Improving scientific knowledge related to user centered design for geoinformation products

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ABSTRACT
This position paper describes some of the results of the researches we have developed in our research group (<http://dgp.cnpq.br/dgp/espelhogrupo/7239248197975667>) that are related to the posted challenge "Designing across Human Abilities and Map Use Contexts". In order to collaborate in this workshop we would like to present some of our research projects by their proposals and results.

Keywords
User-centered design; geoinformation product; user requirements

INTRODUCTION
Our contribution for this workshop is based on the following hypothesis: "When we assume that an understanding is systematic we also assume that the knowledge we seek can be related to a system. The system is a geoinformation product, and the approach for designing the product is systematic. Therefore, a systematic understanding can be related to a systematic approach to design a geoinformation product, and it provides the knowledge background that is necessary in every design decision". The geoinformation product design is a process that begins with knowing the map users and their requirements when we are adopting the user centered design (UCD) approach. That means every design decision has to be based on the users' needs and requirements. Furthermore, we can assume that the requirements definition as well as the use context is the first step of designing a geoinformation product. A geoinformation product can be a simple map, a set of maps, an interactive map, a web GIS, a geographic information system, and so forth [1].

In this context, we understand that the user needs and requirements are not translated into a set of geoinformation to be depicted on maps; instead, they are the *users' professional responsibilities*. Our understanding of users` needs is not "what the user needs from a map", instead we start a geoinformation product design establishing "for what the user needs a geographic knowledge and what is his/her knowledge background that is going to support his/her spatial decision-making". Then, the first step of a geoinformation product design is to elicit and document the users' requirements, including the definition of its use context [1]. Consequently, we are able to define the spatial analyses that the users have to develop as well as the characteristics that must be stored in the geoinformation product. Based on the geoinformation characteristics the designer defines the graphic solution for every possible thematic representation as well as the possible interaction tools. Cartographic design decisions and human abilities are related to the knowledge background needed at this design process step.

The three interactions of the research challenge proposed for this workshop can happen in every step of the geoinformation product design. In order to build a systematic understanding of them, we need to define every step of the design process as well as of the knowledge background that is necessary to make better decisions for the product design.

Over years of practical experience, we could figure out some difficulties on decision-making for cartographic product design. These difficulties might be associated with the process of making decisions through the design process. In order to improve our capabilities of making efficient decisions, we have tried to understand the source of those difficulties. In this paper, we present some of those issues that can bring difficulties to the design decision process. Some of these issues we understand as research problems and we have developed them into research projects.

SOME RESEARCH WORKS, THEIR PROPOSITIONS AND RESULTS
In this section, we present some of our research projects by their proposals and results. It is important to emphasize that all research projects we address here — two doctoral dissertations and four master theses — we develop under UCD approach. We relate each research problem and results to one of those intersections that are part of the research challenge proposed on the guidelines of this workshop (Figure 1).

Human Abilities and Cartographic Design Decisions Intersection
There are two research works [2, 3] we place within the intersection: "human abilities" and "cartographic design decision" (Figure 1, number 1). For both investigations, we relate the research problems to human perception and

cognition, and their results discussion aimed to provide improvements in cartographic design solutions.

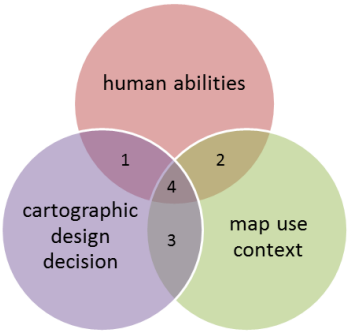

Figure 1. The illustration of the workshop question.

Santil [2] proposed the follow research problem in his PhD dissertation: "when the point and line symbols are designed from visual variables that stimulate the perceptual property called *selectivity* [4], what is the visual perception result?" Santil [2] has applied a set of experiments in order to verify if the Gestalt laws - proximity, similarity, and *prägnanz* – might help us to understand how we see those groups of symbols. From his experiments, we may conclude that *proximity* is a key element in seeing *groups of symbols*, but *similarity* is the factor that imposes the *unity of symbols*.

Andrade [3] has investigated how the perception of cartographic representations generated with pictorial symbols can stimulate the acquisition of spatial knowledge by users of tourist maps, when they perform map-reading tasks. In this investigation the results were discussed in accordance with the Gestalt laws — figure-ground relationship, *prägnanz*, proximity & similarity, and visual unification — in order to figure out how much the Gestalt laws influence the map reading process. Furthermore, those results can help the geoinformation designer to make better decisions about visual characteristics of the maps.

Human Abilities and Map Use Context Intersection

One of the master thesis investigation was developed from a research problem [5] related to Spatial Cognition issues and VGI. We can place this investigation within the intersection between "human abilities" and "map use context", intersection number 2 (Figure 1).

The research problem he has addressed is how the mental processes of knowledge organization affect the reliability of VGI semantic content. By testing 30 subjects, he has found that the reasoning of individuals depends on their cognitive skills of knowledge organization. The results pointed out that the participants understand geoinformation on a VGI system in accordance with what Rosch [6] called *basic level categories*. Moreover, the results also showed us that the participants organize their geographic knowledge by means of partonomic and taxonomic processes [7]. We concluded that mental processes of knowledge organization have triggered the reliability judgment of individuals.

Cartographic Design Decisions and Map Use Context Intersection

There is a research work under development [8] that we understand in the intersection: "cartographic design decisions" and "map use context" intersection (Figure 1, number 3).The research problem is defined as: how to design improvements in automating geoinformation processes based on urban planners requirements for a geoinformation system? The hypothesis lies upon two primary conditions, which are: (1) the users' requirements must be elicited in accordance with the techniques and methods of the requirements engineering and UCD; (2) the geodata queries and processing must be accomplished by an expert system that replaces some of the user spatial analyses tasks.

Human Abilities, Cartographic Design Decisions, and Map Use Context Intersection

There are two research works at master level [9, 10] we relate to the intersection of the three issues illustrated in the Figure 1 (number 4).

In the first work, Prado [9] defined his research problem as how 2D and 3D geovisualizations can stimulate the spatial knowledge acquisition by soil scientists when they have to understand the landscape properties in order to define the soil samples locations. The hypothesis was that the 3D cartographic representations are more effective because they release our mind from creating mental images of the relief from 2D representation by contour lines. Consequently, the soil scientists need less cognitive effort to understand the landscape from cartographic representations, and they can focus their attentive cognition in the relationship between the landscape variables and the landscape patterns that influences the soil formations.

The second master thesis is being developed by Yamada [10]. Her research problem is proposed as "how is the mental schemata of urban planners when they define and represent *urban public spaces*?" We seek the answer of this research problem by discussing the results of the following steps: (1) to identify the components of the propositional schemata of urban planners; (2) to identify how their image schemata is used when they delineate *public spaces*; (3) to understand the relations between the urban planners propositional and image schemata; (4) to verify what are the knowledge schemata components that are usually depicted in maps, and what of those are not.

CONCLUSION

This paper describes some of the projects our research group have been developing over the last 10 years. For each of those projects, our starting point in defining the research problem is the relationship between the technological solution and the theoretical knowledge on Cartography and

GIScience. One of our premises for every research project we develop is that the success of a geoinformation product is dependent on the abilities of the cartographer, or geoinformation expert, to take into account the needs of the users in each product design decision.

The systematic structure of cartographic product design and production makes clear to us, cartographers, some lack of scientific and technological knowledge. A systematic understanding of human abilities, design decisions and map use context can be built from two point of views that are related to each other: (1) the design of a geoinformation product can be developed in accordance with the UCD approach, and (2) the scientific approach can be related to the knowledge intersections proposed in the big question of this workshop.

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