Chapter 1
Persuasive Communication

Jean-Paul Close and Jaap Ham

1.1 Introduction

In marketing terms, a business model uses communication instruments to attract customers or develop brand awareness and loyalty. There is always a degree of manipulation in such communication, as we try to influence human purchasing decisions through persuasion. Persuasion is therefore more than the simple act of providing information; it is a professional and measureable expertise in influencing decision-making. In commerce, there is a competitive environment in which a company tries to excel. When, however, we deal with the introduction and deployment of peer 4 regional development, we are not selling anything. We are inviting the population to take active part in the development of local core human and natural values that affect us all. This participation can be measured in the amount of response achieved, changes observed and improvements measured within the pursuit of the core values desired. In AiREAS, we measure air quality, health and regional dynamics. This gives us a great responsibility when dealing with persuasion. We don't lie or twist the truth to get a sale; we <u>positively</u> invite for innovative change with validated information and interpretation of data. And we measure and celebrate our results in terms of health and air quality development, not our bottom line financial gain.

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The ILM provides us with near real time information about the fine maze status of air quality in the city of Eindhoven. The experimental App for mobile phones, developed by Imtech/Axians,[1] provided the same information as the AiREAS website, together with a color change for each airbox when certain values were exceeded. Figure 1.2 above represents a screenshot of the App. At the level of AiREAS's founders, we made effective use of the App to observe the network and register specific cases of pollution as they occurred in real time. When we noticed something odd through the App, for instance, a sudden peak in one or more airboxes, we could go into more depth by opening a special PC application developed by our Airbox co-creation manufacturer and partner ECN. All of these large, experimental, tools were only in the hands of partners within the kernel of AiREAS. The question arose as to whether these tools were suitable for extensive public use for the persuasive effect of participation and social innovation? We ourselves were, of course, already motivated; otherwise, we would not have started such a complex mission as AiREAS. But could we motivate others?

1.2 University for Technology[2] in Eindhoven (TUe)

Different universities participate in AiREAS, each from their specific area of expertise through highly motivated and socially committed specialists. Results that they achieve in AiREAS are documented and published, specifically by their individual academic partners, but also together from a group process perspective. The ILM and academic partnerships also led to new research, majors, minors, Ph.D. and master programs, etc. The University of Twente, for instance, uses the AiREAS infrastructure and partnership organization for their DAMAST project, financed through Maps4Society.[3] DAMAST is an automated risk assessment program on exposure to air pollution. At the same time, the university professors and researchers have been very influential in the spatial design and rollout of the ILM—phase 1. Involvement, therefore, has a two-way reciprocal value for AiREAS, the university, the students and the scientists.

In the same sense, Dr. Jaap Ham had already been involved in early stages of AiREAS for the purpose of influencing the 'soft' side of our activities, referring to human interaction and behavioral analysis, as opposed to the 'hard' side consisting of applied technology, economy, products and infrastructures. This 'soft' side is highly underestimated when dealing with issues of sustainable progress. When dealing with the financing of new AiREAS projects, attention tends to go to the tangible, material implications that define economies, rather the intangible,

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[1]https://www.axians.nl/over-axians/vinci-energies/.

[2]https://www.tue.nl/en/.

[3]Maps4Society is an initiative of the Dutch Technology Foundation http://www.stw.nl/nl/programmas/maps4society.

immaterial ones that define social wellness, co-creation and involvement. In AiREAS, we were introducing a new balance by trying to make the invisible visible, not just in air quality but also in human behavior, motivation and change. Jaap had already surprised the group when the discussion turned to the possible importance of 'awareness' in provoking change. I had introduced the concept of civilian BAGE,[4] a staged process of people who become aware of the need for change, accept the responsibility to do so and get rewarded afterwards. Jaap reflected back that no awareness is needed. People are essentially followers of the pack. They tend to do what their neighbors do or blindly behave according to the cultural patterns defined locally, no questions asked. This is referred to as "the principle of least effort".[5] A daily routine is always 'normal' unless something happens that upsets that routine. It is human nature then to try to get back to 'normal'. This hardly involves the revolution of disruptive change; it is mostly a safe status quo or gradual evolution.

Jaap used the example of the enormous marketing effort in town to introduce solar panels through the distribution of flyers in areas with an extensive amount of home ownership. No commercial successes were registered at all, despite local awareness about the need to address energy issues. That is, until a young entrepreneur visited his uncle in town. The youngster had started a business installing solar panels and asked his uncle if he could place some on his roof. The uncle accepted and even offered to have a word with a friendly neighbor to see if he also wanted to participate. The solar panels were installed, and within 6 months, the entire street was using them.

This example showed the tremendous waste of resources involved in the distribution of flyers while the personalized approach had far-reaching and much more cost-effective consequences. Between the youngster and his uncle, there was a level of trust, just like the relationship between the uncle and the befriended neighbor. The rest was just copycat behavior of a street that does not want to stay behind. This learning process also became significant in the subsequent processes of AiREAS. We learned that personal attention and interaction generated a much larger and more positive response to change than any other means of communication. Persuasion needed to be personalized, based on trust and reciprocal personalized reward. When persuasion achieves its objective in a small portion of society and becomes visible, then human nature will do the rest.

Awareness on its own is therefore not enough to influence the masses. Many people are aware of pollution, climate change or the amount of plastic in the sea. They understand the problem, but barely translate that into a need for individual behavioral modification. 'Why should I change if the rest of the world does not?' The follower mentality is also culture-driven. 'Everyone does it, so I do the same, even if I am aware that it is wrong or should be done differently.' Within this

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[4]"Sustainocratie, de nieuwe democratie waarin de mens centraal staat", in Dutch (2012, MultiLibris).

[5]Zipf, George Kingsley. "Human behavior and the principle of least effort." (1949).

spectrum, the concept of persuasion becomes interesting. How can early adopters, the pioneers of change, finally produce the entire chain result as if it were a line of dominos falling after the first one is pushed over? How do we involve such early adopters? What instruments persuade? How do we visualize the positive contributions? It was Henry Ford, automobile manufacturer, who said, about disruptive innovation, "If I had asked the masses about their innovative wishes for mobility they would have asked for a faster horse".

Change is hence a leadership issue, not a democratic or market working process, in which leadership sees a new reality well before it is commonly present in the mainstream activities.

With this in mind, we looked again at our mobile App. The tool was clearly informative and useful for the selected group of AiREAS intimi. But was it persuasive? With this question, we entered the expertise of Jaap Ham, who decided to use it as a learning tool in his short course on persuasive communication.

1.3   Method Used

Every year, students from all fields of study within the TUe can take a short course of 2 months created by Jaap. They can choose the cases they want to work out and, as such, enter a participative learning process. One of the options to choose from is the AiREAS App.

When a group chooses to take on the App, they receive a presentation from AiREAS Sustainocrats about the objectives, the background of the App, and the challenge of persuasion that we face. They also receive access to usage of the App. Then, they have 2 months to develop their views, applying scientific knowledge provided by Jaap and the world's literature on the subject of persuasion.

The first group of students to reflect on the App did so purely from a point of view of persuasion without additional concrete adaptations. Subsequently, they would add something new, showing an evolution in the processing of the tooling. The tone was set with a score of 3 out of 10 for the App on the scale of persuasion. This is, of course, low in an absolute sense, but for AiREAS, a valuable key indicator. We need to recognize that the App was never primarily envisaged from a point of view of persuasion and had been experimentally developed by technicians who wanted to display the information of our measured data on a handheld device. Having a working model of such an App allowed us to engage in the learning process of this new field of communication, together with the creativity of the students. A 3 out of 10 triggered a lot of curiosity among the AiREAS partners and opened up the dialogue between value-driven entrepreneurship, persuasion, citizenship and technology.

The students were asked to produce a report, a presentation and a poster. One of those reports excelled and received an 8.5 out of 10 from Jaap. AiREAS was also enthusiastic about the insights developed by these students and decided to incorporate their entire work (with their permission, of course) into this publication.

They hence appear as co-authors of this chapter. The report is complete enough to finalize this chapter with its publication. It is now up to AiREAS and its expansion across the world as to how we shall use this knowledge in pursuit of our health deal with the world.

The report

0HAUB0—USE-HIT-3 Projects—The Human in Technology—Research Project Report—2014–2015

USE - HIT Projects 2014 - 2015

Research Project Report

Analyzing the persuasiveness and usability of the AiREAS application in raising awareness of air pollution and decreasing the contribution of the individual

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Introduction

Air pollution is an increasing problem in our current day society. Polluted air can cause cardiovascular and lung diseases, which especially affect old people, children and people already suffering from such diseases.[6]

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[6]"Effecten." [Online]. Available: http://www.rivm.nl/Onderwerpen/F/Fijn_stof/Effecten (Accessed: 07-May-2015).

This research will mainly focus on particle pollution. Particle pollution is the term for a mixture of solid particles and liquid droplets found in the air, such as dust, dirt or smoke. Particle pollution[7] consists of inhalable particles, which are categorized by size:

- Ultrafine particles with a diameter smaller than 0.1 μm (PM 0.1)
- Fine particles with a diameter around 2.5 μm (PM 2.5)
- Respirable suspended particles with a diameter around 10 μm (PM 10).

The smaller the particles, the more danger they pose. Small particles can reach deep into the lungs after inhalation or even pass the vessel walls and get into the bloodstream.[8]

Recent studies have shown that an increase in air pollution created an increase in cardiovascular and lung patients. The inhalation of these particles can cause inflammatory responses and toxic effects. Lung cancer and lung fibrosis are especially common diseases in polluted areas, and children suffer more from asthmatic attacks.

Particle pollution is produced through two separate processes: mechanical and chemical. There are different sources of particle pollution. On average, industry is responsible for 41.1 % of particle pollution, mobility for 28.9 and households for 7.7 %, as indicated in Fig. 1.1. To decrease particle pollution, various measures can be taken, including pollution prevention, control technologies and control measures, and may be implemented through regulatory, market-based or voluntary programs.[9] Decreasing the contribution of individuals or households to air pollution is another important measure that can improve the air quality. Changing everyday behavior can have an immediately positive effect, for example, using bicycles instead of automobiles or dressing warm instead of using the fireplace. To change behavior, awareness of the production of pollution has to be raised. Here is where technology comes in. Technology can be used as a persuasive tool to change behavior by raising awareness.

One example of a persuasive technology related to fine particle pollution is the AiREAS application. In general, AiREAS is an organization that wants to raise awareness about air pollution and achieve their goal of a cleaner and healthier city. The function of the application itself is to use the data to notify people of the different polluted zones. This can persuade people in two ways: if the zone is highly polluted, individuals can choose to avoid polluting activities, such as not using the barbeque or the fireplace. Also, people will be able to avoid highly polluted areas when travelling through the city.

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[7]O. US EPA, "Health|Particulate Matter|Air and Radiation|US EPA." [Online]. Available: http://www.epa.gov/airquality/particlepollution/health.html (Accessed: 07-May-2015).

[8]O. US EPA, "Basic Information|Particulate Matter|Air and Radiation|US EPA." [Online]. Available: http://www.epa.gov/airquality/particlepollution/basic.html (Accessed: 07-May-2015).

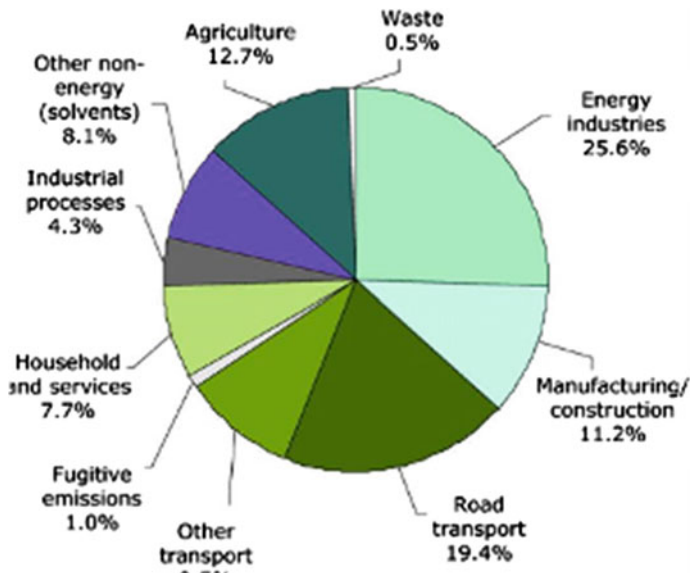[9]Cees Midden and Jaap Ham, Persuasive technology to promote environmental behaviour, vol. Hoofdstuk 23.

Fig. 1.1 Sources responsible for particle pollution in Europe (SurveyMonkey, 2 juni 2015, https://www.surveymonkey.com/)

However, using this kind of technology can only raise awareness if the application is actually persuasive and useable enough. Therefore, the current research analyzes the persuasiveness and usability of the AiREAS applicationand, where necessary, provides new ideas for improving the application.

1.4 Research Question 1

What strategies of persuasiveness based upon Fogg, Oinas-Kukkonen and HarjumaaandCialdini are already present in the AiREAS application?

1.5 Method

1.5.1 Participants and Design

In order to test the persuasiveness already present in the AiREAS application, three different persuasive strategy frameworks were used, e.g., Fogg, Cialdini and

Oinas-Kukkonen and Harjumaa, as previously described. We have evaluated the application in regard to every aspect of each strategy with a score between 1 and 10. This score will be based on the degree of presence of a certain technique in the current application, with 1 meaning it is not present in the current application and 10 meaning that it absolutely is present. The average score of every aspect of each strategy is shown in Appendix I.

1.6   Materials and Procedure

All criteria were applied according to the literature of Fogg,[10] Cialdini[11] and Oinas-Kukkonen[12] and Harjumaa. We have independently examined the degree of presence of the different criteria of each framework and scored these. The five different scores of every criterion were averaged, and thereafter, an average end score of each framework was calculated. These results were processed in a bar graph and will be compared with each other to determine the persuasiveness of the application.

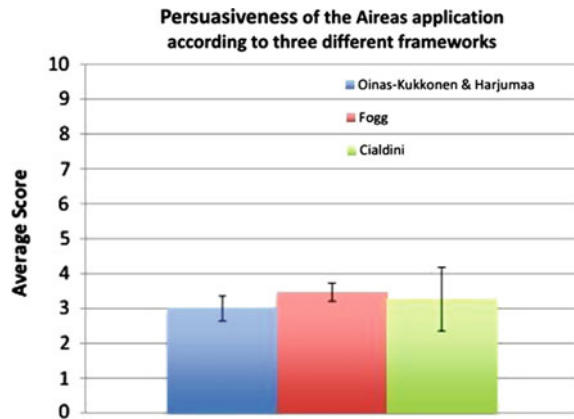## 1.7   Results

1.7.1   Hypothesis Testing

Before analysis was performed, we took a brief look at the application in order to get an idea of its persuasiveness. It was concluded that the application mostly provides information about the fine dust distribution in Eindhoven, but it is not, in fact, very persuasive. Therefore, we hypothesized that the application will get a low score on persuasiveness according to the three different frameworks of Fogg, Cialdini and Oinas-Kukkonen and Harjumaa. In order to test this hypothesis, five users examined the different criteria of each framework and scored these as described above. These scores were averaged in order to determine the persuasiveness of the current application.

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[10]Fogg, B. J. (2002). Persuasive technology: Using computers to change what we think and do. Ubiquity, 2002 (December), 5.

[11]Cialdini, R. B. (1993). Influence: The psychology of persuasion. New York, Morrow.

[12]Oinas-Kukkonen, H., & Harjumaa, M. (2008). A systematic framework for designing and evaluating persuasive systems. In Persuasive technology (pp. 164–176). Springer Berlin Heidelberg.

Fig. 1.2 Results of the persuasiveness analysis according to the three different frameworks of Fogg, Cialdini and Oinas-Kukkonen and Harjumaa

Persuasiveness of the Aireas application according to three different frameworks

1.7.2 Exploratory Analysis

The results are shown in Fig. 1.2. Raw data can be found in Appendix I. The graph in Fig. 1.2 shows the three average scores of the three different frameworks. It can be seen that all of the frameworks have an average score around 3. However, the application scores the highest on persuasiveness according to Fogg and the lowest according to Oinas-Kukkonen and Harjumaa.

1.8 Conclusion and Discussion

The persuasiveness of the AiREAS application has been examined using the criteria of Fogg, Caldini and Oinas-Kukkonen and Harjumaa. Five different evaluators have independently executed the persuasiveness of the application. The five different scores of every criterion were averaged, and thereafter, an average end score of each framework was calculated. The results can be seen in Fig. 1.2. All the frameworks received an average score around 3, which means that the AiREAS application is not very persuasive. Based on Cialdini, the application is the least persuasive, and based on Fogg, the application is the most persuasive. Because of the low scores, it can be concluded that many persuasive strategies are lacking in the current application. In order to reach the goal of persuading users to produce less fine dust or avoid polluted areas, far more persuasive strategies have to be implemented in the AiREAS application. One of the most important of these is probably the possibility of tracking the user's own behavior, so as to make a personal application that is different for each user. As people can be sensitive to the accomplishments of others and may try to top them, other important strategies that can be implemented in the application are social comparison, competition and social facilitation. When users can track other users' behavior as well, competition is possible.

Furthermore, people tend to be more easily persuaded into acting upon certain behavior when there is a chance of being rewarded, so virtual rewards would also be a good addition to the AiREAS application. In research question 3, more detailed research is provided in which the type of feedback best suited for creating behavioral change is investigated.

1.9 Research Question 2

How usable is the AiREAS application?

1.10 Method

1.10.1 Participants and Design

Usability can be defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. We evaluated the usability of the AiREAS application ourselves by analyzing the following five primary criteria: effectiveness, efficiency, learnability, memorability and satisfaction.

After we evaluated the AiREAS application ourselves, we asked five random participants from different backgrounds and age groups to evaluate the application. The only thing they had in common was that none of them had ever used the AiREAS application before.

1.11 Materials

We scored the above five criteria on a scale of 1–10. By averaging these scores, we determined a usability score for the AiREAS application. We provided the participants with the System Usability Scale (SUS).[13] SUS is a quick, reliable method for measuring the usability of a system. The SUS questionnaire consists of ten items with five response options to choose from, ranging from 'strongly agree' to 'strongly disagree'.

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[13]A. S. for P. Affairs, "System Usability Scale (SUS)," 06-Sep-2013. [Online]. Available: http://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html (Accessed: 07-May-2015).

1.12   Procedure

We used and analyzed the application separately, before evaluating it on its usability by using a table to score the criteria. We approached the participants personally and let them use the AiREAS application for a couple of minutes. We didn't tell them the purpose of the evaluation up front, so that the usability would be evaluated in an unbiased manner. After the participants indicated that they had seen the whole application, they were provided with the SUS to evaluate the system on its usability.

1.13   Results

1.13.1   Hypothesis Testing

After quickly browsing through the application, we came to expect that it would prove not to be very usable, since it lacked certain basic features. This hypothesis applied to the SUS questionnaire as well, as the participants evaluated the same system; it could be assumed that they would miss the same features as we did.

1.13.2   Exploratory Analysis

In our own analysis, and based on the 1–10 evaluation of the assorted criteria, the application scored best on efficiency and worst on satisfaction, as can be seen in Fig. 1.3. The scores were averaged, which gave an outcome of 4.7. The outcome of the SUS questionnaire was higher than that of our own evaluation. With a score of

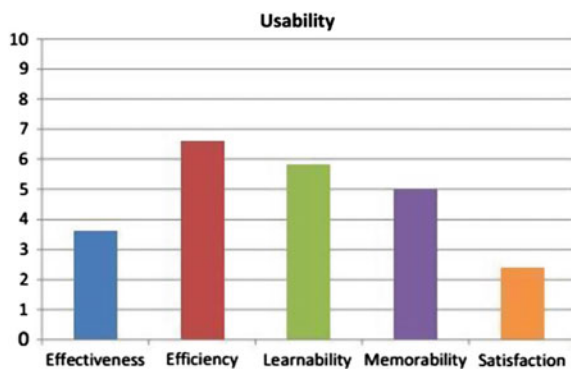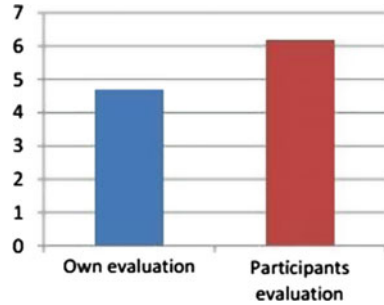**Fig. 1.3** Evaluation of AiREAS application on five criteria

Fig. 1.4 The average
outcome of our own
evaluation versus the
evaluation of our participants

62 on a scale of 100, the participants evaluated the AiREAS application better than we did, as can be seen in Fig. 1.4. The raw data are shown in Appendices II and III.

1.14 Conclusion and Discussion

In averaging these scores (4.7), we agreed that the application was not very satisfyingly usable. The average outcome of the evaluation of the other participants was higher than that of our own evaluation. We assume this was due to our bias, since we approached the application with a more critical eye, given that we are researching it. The most striking result was that all participants found the application cumbersome to use and that they all assumed that they would not tend to use the application with any real frequency. We assume that these results are not directly related to the usability of the application, but rather that they are related to the lack of a clear goal.

We believe that the AiREAS application has high potential, since it could contribute to the solution of a major societal issue, namely air pollution. AiREAS could be used to make users more aware of their behavior in regard to air pollution, but we found that our participants were not really aware of this. The main improvements should therefore focus on making it more attractive for the user to use the application frequently and making the goal and relevance of the application more clear. Future research could be done in both these fields.

1.15 Research Question 3

Does direct feedback in the form of red/green colors or verbal feedback in the AiREAS application improve the awareness of humans regarding the presence of fine dust?
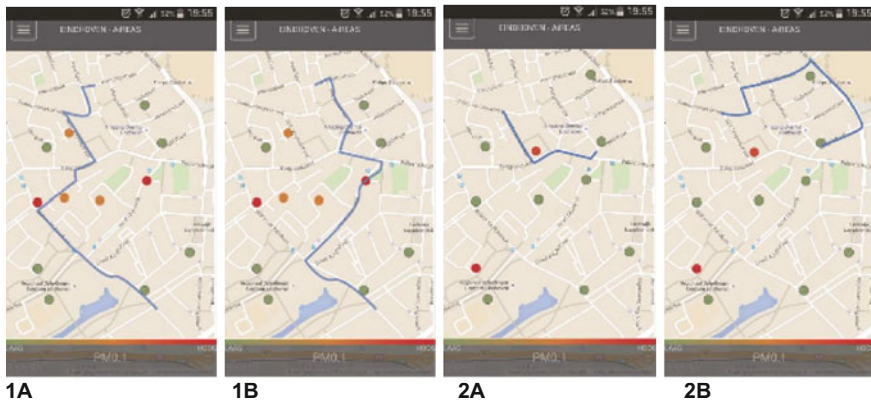
Fig. 1.5 Picture 1**A** and 1**B** show two routes with the same length; the participant had to choose either **A** or **B**. Picture 2**A** and 2**B** show two routes for which the length differs and the healthier route is longer; again, the participant had to choose either **A** or **B**

1.16 Method

1.16.1 Participants and Design

In order to answer this research question, an online questionnaire was created in three different versions. One version contained no feedback, one contained direct verbal feedback and one had direct feedback with red- and green-colored symbols. We wanted to represent the city of Eindhoven, because the AiREAS application is only available in that city. There are currently 223,220 people living in Eindhoven,[14] so, using a 95 % confidence interval and a 10 % margin of error, 68 participants were needed in order to achieve reliable results.[15] Eventually, 75 participants submitted the questionnaires, giving us a margin of error of 9.3 %.

1.17 Materials and Procedure

The questionnaire consisted of ten questions each, with a choice between two different routes. These routes differed from each other in their amount of pollution, and the participants had to choose which route they would take. An example of these choices can be seen in Fig. 1.5. In questions 4, 7 and 8, the choice was more difficult for the participants, because the unhealthy choice was the shorter route. This way, the influence of time over health could be evaluated.

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[14]Eindhoven Buurtmonitor, 1 januari 2015, http://eindhoven.buurtmonitor.nl/.

[15]SurveyMonkey, 2 juni 2015, https://www.surveymonkey.com/.

Table 1.1 Example of the different kinds of color and verbal feedback in the questionnaire

	Verbal feedback	Colour feedback
Correct	Well Done! This is the most healthy route. Although this route guides you through a polluted area, the alternative route guides you through more polluted areas	
Wrong	Too bad! This is not the most healthy route. This route guides you through a lot of highly polluted points, while the alternative route guides you through only a single polluted point	

Three different versions of the questionnaire were used, to test the influence of different kinds of direct feedback based on the experiment by Midden.[16] Questionnaires featuring direct verbal feedback and feedback in the form of red/green colors were tested against the questionnaire that contained no feedback.

The direct verbal feedback consisted of an explanation as to why the answer was either correctly or wrongfully chosen. The feedback in the form of red/green colors showed a green thumbs up when the answer was correctly chosen or a red thumbs down when the answer was wrongfully chosen. An example of the feedback is given in Table 1.1.

1.18 Results

1.18.1 Hypothesis Testing

The verbal feedback explains why the answer is wrong or correct, and our expectation was that this would increase understanding of how to interpret the two images. The participants with color feedback would know if they had gotten a question wrong or correct, however they would not know the reason. Their learning curve would increase, however to a much lesser degree than the learning curve of the participants with verbal feedback. Participants without feedback had no

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[16]Cees Midden and Jaap Ham, *Persuasive technology to promote environmental behaviour*, vol. Chap. 23.

understanding of whether their answer was correct. They would not learn anything from the questionnaire. This gives us the expectation that the participants with verbal feedback would answer the highest number of questions correctly and the percentages of correctly answered questions would rise, while the participants without feedback would answer the lowest number of questions correctly. When answering the question as to which route is shorter than the other, most of the participants would answer this question correctly, while the persons without feedback or with color feedback would not choose the right answer.

1.19   Exploratory Analysis

The results are given in Fig. 1.6, and the raw data can be seen in Appendix V. The vertical axis shows the percentage of participants that answered the question correctly and the horizontal axis shows the specific questions. The participants with verbal feedback answered the greatest number of questions correctly. Also, questions 4, 7 and 8, in which the choice was given between the shorter, less healthy route and the longer, healthier route, were better answered by the participants with verbal feedback, while the persons who received no feedback or color feedback mostly chose the unhealthy option.

   In Fig. 1.7, the number of participants who answered the question correctly is shown for questions 4, 7 and 8. The learning curve of the participants without feedback is higher than the learning curve of the participants with verbal feedback. It can be seen that the participants with direct verbal feedback answered the questions better overall. However, the participants with no feedback have a higher learning curve.
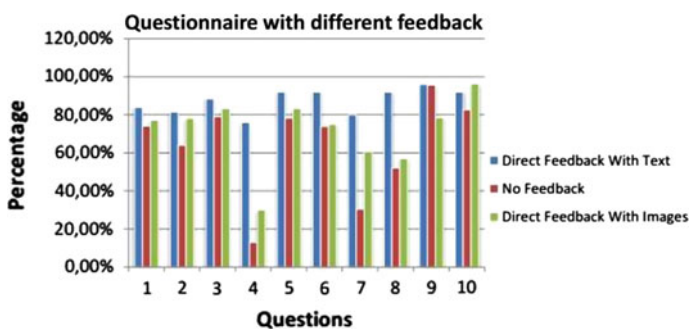

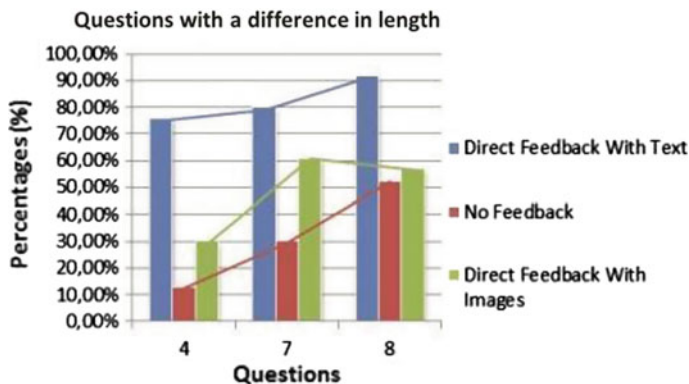Fig. 1.6   Bar graph of the results of the questionnaires

Fig. 1.7 Bar graph of the results of questions 4, 7 and 8

1.20 Conclusion and Discussion

In this research question, we tried to investigate whether direct feedback in the form of red/green colors or verbal feedback in the AiREAS application improves the awareness of humans regarding the presence of fine dust. In order to do so, we created a questionnaire with ten questions; the participants had to choose between two routes. This questionnaire had three different versions, one with direct verbal feedback, one with direct color feedback and one without any feedback at all. In the results of this research, we found that the participants with the direct verbal feedback faired best on the test.

These findings show us that giving feedback indeed changes the behavior of people and can improve it in this way. Direct verbal feedback made a particularly significant difference in this test. The participants with direct color feedback and no feedback provided unhealthier answers. However, they did show a decent learning curve when given situations in which the less healthy route was shorter. These findings could help us to better understand human behavior and could perhaps help other designers in trying to improve the environmental awareness of humans.

In our research, we used an online questionnaire. This way, unfortunately, we were unable to be sure if participants only answered the questionnaire once. We also did not tell the participants whether they were riding a bike, walking or driving a car. Participants may have chosen differently if this had been explained. These limitations were not taken into account when processing the results. However, we do not think that these limitations changed the result of our research.

In conclusion, when trying to improve the awareness of humans regarding the presence of fine dust, using direct verbal feedback is a good option.

1.21   Overall Conclusion and Discussion

Particle pollution is a huge problem in current day society, as many diseases are related to high air pollution. Therefore, it is important to make people aware of their contribution to air pollution and how they can diminish and deal with the risks of a high concentration of fine dust. In regard to this problem, AiREAS created an application that gives information about highly polluted areas in the region of Eindhoven. To make the application more suitable and effective, we investigated the usability and persuasiveness of this application and how it could be improved. Furthermore, we investigated which type of feedback is best suited to making people more aware of air pollution.

The persuasiveness of the current AiREAS application was evaluated using the principles of Fogg, Cialdini, and Oinas-Kukkonen and Harjumaa. These principles are a useful tool for evaluating the persuasiveness of technology. All principles scored around 3, which means that the application is not very persuasive. It is suggested that a feature be added to the application which gives users the ability to track the behavior of other users. This can lead to some sort of competition between users, which could improve their behavior. Also, giving virtual rewards will persuade users even more, because people are sensitive to compliments.

In order to evaluate the usability of the AiREAS application, we evaluated five criteria: effectiveness, efficiency, learnability, memorability and satisfaction. We also used the SUS questionnaire for measuring the usability of the application. This showed us that the application is neither very attractive nor easy-to-use. Therefore, it could be beneficial to give the application a clearer goal.

To increase the persuasiveness of the application, we investigated whether feedback could help to raise awareness among users concerning fine dust. Results show that using direct verbal feedback has the best outcome. It showed that people are more sensitive to a clear explanation as to which behavior is more desirable compared to color feedback. Implementing this type of feedback could improve awareness of air pollution and thereby decrease the risks for users.

After evaluating the usability and persuasiveness of the AiREAS application, it was concluded there are many points of improvement needed to make the application more usable and persuasive. Furthermore, direct verbal feedback gave the most promising results in making users more aware of air pollution. For future research, it might be interesting to investigate whether people are willing to choose between different modes of transportation. For example, we could research whether participants are willing to cycle to their destination instead of using the car in order to diminish fine dust production. Also, providing a personal questionnaire in which users can choose their own route to a certain destination and give direct verbal feedback could provide insight into improving their awareness of air pollution.

The AiREAS application could be a good tool for making people aware of the risks of air pollution, however it still lacks the persuasiveness and usability needed to reach its goals. Making use of direct verbal feedback has been proven to contribute to reaching these goals.

1.22   Personal Reflections of the Authors

1.22.1   Reflection: Joyce Brouns

The reason I chose the Human in Technology learning line was because I like psychology and was told that this learning line is somewhat psychological. I was not disappointed, because it did have certain psychological factors to it. Why do people behave like they do? How can you change their behavior? I was very surprised when I found out that people are so easily influenced by others and that there are actually techniques to persuade people to do something. However, when someone would ask me what I had learned from the course and whether I found it to be an interesting course, I had to say that I still have my doubts. I think it is great that everyone who is studying at the TU in Eindhoven learns something about ethics. It is important to know that there are some ethic issues behind technology, and therefore, that not everything can be done without thinking at all about the ethical issues behind it. However, it was a pity that the course consists of 20 ECTs and that one subject of 5 ECTs was not enough. You have to take all of the courses and cannot choose between different courses within the USE learning line. If the latter were possible, you could follow different subjects in different areas.

In the first course of the Human in Technology learning line, we had some guest lectures, which sometimes made the course more interesting because of the different points of view. However, sometimes it was just confusing, and different subjects could not be linked very easily, like the course about LCD television, in which someone told us in detail how an LCD television looks inside. This is interesting for some people, but it did not have a clear relationship with the other subjects in the course.

Another limitation within the course was that we had to work with people from other faculties. It was often the case that some people were doing their Bachelor End Project while others were in their first or second year. Therefore, it was hard to make appointments with each other and divide the labor. I did like the fact that we had to do some presentations, because it gave you the opportunity to improve your presentation skills in an easy way.

The project was a great opportunity to use the learning skills in practice, and therefore, I think it is a great aspect of the course, which should be kept.

In conclusion, the course was different from the subjects I follow in my primary study (biomedical engineering) and therefore interesting, but it could still use some improvements to make it a little bit more interesting. The projects were great in the way that they enabled you to bring your learning skills into practice, but it was difficult to do it with people from other years or other faculties.

1.22.2   Reflection: Tim van den Boom

I chose the Human in Technology learning line to gain a better understanding of human-technological interaction. I believed it could help me better understand the

needs of technology to further improve everyday life for everyone. This course gave me great insight into how people interact with technology, how this is influenced by social context and how typical flaws are made when designers create a technological innovation. The idea of a user-centred design is something all designers need to take into account when creating a new design. This way, humans also need to be involved in the early stages of the design. These simple but crucial guidelines are helpful when designing a new technology.

I personally learned something valuable from this USE line and I really think these subjects are important for the education of every engineer. Learning how a design influences the everyday life of a user can help me realize my technical innovation and make it more useable. I do think that this USE line could have had more depth. The things we learned during certain lectures were sometimes very logical and did need to be explained. Also, some lectures were only technical and did not explain the human behavior involved at all. I especially remember the lecture by Ingrid Heynderickx in which she explained how an LCD television works and how many grey levels a television has, although she did not explain the influence on its user.

I did really like this project. Not only did it have a subject that is quite different from the subjects of my study, it also made me use the things I had learned earlier in this course. I really liked meeting with Jean-Paul Close, because it made the goals of this application very clear and helped us with our project. The collaboration among the students was good, if, however, it was sometimes a bit hard to meet up with everyone, because we were all very busy with different projects. But we divided the tasks well and we finished this report without any stress.

1.22.3 Reflection: Marjan Hagelaars

I chose the Human in Technology learning line because it was likely the learning line most linked to my bachelor in Biomedical Engineering and it fit perfectly into my schedule. However, my perception was a bit wrong, as I learned more about the psychological background than anything else. Fortunately, psychology does interest me, mostly as to how people think and their perception of products and their surroundings. In my opinion, however, the learning line is a bit too much. After one course of 5 ECTS, I had learned enough about psychology, with the two other courses of Human in Technology merely acting as repetitions of the first course. My interest faded because of these repetitions and my motivation began to decrease. The project, on the other hand, was a lot of fun. We used the information we learned in a practical sense. My conclusion therefore is that one course with lectures and one project is sufficient; in this way, you keep students motivated. In this project, I learned about the different persuasive techniques, the usability and how all these features are important for achieving an application with a goal of changing the way people think. The USE learning line could stand to become more useful for students, however the concept is clear and USEable!

1.22.4   Reflection: Relinde van Loo

I chose the USE Human in Technology course because I find the combination of technology and human interaction very interesting. The first course was mainly informative and gave a lot of different insights as to how to approach technology from the point of view of society and not the view of a scientist. All the different aspects, such as usability and the design of a product, were addressed. In the second course, I had to design a future product with my project group and evaluate both the design and ethics of this future product. These two courses were very instructive and they made me more aware of all the different sides a person can take when evaluating a product.

This project was mainly about the persuasiveness and usability of the AiREAS application and how to improve these features. I learned a lot about the different strategies of Cialdini, Fogg and Oinas-Kukkonen and Harjumaa, which provide criteria to evaluate the persuasiveness of technology. I didn't know there were so many different aspects important to persuasive technology and I found it pretty amazing to learn and study these. Moreover, this project showed me how hard it is to create technology which is persuasive and which tries to change people's behavior. I mainly focused on research question 1, which was to evaluate the persuasiveness of the current AiREAS application. I was very excited to work on this question, because persuasiveness of technology is what I find most interesting about this project. The conclusion was that the application is not persuasive and mostly provides information; different suggestions were subsequently made as to how AiREAS can improve persuasiveness. I think it is important that AiREAS makes such improvements, because their goal is to improve awareness of air pollution, but with the current application, this goal is not achieved. Their goal serves a good cause and I think that when different improvements are carried out for their application, people will be more aware of air pollution and try to reduce it.

I am very satisfied in regard to our project group and I think we efficiently divided the workload. Our collaboration went very smoothly, which contributed to the fact that we made progress with the report every week. Even though it was sometimes hard to find a time in which we all were available, we made the best of it and sometimes just worked with whoever was available at a certain time. Because of all the holidays and the busy time schedule, it was a bit unclear sometimes as to when the meeting with our supervisor, Jaap Ham, had to take place. Because of this, we missed a lot of meetings, which was a bit unfortunate. However, this did not mean that we didn't make any progress with our report, because luckily, every group member lived up to their own set deadlines for different parts of the report.

In conclusion, I think this project brought me one step closer to understanding the relationship of humans with technology.

1.22.5 Reflection: Daniëlle Ramp

I attended the USE learning line Human in Technology, with a specialization in behavioral and social theories of human technology interaction. I chose this course because of my interest in user-centred design and psychology in general.

In the first course, the focus was on empathy, which contributed to my vision and identity as a designer. In my opinion, way too many decisions are based upon assumptions nowadays. Thanks to this course, it was shown that empathizing with the users and perceiving their behavior gives us great insights and can form a good base for setting design requirements and opportunities.

The second course focused on several psychological phenomena and the online behavior of groups. I found it very interesting to learn about psychological effects, and how small changes can have a huge influence on a process. For example, whether the responsibility is centred or distributed among many has a large impact on the behavior of the individuals in a group, and therefore the group as a whole. To me, this means that if I have to make these kinds of decisions on a systemic level, I will make them very carefully and preferably based upon psychological principles.

The third course focused on persuasive technologies. Together with a group of Biomedical Engineering students, I participated in a research project on the usability and persuasiveness of the AiREAS application. I got acquainted with several theories for evaluating the level of persuasiveness (e.g., Fogg, Oinas-Kukkonen and Harjumaa and Cialdini) and made use of the System Usability Scale, a quick, reliable method for measuring the usability of a system. By means of these evaluation methods, I got to work with hard data, whereas my user evaluations were, until now, mainly based on formative feedback. My experience was that these hard data gave me a feeling of certainty, as numbers often form solid grounds for the decisions you make or the conclusions you draw. Furthermore, hard data is very useful for visualizing results, although we didn't really focus on this. For future projects with summative feedback, I would rather take this opportunity and put effort into communicating the results through clear and attractive visuals.

Although we sent questionnaires around, I wouldn't state that the user was the central point in this research, since we didn't empathize with our users. I am unable to express how our users felt, what they thought or how they acted. As a designer with an interest in social design, I strive towards personal contact with my users, and I found it frustrating and unsatisfying to miss this contact and input now.

For future design processes, this means I see added value in hard data, but to me, this value is mainly located in the area of certainty, argumentation and visualization.

Appendix I

Results of evaluation of the persuasiveness of the AiREAS application	
Cialdini	Average score
Persuasive technique	
Reciprocation	3.4
Commitment and consistency	3
Social proof	1.2
Liking	4.8
Authority	2.8
Scarcity	4.4
Fogg	Average score
Persuasive technique	
Computers as persuasive tools	
Reduction	5.4
Tunneling	1.0
Tailoring	2
Suggestion	1.4
Self-monitoring	1
Surveillance	1.8
Conditioning	1.6
Computers as persuasive media	
Cause and effect	2.8
Virtual rehearsal	3.4
Virtual rewards	1.6
Simulations in real-world contexts	4.2
Computers as persuasive social actors	
Attractiveness	6.8
Similarity	5.2
Praise	2
Reciprocity	2.4
Authority	1.6
Credibility and computers	
Trustworthiness	8.4
Expertise	8

(continued)

Presumed credibility	7.2
Surface credibility	7.8
Reputed credibility	2.6
Earned credibility	6.4
(Near) perfection	7.4
Credibility and the world wide web	
"Real-world feel"	5.6
Easy verifiability	3.2
Fulfillment	3.8
Ease-of-use	6
Personalization	2.4
Responsiveness	2.8
Persuasion through mobility and connectivity	
Kairos	1
Convenience	1.6
Mobile simplicity	7.4
Mobile loyalty	2.2
Mobile marriage	1.4
Information quality	7
Social facilitation	1
Social comparison	1
Normative influence	1
Social learning	1
Competition	1
Cooperation	1.2
Recognition	2.6
Oinas-Kukkonen and Harjumaa	Average score
Persuasive technique	
Primary task support	
Reduction	4.6
Tunneling	1.2
Tailoring	3.4
Personalization	2.6
Self-monitoring	1.8
Simulation	3.6
Rehearsal	1.2
Dialogue support	
Praise	2.6
Rewards	1.2
Reminders	2.2
Suggestions	1.4

(continued)

Similarity	3.2
Liking	4.6
Social role 1	
System credibility support	
Trustworthiness	8.6
Expertise	8.2
Surface credibility	7.8
Real-world feel	5.2
Authority	3.4
Third-party endorsements	2.8
Verifiability	4
Social support	
Social learning	1
Social comparison	1.6
Normative influence	1
Social facilitation	1
Cooperation	1
Competition	1.2
Recognition	2.6

Appendix II: The Outcomes of the SUS Questionnaire

	ptcp. 1	ptcp. 2	ptcp. 3	ptcp.4	ptcp. 5	Average
I think that I would like to use the AiREAS Application frequently	2	1	2	1	2	1.6
I found the AiREAS Application unnecessarily complex	3	2	1	2	1	1.8
I thought the AiREAS Application was easy to use	4	4	4	3	4	3.8
I think that I would need the support of a technical person to be able to use the AiREAS Application	2	1	1	1	1	1.2
I found the various functions in the AiREAS Application were well integrated	3	4	3	3	2	3

(continued)

	ptcp. 1	ptcp. 2	ptcp. 3	ptcp.4	ptcp. 5	Average
I thought there was too much inconsistency in the AiREAS Application	3	3	2	3	1	2.4
I would imagine that most people would learn to use the AiREAS Application very quickly	4	4	4	4	5	4.2
I found the AiREAS Application very cumbersome to use	4	4	4	5	3	4
I felt very confident using the AiREAS Application	4	3	4	3	4	3.6
I needed to learn a lot of things before I could get going with the AiREAS Application	3	4	1	1	1	2

Appendix III: The Reduced Outcomes of the SUS Questionnaire

Sum: 24.8
   Usability AiREAS app: 62 on a scale of 0–100

(1) I think that I would like to use the AiREAS Application frequently
   Score: 0.6
(2) I found the AiREAS Application unnecessarily complex
   Score: 3.2
(3) I thought the AiREAS Application was easy to use
   Score: 2.8
(4) *I think that I would need the support of a technical person to be able to use the* AiREAS *Application*
   Score: 3.8
(5) I found the various functions in the AiREAS Application were well integrated
   Score: 2.0
(6) I thought there was too much inconsistency in the AiREAS Application
   Score: 2.6
(7) I would imagine that most people would leant to use the AiREAS Application very quickly
   Score: 3.2

(8) I found the AiREAS Application very cumbersome to use
     Score: 1.0
(9) I felt very confident using the AiREAS Application
     Score: 2.6
(10) I needed to learn a lot of things before I could get going with the AiREAS
     Application
     Score: 3.0

Appendix IV: Usability Evaluation on Five Criteria

	Daniëlle	Tim	Joyce	Relinde	Marjan	Average
Effectiveness	6	2	3	3	4	3.6
Efficiency	5	5	7	8	8	6.6
Learnability	9	3	9	5	3	5.8
Memorability	8	1	7	7	2	5
Satisfaction	2	1	2	2	5	2.4
Average score	6	2.4	5.6	5	4.4	4.68

Appendix V: The Percentage of Correct Answers in the Online Questionnaire for Persuasiveness

Question number	Direct verbal feedback (%)	Direct colour feedback (%)	No feedback (%)
1	83.87	77.14	74.07
2	81.48	78.13	64.00
3	88.46	83.33	79.17
4	76.00	30.00	13.04
S	92.00	83.33	78.26
6	92.00	75.00	73.91
7	80.00	60.71	30.43
8	92.00	57.14	52.17
9	96.00	78.57	95.65
10	92.00	96.30	82.61

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Reflection by Jean-Paul Close

Persuasion in our societal context of developing core human and natural values is a new field of intelligence. It does not just redefine the characteristics of our human tools, but also the way we communicate, interact and develop our securities. Human tools for sustainable progress are all those instruments that we create that help produce our well-being, not just those from technology, but also those of supportive institutions, insights and cultural aspects. Persuasive tools in this sense are not a commercial issue, but rather one of developing common sense, awareness and responsibility. Feedback is essential for defining what works in the human psychology of *leadership and the nature of following*, and what does not. The feedback is given by the target audience themselves through involvement and by measuring achievements.

Therefore, an App directed at producing change in mentality (value oriented) is different than the act of addressing the mainstream commercially (profit oriented) around specific fragmented needs. This differentiation was relevant when trying to determine the organization that should pay for the creation of the App and if citizens would be asked or not to pay for the service?

Answering the question about citizens wanting or having to pay for the application, we can conclude:

1. When the App is used to trigger awareness and change, it should be free of charge. It is a community leadership tool, not a commercial one. Government should invest in the development using our tax money, justified by the public value development of health (in this case).
2. Once change is accepted by the mainstream, then it is no longer a leadership issue, but one of simple management for growth. The new reality becomes part of a (new) culture in which Apps and other services can be deployed as commercial items. Then, there is no persuasion anymore, just information and interaction within an accepted (new) perception of reality. In this case business invests in the development within a business case.

Persuasion is therefore only "a market" in the field of leadership development or objectives, for instance, in education, market leadership development and the desired evolution of governance into a new level of regional development. It is not a commercial item for the masses. Once persuasion has done its work, a culture change becomes visible with adapted market mechanisms and content, which, in essence, works the same as usual in the economy of transaction. It therefore can contribute to the successful establishment of unique and authentic new markets. Persuasion is hence a leadership instrument of the Transformation Economy of

change (sustainable leadership side in the drawing below), creating the "new sense of what's normal", while marketing is instrumental to management (side of financial management) within the competitive Transaction Economy of growth.

Transformation versus Transaction economies
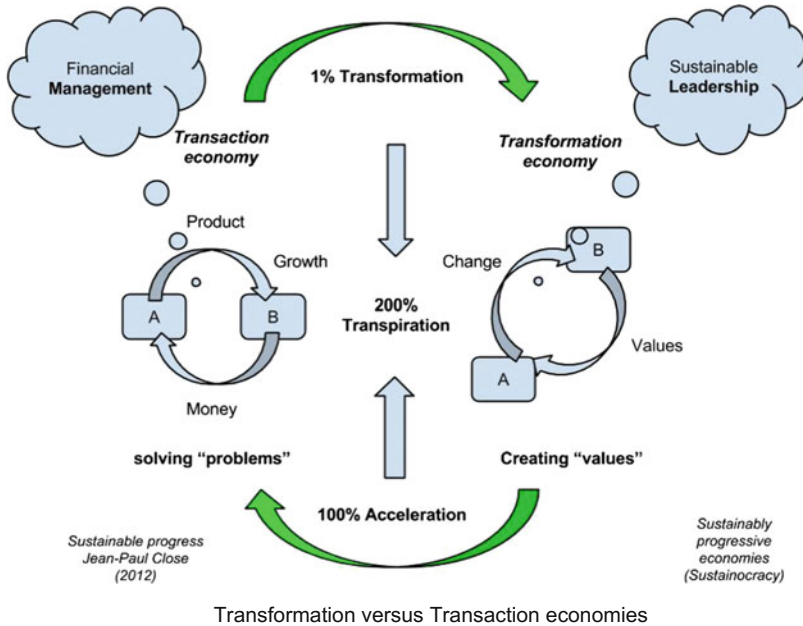
From a regional development point of view, the new paradigm of core values, like health and air quality, positioning ourselves as peer 4 multidisciplinary co-creation, with persuasion on the side of "sustainable leadership", will entirely redefine the economy of growth (see drawing above). It is a clear reference to the way Kondratiev economic waves develop and can even be influenced positively to avoid economic crises in the future.

This particular group of students had to come to terms with this understanding and did an excellent and inspiring job. Their personal remarks are significant and part of a learning curve in which we are all engulfed. We learn as much from our pupils as they do in the process. That is why we call it *participative learning*, a technique that is not simply confirming and sending out known understandings for students to process. It connects students to real life issues in which they need to search for and process known understandings in order to come up with solutions and new insights themselves. It is not the science or knowledge itself that matters but the context and motivation in which it is implemented as an ingredient for

measurable sustainable progression and creativity. Participative learning is a peer 4 (sustainocratic, awareness-driven eco-society) type of dealing with complexity at an early stage of individual human development, helping to develop personal leadership, creativity and awareness quickly for the benefit of universal and human innovation and harmony. We will deal with this in more depth in the other chapters.