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Modalities of Interaction with Information Graphics Through the Web

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ABSTRACT

In the web world, we have an increasing development of interactive information graphics. These are present in several fields, like journalism, science, economics, and statistics. Following the spread of the open data and the definition of new powerful web languages, the interactive information graphics are getting an important role in the scenario of web communication.

These communication artifacts allow visualizing and interacting graphically with data sets according to different levels of complexity. Their digital nature enables them to reconfigure based on the actions of the user who interacts with them.

Starting from the spatial and temporal systems orientation, this article examines, through a theoretical approach, the modalities of interaction with the interactive information graphics.

There are two main categories: the direct interactions, used to graphically manipulate the view, and the procedural interactions that take place through modules and panels, which are characterized by a linear process where each step is designed to support clear and focused operations.

Until a few years ago, web developers were the unique people who developed them, but today, thanks to the emergence of numerous web tools, we can create static or interactive information graphics without the knowledge of programming languages. So, web users, in addition to being user, are now becoming producer. This new aspect raises questions concerning the simplification of the interface for data entry and for management of the graphic.

INTRODUCTION

Currently, a huge daily amount of data is generated from computers, smartphones, sensors, and other network-connected devices. This increases our focus on the ability to extract useful information from the data. Collection, analysis, and data visualization play a strategic role in several fields such as finance, energy, retail, and transportation. Data visualization and sharing through the web has become a powerful tool for understanding the world, and has the potential to influence thinking and modify lifestyles. The gradual spread of Open Data[1] is also helping to provide materials, which can require a large amount of information graphics. Interactive information graphics design has become a problematic point of design culture. Interactivity gives an added value to information; it increases the clarity and dynamism at multiple levels. Its utility is in reducing the cognitive efforts of the user, by structuring the information according to its own logic and increasing the quality and level of detail.

This paper will analyze how we interact with graphical representations of data produced and visualized through

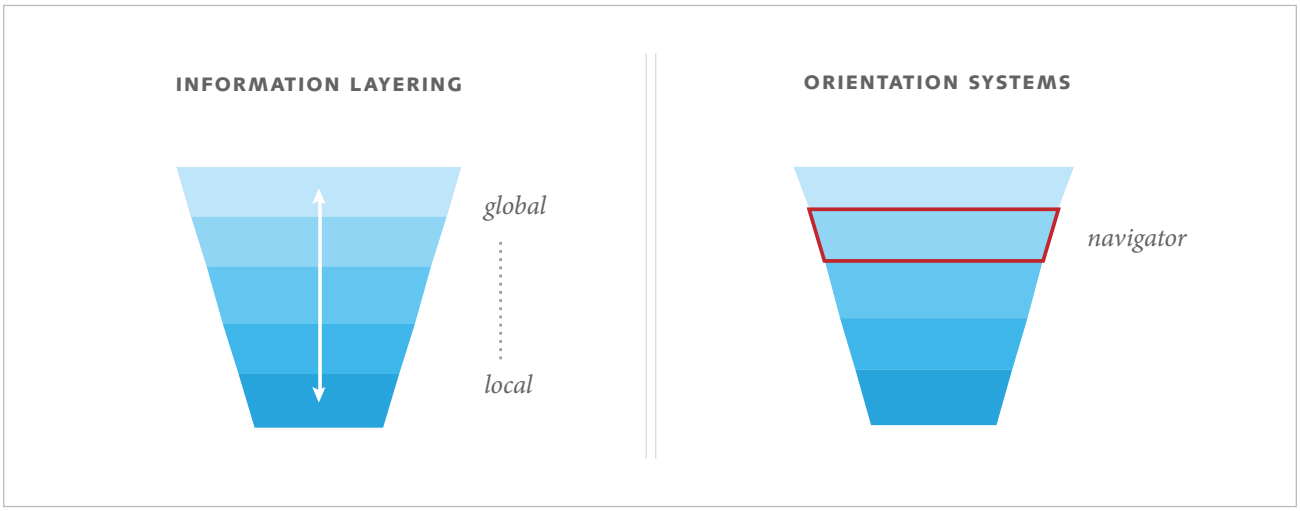

FIGURE 1: *Visual representation of the spatial orientation system.*

the web. In a context that points more and more to mobile devices, there are interesting aspects that arise mainly related to access of information, orientation, and simplification of the graphical user interface.

ORIENTATION SYSTEMS

The main challenge for information designers is developing solutions that can display large amounts of data in a limited space and provide information according to user requests. The graphical user interface must allow the expansion of the information when the user wants to go into detail, and must contract it if the user needs an overall view.

Orientation tools are used in interactive representations of data with information layering. In a macro-level, the layering is of general-detail type. The layering, in a micro-level, is distinguished instead into two types: global-local type; and before-after type. In the micro-level of layering we have spatial and temporal views.

With information layering, orientation tools indicate the point where the user is located within interactive representations of data. Orientation tools often obtain the status of navigation tools. They make the relationship between data displayed and all data analyzed explicit.

SPACE ORIENTATION

The navigator is used in visual representations of data through orthographic, isometric, or perspective views. It is a graphical element with interactive functions[2]. The navigator reproduces the global area of information graphics and highlights the part observed by the user. Its main purpose is keeping the visual relationship with the overall view when the viewer enters it.

The navigator can also have a narrative value in cases where it reports the widened environment in which the information graphic fits. As a navigation aid, it is commonly found near the instruments for view manipulation.

The navigator is a miniature, so it involves several issues related to the data reduction. It operates in two stages: One stage is the level of detail displayed by visual representation. The second is the level of iconicity, or level of similarity, of the image[3].

TEMPORAL ORIENTATION

In interactive information graphics the display of temporal variables is managed through an interactive timeline. The timeline is an interactive bar that shows the period of time during which a phenomenon occurred. Its purpose, as with all information graphics that display diagrams, networks, and cartographies[4], is to show the

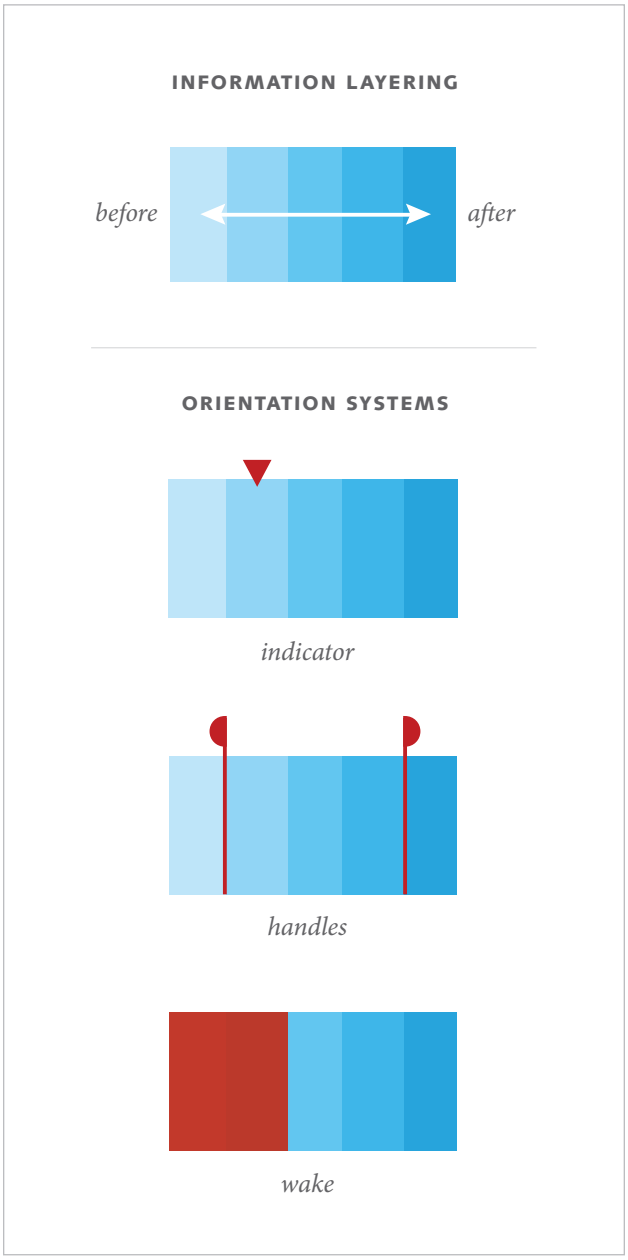

FIGURE 2: *Visual representation of the temporal orientation system.*

relationship between the displayed period and the whole extension of the phenomenon.

Three types of elements indicate the time or period to which the displayed values belong. They are: the indicator, the handles, and the wake.

The indicator identifies the events occurring in a specific moment in time. It flows along the time axis through drag and drop, or through arrows with interactive functions. These two features are joined to a third, the auto play. In this case the information graphic shows, in a fluid way, the trend of the variables in the analyzed time period. The timeline with the indicator may promote, in addition to the vision of the trend variables, the vision of important moments. This takes place through additional indicators in correspondence between significant events. If the user selects these indicators, the main indicator drags the view on the currently selected time.

The handles indicate that the observed values belong to a period more or less wide. It is possible to exercise more actions on the timeline. It is also possible to increase or restrict the amount of time by sliding it linearly along the whole time axis.

Finally, the wake shows a moment in time but suggests what has happened before. We can see the origins of this tool in media players. It is displayed through a bar that fills from left to right.

OSTENSIVE & ELABORATIVE INFORMATION GRAPHICS

The interactions that take place with interactive information graphics via the web can occur either a direct way or in a procedural way. The first allows the user to change the view graphically. This occurs through graphic elements able to perform interactive functions. The second consists of clear and targeted operations requested by the user. These operations take place through panels and forms to be filled by step-by-step approach.

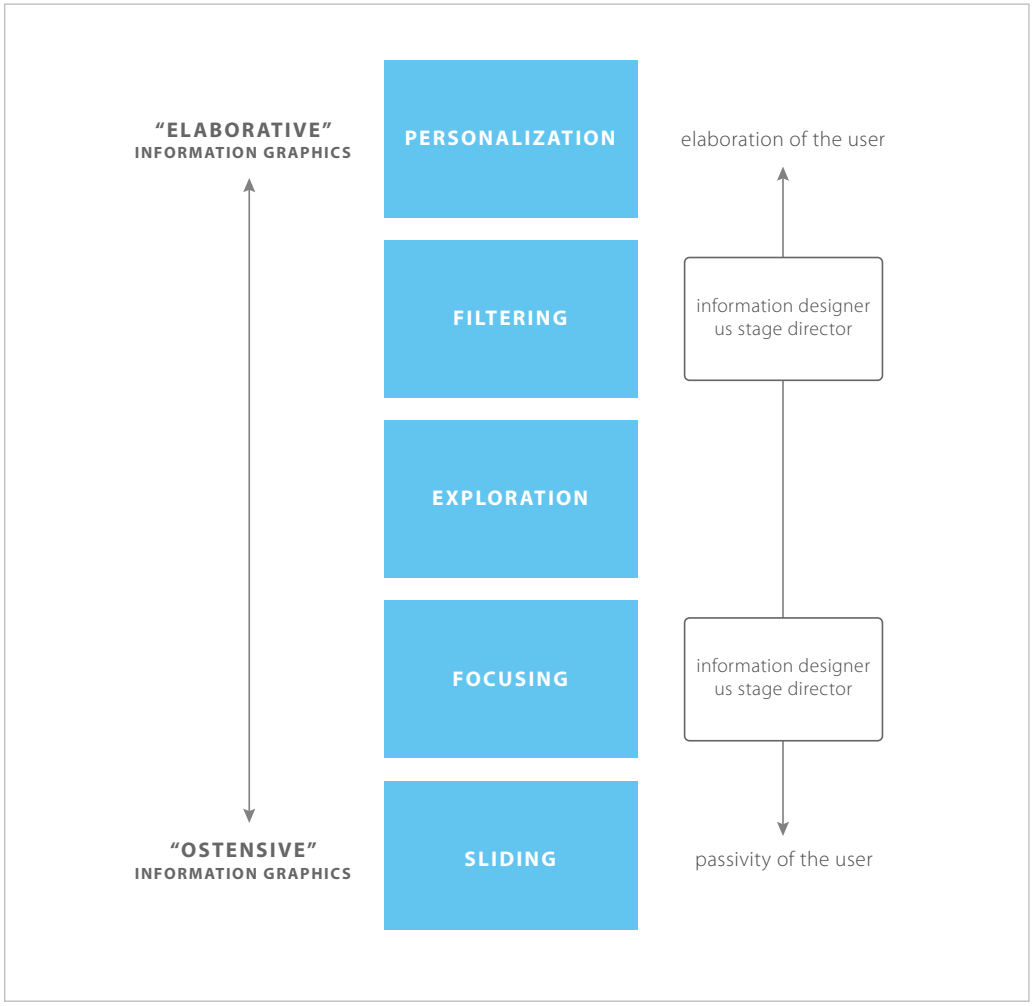

FIGURE 3:
The schematic displays the different modalities of interaction with the interactive information graphics through the web.

The modalities of interaction with interactive information graphics can be classified according to the level of cognitive involvement of the user. The most minimal types of interactivity with data visualization occur in the types we call "ostensive." Ostensive information graphics are aimed mainly at a general observation, without an intensive cognitive involvement.

Conversely, in "elaborative" information graphics the user instead has a high power of manipulation. Elaborative information graphics allow the user to filter the information and to find new meaningful relationships between the phenomenon components.

At these two opposite conceptions of data visualization lie two corresponding approaches to the role of information designer. In one model, the information designer does a job similar to that of the illustrator wherein he optimizes the two-dimensional space because it can show the data in a clear and precise way.

In the other, there is the idea of information designer as a "stage director."[5] In this model, the information designer plays a role in both spatial and temporal dimension. The design focus moves away from the representation of the elements to the study of the actions that users can perform.

The modalities of interaction with the interactive information graphics through the web are: sliding, focusing, exploration, filtering, and personalization. These have an additive character, as two or more modalities can occur within the same graphic. The use of more modalities of interactions has three fundamental goals: reducing the complexity of the visualization, increasing the user's manipulative actions, and encouraging the observation of all the variables that data visualization displays.

SLIDING

The term *sliding* indicates interactions used in order to facilitate the display of information graphics according to a consequential order. The user's actions are limited to the linear view of the evolution of the variables.

This kind of interaction does not provide the ability to display all data, nor does it favor the comparison between the variables. However, the sliding facilitates the comprehension of the consequentiality of examined events, and it allows understanding the relationships between single views and the whole phenomenon.

FOCUSING

Focusing simply means highlighting one or more data of the graphical display. The focusing is carried out by direct selection. This has a dual function; distinguishing the trend of a variable, and viewing its details.

Placing the focus on a variable means upsetting the balance between it and the others. The selected item acquires greater importance, so it lingers in the foreground. The other items lose their importance and fade into the background.

The weight of the elements can be modified, however. This modification takes place in two ways. It may occur through the use of graphical expedients, which modify the appearance of the selected element. For example a selected element may change its color, its opacity, or its stroke. Or it may be modified through change of scale by altering the proportions between values for communicative purpose.

EXPLORATION

Exploration takes place in two and three-dimensional information environments. In the case of two-dimensional environments the point of view is always perpendicular. The user is free to move the view along three axes: the vertical axis, the horizontal axis, and the axis of the depth. In the case of three-dimensional environments, a fourth axis is added. This axis allows rotating the point of view in a non-perpendicular way.

The information graphics that use the exploration are able to switch between simplified representative modes and detailed representative mode. The simplified representative modes remove the useless information but are still able to show the complexity of the phenomenon. The detailed representative mode shows a high level of detail and requires a strong cognitive effort from the user.

The modalities of exploration also use data filtering techniques. These techniques allow limitations on the number of elements displayed.

FILTERING

Filtering is used to filter the information of the graphical display. Through this modality of interaction the user can visualize only data of interest.

The filtering can reach even higher levels of complexity according to the number of variables. Currently issues about the filtering arouse much interest because it is a powerful tool to reduce complexity.

The filter is made up of a set of textual or graphic elements that represent the variables displayed by the information graphic. When the user selects one or more elements the relative variables will be displayed.

Filtering data systems contain two or more filters. These systems have either a hierarchical or a free structure. In the hierarchical structures the elements are nested

one inside the other according to a hierarchical correlation. These structures allow passing from the section of a macro-area of interest to a single item.

In the free structures each filter has no correlation with the other. This means that each user's choice does not exclude information, but adds more.

PERSONALIZATION

At the top level of the range of the user's cognitive involvement implemented by interactive information graphics are techniques that allow data input by the user. *Personalization* techniques have a powerful effect of cognitive involvement because they allow users to understand the data displayed by comparing them with their personal data.

Interactive information graphics are dynamically generated according to the data entered by the user. The customization features are carried out, through a step-by-step approach, by fillable text fields and interactive panels able to receive inputs from the user. Their level of complexity varies with the type of information required.

CREATING ONLINE INTERACTIVE INFORMATION GRAPHICS

There are many online tools[6] that allow users to create interactive information graphics without also having to know the technologies for its development. They use a What-You-See-Is-What-You-Get method. A graphical user interface can manipulate the appearance of the interactive elements.

Tools allow creating diagrams, networks, and cartographic graphics. Furthermore, some tools allow the creation of complex interactive information graphics, like sinusoid derived by mathematical functions or combinations of different kinds of graphics. All the tools for creating interactive information graphics are made up of four main areas that correspond to the four main steps of the

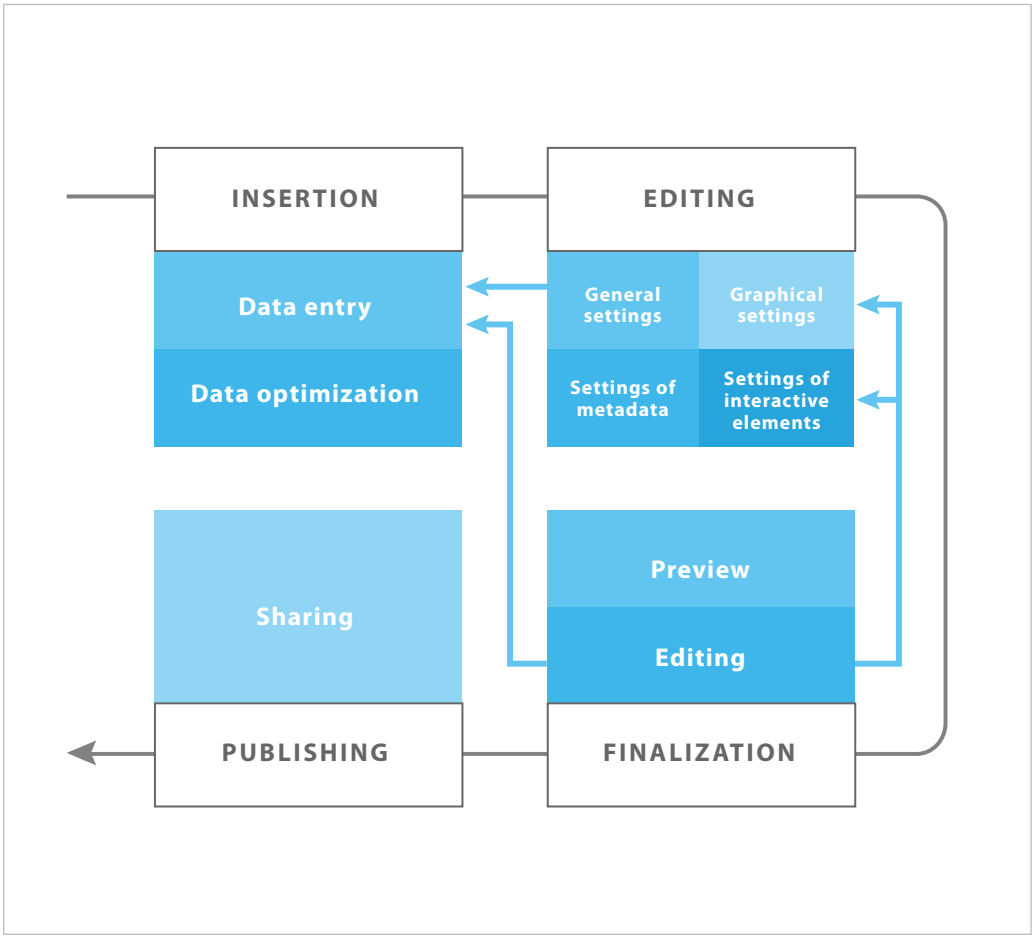

FIGURE 4:
The schematic displays the main sections of the web tools for creating interactive information graphics. It also displays the main relation between the parts.

develop process: data entry, graphical editing, preview of the interactive information graphic, and sharing.

Data entry takes place by entering data directly into the fields provided by interface or by uploading a table produced with a spreadsheet. In data entry there may also be tools for data optimization such as converters and filters. The actions of these instruments may modify the perception of the data, but they are always reversible.

Graphical editing is the core of any tool. Usually this area is divided in four sections: general settings, graphical settings, settings of the metadata (e.g., title, subtitle, author, and data source), and settings of the interactive elements. Users can edit the graphical visualization through single or multiple-choice menus, sliders, and text fields.

The instruments available in the data entry area and graphical editing area are often numerous, so it is necessary to reduce the complexity through appropriate systems. The main simplification method is the use of a menu. Relatedly, there must be good categorization and the use of a suitable taxonomy.

The preview of the interactive information graphic provides the user the opportunity to edit the data and the graphical features. These modalities of interaction start through direct selection of an editable element. Following the related menu will provide editing instruments. In this view multiple kinds of interactive elements combine to provide the user a high possibility of change, even with simple modalities.

At the "final mile", the area for sharing does not allow any editing function. This area displays the source code that generated the information graphic, the link for sharing, and the buttons for sharing through social networks.

BIOGRAPHY

Giovanni Profeta holds a Master Degree in Visual and Multimedia Communication at University Iuav of Venice. He collaborated on projects about web design and digital publishing. Currently he is carrying out projects of applied research at the Interaction Design Lab SUPSI, focused on data visualization and interaction design. He teaches web design and languages of interaction at the Bachelor in Visual Communication.

NOTES

1 The Open Data are data collected or produced by government institutions and publicly released.

2 Botta, Massimo. *Design dell'informazione. Tassonomie per la progettazione di sistemi grafi ci auto-nomatici.* Trento: Artimedia, 2006.

3 Anceschi, Giovanni. *L'oggetto delle raffigurazione.* Milan: ETAS Libri, 1992.

4 Bertin, Jacques. *Graphique et le traitement graphique de l'information*. Paris: Flammarion, 1977.

5 Anceschi, Giovanni. "L'aeroporto: una scena multimodale". *EC*. Dec 31, 2005, http://www.ec-aiss.it/index_d.php?recordID=90.

6 Following a short list of tools: Am Chart Visual Editor, Chartle, Create Graph, Diy Chart, Chart Go, Chart Tool, Pie Colour, CSS Chart Generator.

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