Human-Data Interaction in Geoprocessing Applications: Design Implications from the Perspective of Specialists

Bruna Santana Capeleti[1], **André Pimenta Freire**[1]

[1]Departamento de Ciência da Computação - Universidade Federal de Lavras - Av. Bueno da Fonseca, 543 - Inácio Valentim, Lavras - MG, 37200-000

bruna.capeleti2@estudante.ufla.br, apfreire@ufla.br

Abstract. *Data analysis with geoprocessing systems demands apropriate processes to improve the interactive technologies used in these systems, considering user-centered approaches and strategies to reduce the inherent complexity. Another aspect gaining force in the last years is the concept of human-data interaction, which consists of evaluating how users interact with data, not only how the data is presented. This paper aims to provide an analysis of the perspectives of specialists in geoprocessing. It describes the main issues of developing applications focused on geoprocessing and challenges in designing interaction with such systems in four main categories of issues that can influence the production of geographic information products focused on user's needs: technological limitations, closed product scope, low number of specialists in geoprocessing and requirements not focused on geoprocessing. This research aims to integrate the information obtained from this study with a usability evaluation of geoprocessing systems.*

1. Introduction

Effective data handling is essential to build knowledge and is also vital to decision-making processes. Nakić *et al.* [Nakić et al. 2022] state that "visualization of geographic data is part of many widely used solutions that aim to communicate the information to the end user".

Human-data interaction is another important aspect concerning how users understand and interact with a specific piece of data that is being presented. Until recently, the data was projected and designed without asking if the users could understand what was represented, the focus of the "interaction" was the data itself [Werman 2021]. The human-data interaction allows learning about various topics, using methods with tools that support the data life cycle, allowing access and comprehension by users [Victorelli et al. 2020].

Regarding geographic information, users must be able to interact and deal with the information provided, allowing them to interpret the data correctly. In general, when it comes to how users interact with data, three aspects need to be taken into account to guarantee a better interaction: the first is readability, which focuses on presenting the data more transparently and understandably for readers. The second is action, which consists of what will be done by the user with the information absorbed from the data. The third and last is negotiability, which consists of viewing the change of the individual and society as a result of data interpretation over time [Mortier et al. 2014].

This paper aims to understand the factors involved in the process of needs-finding and discovery of geoprocessing applications focused on user-centered design, and the data provided from this paper is going to compose a Master's dissertation related to human-data interaction in the context of geoprocessing. The analysis was built from the perspectives of geoprocessing specialists and their experiences with developing interactive geoprocessing projects.

In this study, we conducted in-depth interviews with three geoprocessing and data science specialists involved in several projects. Their projects provided data visualization with geoprocessing for specialists and governmental projects for the general public. The questions were related to their experiences and problems while working in the area. After analyzing their experiences, four categories were produced to illustrate the issues they mentioned.

2. Methods

The main goal of this research was to understand the most critical issues in producing geoprocessing systems that can be good for user experience but also more viable to produce by specialists. The goal was to understand what hinders products from being created with a more user-centred design. The study involved in-depth interviews with specialists in geoprocessing or data science. The paper reports on interviews with three specialists. The Ethics Committee approved the interview process, with the code not identified for anonymous review.

2.1. Interview procedures

Before starting the interview process, the project was submitted to the Ethics Committee for evaluation, including the interview script, and authorization of the company to interview the specialists in geoprocessing were submitted. After the committee's considerations regarding data security and how participants were to be approached, the project was accepted. The second step was to get in touch with the specialists indicated by the company to invite them to the interview. The contact was made through e-mail explaining what was the purpose of the research, and in case of interest in participating, when the specialist was available to talk. In this contact, the researchers gave each participant an overview of the research and its goals. Once the specialist accepted the invitation, the interview was scheduled according to the specialist's availability.

For interviews to take place in the best way as possible, an appointment was made with the specialist, and, by the time of the meeting, the Google Meet platform was used, where the participant was asked if the meeting could be recorded for later analysis. Before the interview started, the interviewer presented herself and explained the research goals and for what purpose the data was going to be used. Having the intent of the interview explained, the researcher started to share the questions with the participant.

The researcher in charge of the meeting also had contact with actual cases that happened in specialists' jobs, collecting the data without involving the application's names in the results, intending to provide confidentiality.

In this study, the company name as well the products the specialists worked with are not going to be disclosed.

2.2. Interview's questions

The interview had 10 questions, that were selected according to the workflow and scope used in the company, the questions were presented as follows:

1. Tell us about your experience interacting with geoprocessing data. What were the positive and negative points?
2. In your opinion, what is the best way to make a geoprocessing data presentation?
3. Do you believe that the presentation of geoprocessing data can variate according to the context?
4. What kind of visualization have you worked before?
5. Have you ever been blocked to make a data presentation because of technological limitation? If so, can you give us examples?
6. What technologies for data presentation do you use? What are the possibilities of data representation? What are its limitations? Do the new technologies help to answer questions costumers want to answer with data exploration?
7. What data techniques do you use when you want to highlight some specific item?
8. How do you identify user's necessities in requirements gathering in geolocation systems?
9. What are the main difficulties to enumerate user's needs during data requirements gathering?
10. During the contact with the costumer, have you ever had divergent perceptions about data presentation? If so, tell us about how the points of view were exposed and what conclusion was taken from it.

3. Results and Discussion

During the interview, the participants were invited to talk about their experiences and background concerning geoprocessing and data science. To understand the issues related by the specialists it was also important to understand their experiences, including the examples, to visualize the category of product they worked on involving geoprocessing. The procedure to organize the results was based on the issues related by the specialists, considering the projects they worked on, to understand if the issue reported was a common item among the specialists.

The current results provide an account of the views of three specialists. They offer crucial aspects to understanding how geoprocessing teams work, how they manage the data and how technological elements can influence the quality of the product generated.

According to them, geoprocessing applications have different subareas involving surveillance, resources and traffic management, among other areas. However, even though the subareas are different, it does not mean that the lessons learned from one application can not be used in others. They also mention the connections users can find between different platforms once they use the same tool. It happens because the tools used to produce geoprocessing are the same in most cases.

Participants informed that they frequently used the same tools in different projects. The specialists also told us that the functionalities presented in these tools are basic, hindering the development of more thought-out platforms for the interaction itself.

Another topic mentioned by the specialists concerns the discovery process of the products. In most cases, such processes do not involve specialists in geoprocessing to

understand the stakeholders' needs. The general requirement document is delivered to the geoprocessing team without the appropriate requirements for building a geoprocessing application.

Product scope is another aspect that can stay in the way of producing geoprocessing applications focused on users' needs. According to the specialists, until recently, there was no space to talk about how users would be able to interact with the platform. Participant P3 mentioned that "in many cases, people believe that geoprocessing is just focused on the environmental area (in the company's context). But it is not. It is something very interdisciplinary".

In one of the participants' experiences, geographic information was added to the product after the other functionalities were already developed and operating. According to the specialist, it was not a good experience because the right path to follow is to develop the system considering the geographic information that needs to be there.

In another report, the participants had to transform the map's scale from a state of Brazil to a more detailed scale. As specialists, the participants already knew that what was required was probably impossible to perform. As a result, the team performed the required update in only one city as an initial test, proving the specialists' point of view when it did not work. Participant P1 gives an insight about who must be involved in the product discovery process: "When we are discussing and finishing the product scope, everyone needs to be in the discussion: the database specialist, infrastructure specialist, geoprocessing specialist and data science specialist, so we can see if the system is going to support what is being required by the stakeholders". Participant P2 mentioned something similar in the interview: "I believe that database and development areas should be by our side; it is something that must be with us".

One aspect that the specialists brought up is how their team works. According to the type of demand, a particular specialist develops the solution. It keeps a better pattern in the solution process once one specialist has already worked with the stakeholder or project before. The interview recordings were analysed, and the main topics were grouped by categories, allowing us to identify what issues influence the most regarding the professional vision of geoprocessing and what implications it brings to design. Besides that, the specialists also brought many visions about the issues in producing geospatial technologies more focused on user needs. Considering the results obtained until the moment, the following categories illustrate the production of technologies focused on user needs:

1. **Technological limitations**: According to the specialists, in most cases, the tools and software used to produce geotechnologies have limitations related to file size, image quality, not having specific tools to work, limitations to develop a design focused on user's needs, among other aspects. They also mentioned feeling frustrated about the kind of product proposed in the first contact with the stakeholders and clients and then what is delivered just because of these limitations.
2. **Closed product scope**: Sometimes, the plan to construct the product has limitations according to the budget, deadline or other project aspects. Due to these issues, developing geotechnology focused on users' needs is not always possible. The discovery process can also influence this item because when the discovery is not focused on specific geoprocessing demands, it may not be considered when considering the project scope.

3. **Low number of specialists in geoprocessing**: For large projects, it is necessary to have a higher number of specialists to develop and evaluate the product. However, according to the specialists, it is hard to find qualified professionals. Even for participating in the requirements discovery process, a big team is required, so they can share the tasks to have better results.
4. **Requirements not focused on the geoprocessing**: When developing a product involving an information system and a geographic information system, in many cases, the requirements are written focusing on the system itself, not on geoprocessing's needs. It happens because the team that performs the discovery process is not a specialist in geoprocessing, and neither is the product owner that finishes the requirement document. In the participants' case, the demand arrives to the project managers, that ask for an innovation team (where there are professionals in UX/UI and management) to perform a discovery process. As mentioned before, the discovery process did not involve people from other areas, just the product owner. For a specific demand, the team invested in inviting one specialist from geoprocessing to build the product together in the discovery process. According to the participant, delivering a better product at the end of the process was crucial. Having the scenario and an example that the presence of a specialist contributes to the requirement development, it becomes easier to see that it is not possible to develop a product considering the user's needs for geoprocessing when it is not clearly specified.

Having the specialist's point of view, we can already start to visualize points to make adjustments and improvements. These improvements may contribute to the development process focused on geoprocessing, such as negotiating the scope, including adequate technological support for geographic information, better infrastructure, and space to develop and evaluate the product produced.

To improve the production of geoprocessing products, it is necessary to include in the requirements construction the aspects related to geographic information, not focusing only on the general function of the product. To bring this approach to practice, the product discovery process needs at least one specialist in the geoprocessing area to understand the goal of the product and what the needs are and discuss the ideas, creating and adjusting the product scope at the right time. From the participants' point of view, it is crucial to approach aspects in the requirements elicitation process, such as: types of visualization matters the most for stakeholders, what functionalities the map must have, what layers can be used, how the permission of these layers is going to be managed, the profiles that must have access to the map, beyond other technical terms related to geoprocessing.

Participant P1 provided a statement related to the relationship between people who are involved in the discovery process and the final users: "In many cases, we watch the product being developed by people who do not understand geoprocessing and who will not use the system. We don't have the specialist view, neither the final user's view". The most important thing when building a new product is to bring the final user, the person who is going to consume the data, to tell what are their needs and questions to be solved. In many cases, companies send a team that is not directly involved in the use of the application that is being developed.

When having the proper scope defined, the specialists can look at the products

they have already worked with and visualize good examples that can be applied to the following product. With this process, they can have the time to think about the appropriate design form and have someone prototype and suggest a design that follows usability patterns. The companies should also evaluate the number of geoprocessing specialists in their team, so the work quality can be improved, and the tasks can be well-distributed.

The tools used to produce geoprocessing applications also need to be improved, not only to provide better performance for specialists. They also need to allow designers and specialists in geoprocessing to work together to develop the product with a better usability pattern. Besides, tools need to support issues like file size and image quality.

4. Conclusion and Future Work

This paper presents preliminary results of interviews involving specialists in geoprocessing or data science and aims to understand what are the main difficulties of developing applications focused on user's needs. The literature presents examples of usability tests involving users, bringing the results that issues found by most of the participants were related to user interface and design. Because of that, it is essential to look at the other side, looking for the issues the specialists found in developing this kind of technology.

According to the insights from the interview, it was possible to understand that there are technological limitations and project scope as the main issues to disturb the development of a product with geographic information that presents a good design. Because of that, this study brings up the importance of improving the processes such as product discovery, also focusing on the geospatial team's needs to develop a product more correctly and efficiently. Besides that, it is also necessary that geoprocessing tools be adequate to support design modifications according to the recommendations of the usability team.

For future work, this research will compare the results of this study with the perception of users who consume geoprocessing information. To integrate the results from users and specialists, the authors will also study real geoprocessing governmental systems to evaluate their usability through heuristic and user evaluations. By the end of the research, the data will be analyzed, and heuristics for human-data interaction focused on geoprocessing will be developed by the authors.

References

Mortier, R., Haddadi, H., Henderson, T., McAuley, D., and Crowcroft, J. (2014). Human-data interaction: The human face of the data-driven society. *Available at SSRN 2508051*.

Nakić, J., Kosović, I. N., and Franić, A. (2022). User-centered design as a method for engaging users in the development of geovisualization: A use case of temperature visualization. *Applied Sciences*, 12(17):8754.

Victorelli, E. Z., Dos Reis, J. C., Hornung, H., and Prado, A. B. (2020). Understanding human-data interaction: Literature review and recommendations for design. *International Journal of Human-Computer Studies*, 134:13–32.

Werman, T. (2021). Human data interaction (hdi): The new information frontier. Available online at encurtador.com.br/puEK3, last accessed on 19 January 2022.