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How design the future hydrogen users' needs?

A contribution of prospective ergonomics.

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Abstract. The energetic transition will be a major challenge in the next years. Today, we must imagine future needs and uses of alternative energy such as hydrogen. For this, we need to define and design innovative services which will satisfy future expectations of future users. But how can we evaluate and design products and services when they do not yet exist? In this case, it is hard to animate focus groups of users, impossible to analyze the usages, complicate to understand user's opinions... To deal with these questions, it is necessary to introduce prospective and creativity in the ergonomics approaches, so-called prospective ergonomics. Our project and the first results obtained show how different "actors of hydrogen" imagine the future uses of this energy from different points of view. We chose to organize three staff of professionals (production, transport and energy distribution) and we made a lexical analysis of their conversations. We present in this communication the process of lexical analysis and main results obtained. We explain, how we created 4 fictitious users called "Personas". The main role of these personas is to facilitate ideation in order to allow the hydrogen professionals to design new products and innovative services.

Keywords: prospective; ergonomics; energy; user centered concept; lexical analysis; personas.

1 Introduction

Nowadays, trying to understand how an object (a phone, a watch, a car...) will be accepted and used is simple, because ergonomics brings up relevant concepts on existing user experience. We can interview, observe, or create specific groups, to ask people about their usages and analyze the strengths and weaknesses. But what can we do when the object does not exist and when the concept is very fuzzy? Gibson said [1], "to see things is to see how to get about among them and what to do or not do with them". Research in the ergonomics field consider that we can foster creativity and generate knowledge about the present or future use of a product by applying

adequate methods, such as « scenarios based reasoning », [2], « persona creativity » [13], « analogy based approaches » [4] or « counterfactual reasoning » [5]. Prospective ergonomics is defined as being an ergonomic intervention mode which identifies current needs, foresees changes and anticipates future users [6].

The work conducted on this project is to imagine the hydrogen uses and identify the reluctance that hinders the energy transition. Using hydrogen, as energy is still anecdotal, it would be increasingly challenging for us to understand users and to require users to respond how they feel about it. This paper uses a method called “Staff of experts”, based on the participation of professionals from three areas: production, transport and storage of hydrogen. We proposed them imagine the uses, the bottlenecks and the behavior of future users.

After an introduction, we give the theoretical background, describe the method used for this study. Then, the main results for different staff are given, first in the form of text analysis, and second in the form of personas.

2 General background: prospective ergonomics approach

Prospective ergonomics is defined as being an ergonomic intervention mode which, on the one hand, identifies current needs, foresees changes and anticipates future users, and on the other hand, creates systems, products or services which meet those needs according to health and safety, comfort and well-being, performance and satisfaction criteria [6]. Prospective ergonomic intervention is therefore speculative and inventive. Focusing on changes in human activity, the ergonomist takes on the role of a pilot who initiates, defines and manages the project from beginning to end, bringing in other actors (or professionals) to implement, or execute his/her plans. To achieve these aims, prospective ergonomics must fulfil three kinds of tasks: 1) Identify current needs, understand their changes over the long term, anticipate future needs, define, reference, validate and assess them, put them in order of priority, and carry out simulations, 2) Study technological, social, cultural, and economic factors which accelerate changes in human activity situations to which humans are required to adapt, 3) Imagine, invent, create and build systems, products and services beneficial to humans, providing comfort, well-being, allowing for personal progress and a better quality of life in general. Prospective ergonomics will complete the scope of ergonomic intervention modes by taking the future into account. Prospective ergonomics place the human in the central position in new practices, behavior, and organization. Focusing on changes in human activity, the ergonomist takes on the role of a pilot who initiates, defines and manages the project from beginning to end, bringing in other actors to implement, or execute his/her plans. To achieve these aims, prospective ergonomics must fulfil three kinds of tasks:

- Identify current needs, understand their changes over the long term, anticipate future needs, define, reference, validate and assess them, put them in order of priority, and carry out simulations;
- Study technological, social, cultural, and economic factors which accelerate changes in human activity situations to which humans are required to adapt;

- Imagine, invent, create and build systems, products and services beneficial to humans, providing comfort, well-being, allowing for personal progress and a better quality of life in general.

Based on the same principles as corrective and preventive ergonomics, prospective ergonomics will complete the scope of ergonomic intervention modes by taking the future into account. This will enrich its relationship with other fields, not only psychology, biomechanics, physiology, cognitive sciences, scientific engineering, but also with sociology, anthropology, design, marketing and business management.

The prospective approach is a participatory process to design possible futures in the medium or long term. It is above all a state of mind (and anticipate wish) and the expression of a state of current and future needs. Let us then observe all the fields involved in the prospective approach. What motivated a prospective approach being integrated into these fields is simple and pragmatic: the prospective approach offers tools and methods which enable professionals to focus on the right questions and reduce inconsistency in reasoning for developments in the future. Our research project aims to address this delay. Applying a prospective approach in other fields will undoubtedly cause changes in our vision for the future. It broadens the perception of the problem by including demographic, economic, technological, social, cultural, historical, and legal data that highlight changes in future, trends. It keeps a watch on technologies, checks patent deposits and seeks to identify tomorrow's technologies.

Prospective ergonomics's aim is to develop prospective schemas by:

- Producing knowledge about future users: These are techniques that are able to understand future clients, such as the technique using personas [7, 8], and scenarios to pre-testing of new concepts and evaluation of their impact on target users.
- Stimulating creativity and organization in innovative projects. This includes various techniques of constraint management [9] or social development of future needs [10, 11] which will support user creativity.
- Previewing artefacts so as to tailor product use or future services. This involves not only making models, and prototypes, but also system simulation in immersive environments.
- Understanding forms of appropriation of artefacts, beyond the functional approach which limits usage to realizing the system's functionality. Artefacts are designed for users who in turn redesign them.
- Understanding unfortunate experiences to provide suggestions for improvement while estimating performance for the future use of the artefact.
- Studying products and services successes and failures comparable to the ones we wish to create or belonging to the same technological ecosystems.
- Using trends to define the direction innovation needs taking.

3 Research Framework

3.1 Context

The aim of this paper is to present and discuss an innovative method related to prospective ergonomics to produce new ideas on the usages of hydrogen energy. While a large number of debates are placed on the emergence of a hydrogen civilization, the Lorraine Region (north-east of France) has undertaken to transform its territory into a showcase for the development of hydrogen power. To accompany these radical changes, the aim of this research is to think about how hydrogen and the technologies associated with it are going to challenge our daily lives: What are the predictable reactions and problems? What are the pitfalls to be avoided, the development strategies to promote it?

3.2 Objective, problem and method

Our objectives were to understand how the experts perceive the possible, the acceptable, the potential and the uses of hydrogen technology in the near or more distant future. To do so, we have adopted a step-by-step approach, based on the Expert Community Staff [10, 11, 20]:

- A community of expert staff is a group of experts representing actors directly or indirectly involved in a community project.
- The experts were gathered under the responsibility of animators in a controlled, scripted and filmed situation.
- The main goal of those staff of experts was to collect data which could enable us to use other methods for finally, define scenarios of future use for technology, product or service.
- The role of the animators (2 in our case) is, for example, to create a dialogue between the experts, to react on existing products and services, to express the needs, expectations and requirements of target users, and to explain useful knowledge necessary for the use.

For our study, we created three staff of professionals on three themes

- Transport and hydrogen.
- Production of energy with hydrogen
- Energy distribution with hydrogen.

The process of each expert staff was done in four phases:

- Each participant's presentation,
- Knowledge generation and discussion about needs, future needs, expectations, future users' requirements on hydrogen and its use,
- Presentation of videos on the discussed theme and expert's reactions/discussions over the content,

- Synthesis and sorting of knowledge related to hydrogen and its use (cards sorting method).

At the end of the meeting, one main question was asked: What is the most important ingredient for success in energy transition to hydrogen? The card sorting method was used to organize the knowledge of hydrogen and its use. Each focus group lasted three hours. Discussions and interactions were filmed using our living lab.

4 Findings and main results

4.1 Statistical analysis of the corpus

We performed a lexical analysis of all conversations, on the one hand, staff by staff and in second hand for all staff. The main objectives were:

- To highlight the significant words,
- To build thematic classes,
- To find patterns to find blocking point of acceptance.

With over 9 hours of video, the text file contained 161 pages. We have automated analysis using the software Iramuteq. Iramuteq stands for "*Interface de R pour les Analyses Multidimensionnelles de Textes et de Questionnaires*", (i.e. "interface of R for multi-dimensional text and questionnaire analysis"). Iramuteq is built on top of R). This software allows analyzing documents that are segmented into chunks. Input documents are plain text files that contain simple mark-up that identifies variables and topics. Iramuteq analyses verbs, words, adjectives and carry out a top-down hierarchical classification and produce a bi-dimensional graph (fig. 1)

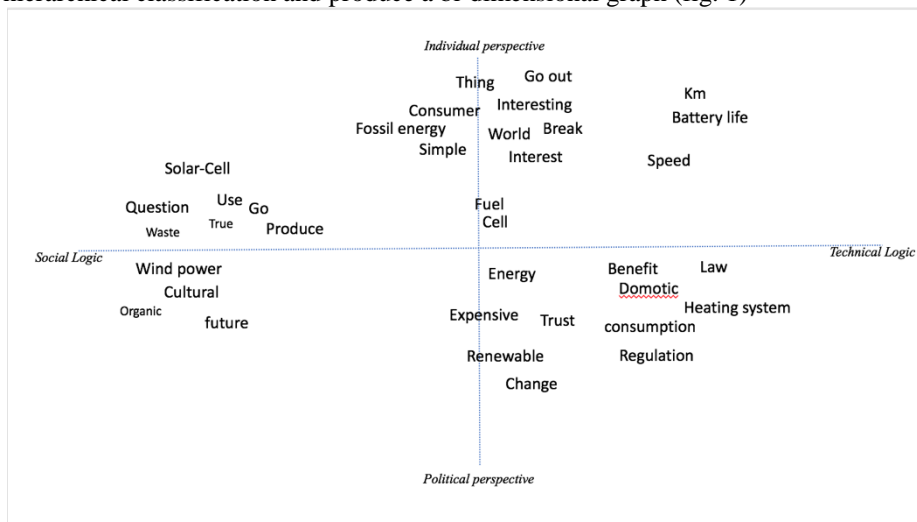


Fig. 1. Graphic of words and axes related to the corpus produce in three expert staff.

In this bi-dimensional graph, we obtained a clear differentiation between four variables. The first two are on the horizontal-axis (Fig 1).

- On the left, we can find a set of references to a social logic with words like “concern”, “charge”, “effort”, “communication”, “trust”. On the right, from a technical logic, we read more technical terms like “engine”, “fuel cell, energy, gas, heat, produce electricity”.
- On the vertical-axis we have a comparison between investments realized today in other countries and what needs to be done in France in the coming years. At the bottom of the vertical axis, we find a “political perspective” with the words like “states directive, national, Tokyo, unit etc.”. At the top of the vertical axis, the preoccupations are individual. There are more individual terms like: “consumers, financial, complicated change, worry, to evolve”.

By placing on the axis, the characteristics of a person (more individual, more social, more technical) we can find the words that characterize the potential user in terms of their expectations, needs and fears. This characterization of users can help to find for each of them the best solutions in an energy transition.

Another result is the classification of words in statistical categories (Fig 2) The percentage for each class indicates the proportion of the class in the text. Each class contains a set of words. The first words are the most representative of the class, those that were more frequently reported. The software does the calculations with the same settings for all the staff.

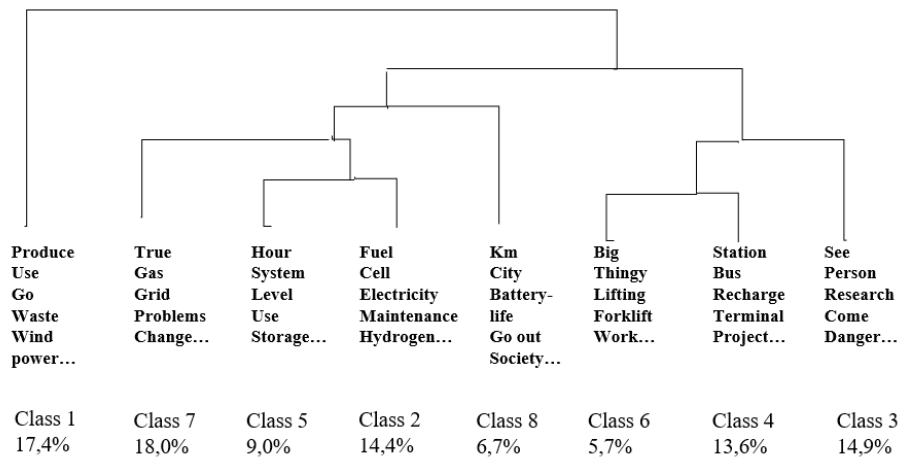


Fig. 2 : Dendrogram of classes, main words, and percentages of each class.

4.2 Interpretation of trends and future demands

Experts agree that users, and factories in particular, increasingly integrate environmental concerns into their choices. For them, hydrogen makes it possible to

increase the share of renewable energy. That would be the main selling point. They also recognize that the ecological dimension should be important, but with an equal price level. For the general public, the possibilities offered by hydrogen are unknown. On the other hand, some of the users associate (according to the experts) hydrogen to clean energy, because there is no release of CO₂. This is false if one studies the manufacturing process. The performance or overall energy balance is not addressed in the public debate. The expert community knows that the main challenge is to decarbonize hydrogen by diversifying possible sources. In this context, experts are reluctant to communicate on the more or less clean level of hydrogen:

- *“This is an overall argument, the most important one”.*
- *“All levels exist on the cleanliness of hydrogen production.”.*
- *“The danger is to overestimate hydrogen”.*

Experts insist that the danger is under control. Developments could better secure processes, for example by making inflammation visible. Once again, they question themselves about the meaning of the message to be transmitted. The problem is to avoid fears that were not present until then:

- *“These are long-term efforts to give a positive image, it’s easier to change the name!”*
- *“It is a difficult gas to handle, but we know how to control the danger”.*

For experts, the economic stakes are clearly energy independence. In terms of employment the impact is easily calculable. They think jobs could simply be transferred from one sector to another. Experts believe that it will be necessary to introduce hydrogen in a transparent way. Using hydrogen should not be a consumer choice.

4.3 The elaboration of “Personas” or the description of future users

The creation of the personas was based on the transcription of the video recording and took place in two steps:

The identification of relevant variables.

We identified the variables likely to have an influence on consumer and expert behavior. Two profiles of final users and two profiles of experts were built according to for types of concern (Tab 1).

The enrichment of the personas with relevant information.

The level of detail and the nature of information to be integrated depend on the type of product the personas have been created for. We based on the meaning categories which are usually used in the definition of persona profile (Fig 3).


- To render the personas credible, we have added a photo, a name, an age and a marital status.
- Aspects related to attitudes and behaviors: For each type of concern, the position of each persona is developed. This position influences his role concerning hydrogen, his current or future choices and the way he perceives hydrogen.

— The context of use.

Concern	Final users		Experts	
	Pierre GILLES	Cécile APTEL	Laurent LALOE	Martin CACHE
1. Ecology	The ecological dimension is a bonus. +	Hydrogen is a clean energy. ++	Ecological aspect is just a sales argument +	The challenge is to make this energy green. ++
2. Cost effectiveness	What is important is to obtain a rapid return on investment. ++	In comparison with the current situation, losing money is not an option. +	The government has an important role to encourage economically consumer. ++	The main advantages: the energy independence and the economic opportunities. +
3. Safety	No concern	Many questions ++	The risk is low and under control.	It is important not to add unnecessary fears.
4. Autonomy	Ready to manage different sources of energy. ++	The ideal is not to worry about anything.	Consumers must become producers! ++	Consumers want to maintain a good level of comfort! ++


Table 1. Structure of personas, significant points of view of each persona

Laurent LALOE *Hydrogen as the energy vector of the future*
Perceives hydrogen as a tremendous opportunity



Research Director
42 years
Married, 2 children

As long as we have not put a cash value on the environment, there is no reason why an end customer would spend more money!



His perception of hydrogen

Laurent is convinced of the potential associated with hydrogen. Concerning energy independence, storage possibilities, transport between production and consumption centers ... hydrogen provides undeniable solutions. Ecologically speaking, Laurent points out that hydrogen is not a clean energy, at least for the moment! He recalls that the issue among the community of experts is: how to decarbonize hydrogen production?

His rule, his choices

Laurent has chosen not to worry about users now. It's about getting the support of the government. At the same time, Laurent would like more debates, information in the media about hydrogen. After all, users will have to arbitrate between different solutions for each type of application

Fig. 3. Extract of the persona Laurent

For the experts, we specified a domain of expertise. Concerning the final users, we have anticipated some contexts of use.

4.4 Towards a superposition of future expectations and future users

We point out that potential users were apprehended through the experts. However, the most highly recommended method is without doubt the direct access method. If in the area of an exploratory study, this methodological approach is relevant, it must be reoriented in pursuit of the project. The object will be to enrich the personas based on the analysis of the consumers' own points of view.

As part of this exploratory study, personas help restore the majority of themes addressed in focus groups. Spontaneously, the experts discussed some points that are put forward by one or more personas.

The lexical analysis had two major impacts on the elaboration of user models, or personas. Firstly, the analysis enabled us to validate four profiles of users that had emerged from a thematic analysis of content.

The attitudes, values and behaviors of these personas were in line with the classifications.

Secondly, personas were positioned along two axes (Fig 4): Individual perspective vs political perspective and social logic vs technical logic. Indeed, even if they share common lexical fields, each of them points out a major concern:

- Cécile: time required for energy management and safety.
- Pierre: new opportunities in everyday life.
- Laurent: technological issues.
- Martin: technological acceptance from users.

Laurent is a technician. The daily difficulties are not his primary concern. For him Hydrogen is the solution to the problem of declining fossil fuels but the change is also, and primarily, a political will. Laurent seems little interested in the social aspect. The impact on society can only be beneficial even if it requires behavioral changes. Martin is a professional too. For him, using hydrogen will impact the lives of people (price, constraints, etc.). He hopes that we can no longer impose life choices. Martin thinks that consumer perception and opinion are important, we can no longer impose life choices against the will of users. Pierre is the example of the optimist user. He enjoys new technologies. He likes to manage their accounts (bank) online. He buys on the web and he expects to manage its energy with automation tools. This is an optimistic environmentalist. He thinks that all the decisions taken will have a positive return on the environment and people's lives. He is eager and ready to participate in this experience. Cécile is a dubious user. It would be hard to change his life habits. She likes her standard of living and do not want to have high stress. She knows that the ecological factor is important and she wants to make an effort but she refuses to be impacted by technical constraints.

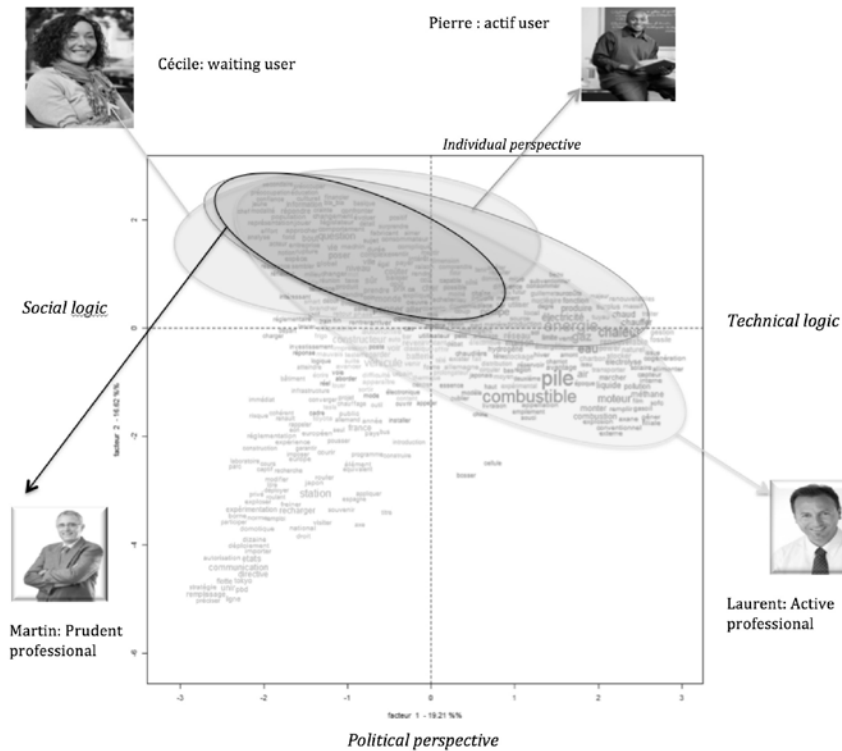


Fig. 4. Positioning personas on factorial analysis graph of discourse.

5 Conclusion

This work presents a perspective design method based on lexical analysis of speech of professionals of hydrogen. Our goal was to understand how the hydrogen industry experts imagine future applications. Our study shows significant differences depending on the sectors. We categorized into 8 classes major areas of inquiry.

From classes, we built a model on essential needs. We identify three major themes:

- Benefits of hydrogen.
- Making in the future.
- Desires of politicians and consumers.

Benefits of hydrogen, making in the future and desires of politicians and consumers. The most reported words in the lists are: "battery, energy, heat, safe, thinking, vehicles, petrol stations". From this, it is possible to construct a sentence that summarizes all the speech: *"The batteries are sources of energies of tomorrow. They can generate heat, they are safe."* I am thinking that vehicles in the future will have a self-sufficiency and we can easily find hydrogen stations " or "I think that

vehicles in the future will be self-sufficient and hydrogen stations will be easily found". Ecology is mentioned but is a major argument for only one category of experts (transport staff). This work is the beginning of different studies on the acceptance of hydrogen energy.

The "persona based" method proposes that one fictitious character can individually represent a whole category of likely future consumers. To summarize, on the one hand, the persona's features enable professionals of hydrogen to create scenarios for the use of products or services and, on the other hand, they enable distributors to develop a marketing strategy for the same product or service. This work also shows that the persona based method can be enriched by a lexical analysis and it contributes constructing representations of hydrogen uses.

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