due to intelligent environments and mobile augmented reality applications. Milgram's Virtuality Continuum presents an axis where mixed reality extends from real environment to completely virtual environments. Applications for Augmented Reality build upon a real environment and adds virtual media to a real environment, presenting information that is not visible in the real world (Ternier et al., 2012).

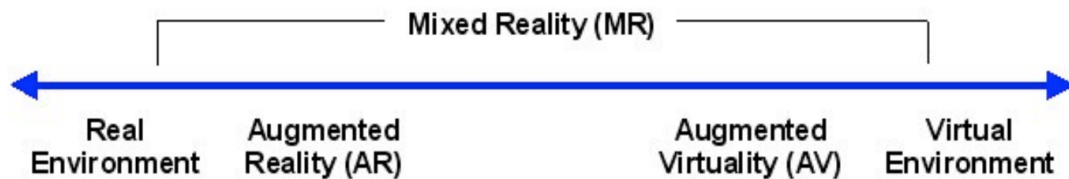


Figure 4.1: Milgram's Virtuality Continuum (Ternier et al., 2012)

In recent years the concept of gamification has emerged. Gamification is *the use of game play mechanics for non-game applications, particularly consumer-oriented web and mobile sites, in order to encourage people to adopt the applications* (Xu, 2011). In short,

Gamification is *the use of game design elements in non-game contexts* (Deterding et al., 2011).

IT research company Gartner predicts that by 2015, more than half the companies will employ Gamification in managing innovation processes (Xu, 2011). The same explosion is expected by M2 Research, who predicts that game mechanics production will generate \$ 1,6 billion in revenues. 23 % of social media marketing budgets will be attached to gamification according to the same source. Gamified applications already exist in many fields of human behavior, such as productivity, finance, health, sustainability, news, user-generated content, e-learning etc. Due to the novelty of gamification as a concept since 2010, it has also received a lot of criticism, because it is a buzzword and the activity is playing rather than learning without purpose. Gamification is still considered to be on the rise in the Hype Cycle, since its practices are new and without sufficient enough research backing it up. Only time will tell if gamification will emerge as a layer that will change the world (Xu, 2011).

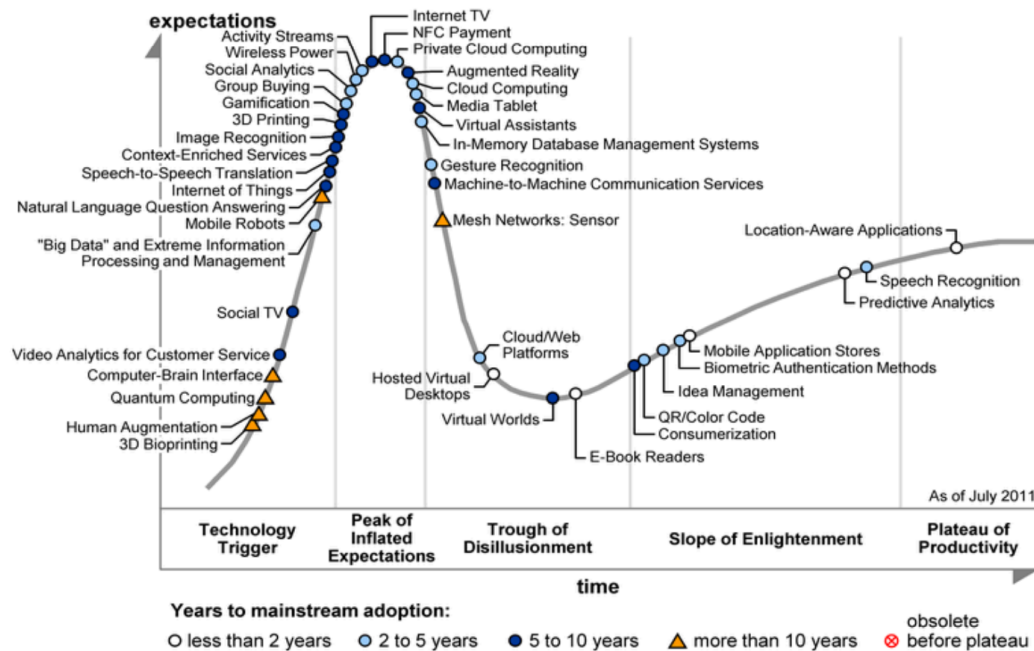


Figure 4.2: Gartner Hype Cycle for emerging technologies (Gartner, 2011, p. 2)

However, gamification has a lot of supporters among academia, game designers and researchers. Researcher and game designer Jane McGonigal is one of them. McGonigal points out in her findings, that solving game-like obstacles has to do with eustress, or positive stress. In her book "Reality is Broken" she argues *that the blissful productivity comes from the flourishing feeling, i.e., Positive Emotion, Relationships, Meaning and Accomplishments* (Xu, 2011). Likewise Byron Reeves argues in his book "Total Engagement" that games in the virtual world can change the way people work and businesses

compete. Seth Priebatsch points out that the last decade was the decade of social media, while the next decade will mostly be about games. The social layer is about the connection, while the game layer is about influencing behaviour by using dynamics or other forces to grasp the user behaviour and because of that it is becoming more and more important (Xu, 2011).

This is also something that Gabe Zichermann mentions in his book “Game Based Marketing” that *games can help improve the outcomes in every aspect of life [...] and that Marketing has always been about a certain degree of persuasion and motivation, and a degree of manipulation* (Xu, 2011, p. 13).

One example of a successful gamification service that takes up sustainability issues is Recyclebank. Recyclebank’s game concept is about getting the users to do Green Challenges, showing them to take green actions to live in a more sustainable way. The numbers gathered in Google Analytics and ROI research for Recyclebank has shown that:

- *Gamification can increase awareness of positive environmental actions. 97% of participants surveyed said the game increase their knowledge of the environment.*
- *Games can drive individuals to take positive social and environmental actions. Most participants surveyed indicated they are very or extremely likely to take green actions as a result of participating in the challenge.*
- *Games are an effective and appealing educational tool. 86% participants agreed online games and contest can be a good way to inform and educate them personally* (Xu, 2011, p. 5).

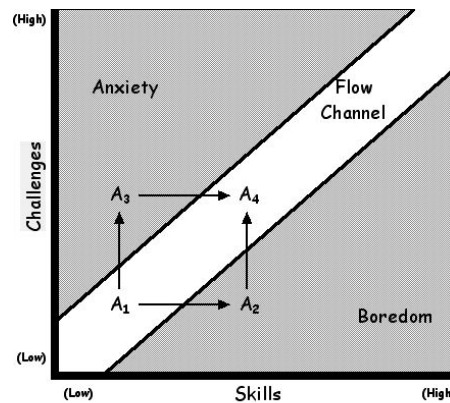
There is always some science behind gamification, but what makes online games so engaging? Online games are voluntary experiences, yet still some become highly addictive. The May 1998 issue of Nature published the results of research, that video game players experienced regular releases of dopamine during gameplay, while actively being focused on the video games. In some regard then, games stimulate pleasure centers in the brain, raising the dopamine levels to an all time high during gameplay.

Dopamine is a neurotransmitter that signals pleasure rewards for food, sex and addictive drugs, such as cocaine (Xu, 2011, p. 6). Games in a sense then, can prove to be an effective tool for its engaging digital media and its availability in everyday life, which is why game elements are so important and used actively in gamification settings (Xu, 2011).

According to psychology professor Mihaly Csikszentmihalyi, games provide a *specific kind of happiness that he named “flow”, which is widely accepted to be one of the fundamental reasons that people play games* (Xu, 2011, p. 9). “Flow” can be described as a state of mind where the individual is fully focused, has lost self awareness, is neither bored nor overwhelmed and has a sense that time is flying. There are seven core compo-

nents of “flow” summarized in the table below. Conditions must be reached before the state of “flow” can be reached (Xu, 2011).

Conditions of Flow	Explanation
Clear tasks	The person understands what they must complete.
Feedback	The person receives clear and immediate feedback showing what succeeds and what fails.
Concentrations/focus	The person is not distracted and can fully attend to the task.
An attainable, balanced goal	The goal is challenging and within their abilities to complete.
Characteristics of Flow	Explanation
Control	The person believes their actions have direct impact on tasks and that they can control the outcome.
Diminished awareness of self	Complete focus on the task leaves little room for feeling self-conscious or doubt. Often described as becoming a part of the activity.
Altered sense of time	Perception of time is distorted. Seconds can feel like minutes, minutes like hours. Time also passes by quickly, unnoticed.



From *Flow: The Psychology of Optimal Experience*
by Mihaly Csikszentmihalyi (page 74)

Figure 4.3: The state of flow is achieved between anxiety and boredom (Xu, 2011, p. 10)

When a person has reached the “flow” state of mind it is important that the goal is balanced, i.e. it is *challenging but yet achievable within the individual’s ability* (Xu, 2011, p. 9). To maintain the “flow” state of mind the challenge must increase along

with improving skills, this balance is referred to as the flow channel as shown in Figure 4.3. The state of flow is achieved between anxiety and boredom (Xu, 2011). Research has gone into the field of persuasion, since Stanford University's researcher BJ Fogg has described in his model what causes behavior change. The model, shown in Figure 4.4, shows three different elements:

- *Motivation: the person wants desperately to perform the behavior (is highly motivated)*
- *Ability: the person can easily carry out the behavior (considers the behavior very simple)*
- *Trigger: the person is triggered to do the behavior (is cued, reminded, asked, called to action) (Xu, 2011).*

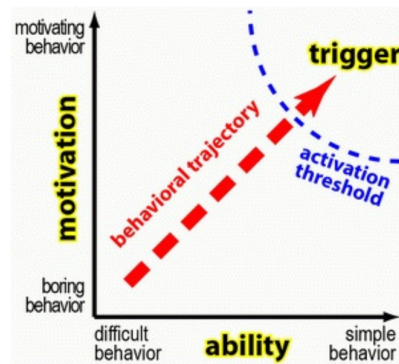


Figure 4.4: Fogg Behavior Model (Xu, 2011, p. 11)

Michael Wu is a researcher who has adapted the Fogg Behaviour Model to show that gamification is able to drive person's actions, and in game mechanics as well as game dynamics users will drive above the activation threshold, i.e to the upper right of ability-motivation axis. One could say then that *successful gamification is all about making these three factors occur at same time* (Xu, 2011, p. 16).

To get the users more engaged in the game setting, what one can do is to include some common reward features in order to form a gamefied connection to the user, as shown in Figure 4.5 Gamification practices 1.0.

A reward may be intrinsic or extrinsic. Extrinsic rewards are points, levels, badges, scoreboards, assignments or even services or products. Intrinsic motivators, such as positive emotions, relationships, meaning and accomplishments are determined by the persons own will or desire (Xu, 2011). Nicole Lazzaro has the opinion that *the use of extrinsic motivation will decrease motivation to use your products and services once you remove that reward. You have to keep upping the dose to have the same motivation and change in behavior over time* (Xu, 2011, p. 19).

	Reward	Status	Achievement	Self Expression	Competition	Altruism
Points	●	●	●		●	●
Levels		●	●		●	
Challenges	●	●	●	●	●	●
Virtual Goods	●	●	●	●	●	
Leaderboards		●	●		●	●
Gifts & Charity		●	●		●	●

Figure 4.5: Gamification 1.0 (Xu, 2011)

Likewise Vockell states, that extrinsic rewards actually reduce long-lasting interest in a topic, *while in intrinsic motivators, people are best motivated when they are working toward personally meaningful goals whose attainment requires activity at a continuously optimal (intermediate) level of difficulty* (Xu, 2011, p. 19). Michael Wu argues however, that in gamification extrinsic rewards can jumpstart intrinsic motivation, which will in the end be the primary driver for the users long-term motivation and engagement. In the research, Nicole Lazzaro has presented four steps to design better engagement in games, especially the MSO (Massively Social Online) games, by releasing the players emotions during the play: Hard Fun, Easy Fun, Serious Fun, and People Fun.

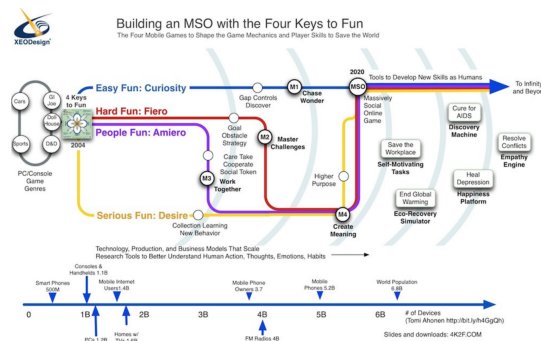


Figure 4.6: Four Keys to Fun Game Map (Xu, 2011)

In order to make a good game, three pillars need to be set and clear. Game designer Marc Leblanc describes the three pillars of a good game in the following section.

- *Mechanics: the various actions, behaviors and control mechanisms afforded to the player within a game context. They make up the functioning components of the game.*
- *Dynamics: run-time behavior of inputs and outputs between player and game. They are the player's interactions with the mechanics.*
- *Aesthetics: The desirable emotional responses evoked by the game dynamics. They are how the game makes the player feel (Xu, 2011, p. 22).*

Amy J. Kim has presented a framework for Smart Gamification. She takes note of previous research and designs the effective player journey with intrinsic reward preferred over extrinsic rewards. The player should progress from novice to expert and lastly to master. Kim suggests different techniques to this such as in Figure 4.5 to meet the players needs, *where novices need onboarding, experts need fresh content, activities and challenges, and masters need exclusivity, recognition and impact*. Figure 4.7 shows the overview of the player's lifecycle (Xu, 2011, p. 22).

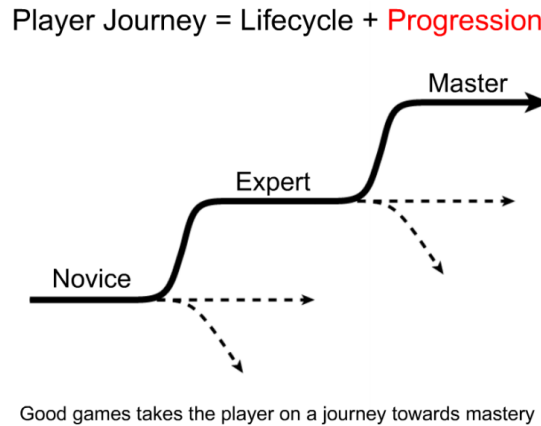


Figure 4.7: Player Lifecycle (Xu, 2011)

Lastly, it can be said that gamification is a quite new phenomenon, in which some circles of industries as well as academia believe it to be a world changing layer. In all areas of human life, where motivation needs to be enhanced or where engagement is a priority, gamification settings will be used more and more to achieve this. However, due to the novelty of gamification, there is still room for additional research to be made before gamification settings will reach their full potential.

4.2.3 Mobile development

The fast cycle of mobile development continues to show promise toward a diverse market of mobile devices. Only two decades ago computers were tied to the desk, mobile phones were only voice transmitters and laptops were connected to traditional networks (wired). As wireless networks, mobile devices and software applications have been developed in an inconceivable speed for the last decade, it is easy to see that it is an age for new businesses and idealistic entrepreneurs.

The last few years have seen the proliferation of mobile devices, laptops, PDAs, tablets and smart phones and their access to networks everywhere. They are devices that fall into the category 3A, anytime, anywhere, anyone (Rodriguez et al., 2013).

The combination of computing power, access to novel onboard sensors and ease of application transfer to market has made mobile devices the new computing platform for

businesses and independent developers (Dehlinger and Dixon, 2011, p. 1).

According to the statistics, mobile-connected devices will surpass the world's population, more than 7 billion by the end of 2014 (Cisco VNI, 2014). Also, the recent technological development allows using applications in practically all aspects of life, such as, social, business, entertainment, gaming, productivity, health and home (Dehlinger and Dixon, 2011). According to Cisco VNI's estimates, the mobile data traffic in 2013 was 18 times bigger than the total global internet in year 2000. Overall mobile data traffic is expected to grow to 15,9 exabytes per month by 2018, a nearly 11-fold increase since 2013. The trend is shown in Figure 4.8.

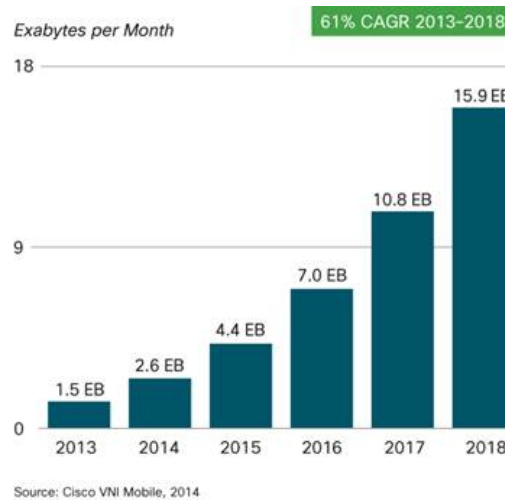


Figure 4.8: Overall data traffic 2018 (Cisco VNI, 2014)

Data traffic in 2018 in different regions in the world is estimated to be; Asia Pacific 42,4%, North America 18,6%, Europe 22,3%, Middle East and Africa 9,4% and Latin America 7,3%. (Cisco VNI, 2014). The trend to smart traffic is driven by smarter mobile devices, emerging wearable devices and video dominance in mobile applications. The share of smart devices and connections is expected to develop as shown in Table 4.1.

As can be seen from Figure 4.9, smart traffic is expected to increase its dominance in 2018.

When device capabilities are combined with faster, higher bandwidth and more intelligent networks, it leads to wide adoption of advanced multimedia applications that contribute to increased mobile and Wi-Fi traffic (Cisco VNI, 2014).

Along with the rapidly growing data traffic and device and network development the recent few years have experienced an explosion in the development of mobile applications. According to Gartner (2013) the total revenue in 2013 for mobile app stores is about 26 billion dollars, up from 18 billion dollars in 2012. Free apps account for about 90% of all downloads. As can be seen from the table below, mobile application downloads will

Region	2012	2018
North America	65%	93%
Western Europe	45%	83%
Central and Eastern Europe	15%	61%
Latin America	14%	55%
Asia Pacific	19%	47%
Middle East and Africa	10%	36%

Table 4.1: Regional Share of Smart Devices and Connections (Percent of the Regional Total) (Cisco VNI, 2014)

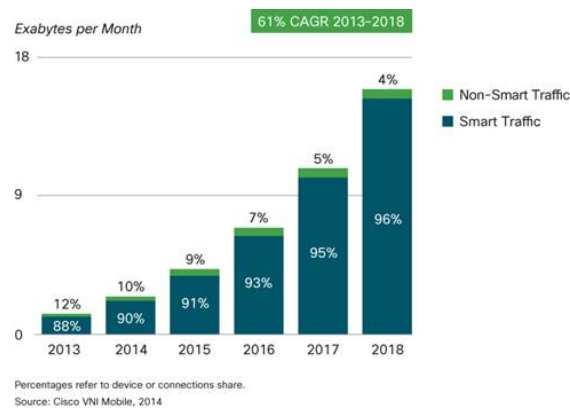


Figure 4.9: Effect of Smart Mobile Devices and Connections Growth on Traffic (Cisco VNI, 2014)

increase strongly through to 2017.

	2012	2013	2014	2015	2016	2017
Free Downloads	57,331	92,876	127,704	167,054	211,313	253,914
Paid-for Downloads	6,654	9,186	11,105	12,574	13,488	14,778
Total Downloads	63,985	102,062	138,809	179,628	224,801	268,692
Free Downloads %	89.6	91.0	92.0	93.0	94.0	94.5

Table 4.2: Mobile App Store Downloads, Worldwide, 2010-2016 (Millions of Downloads) (Gartner, 2013)

There are two major developments that have boosted the mobile application development. First, is the availability of increased network bandwidth from 2G to 3G and LTE.

Second is the introduction of devices with touch screens, large screens, increased memory and high speed processing capability (Vithani and Kuma, 2014).

In fact the introduction of the iPhone and iPad touch-based interfaces was the turning point for the development of user interfaces for mobile learning. As Specht (2014) explains the linking of the mobile learning support to the current context is seen as key to efficient and effective design of mobile learning applications.

Mobile interface design became a critical factor when developing human computer interaction for navigation in complex information spaces with a reduced information channel like the mobile phone's small display. Modern apps will link the user more to the user's current context via sensors regarding location, via information sources in the vicinity, previous use of information or the social context of a person. Contextualized learning support will filter information and functionality in a user friendly mobile application. There are five fundamental categories for context-aware computing as Specht (2014, p. 63) explains:

1. **Individuality** - *which includes information about objects and users in the real world*
2. **Time** - *these can range from simple points in time to ranges, intervals and a complete history of entities.*
3. **Location** - *these can be described based on quantitative or qualitative location models, which allow working with absolute or relative positions, respectively.*
4. **Activity** - *refers to what the entity wants to achieve and how. This reflects the entity's goals, tasks and actions.*
5. **Relations** - *captures the relation an entity has established with other entities, and describes social, functional and compositional relationships. Context-aware technologies give an option to augment the learner's environment with relevant and supportive information and services.*

The emerging operating systems and platforms for the development of applications have been intense and fierce. Two development platforms have emerged as winners, Apple's iOS and Android with Samsung, Google and HTC. All others have been marginalized as can be seen in the following Figure 4.10.

Gartner (2013) estimates in his research that by 2017 90% of all global downloads will be from Apple and Android app stores. However, because application development practices are still evolving, there are two technical approaches to go forward in the development of mobile applications. Only native platforms should be used when talking about optimum user experience, since it brings out all the enhanced and specific functionality of that platform.

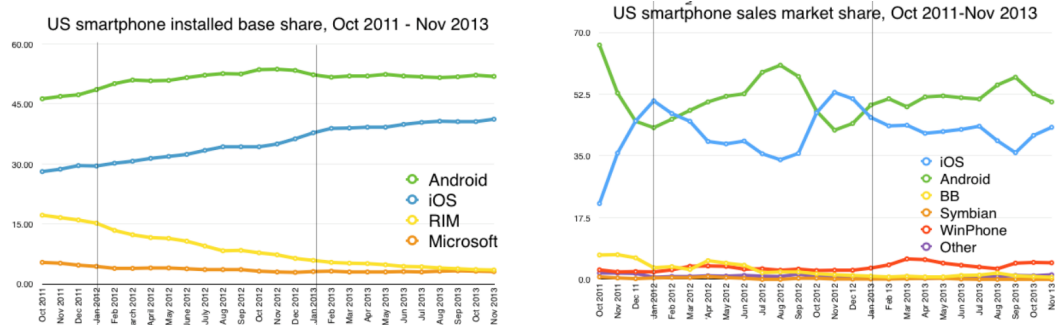


Figure 4.10: Fragmentation of users (Bresnahan et al., 2014)

On the other hand, for maximum portability of content, the best technical solution is to develop a Web app. However this excludes some of the best phone features such as native menus, GPS location, camera and other app functions (Specht, 2014).

According to Specht (2014, p. 103) there are four relevant technical approaches to develop applications:

1. **Open apps** - Involves software techniques that enable developers to create an app that runs on different mobile phone platforms in a single build (cross-platform development)
2. **Open content/content formats** - Allows individual pieces of content to display on multiple devices, using industry standard “players” (e.g. e-book readers) or with native device support (e.g., audio and video files)
3. **Open content with embedded interactivity** - A hybrid between the above two approaches, and is the ideal scenario for learning interactivities, because it combines content with appropriate learning interactions (e.g., a Web app: HTML + JavaScript)
4. **Open protocols, and formats to encourage sharing** - Involves both the sharing of content and the sharing of tracking, progress and messaging between applications.

Already today there are more than 1 million mobile applications available for iOS and Android combined but there is still a lot of unfinished work to do in order to achieve new useful mobile applications with the best possible quality (Cosmina and Razvan, 2014). Creating mobile applications present a lot of challenges. Issues that characterise mobile applications development are; life span, complex functionalities, fewer physical interfaces, higher number of screens for interaction, battery and memory usage, cross platform development and maintenance (Vithani and Kuma, 2014). The development of cloud computing has greatly enhanced the possibilities to build successful cross-platform mobile applications (Cosmina and Razvan, 2014).

4.2.4 Android Design

The Android Design (Android Design, 2014) provides designers and developers with materials to use in the development process. Google (makers of Android) start with their design principles that has three main goals: enchant me, simplify my life and make me amazing. In the android design website they present basic information about styles (such as color and iconography), patterns (such as app structure and notifications) and building blocks (such as lists and buttons). They also provide you with downloads of stencils and icons and they have design-oriented videos from Google's developer conference Google I/O.

Google Play Services

Google Play Services (2014) provides developers with easy and fast access to Google services. The services include a safe and consistent authorisation API (application programming interface) for google accounts. Some features included in the services:

- **Maps:** *Embed maps in applications, create custom marker and draw regions on the map and also the possibility to add Street View.*
- **Google+:** *Provides a trusted and secure way to log in to the app, access to Google account and friends, create interactive post on Google+ and add +1 button.*
- **Location:** *Provides location with the help of different technologies that minimises power consumption and lets apps set up geofences which will notify the app if the phone is in that area.*
- **Cloud Messaging:** *Lets servers send lightweight data to Android phones, can be used for telling the app that there is new data to be downloaded from the server or for instant messaging.*
- **Games:** *An easy way to implement achievements and leaderboards in apps. Enables to save game data to be stored in the cloud and provides API for creating multiplayer games.*

4.2.5 Related work

Västtrafik has four apps on Västtrafik on Google Play Store (2014) and there is a travel planning app for Stockholm and some other apps that are related to our work, because they have gamification elements. There is also a website that has sustainability promotion combined with gamification. We will describe all of Västtrafiks apps and some of the gamification apps.

Västtrafik “Travel planner”

This is the main app for Västtrafik, where users can plan trips, locate the nearest stops, see routes on a map and get prices and sms codes. The design looks outdated and the app has not been updated since April 3, 2013. The average rating on Google Play Store is 3.8 out of 5.

Västtrafik “Var är bussen? (Where is the bus?)”

With this app users can find nearby stops and choose which bus, tram or boat they want to use. The users will see the closest bus on a map and it will update every 30 seconds. The last update was April 4, 2014 and the average rating on Google Play Store is 3.2 out of 5.

Västtrafik “SMS-tickets”

In this app users can view and find all the sms codes for purchasing tickets. It also lets users purchase tickets and remembers the last purchase. The last update was December 18, 2013 and the average rating on Google Play Store is 3.1 out of 5.

Västtrafik “Tram sightseeing”

This is, as the name suggests, an app for sightseeing, in Gothenburg. The users get voice notes about the sights they pass with the tram and the app tells the user where to get off and change trams. The app also shows users where to buy tickets. The last update was May 29, 2013 and the average rating on Google Play Store is 3.8 out of 5.

STHLM Traveling (SL)

This is an open source travel planner for Stockholm, the user can point on the map to select locations and there is real-time update for bus, metro, trains and tram cars. It also has traffic status and helps the user with SMS tickets. The last update was June 14, 2014 and the average rating on Google Play Store is 4.3 out of 5 (STHLM Traveling (SL), 2014).

Foursquare

Foursquare (2014) is a social app where users can check in at places, find nearby places and money-saving deals. The user can add friends and follow what they do and where they check in. The gamification parts of this app includes points, badges, stats and

mayorships (mayorship is given to the user that checks in the most at a place). The last update was May 14, 2014 and the average rating on Google Play Store is 4.2 out of 5.

Waze Social GPS Maps & Traffic

Waze (2014) is a community-based navigation app. The user gets real-time traffic information from the other users using the app and the users can also report accidents, hazards and events. The app has voice navigation, automatic re-routing and learns your preferred routes and destinations. The users can also edit the map to add new roads or delete those which are not accessible anymore. The gamification part of this app includes points and levels. The points are used to compare you to other drivers and the levels are based on how much the user drives. Higher levels unlock new so called moods and make the users' reports have a bigger impact on the map. The last update was February 20, 2014 and the average rating on Google Play Store is 4.6 out of 5.

Recyclebank

Recyclebank (2014) is a website promoting sustainability by letting users earn points by recycling, reading articles and taking quizzes about sustainability. The points can be used to get rewards, e.g. discounts at stores and magazine subscriptions. There is also an app (Recyclebank, 2013) where the users can browse and redeem rewards and earn points by recycling reporting and entering Recyclebank point codes. The last update of the app was September 13, 2013 and the average rating on Google Play Store is 3.5 out of 5.

4.3 Methodology

In this section we will talk about what interaction design methods we used in our thesis.

4.3.1 User-Centered Design

User-Centered Design (UCD) is a design process that focuses on the needs and wants of the users that will use the product or service which is being developed. Gould and Lewis (1985) proposes three main principles of design:

1. **Early Focus on Users and Tasks** - *First, designers must understand who the users will be. This understanding is arrived at in part by directly studying their cognitive, behavioral, anthropometric, and attitudinal characteristics, and in part by studying the nature of the work expected to be accomplished.*

2. **Empirical Measurement** - *Second, early in the development process, intended users should actually use simulations and prototypes to carry out real work, and their performance and reactions should be observed, recorded, and analyzed.*
3. **Iterative Design** - *Third, when problems are found in user testing, as they will be, they must be fixed. This means design must be iterative: There must be a cycle of design, test and measure, and redesign, repeated as often as necessary.*

In the book “The Design of Everyday Things” Norman (2002) states that you should “make sure that the user can figure out what to do, and the user can tell what is going on” by making it easy to determine what actions are possible, making things visible, including the conceptual model of the system, the alternative actions, and the results of actions, making it easy to evaluate the current state of the system and follow natural mappings between intentions and the required actions; between actions and the resulting effect; and between the information that is visible and the interpretation of the system state.

Since 2010 there is an ISO standard (ISO 9241-210, 2010) that states what defines an user-centered design process:

- *The design is based upon an explicit understanding of users, tasks and environments.*
- *Users are involved throughout design and development.*
- *The design is driven and refined by user-centered evaluation.*
- *The process is iterative.*
- *The design addresses the whole user experience.*
- *The design team includes multidisciplinary skills and perspectives.*

4.3.2 Brainstorming

Brainstorming is when a group of people gather in order to come up with ideas and think outside the box around the problem at hand. There is usually a group leader or facilitator who will keep everyone as free flowing and open as possible. The ideas will not be evaluated or commented until after the brainstorming session is completed and the reasoning behind this is that it is the amount of ideas that count, not the quality and the crazier ideas.

Kelley (2001) writes in his book “The Art of Innovation” about the “Seven secrets for better Brainstorming”:

1. **Sharpen the focus:** *If the problem being solved is too broad, one should consider making a question out of it. The question should not be too narrow or product*

specific, neither should the question be constructed so it would suggest that the answer already exists.

2. **Playful rules:** *The ideas that come up during the brainstorming may not be critiqued or commented. It could also be a good idea to put up some rules on the wall or whiteboard, to keep the participants on the right track.*
3. **Number your ideas:** *Numbering the ideas is good for two reasons, one is that it helps to keep the participants motivated, for example getting to one hundred ideas before the session is over. The other reason is to make it easier to jump between ideas and still keep track of where you are.*
4. **Build and jump:** *Try to do small changes to already existing ideas, pushing the ideas further in the same direction or onto a totally new path.*
5. **The space remembers:** *Spatial memory is an important part of brainstorming, one should try to cover the room in paper so that you don't run out of space and have to erase previous ideas. This way the group can easily build and jump between ideas and go back to the original idea and get back into the mindset they had when it was created.*
6. **Stretch your mental muscles:** *It is important to have some sort of warm up exercise, so that the participants clear their heads and become more free flowing. One exercise would be to give the participants some content related homework in order to get a feeling for what one can do with the products that is currently on the market.*
7. **Get physical:** *Do not be afraid to get visual, you might have to sketch or do mind-mapping in order to explain your idea. Sometimes it is even better to bring some materials so participants can build models of their ideas.*

4.3.3 Cognitive Walkthrough

Cognitive walkthrough is an effective method for getting to know the users' needs and mental model (Cooper et al., 2007). In a cognitive walkthrough the evaluators specify some tasks that the users will perform on the current prototype or interface design, then motivate each action the users have to take in order to complete the task (Lewis and Rieman, 1993). If the users fails to complete the task, a problem has been found. Wharton et al. (1994) has an overview on how the cognitive walkthrough process looks like:

1. *Define inputs to the walkthrough; who are the users, task for evaluation, action sequences and description or prototype of the interface,*
2. *Convene the analysts*

3. *Walk through the action sequence for the task*
4. *Record critical information such as user knowledge and notes about issues and design changes*
5. *Revise the interface to fix the problems*

4.3.4 Expert Evaluation

This method is used when you want someone with expertise in user experience theories and user behaviour to evaluate the design or prototype. The expert will use the prototype and write down positive and negative findings that affects the user experience (AllAboutUX, 2014). This method is cheaper and faster than having normal users evaluating the prototype because you only need to invite one participant. The downside of expert evaluation is that it is hard to evaluate long-term user experience and experts are also hard to come by.

4.3.5 Prototyping

A prototype is a rough version of the product, which is used by the developers to let users interact with it to gain knowledge and insights about the users. It is much easier for the users to explain what they like, dislike and what is missing when they get to interact with a real item instead of just talking about it.

"It is often said that users can't tell you what they want, but when they see something and get to use it, they soon know what they don't want." (see Preece et al., 2007, chapter 11.2)

Low-fidelity prototypes

There are two types of prototypes (Preece et al., 2007); low-fidelity (lo-fi) and high-fidelity (hi-fi). Low-fidelity prototypes is the cheapest and easiest way of doing prototypes, it only requires pen and paper to do one of these prototypes. It is also possible to use other simple materials such as cardboard or wood. The use of simple materials make the prototypes a lot easier to make, because it requires no or very little skill, and it also enables for quick modifications. There are several types of lo-fi prototyping and below are explanations of a few of them.

Storyboards

Storyboards are sequences of sketches which explain how one scenario of the use cases, show what the product might look like (Preece et al., 2007). Storyboards shows how the user interacts with the product in each step and also helps to "understand the flow of the user's work" (Snyder, 2003). A storyboards looks like a cartoon strip, which

makes it easy to follow in which order the sketches should be read as shown in Figure 4.11.

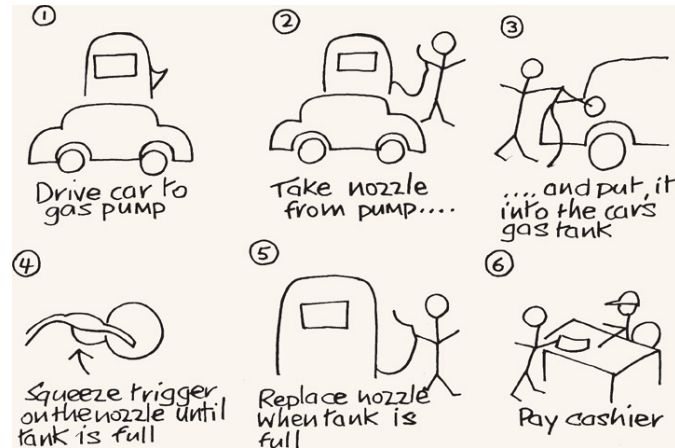


Figure 4.11: “A storyboard depicting how to fill a car with gas” (Preece et al., 2007)

Sketching

Sketching is a big part of prototyping, because it is the easiest way to get your ideas across to another person. Try to keep the elements in the sketches as simple as possible in order to make it easy to understand, some elements can be boxes or stick figures (Preece et al., 2007). One should note that sketches are not prototypes, sketches are used when you need to explore different alternatives. Sketches are the biggest part of the early design stages with its low cost and fast creation time (Buxton, 2007).

Wizard of Oz

This technique is based on the book “The Wonderful Wizard of Oz.” by Baum (1987), in which a girl is swept away in a storm to the Land of Oz. In order to get back to where she came from she must seek help from the Wizard of Oz. But the wizard is actually an illusion created by a machine controlled by a man behind a screen. This prototyping technique uses the same illusion in a prototype where the user sits by a computer screen and interacts with the program prototype, but on the other side of the program there is an operator who responds to the users interaction and updates the users screen manually.

Paper prototyping

Paper prototyping is used when developing and testing software for any kind of platform. You draw the different screens of the software you want to test on paper and then you let your users test the prototype. You might also want to draw menus, dialog boxes and other things which might be needed for the testing experience. (Snyder, 2003) talks about some of the advantages of paper prototyping in her book “Paper prototyping”;

- *Provides substantive user feedback early in the development process—before you’ve invested effort in implementation.*

- *Promotes rapid iterative development. You can experiment with many ideas rather than betting the farm on just one.*
- *Facilitates communication within the development team and between the development team and customers.*
- *Does not require any technical skills, so a multidisciplinary team can work together.*
- *Encourages creativity in the product development process.*

Here is the definition of paper prototyping that (Snyder, 2003) uses in her book “Paper Prototyping” in chapter 1, paragraph 4:

“Paper prototyping is a variation of usability testing where representative users perform realistic tasks by interacting with a paper version of the interface that is manipulated by a person “playing computer”, who doesn’t explain how the interface is intended to work.”

High-fidelity prototypes

One noticeable difference between hi-fi and lo-fi prototypes is that hi-fi prototypes are made out of the materials that the final product would be made out of. If it is a software prototype, it will be an almost complete product and will work as the final product is intended to work. The only exception would be that it still is a prototype and may be changed until the final version is released. (Rettig, 1994) identifies some problems with hi-fi prototypes, compared to the cheaper and easier to make lo-fi prototypes:

- *Hi-fi prototypes take too long to build and change.*
- *Reviewers and testers tend to comment on “fit and finish” issues (with “fit and finish” he means the actual interface design, not the overall layout and feel).*
- *Developers resist change.*
- *A prototype in software can set expectations that will be hard to change.*
- *A single bug in a hi-fi prototype could bring a test to a complete halt.*

4.3.6 Focus Group

If you want to interview several people at a time, then the focus group method is a good way to conduct a group interview. Gather users from the identified target group, usually 3-10 persons, in a room and ask them questions about the product (Preece et al., 2007). Focus groups are used for gathering reactions on the form of the product, visual appearance and also reactions towards a product they have used for a period of time (Cooper et al., 2007). There are also some things to be aware of when preparing and conducting a focus group according to (Baxter and Courage, 2005):

- **Avoid Predictions:** *It is recommended that the participants should not pretend to be in situations in which they have no experience.*
- **Avoid Sensitive or Personal Topics:** *Do not discuss topics like politics, sex or morals, they can make the participants feel uncomfortable and lead to heated discussions.*
- **Use a Skilled Moderator:** *Every focus group needs a skilled moderator to avoid bias, to probe for more information and to make the quiet participants talk.*
- **Observation is Still Best for Understanding Tasks:** *Sometimes participants may say that they would complete a task in a specific way, but when they actually try to complete it, they do it in a completely different way than first anticipated.*
- **Focus Groups are Not Appropriate for Comparative, Competitive, and Benchmarking Data:** *Focus groups should be used for discovery of unexpected uses and problems, not individual data.*

Focus groups allow interviewers to study people in a more natural conversation pattern than what typically occurs in a one-to-one interview. In combination with participant observation, they can be used for learning about groups and their patterns of interaction (Baxter and Courage, 2005).

4.4 Design Process

Figure 4.12 shows the overview of our iterative design process and how we walked through the different stages in the project.

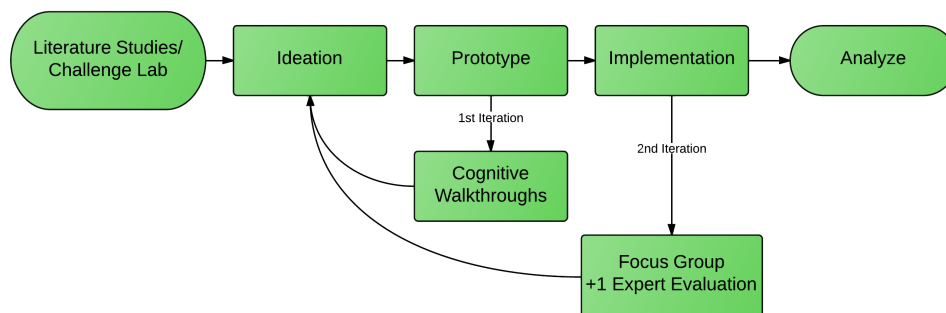


Figure 4.12: Overall Design Process

4.4.1 Literature studies

To get a better overview on the gamification practices, the current mobile development and acquiring more knowledge about design methods, a literature study was held at the start of the project. The knowledge gathered kept the design process decisive and the gamification research extensive, in being informed about gamification practices in general while making sure that validity was obtained.

The term gamification is relatively new and still evolving, so literature studies gathered for this project are mostly new. What this calls for is getting the newest information, since the field of gamification and web development is ever-changing and can be easily outdated from a technical viewpoint. The pre-study consists of research papers, books, online studies, websites etc. from trusted sources in IxD, gamification, web development and in AR.

Planning

The planning section shows how the project was planned, before starting the implementation phase. The initial scheduled time plan gives a glimpse on how the design process was intended for the methods, research studies, evaluation of the prototype and the overall writing procedure.

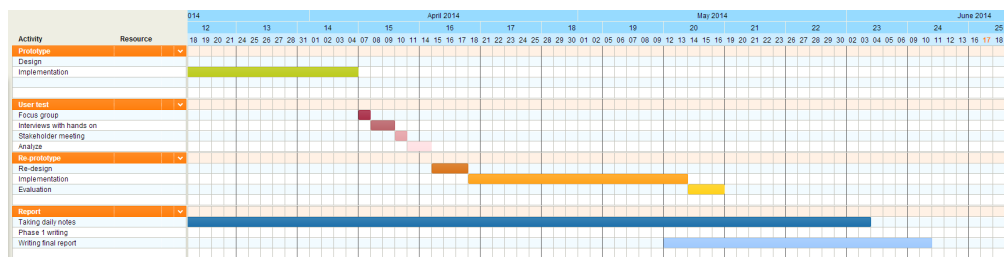


Figure 4.13: Planning schedule

Focusing on finding different gamification practices in applications and exploring how AR could play a vital role in the interaction of mobile development, we found that the extensive research and access to web implementations could help us take a more practical approach than what we initially thought. Acting on a practical approach helped us being more intuitive, being accustomed to following an interaction design approach where concrete studies would serve us well throughout the project, to show the possibilities that can be achieved with user testing and native mobile development.

4.4.2 Ideation

After visiting the “An electrified city” seminars (Gothenburg, 2014) in Gothenburg and seeing commercial actors come together, we started to come up with ideas that could

benefit the public transport sector. Since ElectriCity's project aim is to generate a sustainable future with open innovation solutions around the new electric buses and other services, we agreed that this would be our niche area to focus on. Enabling a gamification service for public transport was something in which we saw potential to promote these buses that commence traffic in 2015. The idea came to us quickly and knowing that we wanted to implement the use of AR for gamification purposes and lift it up to another level with Google Play Services, we began brainstorming with sketches that ended up being wireframes.

Brainstorm sketches

Using sketching as a brainstorming method for the design process, helped us to complete the wireframes early, which actually would get used in the cognitive walkthrough session with heuristic evaluation later on. These brainstorming sketches became a creative and effective way to express what was needed in the design and what could be implemented within the given timeframe which we had.

4.4.3 Prototype

This section describes the prototype, expected findings and the changes made on the basis of the user interviews and focus group session.

Cognitive Walkthrough

This section describes a cognitive walkthrough session aiming to evaluate a design concept for the gamification functionalities of the app in the ElectriCity project. The cognitive walkthroughs were conducted with heuristic evaluation to ask the C-Lab students what their thoughts were on the sketched wireframe design. Their mobile app experience ranged from average to good and adding to this, one expert evaluation was gathered from a gamification expert working in the Interactive Institute Swedish ICT (2014).

The cognitive walkthrough session was open and the participants were allowed to ask questions or give feedback at any point during the walkthrough. The participants were interviewed by one person as another person was taking notes. The walkthrough was outlined by using sketches of different gamification aspects of the developed design. All in all, 4 sketches were used for the wireframe design and 3 pictures were used regarding the AR functionality.

During the cognitive walkthrough session sketches were shown on screen without the additional explanation text on the side of the sketches which you currently see on the wireframe. The users were asked to describe what they saw and how they interpreted it. If the user had misunderstood something in the sketch or picture, then it was explained,

ensuring the user was aware of the context and the functionality. Following that, a general discussion about the design was held, to gain ideas for possible improvements. In the end of the cognitive walkthrough, the users were asked if they were missing any features that should be added to the design.

Questions used:

What is visualised on the current page?

What purpose do you think the current page has?

Is something missing?

How would you solve the problem?

Each cognitive walkthrough brought forth specific feedback, mostly about the same wireframe function, which helped us realise where the design should be improved. The users were also asked if they would come up with their own suggestions for solving the design problems that arose during the interviews.

Sketches and pictures used during the cognitive walkthrough:

Sketch 1: E-ticket page

Sketch 2: Buses page

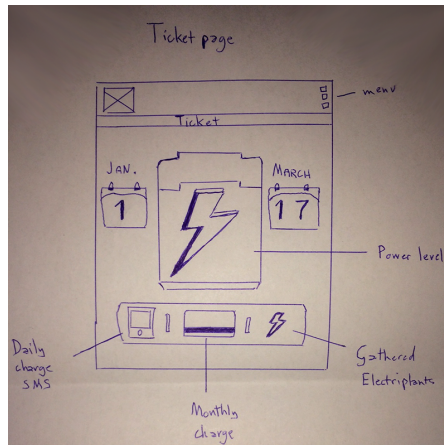
Sketch 3: Profile

Picture 1: ElectriCoins part 1

Picture 2: ElectriCoins part 2

Picture 3: ElectriCoins part 3

The cognitive walkthrough session was held in Kuggen, Lindholmen Science Park, in the C-Lab meeting room with 6 C-Lab participants as everyday users, 1 C-Lab coordinator and 1 gamification expert from the Interactive Institute Swedish ICT (2014). The cognitive walkthrough session was scheduled to approximately 30 minutes per person. These are the overviews and expected findings on the basis of the sketches and pictures:

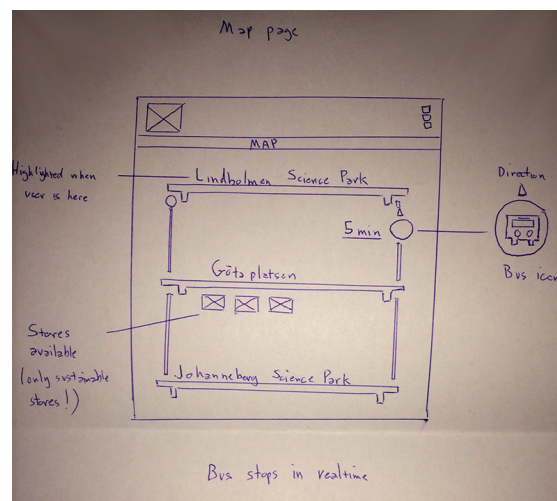


Sketch 1: E-ticket page

This sketch is an overview of the E-ticket page from which the user can charge his travels with different payment methods and view how much he or she has left from the calendar view. The purpose of this sketch was to gather overall feedback on the general graphical style, the layout of charge components and if the presented information is clear and sufficient.

Expected findings

People might find the power level and purchase date hard to interpret. Icons may not be sufficiently evident of what they represent.



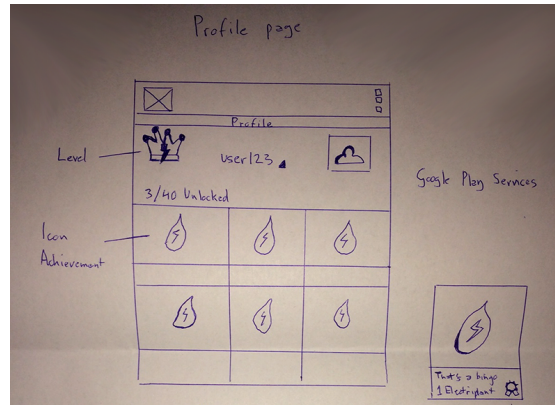
Sketch 2: Buses page

The sketch was used to get feedback on whether this was a proper way to inform the traveler in real time how near the buses are from the stops and to receive suggestions for how they could be improved. If the user wishes to view several more bus stops, then

it is possible to use the scroll down functionality of this page.

Expected findings

The user may not recognise the highlight function as showing user's position.

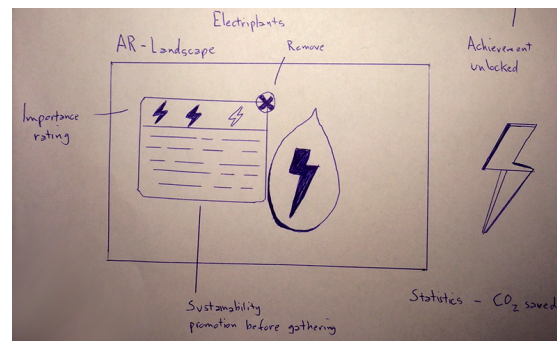


Sketch 3: Profile

The sketch shows an example of a user account for gamification purposes. The feedback about this sketch was to see if the user understands the layout and imagining what kind of gamification information they will receive when unlocking achievements.

Expected findings

The user might want to have numbered levels instead of icons. The users may want to see their collected ElectriCoins on this page



Sketch 4: AR - Landscape Electriplants

This sketch shows the early designed AR view when the user is in landscape mode to collect Electriplants (now called ElectriCoin) for the so called power level boost. The sketch was not used during the user interviews because it was replaced with the pictures below.

Expected findings

They might find importance rating confusing, because all things that improve sustainability is important. Instead of importance rating, we could have impact rating (CO2).



Picture 1: ElectriCoins part 1

This picture shows the “floating” ElectriCoin, how it could be viewed in the AR environment by the bus stop. The next picture will show what happens when the user collects the ElectriCoin. The purpose of this picture was to visualise the gameplay in a “real view” setting to see how the users react in the game layout and also why our design decision was to separate the gameplay to be viewed in landscape mode instead of portrait mode.

Expected findings

It might be hard to figure out how close you need to be to pick up an ElectriCoin. A radar function might be needed to see if there are any coins nearby.



Picture 2: ElectriCoins part 2

The picture shows the ElectriCoin, but now in a transparent background with the Daily Challenge, because the user collected it. The user can now press “ok” in order to get the ElectriCoin and get information from the sustainability pop-up.



Picture 3: ElectriCoins part 3

The purpose of pictures 2 and 3 are to gather the users’ thoughts on the cross and “ok” button, finding out which one they preferred most and to visualise the gameplay follow up, and finding out if there are any further questions left.

Expected findings

Users might find it annoying with the Daily Challenge popup. The “ok” button will probably be more liked than the cross button, since the cross button might just “dismiss” the promotion in the mindset of the user.

Re-design

The major change made after the cognitive walkthrough session was in Sketch 1: E-ticket page where the starting date of the calendar view was removed and the end date of the calendar was moved inside the battery. Also, there will be text on top of the battery indicating which month it is and when the battery power level is low. The text will show if the user has 1 week left or 3 days left. The SMS, online transaction and ElectriCoin icons will be remade and have a heading called payment methods.

Sketch 2: The Buses page remains mostly the same with the alteration of removing the sustainable stores icons from the view and changing the heading to Buses instead of Map.

Sketch 3: The Profile page will include, in the low right corner, the amount of Electri-Coins the user has and a grid overview according to Google Play Services for unlocking achievements.

Picture 1: ElectriCoins part 1 remains the same after user interviews.

Picture 2: ElectriCoins part 2 and Picture 3: ElectriCoins part 3 indicated that the OK button will be implemented for the app design. The Daily Challenge heading is changed to Daily Tip after the user interviews.

Results from the cognitive walkthrough session

The results from the cognitive walkthrough session showed us with the help of the wire-frame sketches and in-game pictures that the app design needed some redesigning. A total of 7 everyday users (C-Lab) results are explained in this section, together with 1 gamification expert. Additionally, the gamification expert's statements from the cognitive walkthrough session are added as an appendix to the research.

Asking the users about the users gaming experience, 6 of 8 have some kind of experience of browser games or app games.

E-ticket page:

The results of the E-ticket page shows that reading from left to right in the visualisation of the battery, is understood by most users as a part of the power level counted in days. The design of the battery also seemed to appeal to many users. However, it was changed because we wanted to simplify the E-ticket page further.

The follow up question was: is the start date really necessary when you are on the E-ticket page?

We asked this question because people who buy their bus cards from the refill shops tend to ask only about the end date, not about the start date.

All users agreed that the start date was not needed. Acknowledging this, the end date is the most important one. This is why we took the design decision to move the end

date inside the battery itself. Additionally, we state weeks or days remaining above the battery because many of the participants said they would like to see the time remaining until when they need to refill the E-ticket page. This redesign was made after the user interviews were concluded.

The payment methods heading (as we call it now) for the pay functions of the E-ticket page will likely help the users to better understand what the three pay icons represent. At first, the wireframe sketch did not have the heading, nor a particularly clear view of what the pay icons were. 6 of 8 asked what the icons actually meant. Some users also pointed out that they want to have some kind of visualisation of the currency, displaying the amount and information about what you get when you gather ElectriCoins.

Bus page:

The results of the Bus page show that 6 of 8 understood that the scroll down function on the Bus page meant to navigate to more stations. 8 of 8 users understood by themselves to scroll down in order to view more achievements on the Profile page in the achievement section.

The Bus page had some issue with the smaller bus icon, users asking what purpose it served. 3 of 8 did not understand that the smaller bus icon indicates that the bus is waiting at the station. Most users liked the idea of having the colors green, yellow and red, representing a “traffic-light” countdown of when the bus is leaving.

When asked, what the bus stop represents in the page view, 5 of 8 users did not understand that this was meant to represent both “to” and “from” directions on the bus stop. Three users had trouble knowing what station they were at (the highlighted text function), but we believe this will be solved by having the actual app live, because the users can then see the interaction of this page more clearly.

They also pointed out that if the bus icon was moving in real time towards the bus stop heading (sketched in the wireframe) they would probably have understood it better and known where they were located.

Profile page:

The results of the Profile page show that 7 of 8 understood the gamification profile and could point out where the username, profile picture and player level was. Most of them figured out that the icon to the left was an indication of the player level.

In this section we asked a follow up question, whether they would like to see how many ElectriCoins they have gathered and where they would like it to be displayed. Most users agreed that it could be displayed in the lower right corner.

3 users mentioned that it would be good to have some kind of social media or friend function on this page as well.

The greyed out achievements will be added to the real app, so that the users can see what achievements they can get from the gamification service. We also asked the users about their opinion if the greyed out achievements should have a lock icon instead of

being greyed out. The immediate response from the users with more gaming experience was that this could be misconceived as a premium feature to buy something in order to get it, which is why we keep the greyed out achievements as they are.

Electricoin pictures:

The results from the Electricoin pictures show that 8 of 8 users would tap directly when they see the Electricoin, therefore we now know that the gathering perspective is self-explanatory. 5 of 8 users said the Electricoins reminded them of Super Mario and saw this as a good thing for the playability.

The Daily Challenge heading arose questions and misunderstandings. 6 of 8 users misunderstood it, or thought it was part of something they needed to achieve before gathering the Electricoins. Afterwards, we asked the users if they preferred the Daily Tip heading instead of The Daily Challenge heading, and 7 of 8 answered that they preferred the Daily Tip.

7 of 8 preferred the ok button to the cross button. One user said that the buttons can be either or. If there would not be a button at all, then most users would tap outside the box.

As we displayed the augmented reality view we also had an in-game coin sound to see if the users understood that the Electricoin had been gathered when the sound was played. 8 of 8 understood this.

Some users also suggested adding bus information in the augmented reality view while gathering Electricoins, but we reminded them that this screen should not have too much information or objects in order to avoid information overload.

We also discussed about the AR-view, asking if a start-up screen should be implemented, displaying some kind of information about how to play the game. Solutions for this could be screenshot explanations of the AR-view in the Google Play store as well as some sort of notification message to the user, in case the user does not know, or has not used the AR-view before.

4.4.4 Implementation

Before starting the implementation phase, we selected Android as the core development platform and chose to go with a native development approach, since Android is one of the top contenders in the smartphone market today. The implementation was done using the Eclipse (2014), because we had prior knowledge in working with both Android and Eclipse. We also think a native app is more smoother than using a library that combines all the different mobile OS's. The augmented reality part of the app is provided by Wikitude (2014).

Focus group

The focus group section describes the interview of an app prototype. The selected users for the focus group are the same as before, C-Lab students that act as everyday users of the app, and separately an expert evaluation of the app prototype with the same gamification expert from the Interactive Institute Swedish ICT (2014).

The qualitative research aims to evaluate the user perceptions about the app itself, being able to talk freely to anyone in the group, at any point during the discussion. We want to point out is that android users are able to download the app from a QR-code on-screen and are able to give their reflections about the app from their own smartphones. Others are handed out two android smartphones with the app installed for them. The interview was informal and conducted by 2 persons, one moderator and one taking notes.

During the focus group session, users were asked to try the different functions of the app and to ask questions, if there was something that they did not understand. Following that, a general discussion was held, in order to assess possible improvements to the functionality of the app.

The focus group session was held in Kuggen, Lindholmen Science Park, in the C-Lab meeting room with 6 C-Lab participants as everyday users and 1 Gamification expert from the Interactive Institute Swedish ICT (2014). The focus group session lasted for approximately 120 minutes. Below are screenshots of the app and the expected findings about each app page.

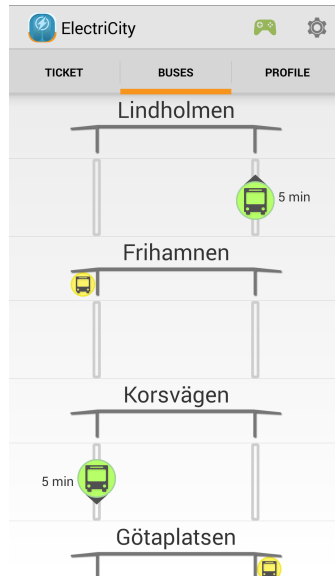


Figure 4.14: Buses page

App page 1: Buses

The bus page is the starting page of the app, here the user can scroll down and zoom in and out to view a more detailed view of the buses. The buses are intended to move in real-time for a smooth flow and to show the time of the next bus that the user will take. The colour system consisting of green, yellow and red shows if a bus is coming towards the user, if it is stationary or if it already has gone.

Expected findings

The user may not know which bus is the incoming bus, because the app needs a highlight function and an icon to show where the user is. Because the app is not currently showing the bus information in-realtime, the user may find it difficult to interpret the color system.

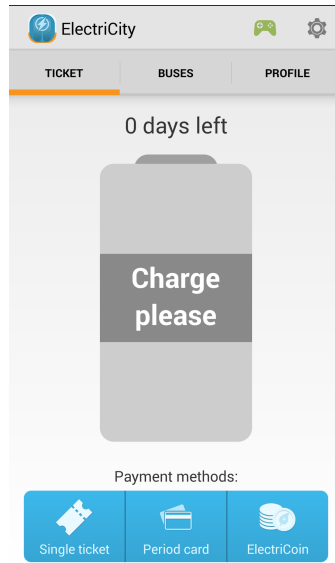


Figure 4.15: Ticket page

App page 2: Ticket

The ticket page shows the user how long the ticket is valid for (the power level of the battery) and the three different payment methods. On this page the user can see the greyed out battery (and 0 days left) which asks the user to refill the battery with more travel days.

Expected findings

The users might find it hard to interpret the power level of the battery and the end date.

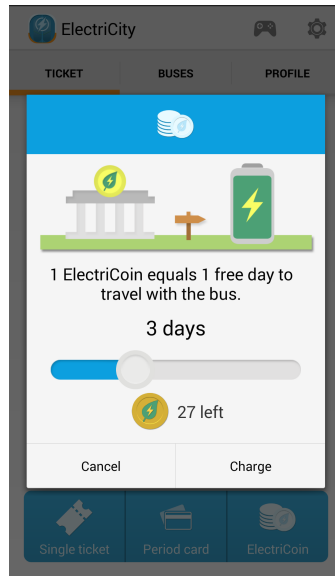


Figure 4.16: ElectriCoin Payment

App page 3: ElectriCoin Payment

The ElectriCoin payment shows and explains to the user how much a day's travel with the electric bus is worth in the ElectriCoin currency and how many ElectriCoins are left when the user charges the battery.

Expected findings

The user may wonder why you can only buy up to 7 days of travel with the ElectriCoin when using the slider.

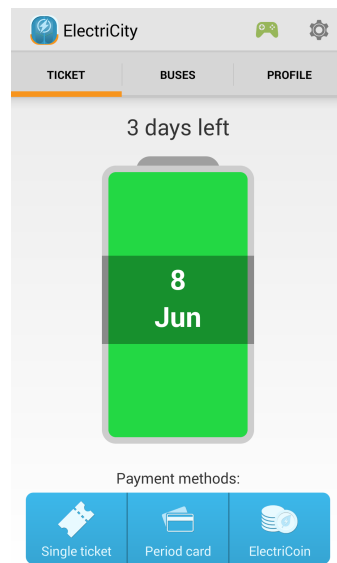


Figure 4.17: Battery charged

App page 4: Battery charged

The ticket page shows that the battery is refilled after using the ElectriCoin payment function. The user refilled the battery with 3 days and can now see that they have 3 days left as well as the end date, 8th of June. The power level of the battery decreases when a day passes by, showing the users a color visualisation of how much time they have left before they need to refill the battery.

Expected findings

At the moment the user cannot see the color visualisation when charging the battery, therefore they may have questions regarding what it might look like when the power level is low.

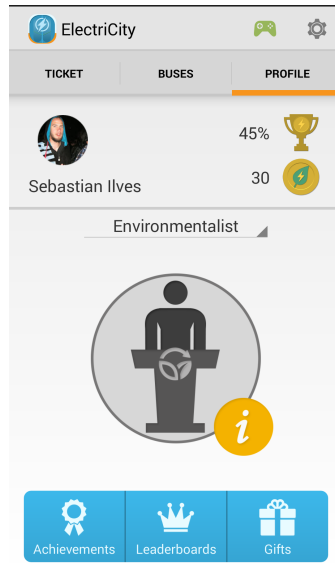


Figure 4.18: Gamification profile page

App page 5: Gamification profile page

The gamification profile shows, when logged in with the green lit game controller, the users profile picture from Google+, name, current amount of ElectriCoins and the percentage required until unlocking the next achievement. Below that, there is a game track feature which enables the user to choose a game track that they want to achieve. The idea is to engage the player into a continuous game flow by achieving the different track goals they need to do weekly. On this page there is an environmentalism track which, for example, could have a requirement of tweeting, sharing 5 or more sustainability pop-ups (which show up in the AR-view) to a social media platform and then perform them.

Additionally there are three different buttons which the user can navigate in, which will be explained in the sub-headings of app pages 7, 8 and 9.

Expected findings

The user may wonder what the percentage next to the trophy stands for. It might be hard for beginners to interpret the game track function.

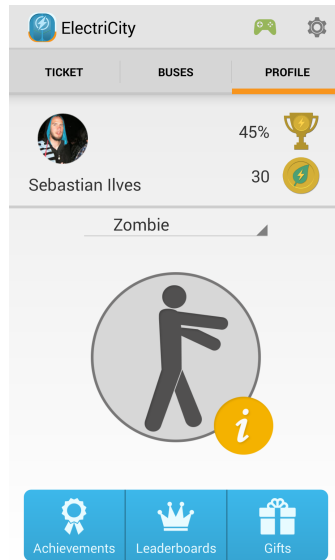


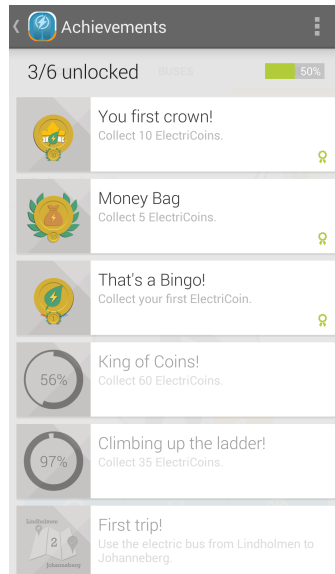
Figure 4.19: Inactive user

App page 6: Inactive user

As explained above in app page 5, the gamification profile page shows a zombie as a game track, which means that the user has been inactive for up to a week. Other game tracks which we have implemented are; Achievaholic (the user does all the category game tasks of the week), Big-hearted (sharing up to 10 ElectriCoins per week with other users on Google+) and Master of Coin (the user gathers up to or more than 70 ElectriCoins a week).

Expected findings

As mentioned before, the users may need an explanation what the game tracks stand for and what they need to do in order to achieve them. This could be solved with an info button next to the game track image.

**Figure 4.20:** Achievements**App page 7: Achievements**

The achievements are unlocked when the user has gathered enough ElectriCoins, earning them an achievement badge in the process. The list and icons are greyed out when achievements are not yet unlocked by the user. The user can also see how many more percentages are needed to the next achievement on this page.

Expected findings

The user may want to see each achievement badge individually when pressing them on this page.

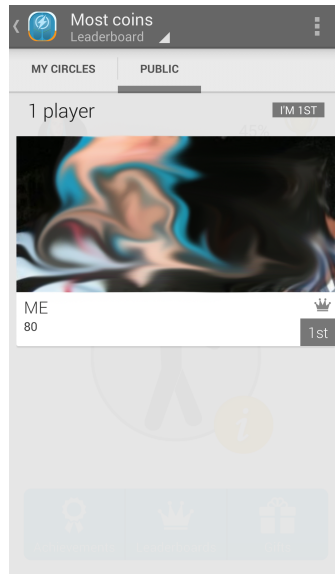


Figure 4.21: Leaderboard

App page 8: Leaderboard

The leaderboard page shows the game stats, meaning who is ranked the highest. The current leaderboard is selected and viewed in the public section, adding a list of profile pictures of the users ranked and their scores. The user can also see in greater detail how their friends are doing in the tab section my circles.

Expected findings

New android users may be unfamiliar with the Google Play Services extension for viewing leaderboards etc.

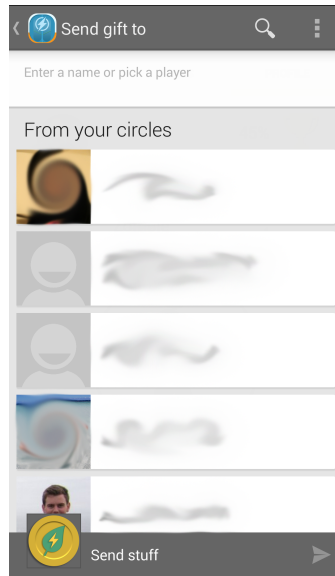


Figure 4.22: Send gifts

App page 9: Send gifts

The gift sending function enables the user to send gifts (ElectriCoins) to contacts or friends on Google+.

Expected findings

The user may ask why he or she would want to give away ElectriCoins to someone else.



Figure 4.23: Augmented Reality

App page 10: Augmented Reality

Augmented reality is used to find ElectriCoins on the bus stops. As the user collects the ElectriCoins, the user can make use of the radar function to see if there are more

ElectriCoins in the vicinity. A coin sound is played once the user picks up an ElectriCoin, in order to let the user know that they have gathered it. If the user has collected enough ElectriCoins, a notification about the achievement will show up as a pop-up on the screen.

Expected findings The user may find the radar function hard to read.

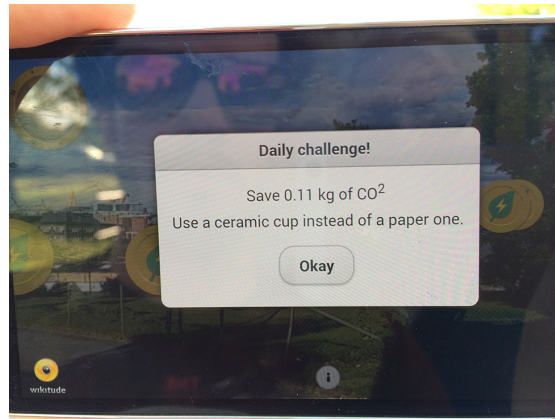


Figure 4.24: Sustainability pop-up

App page 11: Sustainability pop-up

The pop-up with sustainability information appears when the user has collected an ElectriCoin, therefore getting aware on how much CO₂ is saved when doing a green action. Another function that could be added here is a sharing function to the pop-ups, so the user can share their green actions to raise awareness via popular social media platforms.

Expected findings The user may find the sustainability pop-up annoying.

Redesign

The redesigns made to the app were minor, mainly due to the time constraint and because the current implemented features already show enough concrete gamification examples about how to promote the use of electric buses. One redesign worth mentioning, is the slider function, where the user can refill the battery with ElectriCoins. Adding the current amount of ElectriCoins underneath the slider was something that was needed, because the users wished to see how many ElectriCoins they had left when refilling the battery.

Results from Focus group

The results from the focus group session helped us find some minor design flaws which needed correcting. When we asked the users about their gaming experience, 5 of 6 participants had some kind of experience with browser games or app games. As the users downloaded and installed the app, at first there were a few app crashes, which lead to unnecessary discussions about trying to fix the bug problems. After agreeing that the problem was because of the current app version, which did not support some of the users' old devices, we let them use our Android devices in the session instead.

An improvement for next time with the focus group, would be to explain at the start of the session in detail what we were going to test, so that the participants would know which implemented functions are important to get their feedback on, and only then let the users use the app. Nevertheless, the focus group discussion led to discussing the navigation of the app, the iconography, what missing features there were, how they would improve the app and what they thought about the ElectriCoin concept in general.

The bus page brought up some questions as expected, since the buses did not move in-real time because the page was just a visual overview of the buses. 4 of 6 users want to expand the view when they click the bus station. We also asked them if they would like to have something that would colour the trail (bus line) behind the bus icon, to show what direction the bus was heading. 5 of 6 users agreed that this would be a good feature to add. 3 of 5 users understood the color system straight away, while the rest wanted an explanation of the system. The bus page did appeal to most of the users and they said that with the highlight function and an explanation of what the icons were, they would quickly be able to assess where the buses are arriving etc. Some users also asked if there could be sustainable stores, where they could pick up more ElectriCoins, as icons on the buses page.

3 of 6 users understood the ticket page, when asked to explain the connection between the battery and the time visualization. These users added that they would like the battery to have a thunderbolt picture somewhere inside the battery, in the same way as it is displayed in the app launcher icon. This could be done in a later implementation, in order to raise trust and for the users being able to see the connection that the battery is actually the ticket, which they can ensure belongs to Västtrafik.

5 of 6 said that it was essential to keep the displayed ‘days remaining’ on top of the battery. 3 of 6 users instantly pressed the battery when they saw it and as we talked with the users, they said that they would like to see an implementation of a hidden action, information of what the battery charge consists of when the user presses it.

In the gamification profile, all users agreed that the info icon on the game track will help inform the users how to perform the weekly gamification tasks. Some users also mentioned that they would want to see a history of how many ElectriCoins they have collected, displayed on the gamification profile.

Regarding the augmented reality, most of the users thought that the transition from portrait view to landscape view takes quite a long time to load. This could be solved by buying the watermark license from Wikitude. It is worth mentioning, that because some Android devices might have autorotation turned off, it could be good to implement a function in the app to turn it on, in order to see the AR elements when gathering the ElectriCoins. We understood this after one user did not receive any ElectriCoins on screen in the beginning.

6 of 6 users admitted that they overlooked the AR compass when they saw the ElectriCoins in the AR environment, because they started to collect ElectriCoins straight away, instead of viewing what the compass did.

Some users said they would like to have some kind of amount indication, such as an ElectriCoin bag showing how many ElectriCoins they have in the AR view, enhancing the digital coin sound being played once you pick it up. Also, one user added that they would like to have an exit prompt from the AR.

After seeing the entire app, 3 of 6 users suggested that they would also have liked to have a tutorial on how the app works, which could be added as an optional function. In this case the implementation could be, for example, a pop up walkthrough when the user logs in with the Västtrafik credentials for the first time. After rounding up the focus group session, 6 of 6 users agreed that the ElectriCoin gathering function was the most fun thing to do with the app.

5

Result

In this section we will elaborate on the results from our research question which is: A mobile application for public transport - How can gamification be used to promote the use of electric buses for a sustainable future?

To get to the results we used an iterative design process which included research, ideation, prototyping, implementation, cognitive walkthroughs and a focus group. We started first with the research phase which was the whole Challenge Lab process (3 months).

Before the research phase was over, we had already found a project ElectriCity (Västtrafik, 2014) which we wanted to delve deeper into. ElectriCity (Västtrafik, 2014) is a project which will introduce electric buses in Gothenburg's public transport system in 2015. Västtrafik (2014) said that they want to "increase the attractiveness of public transport" by implementing new services with features such as gamification. In the ideation phase we came up with ideas how to implement gamification in a public transport app and we came up with the term ElectriCoin, which is a virtual currency used in the app for buying tickets. We selected the best ones and moved into prototyping to create some wireframes for the screens we wanted to have in the app. We then tested the wireframes on users in cognitive walkthroughs and went back into ideation to solve the problems that rose up during these walkthroughs. Instead of making new wireframes, we went into the implementation phase to produce a high-fidelity interactive app prototype in Android. When we had a working hi-fi prototype, we gathered users for a focus group and we also conducted an expert evaluation with a gamification expert from the Interactive Institute Swedish ICT (2014). The next iteration did not involve any user tests because we had no more time and we only had enough time to correct the problems that arose from the last focus group and expert evaluation.

5.1 Final Design

In this section we will present and describe the final design and all of the pages of the app. We will not describe how we reached the design because that is already explained in the Design process section.

The ticket screen contains a large battery which represents the time the user has left to ride with the bus. When there is no time left, the battery will be depleted and will tell you to charge it. There are buttons on the bottom of the ticket screen for charging the battery; single ticket, period card (months/year) and an option to use ElectriCoins to pay for the charging. The picture in the middle of Figure 5.1 is the charging method we implemented, the one where the user pays with ElectriCoins, and where it is possible to select how many days to charge the battery. The last picture shows the screen when the battery has been charged; it shows both how many days are left and which is the last day available to ride the bus.

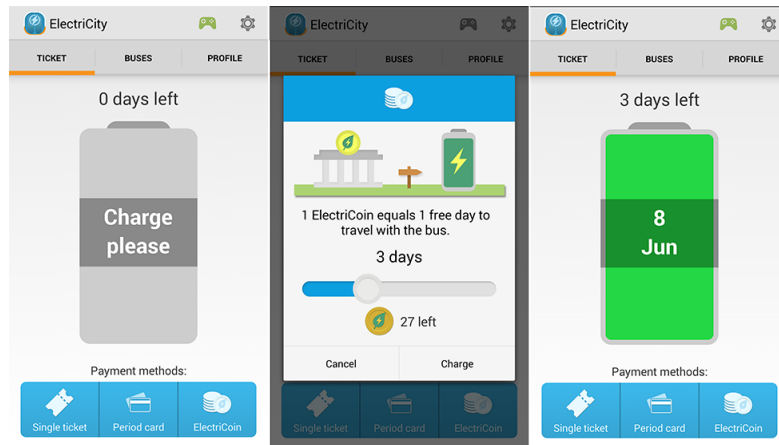


Figure 5.1: Charging flow

The Figure 5.2 shows all of the screens side by side, in the way they are implemented in the app. There is also an indication in the tab bar to show where in the app the current page is located. The second picture in Figure 5.2 shows the buses which are present on the electric bus line. The buses will be updated in real-time and move around the abstract map, but for now it is just a static page. A green icon means that the bus is moving, it also shows how many minutes until it arrives at the next stop, and a yellow icon means that the bus is currently waiting at a bus stop. The last picture shows the gamification profile, the green controller at the top in the action bar tells the users that they are signed in. The profile contains the users' picture and name from Google+, the trophy tells them how close they are to complete the next achievement and the coin symbol shows the amount of ElectriCoins the user has. Below this information we have the game track, which is almost like a title for the profile where the user can choose a different game track when they have completed the objectives in order to receive that

track. The different tracks are Environmentalist, Achievaholic, Zombie, Big-hearted and Master of coins. The last part of the profile page has buttons for the game features from Google Play Services (2014): Achievements, Leaderboards And Gifts.

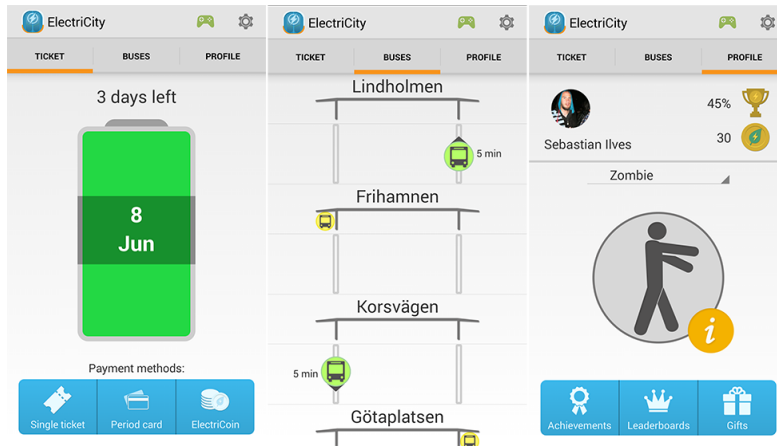


Figure 5.2: All the main screens

Figure 5.3 shows the interface for the game features mentioned in the previous paragraph and the achievement screen shows all the achievements and how many of them the user has unlocked. The leaderboard screen is a normal leaderboard which ranks the users according to who has the most coins. The last screen is for gift giving and lets the user select who to send a gift to. The only thing the developer can influence in the design is the amount and design of the achievements.

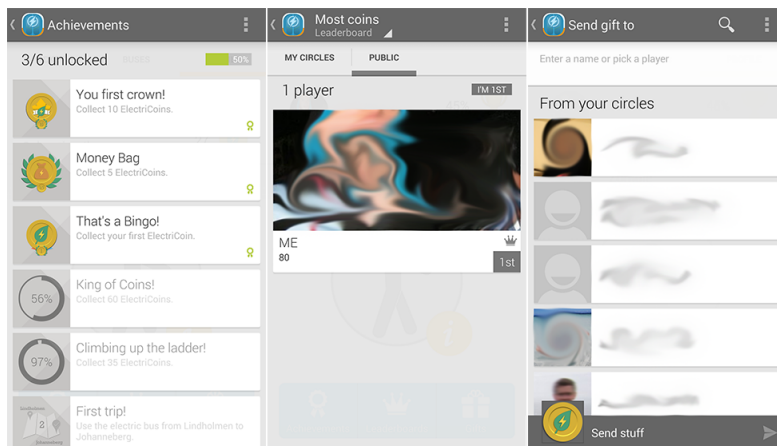


Figure 5.3: Achievements, Leaderboards And Gifts (Google Play Services, 2014)

This is the gamification part of the app and to get to this part the user has to turn the phone to landscape mode. As seen in Figure 5.4 the user looks at the world through the camera of the phone and the app will load ElectriCoins from a server and present them as part of an augmented reality experience. To collect a coin, all the user has to

do is press the coin on the screen, then a “Super Mario like” coin sound will play and a popup containing sustainability-related information will be presented to the user. To remove the popup, the user has to click the “Ok”-button or click outside the popup itself.

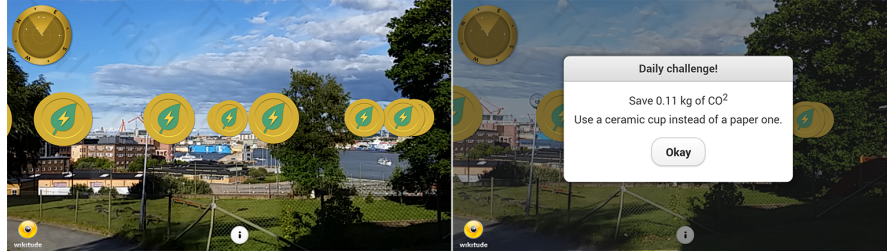


Figure 5.4: Augmented Reality view

5.2 Can gamification promote the use of electric buses, while raising sustainability awareness?

When users tested the gamification part of our app, we noticed that they got almost completely immersed in the search for ElectriCoins, that some users were hard to reach and that they only started to talk again after they had found all the coins. They already knew what the ElectriCoins was supposed to be used for, so they knew that the more coins they had, the more free trips they could take. When a user found a coin, he or she sometimes said out loud the sustainability-related information to the other users, perhaps to see if the others already knew that information or to see if the others had found some other sustainability-related information. 97% of the users of Recyclebank and their environmental gamification website, stated that gamification increased their knowledge about sustainability (Xu, 2011).

We believe that gamification can be used to raise environmental awareness and the use of environmentally friendly transport solutions, such as electric buses. We draw this conclusion based on our own experiences with our app prototype and the users helping us during the testing and evaluation phases of our project. We also note that gamification can help people gain knowledge and be an effective and appealing educational tool (Xu, 2011).

6

Discussion

This section analyses the entire C-Lab process as well as the gamification project, what the outcome of the methods and results were and concludes with how C-Lab has influenced us as interaction designers. We have added recommendation and future work sections to the end of the paper.

6.1 C-Lab process

The C-Lab process (also known as the C-Lab method) has certainly helped us broaden our perspective on sustainability and how to work together in a transdisciplinary group of 12 master students.

Defining our research question has been partly because of C-Lab but also because of our background in IxD. What has played a vital role in identifying the project is mainly the knowledge perspective which was formed in the beginning of C-Lab. Sometimes it might be hard to adapt to a specific research area if you already have chosen a topic beforehand.

We had some ideas before entering C-Lab but they changed after the C-Lab process, when we learned how important behavioral change is in society. The different tools, methods and frameworks written in this thesis can be seen as a general overview of the steps in the C-Lab process, while the inside-out perspective with the stakeholder interaction can be seen as more of an iteration that lasted throughout the whole process.

Meeting with stakeholders to discuss sustainability issues and getting an understanding about how the system works today, raises the level of understanding when forming the facts and figures together with face-to-face interaction. However, the selection of stakeholder interaction should always be sampled diversely in each sector in order to

be adequate. In the beginning of the C-Lab process it was hard to get in touch with the stakeholders from the industry, hence it was hard to assess their perspective. Fortunately enough, in the later stages of the C-Lab process we got hold of them. One tool in particular which served the stakeholder interaction well, was the dialogue tool, which helped us to see if the stakeholders had a hidden agenda or if they were talking freely.

Since the C-Lab process consists of a lot of tools and methods, it is hard to pinpoint which tool or method was the most important one during the process. Backcasting (Holmberg, 1998) was an important tool which helped us define what a sustainable future is. Another approach which the C-Lab process also used was design thinking (Örjan Söderberg, 2014), which was helpful in narrowing down and focusing on the desired outcome of the project and the needs of users.

Not all tools or methods introduced were used, such as the Casual Loop Diagram, which lead to inconclusive results. However, the variety of methods and tools which were used within C-Lab is what makes C-Lab a good development platform from which to develop individually and as group.

6.2 Project

At the start of the project, since all interactions of the app are not easy to explain with words, the wireframe sketches made it easy for us to explain the concept of the app to the users, while we were conducting the cognitive walkthroughs.

As we already mentioned in the result section, both usability studies were conducted with the C-Lab and the gamification expert from the Interactive Institute Swedish ICT. Therefore it was interesting to see how they interacted with the app prototype the second time. What we learnt was that they were more familiar with the whole concept of app rather than specific functions.

The page that the users remembered best was the ticket page and the profile page, but they needed more explanation about the bus page because it was just a visual overview of the buses. Once this section is fully implemented with interactivity we believe it will suffice.

Although we were not able to make any further modifications except one (see screenshot 3) after the focus group session, because of too many split opinions from the users during the focus group session, it nevertheless gave us good insight on the overall functionality of the app on different android devices.

Some of the users lacked domain knowledge in gamification, which could explain this, as some of them have not used gamification services or relating games that offer achievement badges. This is one of the reasons, why we also included an expert evaluation from the start of the design process and at the end, to assure that the gamification service was relevant and comprehensive.

As we explored our gamification service on mobile devices, it was quite easy to recruit almost anyone as an everyday user for the app prototype, since smartphones are a common format today among users.

However, the average smartphone user may not be familiar with AR or with gamification, since both practices are quite new, meaning that all user tests done in this thesis, cannot affirm one correct answer when designing within this field. Finding these users with the knowledge would be time consuming, which is why we chose to recruit users who could come in on a short notice. The focus lay more in a practical approach, familiarising us with today's technologies, creating an app prototype which could show the potential of a gamification service for sustainable public transport.

6.3 Conclusion

This study provides a theoretical and practical approach about what to consider when designing a gamification service for sustainable public transport. We have explored gamification practices in the mobile development sector, been inspired by the kind of applications which are currently available, we have uncovered early on what design changes were needed with the help of user studies and finally we have been able to create a working prototype.

We believe, in order to engage users in sustainable everyday actions, you need to use gamification practices in order to inspire others to act while having fun at the same time. Behavioural change is needed in society and what better way to change people's behaviours than acting locally with an application for public transport?

Coming from an IxD background, these gamification and web development practices represent a very traditional way of creating interactivity within our design field, but the ideation and research phase of C-Lab has changed our perspective somewhat on what sustainability is. We have been influenced by C-Lab by seeing the different layers in sustainability and how closely related this is to design as well.

Most people only see the tip of the iceberg when they look above the surface of sustainability behaviours. They do not recognize the other layers below the surface, such as the purpose of the contribution and service sectors, the identities of local and global issues, the beliefs in making a difference and what the core human values and capabilities are.

In design it is the same thing. People only see the tip of the iceberg, which is the visual design, but there are more layers to consider, such as wireframes, screenflow, site maps, scope of requirements, content, concepts, implementation and user research etc.

Therefore, implementing AR technology, with gamification practices, can potentially be a new recipe for success to cross new borders for a wide variety of sustainable public transport applications. We believe that creating an app for sustainable public transport, which follows gamification practices, will form a new shift and go beyond the current

paradigm of apps.

6.4 Recommendation

When looking back at the C-Lab process in general, we can make the following recommendations. Time was always an issue during the project phase, because the C-Lab process took up most of the time throughout the 5 months of our thesis. To ensure a better workflow for the future of C-Lab, internal weekly meetings by the C-Lab students, as well as an agile project management tool to keep the overview of the lab in check, should be included.

The fact that the next C-Lab group will have its first phase of the C-Lab process as a course, will definitely help speed up the process and give more time for the students to work with phase 2 of the project. However, the above-mentioned workflow suggestions should also be implemented more decisively in the project phase in its iteration to keep the group together. Having workshop sessions such as dialogue tools and leadership modules is something that should be kept in high regard, since they are crucial for forming the group in C-Lab and establishing trust with each other.

Other tools, such as the sustainability compass, is a good start up tool for the C-Lab group, with which to find out where the sustainability issues lay, as well as seeing what the majority of the group thinks about sustainability.

Stakeholders could have been invited by the students earlier on, in order to give more responsibility to the students. However, the meetings that the faculty C-Lab group had set up, was an essential part of discovering what possibilities lay in sustainable change.

The backcasting method could have been made more visible during the project phase, in order to show the iterations of each and every ongoing project in the C-Lab.

To summarise, the C-Lab process has become a new solution on how to handle innovative and sustainable workflows, which we welcome other universities to try out.

6.5 Future work

The end result of this study is a working prototype of an app that can be made applicable to the ElectriCity project, if Västtrafik sees it conceivable.

The app could be further improved by conducting more user studies and by adding more gamification functions to it, but for now it may show enough promise for Västtrafik to consider connecting it to their new electric bus line system which commences in 2015.

Finally, the gamification concept of the app can be further diversified to include more electric powered transports such as trams, trains or carpooling systems in general.

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A

Appendix A

Expert evaluation

User interview 1, Interactive institute: Erik Einebrant

E-ticket page

“I don’t think the ElectriCoins concept is hard to understand, since I am a gamer, the gathering perspective is easy, knowing you can buy something. It’s always easier to refer to a common definition.”

“Good amount of objects, not too much. I could see this working on a lot of different interfaces. “

“Add a badge as mean of payment for the number of ElectriCoins.”

“Personally I would not connect the calendar view to the battery if they’re not meant to visualize something together.”

“Don’t add ads that tease the user. The trust will be diminished then.”

“I would personally not need two dates, but it helped me understand the battery perspective.”

“How much ElectriCoins can I use for payment could be visualized”

Bus Page

“The timetable works, the in real time functionality is a good thing to have.”

“The icons displayed makes sense, the smaller icon meaning there is something at the station and the larger icon has a sense of motion to it.”

“If it’s a longer route then this design might be difficult to view for the bus stops. Don’t go too specific with detail, go simple instead.”

“I truly like the idea. Even if it is a very simple design, it is something I’m really missing in the current system (Västtrafik) today.”

Profile page

“I could see it’s tempting for the users to find out what is unlocked. Designing these achievements is a very important aspect to consider in order to get the user to continue playing.”

“Since you also focus on sustainability issues, you also grasp the view of the environmentalists. Remember to keep that in mind, what different users want to achieve. The achievement levels should also have a sense of replayability, check into that. You should maybe have a long term view of the gaming cycle.”

ElectriCoin pictures

“Oh it’s like Super Mario! It’s a big chance that our generation would like to play it because of the design. ”

“I’m expecting a coin sound when gathering the coin. Either you can just collect the coins or then also be interested in the Daily Tip section. The pop up should not be too intrusive. However, it could be very interesting to adapt this.”

“I feel the transparent background is easy to read on the pop up. You could have either or. This interface can follow any design pattern. For the buttons, the ok button feels more native to use. One could also simply tap or dismiss.”

“I could see that doing something actively like that (finding ElectriCoins), will inspire others to act as well, since if you’re creating stories, then more people will move about, encouraging other people to do so as well.”

Expert evaluation

User interview 2, Interactive institute: Erik Einebrant

App features

“It seems pretty easy to find coins, I do believe gathering a larger number of coins would help the gamification service in not being too easy.”

“The visualization of the battery is easy to understand and the connection to the payment methods. When you press the battery one could have some information displaying about the region the ticket is valid through.”

“The gamification profile is easy to understand, but I am not sure what the trophy stands for. You could maybe change the trophy symbol to the same symbol as in the achievement button.”

“Something that Västtrafik is truly missing is to see all the bus stations in one view, which I think you grasped pretty well on how to display it. You could also implement a function to expand the view when you click on a station and see relevant bus roads and buses moving.”

“As we talked last time about replayability, I believe this is something that gamification services can benefit from. They need to keep the player active from the start as a novice, to a master and then finally coming up to the expert level.”

“You could look into a game called Jetpack Joyride, where the developers have added a replayability function of when the player maxed out their progress they can change it to a badge and see trophies on how many times the player has completed the game.”

“The new game track function you added, could work as keeping the user active weekly, you could maybe connect this somehow to the replayability function.”

“The AR compass could play a vital role in finding the the ElectriCoins, since some coins could be far away, then limiting the view on how far the user can see the coins, you could maybe have a animation of something that shines far away that would increase the interest level of the user and get them walking over to the place of the ElectriCoin.”