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Improving Visual Communication of Science Through the Incorporation of Graphic Design Theories and Practices Into Science Communication

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Abstract

Visual culture is becoming an increasingly prominent part of our cultural identity in the 21st century. Consequently, images have become an important tool with which to communicate science. We identify two impediments to science communicators using visual elements effectively: (1) visual material is typically treated as an add-on instead of being an integrated part of the whole and (2) there is a lack of identifying target audiences and refining visual elements for them specifically. We argue that science communicators can become more effective visual communicators if they incorporate elements of theory and practice from the discipline of design.

Keywords

graphic design, visual communication, science communication, visual literacy, interdisciplinary, recontextualization

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> We regard the visual as an intrinsic and important social and cultural expression of our time.
>
> —Julier (2006, p. 66)

In our transient world, high-speed communication has become the feature that defines the way we connect with each other. As science communicators in our society of "the instant" (Lipovetsky & Serroy, 2010)—where traveling to a distant country takes only a few hours, where finding shelter, clothes or food takes just minutes, and where even to develop "meaningful" relationships can take but seconds—we need to reconsider how we connect with audiences. Our 21st-century society, which is becoming increasingly ruled by multinational corporations, cyberspace, and consumerism, relies on fast access to information. For this reason, science communicators need to find ways to connect at the same fast pace and to spread our messages over wide areas that go beyond the limitations of traditional media. To this end, science communicators have already been using a variety of channels, such as blogs, websites, posters, magazines, video games, billboards, television, apps, and movies. Though each of these media has its own particular interface—either digital or printed—they all have something in common that makes them potentially powerful tools with which to communicate: they share a language—*the visual language*. Ironically, however, much of the theory on which the practice of science communication is based does not embrace such visual speak.

We live in an environment shaped by images, which surround us all the time, telling us how to think, feel, and talk (*First Things First Manifesto 2000*; Adbusters, 1999). In such an atmosphere soaked with visual elements, communication in society has become much more visually focused. Visual culture has started to supplant printed or written culture in much the same way that the latter previously displaced oral culture (Kirrane, 1992). We are now likely to encounter complex texts that contain elaborate visual images, complex design elements, and unique formats (Goldstone, 2004; Jewitt & Kress, 2003; Serafini, 2011). In order to understand such multimodal texts and construct meaning from them, individuals must be able to process the images and elements of design simultaneously with the written text (Gee, 2007; Serafini, 2011).

When communicating science, graphic representations have become important means for improving explanations and understanding of scientific matters (Frankel & DePace, 2012). While it can be argued that there is a long history of visual communications in science, until recently that has largely been confined to graphs and figures for scientific publications and less so for connecting to nonspecialist audiences. Images have long served scientists as tools to explain principles and new theories. These can take the form of either abstract, purely symbolic illustrations (e.g., Bohr's atomic model) or forms we readily accept as highly literal (e.g., NASA's photographs of the Earth).

Nonetheless, not all visualizations are effective ways to communicate. In designing visual communications for science, a number of issues can arise. One of the most frequent is that communicators of science tend to emphasize the written discourse, with any visual material being added only as an extra ingredient. As a result, visual elements used to communicate science are often not well integrated with the prose they accompany. This devalues the role that visual illustrations can potentially have if the visual language used by the science communicators is not the most appropriate one to connect with a nonspecialist audience (Trumbo, 1999): it is not always true that *a picture is worth a thousand words*. In order to construct better visual communications for science, professional communicators need to go beyond using images merely to "illustrate" written material.

The problem with doing this, however, is that—in contrast to experts in visual communication, such as graphic designers—science communicators are not generally trained in visual literacy. As Williams and Newton (2007) so succinctly put it: "To become an educated person in the 21st century requires not only the verbal and mathematical proficiency, but also the ability to interpret, critique, create and use visual communication on sophisticated levels" (p. xv).

Knowing the Audience

We need to recognize that all texts, including visual elements, are consciously constructed and have particular social, cultural, political, and economic purposes. When considering the possible meaning of a text, there is a need to determine how it is constructed by people and the world around them (Department of Education WA, 2013). When designing visual communications, science communicators need to understand to whom they are communicating: they need to know their audience (Jay, 2002).

Until recently, in the field of science communication, the deficit model was the main means favored for communicating science to nonspecialists. The assumption was that if members of the general public were provided with knowledge about scientific matters, their interest and understanding of science would increase (Hart & Nisbet, 2012). Scientific discourse, however, is not a unique entity that can be used to communicate with everybody in the same way. It is instead, as Myers (2003) puts it, "a terrain of competing discourses and practices" (p. 267).

If popularizing science is treated in the traditional way of being a linear one-way communication between two defined communities—the scientific community and the general public—it becomes a mere translation or a simplified description of scientific knowledge. For constructing visual communications of science, we need to be conscious that each social group has its own *persuasive devices*, based on their values, life experiences, and culture (Luzón, 2013). In a similar vein, the scientific community is made up of different disciplinary communities, which vary according to their theories, methodologies, and codes. Accordingly, the popularization of science should not be regarded as a simplification or a "translation" but as a recontextualization of the scientific discourse into another domain. Hence, popularizing science is not just about reporting scientific facts to a less specialized audience but also about representing phenomena in different ways to achieve different purposes (Luzón, 2013).

As the act of communicating is a social process, every time a new piece of science communication is developed, the scientific discourse needs to be recontextualized. Recontextualizing communication to target specific audiences is not a new phenomenon. In the discipline of design, particularly in regard to designing graphic communications, specific theories have been developed to achieve better visual communication solutions that can engage and be useful for a particular audience in a particular context.

User-Centered Design for Science Communication

We advocate the use of *user-centered design* as a theoretical approach that can aid science communicators in the recontextualization process: it works as a guide to define a target audience and to produce more efficient communications. It focuses on the users from a cognitive, affective, and behavioral point of view, as well as the social, organizational, and cultural context in which it will be working (Bowler et al., 2011). In contrast to the common practice in science communication—where the user is excluded until the end—in user-centered design processes, the user's point of view assumes a greater importance and it does so from the beginning of the process. The focus is on users throughout the planning, design, and development phases: in other words, the user is always present in the design process. This method is characterized by (1) an active involvement of users, (2) interaction with the design solutions, and (3) multidisciplinary teams for tackling a specific task (Pelta, 2007).

The point is not only to create something that works but also to design something that works for an intended user (Bowler et al., 2011). Taking such an approach, science communicators need to begin by asking, "Who are we talking to?" It will often be the case that the answer to this question is not easy, as there can be different users involved. While in user-centered design the focus is on the primary user, the interest of subgroups should also be taken into account. After deciding on the target user, it is then necessary to discover what the user needs, wants, and is capable of using (Bowler et al., 2011). The ideal end results of user-centered design processes are design objects that the user can use with a minimum of stress at a maximum level of efficiency (Pelta, 2007).

All this requires a shift in the attitudes of science communicators when designing visual communications if we are to increase our possibilities of engaging with our target audiences. In the field of marketing, there is a similar theory: the consumer-oriented principle. Its aim is to orientate a company or organization's views with marketing activities undertaken from the consumer's point of view: "Only by seeing the world through its customer's eyes can a company build lasting and profitable customer relationships" (Kotler, Burton, Deans, Brown, & Armstrong, 2013, p. 612). If we appropriate this aim for science communication, we could rephrase it as follows: "Only by seeing the world through its audience's eyes can science communicators build durable and beneficial audience relationships."

For science communicators to construct efficient visual communications that can produce a change in the knowledge, attitudes, and the behavior of the public: "It has to be constructed on a knowledge of visual perception, human cognition and behaviour, and with consideration for the personal preferences, cognitive abilities and value systems of the audience" (Frascara, Meurer, Toorn, & Winkler, 1997, p. 4). Visual elements that work in such a manner for science communication can be constructed by employing theoretical and empirical frameworks from the discipline of design studies. We see such an interdisciplinary approach to science communication as being the key to better visual communication in a world where audiences increasingly demand information in a form they can take in and digest quickly.

Teaching Visual Literacy for Science Communicators

We suggest that university-based programs in science communication need to be teaching visual literacy so that they produce graduates with the following attributes:

- An ability to determine the nature and extent of the visual materials needed for a communication task
- The wherewithal to find, develop or access visual materials effectively and efficiently

- An ability to interpret and analyze the meanings of visual elements in communication
- An ability to evaluate and critique the strength of visual elements used in communication
- Knowledge about how to employ visual media effectively
- An ability to design and create their own meaningful visual media
- An understanding of the ethical, legal, social, and economic issues surrounding the creation and use of visual media

The inclusion of visual literacy in the teaching of science communication can be argued for on the basis that visuals, unlike words, have the capacity to communicate complex and complete concepts instantaneously to a larger number of recipients (Hattwig, Burgess, Bussert, & Medaille, 2011; Trumbo, 1999). We follow the classification of Trumbo in recommending a conceptual framework for teaching visual literacy to science communicators that includes three elements: visual thinking, visual learning, and visual communication.

Visual Thinking is the way we classify our mental images by using forms, lines, colors, and composition to make them meaningful. It acts together with critical thinking to show how learners perceive, interact, and respond to a visual environment. It helps us to recognize what we "read" in images and how others "read" them.

Visual Learning consists of two components: the process of gaining awareness of the meaning of visual elements and the process of learning how to use visual representations effectively. Science communicators must become mediators who can "make careful choices about the form of the visual representation, in an effort to share the science in an accurate, articulate way" (Trumbo, 1999, p. 417). By using such tools, we have the potential to not only affect the cognitive processes that are related to written language but also create an emotional bond before a concept is even cognitively understood: the individual becomes engaged on a variety of levels. Such engagement is a key component of successful science communication (Davis, 2010).

Visual Communication is a social process whereby people use visual symbols to intentionally send a message for others to interpret and respond to (Williams & Newton, 2007). They are often confused with displays, but they differ in that a person displaying does not particularly care who sees a visual display or how (or even whether) they respond. Whereas visual communication is a process of sending and receiving messages using visual images and representations to structure the message so that it may be understood and elicit a reaction.

Using Tools From Graphic Design to Enhance Visual Communication

Visual representation of science information can include a diversity of styles and techniques such as highly literal imagery, abstract images, diagrams, symbolic notations, and infographics (data visualizations) among others. Infographics have become one of the preferred tools for communicating scientific findings to fellow scientists and to nonspecialists (Frankel & DePace, 2012). Frankel and DePace suggest some basic tools from the area of graphic design that may be used to enhance data visualization for science communication:

- *Composition*: used to organize the elements and establish their relationship to each other
- *Abstraction*: used to define and represent the essential qualities and/or meaning of the data
- *Color*: applied to draw attention, to label, to show relationships, or to indicate a visual scale of measurement
- *Layers*: used to overlap multiple variables to create a direct relationship in physical space
- *Refine*: the process of editing and simplifying

Davis (2010) similarly called for elements of design to be used to enhance science communication and make it more engaging. It is important to define "How will the graphics be used?" Answering this question requires science communicators to identify what, to whom, and for what purpose do they wish to communicate (Frankel & DePace, 2012).

While the work of Frankel and DePace (2012) is helpful for focusing the attention of science communicators on one way in which visual language can assist communication, we need to keep in mind that such forms of visual communication will not, however, connect well with some audiences. As Sexe (2001, p. 70) stated: "You cannot communicate to all, as we have different "symbolic interests," which sometimes are complementary, others contradictory [translated from the Spanish original]."

Conclusion

We have identified two major obstacles in the construction of visual communications for science. The first stems from the traditional approach of science communicators, whereby visual material is treated as an optional add-on ingredient instead of being an integrated part of the whole. The second is the lack of identification of the target audiences and the refinement of the visual elements for them.

In the 21st century, images have become an increasingly important tool for communication. Visual culture is becoming more prominent as part of our cultural identity. Visual elements, therefore, have assumed a key role in communication and this pertains to science as much as anything else. We contend that in order for science communicators to achieve good visual communication, they must first become visually literate. Design theory and practice, particularly as related to design of visual communications, can potentially help science communicators develop better visual materials with which to communicate.

The challenge remaining is to find ways to support an interdisciplinary approach whereby the theories of science communication can be married to those of design. The outcome should be better visual communication of science—and for some of us that cannot come quick enough.

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