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SCIENTIFIC ILLUSTRATION: A BRIEF REVIEW AND THE EMERGENCE OF 3D ILLUSTRATION

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Abstract

Scientific illustration can be defined as a realistic representation of an object that the illustrator or the scientist observes, pointing out features that they want to show.
Over the years, illustration has fulfilled different objectives, becoming an indispensable tool in the science service, being extremely important to understanding the natural world and recognized as a significant factor in the emergence of modern science (MOSER, 2014). The scientific illustration helps to define the object in a simple way, being instantly "readable" or easy to interpret, even for a non-erudite and is a form of visual scientific communication (MOSER, 2014; CERVIÑO; CORREIA; ALCARÁZ, 2016). For these reasons, drawing is a tool appreciated by scientists.
The aim of this article is to show the different areas of application of scientific illustration and also the emergence of the digital illustration, particularly the 3D illustration.

Keywords: Scientific illustration. 3D illustration. Scientific communication.

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1 Scientific illustration's definition

Scientific illustration can be defined as a realistic representation of an object that the illustrator or the scientist observes, pointing out features that they want to show. Thus, illustration is an important way of science communication, working as a universal language that helps to understand complex individuals or processes (CERVIÑO; CORREIA; ALCARÁZ, 2016).

This type of illustration transmits the interpretation of the observer (the illustrator and/or the scientist), having an informative value (MOSER, 2014). In fact, the scientific illustrations have changed over the years: the highly realistic mode of representation was transformed into an interpretative and selective way of representation (HODGES, 1989; MOSER, 2014). Instead of representing the exact appearance of the specimen observed, illustrators began to highlight special features that are important to show (that are scientifically meaningful), illustrating an accurate ideal in place of a real specimen and creating a simplified, but the more attractive and didactic image (MOSER, 2014; CERVIÑO; CORREIA; ALCARÁZ, 2016; GARCÊS, 2021). This innovative and more abstract form of representation was defined as a new kind of "scientific realism" (MOSER, 2014).

Despite the contribution that the realistic mode of representation had to science, especially during the Renaissance (with highly detailed and technically precise illustration), the "scientific realism" brought a specific purpose: to compare systematically sets of objects (MOSER, 2014). Besides that, the "scientific realism" represents the principal characteristics of the specimen, omitting the information that's not essential to the classification of the organism (MOSER, 2014). To do this kind of illustration it is necessary to have "selective looking", in order to capture the main characteristics of the specimen (MOSER, 2014). Therefore, this type of illustration is considered "accurate" because it represents the key features of a specimen, communicating the essence of the object of observation (MOSER, 2014). This contributes to the application of the scientific illustration, not only to precisely represent the object of observation but also to represent ideas or reconstructions of new findings (CERVIÑO; CORREIA; ALCARÁZ, 2016).

Summing up, the principal concepts of a scientific illustration are: i) the reality inferred, ii) the observation (of that reality) and iii) the interpretation/understanding (of that observation) (CERVIÑO; CORREIA; ALCARÁZ, 2016).

It is important to highlight that, in a scientific illustration, the artist's personal creative perception is not enough, and a holistic interpretation is needed for an efficient analysis. The respect for the investigation, the observation and interpretation of the object of study and the accuracy are the essential points for a good scientific illustration (HODGES, 1989; CERVIÑO; CORREIA; ALCARÁZ, 2016; MARQUES, 2017).

2 Importance of illustration in science

Over the years, illustration has fulfilled different objectives (e.g., religious, scientific, technological, etc.), becoming an indispensable tool in the science service (CERVIÑO; CORREIA; ALCARÁZ, 2016). Historians of science have already demonstrated that the scientific illustration is extremely important to understanding the natural world, being recognized as a significant factor in the emergence of modern science (MOSER, 2014).

Recently, images have become treated as a part of "material culture", becoming even more significant to science (MOSER, 2014). These illustrations facilitate the definition and the classification of the specimen observed and also express the interpretation that scholars are formulating concerning the phenomena studied (MOSER, 2014).

The scientific illustration helps to define the object in a simple way, being instantly "readable" or easy to interpret, even for a non-erudite and is a form of visual scientific communication (MOSER, 2014; CERVIÑO; CORREIA; ALCARÁZ, 2016). Therefore, scientific illustration is vital for a fast progress of science (CERVIÑO; CORREIA; ALCARÁZ, 2016).

Scientists appreciate the use of drawings to illustrate their work because: i) it represents a simplified interpretation of the object of study; ii) they are more abstract (emphasizing the principal characteristics of the specimen) than a photography, but still more accurate than schematics; iii) they present spatial visualizations that could not be photographed or effortlessly schematized; iv) they integrate information from different fields; v) and finally they can be easily shared and understood by the public without a scientific background (GARCÊS, 2021).

Nowadays, with the development of the internet, the scientific illustration gains even more importance, for the reason the internet permits a faster dispersion of the scientific knowledge and more accessibility to everyone and, associated with scientific illustration, it permits the diffusion of this knowledge in a simple and attractive way (even the complex concepts) (GARCÊS, 2021).

3 Applications of scientific illustration

The scientific illustration can be utilised in diverse areas of science, such as medicine, botany, zoology, etc.

When the objective is to represent something that is not possible to photograph, such as plant life cycles, extinct species, subatomic particles or something in outer space the illustration is the only way of visual representation, providing highly valuable scientific information (CERVIÑO; CORREIA; ALCARÁZ, 2016). The **figure 1** is an example of a reconstruction of an extinct species, made from the skull.

Regarding the area of botany, the illustration can be used to do a detailed representation of individual plants, but, more impressive than that, it's also a way to represent an idealized portrayal of generic "forms," showing the roots, leaves, flowers, and fruit of a plant all in a single image (**Figure 2**) (MOSER, 2014).

Taxonomy is one of the most important areas of application of scientific illustration. In this area of study, illustrating is essential to represent the archetype (understood as the prototype) of each species, embodying all the fundamental characteristics of the specimen and aiming to represent the concept of that particular species, rather than the real representation of one single individual (directly observed from nature) (CERVIÑO; CORREIA; ALCARÁZ, 2016). Through illustration, perfect specimens can be constructed from a series of preserved specimens where none of them is completely intact (HOLZENTHAL, 2008). In addition, the illustration of a new species described for science may serve as a type material, in cases, for example, where the studied specimen has not been established or when an author relies on these illustrations for a later description of a new taxon (Art. 72, 74) (INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE, 1999); it is then essential for further analysis.

It is also imperative to introduce scientific illustrations in educational programs. For example, several studies show that the existence of illustrations in medical texts aids in the learning process (GARCÊS, 2021). Hence, science learning combined with pictorial support helps the visual thinkers to better understand the subject of study (SEVARKODIYON; PARIMALAFATHIMA, 2014).

4 Digital illustration: an innovative tool

Nowadays, with the fast development of technology, scientific illustrators have the opportunity to use a new tool: digital programs. These programs have diverse functionalities of illustration (including brushes and pens, gradients, filters, colour libraries, layers and layer effects, layer blending modes, text tools, opacity and transparency functions, file formats, etc.) and they are a good device not only to represent animals and plants, but principally to illustrate more abstract subjects as galaxies, macromolecules like atoms or even subatomic particles, extinct species, etc (CERVIÑO; CORREIA; ALCARÁZ, 2016; HOLZENTHAL, 2008). The principal advantage of the use of digital programs to illustrate is that "mistakes" can be easily undone without ruining the illustration. Moreover, illustrations can be saved in varied graphic file formats for printing, posting on a website, or using multimedia CD-ROMs, such as interactive keys (**SM Video 1**) (HOLZENTHAL, 2008).

Recently, started to emerge of the 3D digital illustration and animation. This kind of representation is a valuable device, having a great utility in teaching, for example, morphology (this representation allows to dissect the studied object, showing the different "layers" of the specimen) (HOLZENTHAL, 2008).

5 Conclusions

It is notable the importance and the diversity of areas here scientific illustration can be applied. Through illustration the scientist and/or the illustrator can emphasize a specific characteristic of the studied object. Moreover, it is essential when the objective is to represent something that is not possible to photograph, such as life cycles, extinct species, subatomic particles or something in outer space (CERVIÑO; CORREIA; ALCARÁZ, 2016).

The digital illustration is an asset since it allows moulding the image accordingly with the study development. Recently, started to emerge of the 3D digital illustration and animation. This is a very useful tool for education, since it allow to show the specimen in different perspectives (e.g. inside and outside of the specimen, zoom in and zoom out to show particularities of the specimen, etc.).

Thus, it is important to do further studies concerning the importance of 3D illustration for science divulgation and also apply this kind of representation in practical cases.



Figure 1. Example of a reconstruction made from the skull of a *Allosaurus* sp., using ZBrush – a sculpting program (ZBRUSHCENTRAL, 2022).



Figure 2. Botanical illustration, made with watercolour, of *Gunnera tinctoria* (Molina, 1767), showing the leaves, the flower and the fruit.

Supplementary Material

SM Video 1. Short animation, showing the morphology of Chelon labrosus (Risso, 1827). Programs used: ZBrush for the sculpture and movie; and DaVinci Resolve for video editing (DAVINCI RESOLVE 18, 2022; ZBRUSHCENTRAL, 2022). Available from: https://drive.google.com/file/d/1MYaNpKtW1SnqlQSwRdqELNElcNryNXbd/view?usp=sharing.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

The author declares that he has been solely responsible for every phase of this research.

DECLARATION OF INTEREST

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