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The Delphi method for future scenarios construction

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Abstract

The Delphi method, originated on the 1960's, is a technique used to help construct present and future scenarios focused on specific issues with the help of experts on the focused subject. The method helps reach a consensus among the participants based on all posted opinions from different experiences and points of view in order to build a common scenario. This paper presents the phases of the method, from the initial preparations of inviting and filtering experts to the final phase of constructing the future scenario. The paper exemplifies the procedures of the method based on the collected data from a research with the objective of creating possible scenarios of technology and innovation advances and interaction expectations in the next 5 to 10 years.

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1. The Delphi method

The name comes from the famous Apollo's oracle, at Delphi, where the priestesses could predict the future of humans through magical rituals. Theodore J. Gordon in his book *Futures Research Methodology*[1] points the origin of the method in the 60's, at the research laboratory RAND, in Santa Monica, California, mostly directed to military issues regarding technology development, as well as, potential political scenarios. RAND researchers explored possibilities in a primitive quantitative simulation model with computers that had not enough capacity to record the amount of data. The method objectives to surface most possible scenarios of a specific topic based on specialists' knowledge.

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Gordon[1] and Justo[2] describe the proceedings of the Delphi as a reunion of specialists from different areas of expertise to concentrate on a specific topic, share opinions until reaching a consensus and build a common possible scenario. Lindeman[3] points that it is a method to combine different opinions from separated experts, through the use of a series of questions in order to produce consensus and eliminate any conflictual situation that a meeting in person could result. Pil[4] considers the method ideal for cases with no means of prediction confirmation and to identify ruptures or innovation in a specific field of knowledge. The Delphi method can be used to help construct present or future scenarios on specific subjects, surfacing a variety of possibilities. It can bring better results in situations (1) where a problem can't be solved by analytical proceedings, (2) the invited specialists to participate have diverse experience and formation, (3) the size of the group of specialists (or their geographical location) could make very hard to have a meeting in person[5].

There are a few variations of the method, but it is fundamental to have a controlled debate with the participants regarding the subject of discussion. It is more interesting when the experts work in different areas in order to present different points of view. As for example, if the topic of discussion would be the terrorism scenario in the next 5 years, would be interesting to have specialists of border security, airport security and explosives as well as specialists of international relations, cultural movements and religion discussing and exchanging ideas about possible scenarios. Gordon[1] puts the Delphi method in three kinds of situational judgment:

- (1) prediction of future developments, as for example “scenario of the social network development in the next 10 years”;
- (2) prediction of possibilities of an event in the future and related recommendations, as for instance “the possibility of establishing an exact date when man will land on Mars”;
- (3) ways to achieve or avert future situations, “the political scenario and food supply in 15 years from now”

The three types of questionnaire proposed by Gordon[1] can ask for a variety of specialists as participants: from experts on the subject, specialists that are in contact with technology research and state of the art regarding the subject, specialists related to ethics, moral, cultural, social from determined area to specialists on scenarios' probabilities.

In order to better exemplify the use of the method, this paper presents the proceedings of the method with the objective of mapping possible scenarios of technology innovations and interactions in the next 5 to 10 years, to understand better the user's expectations, mental models and technology affordances built on cultural conventions that be constructed throughout the years. The questionnaire construction was based on Gordon's situational judgment “prediction of future developments”. The direction choice influenced directly the questionnaire structure as well as the types of specialists to invite.

2. Selection and invitation of experts

The key to success resides in the participants, since the results of the method depends directly on the specialists knowledge on the subject and cooperation between all involved. It is essential to include people that can contribute in a meaningful way to the research. The search for potential participants can be directed through (1) university or research facilities' recommendations, (2) well known authors of publications on the specific subject and (3) through the researchers' chain of contacts. For the application of the method, we used all three suggestions to choose and invite specialists.

After a few months of search, twenty seven specialists from six different countries (Brazil, Netherlands, Finland, USA, Portugal and Canada) were invited to participate in the method. Ten specialists agreed to be part of the research: one from Los Angeles, one from Amsterdam, one from São Paulo, one from Lisbon, six from Rio de Janeiro. It has been documented that the quantity of experts can cover hundreds of participants, with the help of an electronic panel to organize the answers of so many specialists, and sometimes with the help of real time interaction panels. Still, Gordon and Theodore[1] suggest the use of 15 to 35 specialists. According to the authors, when the number of participants is small, the answers have equal weight and the analysis of the results occurs with less intricacy. This direction has been adopted by most of Delphi organizers[1].

In order to assure that specialists involved in the Delphi method are adequate and represent diverse points of view regarding a central subject, it is important to create a system/matrix to map the knowledge and experience desired for the procedures to help filter the invitees. Dalkey[6] suggests the use of a questionnaire to help identify experts that

are better related to the researched topic. The author resumes the questionnaire in five questions: are you an expert in the field and work with the topic in a daily basis? Do you work with the topic occasionally? Have you acquired knowledge on the subject through occasional research/reading? Do you consider yourself an well informed laic on the topic? Do you have any knowledge on the subject?

Based on the topic of possible scenarios of interaction and technology in the next 10 years, all invitees had to act with the proposed topic on a daily basis either through a working company position or scientific research position. The participants selected for invitation had to be specialists in areas related to state of the art of technology and interaction human-technology research. The direction of the filtering procedure tried to group experts from different experience positions that could bring different points of view. After the search through recommendations, publications, conferences and chain of contacts, the invitees had to work in at least three of the related areas:

1. prospecting – the specialist is involved in acquisition of information and research related to products/systems not yet available in the market for consuming or purchase.
2. research – the specialists is involved in products/systems testing. Or conducts/participates of users experience research and mental model mapping. Or is involved in academic research related to technology and usability.
3. project planning – the specialist participates in strategic and conceptual projects creation, either being physical products, systems or services. Or is involved in systems (or services) architecture planning.
4. development/programming – Participate directly in mechanical, graphic or programming development of products or systems.
5. propagation of knowledge/articulation of information – the specialist writes scientific articles, foments propagation of products/systems or knowledge, or writes to channels with opinion influence regarding technology.

3. Applying the Delphi

The objective of the method is to reach a consensus among the specialists on a specific theme in order to create a scenario. It is important that each participant doesn't know the identity of other specialists during the method proceedings, purposely to keep the opinions completely formal and impersonal. Knowing the identity of a worldwide admired specialist could be intimidating and could interfere on the elaboration of opinions.

For this research, all contact and display of opinions occurred by e-mail, having me as the central point of connection. The use of e-mail facilitated reaching the experts from 5 cities through 3 different countries. All names were substituted by code letters to preserve the specialists' identity during the process.

Since the experts are from three different countries, all questions were elaborated in English and Portuguese. All given answers and opinions from the specialists were translated to both languages, to lower the risk of misinterpretation from the participants. If an invited expert had a different native language (that wouldn't be Portuguese or English), the participant could specify a preference between the two options or a third option could be included with the help of a translator.

After the invitation acceptance and selection of participants, the proceedings have four steps, although there can be different ways to approach it, depending on how the phases of the method develop and how the participants interact. Gordon[1] and Justos[2] follow similar directions:

1) Formulation of a questionnaire strategically planned to bring opinions regarding the theme, but from a variety of situations. The questions have to be clear and objective to the participants, to avoid any chance of misinterpretation. The questionnaire is sent separately to each expert in the chosen language. For this research on technology and interaction future scenario, the questionnaire was elaborated with 6 questions, as follows:

- a - How do you see the development and evolution of mobile devices (such as smartphones, iPods, tablets, iPads, iPhones) in 5 years and 10 years?
- b - How do you think touch screen interaction will develop and evolve in the next 5 years? And in the next 10 years?
- c - What will happen to social network in 5 years and 10 years?

- d - What kind of products of digital interaction will be available for purchase in 5 years? And in 10 years?
- e - How the use of 3D interaction will evolve in 5 years? And in 10 years? What will be the possibilities?
- f - Which new media will be available to read books, newspapers, magazines etc in 5 years and 10 years?

2) The second phase starts only after all specialists answer the whole questionnaire. All collected answers were translated to both languages and compiled in a single document. Each expert's name was substituted by a code letter to keep identity anonymous. The answers were organized by each correspondent question, so all experts could have access to all information easily. The amount of opinions can vary accordingly to the invited experts, their knowledge on the subject and the number of questions.

This simple document with all compiled answers is once more sent by e-mail to each participant. This time each specialist reads the opinions and answers of everyone and can comment, agree, add new information or disagree in any part of it. The participants are reminded that the objective is to reach a consensus.

Depending on the amount of questions and opinions from the experts, this phase can present the longest duration. The experts have to read all answers from every participant and include comments, if he/she feels suitable. If there are two or more disparate opinions, a longer exchange of e-mails may be necessary to clarify the points of view, base arguments, and clear any doubt.

3) The third phase puts together all answers and all comments for a second round of analysis. It is expected to have all arguments focused on a central consensus at this point. If necessary, certain subjects can be investigated into a deeper level of information and detail.

4) On the fourth phase, the researcher collects all answers, comments, additions and opinions from the previous phases for analysis of content and a final document is prepared describing the future scenario. For this research, the scenario was presented in 6 parts, each one focused in one specific question. As a final round, all specialists were invited to add a comment to the final scenario.

The construction of the scenario is based on all collected opinions, advancements and innovations proposed and agreed by the totality of the experts or at least the majority of the participants after the fourth round of the method. The scenario should focus on the proposed theme and seek information with similar line of thinking. While analyzing all the content it is possible to point the convergence of opinions, but also some side information, never the less interesting, that can surge from a unique view of one specialist. The side information can be discarded, as they are not part of the consensus, but also can be presented in the final scenario as a possibility of less probability, unless they are disagreed by other participants. During this research, the consensus about the central theme surged and intensified as the phases progressed, but it was interesting to notice a few proposals for the future scene that came from one or two specialists. These solo comments that were not disagreed by other specialists became part of the final scenario as a possibility, nor a certainty. The scenarios that had a split of opinions, were also presented as distinct possible futures.

4. Analysis of the results and understanding the future scenario

Throughout the four phases, the use of the Delphi method enable to identify common lines of thoughts among the specialists regarding the most important topics in focus. Subjects commonly agreed among the specialists were certain to be part of the final scenario. Opinions that brought up possibilities that were not envisioned by others, the specialists participated by either agreeing with the proposed view of the future, adding even deeper complexity to the subject or disagreeing with certain points, as the example collected from the first question (about the development and evolution of mobile devices in 5 years and 10 years). A series of comments on specialist "A" 's answer shows a similar line of thinking and expectation among other specialists:

Specialist A: I believe that what still holds back its bigger expansion and development are 2 factors: input of data (not interaction, but the insertion of more complex and bigger data like this text for example); and batteries energy duration, since batteries technology has not been developed as fast as other aspects of mobile devices.

-- comment C: *I agree. This is still a point to be developed, although younger generations seems to have easily skilled it. But there has been a great evolution on batteries' durability and auxiliary devices for mobile charging.*

-- comment H: I agree: phones can't facilitate adding a lot of data, and their battery life should be longer.

-- comment I: I totally agree, semantics has always been an issue in data input and output, particularly when people search, command, control applications.

Specialist A continues: Besides this, to say some examples, there are already more than one mobile device for each habitant in Brazil, and the spreading of smartphones within the population older than 16 years old, surpass the 14%.

In 5 years, I hope to see these numbers increasing, with more people having access to mobile devices, and the expansion of mobile technology in aspects not related to my previous criticism on their deficiency, as for example, its use as a biometric, authentication tool, and as a mean of paying bills or user identification in several different scenarios.

In 10 years, I think these devices will already surpass the input of data limitations (through voice or gestural interaction) e battery life, and will substitute almost totally the use of computers by common people.

-- comment H: I agree: the phone, with extension devices such as rings and watches and pens that are smart will constitute most computer use.

-- comment I: Does this writer mean the use of "screens" instead of "computers", if so, I partially agree, I think screens will be embedded in a more user-friendly way, less dominant, less demanding.

Specialist A continues: With this, mobile devices will represent the majority of internet access, leaving computers (notebooks and desktops) to very specific tasks. Computers will mostly be used for professional tasks.

B: I disagree with the last paragraph. Not the majority of professionals.

H:if at all. Please realize that the IOT (Internet of Things) means billions more things to contact me and for me to contact. It will be horrible chaos for most people and not too useful.

Understanding the sections of agreements and similar predictions was essential to develop the central points of the scenario. Some comments brought not necessary agreed predictions, but never the less complementary opinions, that have to be brought together. Minor disagreements had to be located and analysed in a sense of finding its purpose and its links to the main scope of the research. Does it affect the main sense of the scenario? Should it be considered a minor possibility, a bifurcation of possibilities or irrelevant information? How many specialists commented in a similar line of thought?

Therefore, crossing all opinions, comments, agreements and disagreements regarding the development and evolution of mobile devices in 5 years and 10 years (first of the six original questions), it was possible to resume a future scenario of possibilities for mobile devices:

"In the next 5 years, the day-to-day use of PCs will go down drastically. Most of its purchase and use will remain only for professional and specific activities. The use of smartphones and tablets will be more and more common in our lives, based on its easiness for common day-to-day tasks. Comparatively, it is already harder for someone to sit at one's desk, turn on a desktop computer just to check e-mail, browse some latest news, research on the web or update one's social network. Considering a generation that first met digital technology through smartphones and tablets, the use of PCs becomes more and more irrelevant and distant. The specialists point a tendency for a more precise and easier touch screen interaction, in lighter, more flexible devices. Mobile artifacts will be more and more used to solve personal chores, like bill payments, products registration and tickets purchase. The big amount of input data will bring advances in capturing data through gestural, voice and optical interaction. The battery technology will not grow as fast as the interaction and apps advancements and will not fulfil user's necessities for day-to-day tasks. There will be a higher concern regarding exponential generation of technological trash.

In 10 years, interaction will transcend tablet and smartphone devices and will be integrated to the environment around us (refrigerators, walls, tables, wearable etc) or projected on surfaces. Tablets and smartphones, completely common and with banal use, will leave the centre of attention. Tendency of devices being more simple and unified, leaving behind the physical existence as we know today. Brain-interface interaction begins.

People will be more and more dependent of apps to perform daily tasks. There will be a higher interaction between apps and more precise data about users. New questions surface regarding privacy and open exhibition of personal life in social and political degree. Advancements of one-to-one advertisement as a reflex. New social inquiries are brought up with the fast technological integration in our lives: what happens to one's data after he/she dies?"

Analysing the several opinions regarding the questions, a few points bifurcated in two different directions, sometimes showing opposed lines of thoughts. The method encourages the participants with opposing ideas to deepen the arguments and reach a common sense. In this case particular, all opposed lines of thoughts were considered split possibilities in a future scenario. All opposed opinions noticed in this particular application of the method were related to technology developments far linked to the main scope of the research.

It was interesting to see specialists from different parts of the world have similar expectations in some points, but having participants from different cultures can bring up different cultural experiences that not necessarily are understood by everyone. Although it did not affect the construction of the final scenario, one point of different cultural view became evident regarding audio books. Specialists from Europe and United States of America have been familiar to audio books for a long time. On the other hand, although technologically easy to reach, publishers in Brazil never bet in the audio books market, interpreting it as a big investment for a low profit return. From this, a very particular prediction regarding the investment in audio books market was inserted that could be true to a Brazilian scenario, but certainly not worldwide. A similar cultural misunderstanding occurred from experts' daily experiences with telephone companies in different parts of the world. The telephony rules and policies, and its control by law, are very different in Europe, USA and Brazil.

Specialist from California: "In 5 years: We shall see modular sets of things that connect to give people more customized solutions that, I HOPE, work across all OSs, data services. Now, in an AT+T Store, I can buy an AT+T 3G Microcell made by Cisco to boost the horrible signal strength of AT+T (and other providers as well in Berkeley, California) , BUT it only works with AT+T equipment, not cross platform, in case I give up on AT+T. In addition, the equipment will NOT work with DirecTV Satellite."

Specialist from Amsterdam: I hope so too!

Specialist from Rio de Janeiro: I didn't understand

Another specialist from Rio de Janeiro: ??? telephone companies?

5. Conclusion

The Delphi method can bring up a variety of future possible scenarios, and during the process of application, the direction of ideas and consensus becomes evident. Even using specialists from different parts of the world, with different cultural experiences and points of view, it was interesting to see many similar ideas and expectations for the future. The expert's view of the future shows the natural uprising line of the nose of innovation graphic of Buxton⁸ with a numerous incremental innovations around touch screen interaction, and its growth to a more precise and more natural gestural interaction. As the incremental innovations are released on the market for consumption, there is an increasing absorption of the technology in our lives, evolving more and more to an ubiquity connection to information and knowledge.

During the execution of the method, the second phase showed to be the longest and hardest to fulfill. Depending on the number of questions and the amount of comments inserted, the document can become very long for reading, and specialists with reduced time to spare can take a long time to finish the task. At the final of the first phase, this research collected 18 pages of first opinions and the second phase took six months to all experts include their comments on the collected answers. The third and fourth phases took just a few days, since the experts focused on specific comments. Even if the method doesn't bring certainties, it can bring out major and lesser possibilities of a future scenario, based on the experience, mental models and expectations of the experts involved.

The experts involved in the process are key to the method's success and surge of possibilities based on real knowledge. It is recommended a careful research and filtering before sending invitations in order to have participants interested in reaching a consensus and the final scenario. When the principal researcher is close connected with research labs, conferences, companies and researchers linked to the theme, the use of chain of connection is the

easiest way to reach experts related to the subject, but it is important to spread the contacts and bring voices from a variety of backgrounds and experiences. Conferences can be a very resourceful base for adding new contacts for the method. From the twenty seven invitee, the majority of acceptance came from experts within the chain of contacts, but the success of bringing experts from different parts of the world amplified the points of view.

Some of the predictions are already starting to show up through papers, labs, lectures and conferences, as for example the use of 3D interaction to mould objects for 3D printing already being tested at a university in Rio de Janeiro, as well as the use of nails and make up for interaction, presented in the paper “FX e-makeup for muscle based interaction”, by Katia Vega[7] at HCII 2014. Future drastic innovations are brewing (and being tested) today and are represented in the nose of innovation graphic by the beginning thin line. Following the nose of innovation theory[8], in 2030 these possibilities could be common place in our day to day life.

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