SCIENTIFIC ILLUSTRATION AS A PEDAGOGICAL TOOL IN INTERDISCIPLINARY PROJECTS

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Keywords

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Abstract

We first encounter scientific illustration at a very early age, when we get our hands on our first popular science picture book, or when entering the education system. Most of us learn from scientific illustration, and some of us create it. Among the latter are students of illustration at the Academy of Fine Arts and Design in Ljubljana. Scientific illustration is part of our curriculum, and we also explore it further in specific workshops and summer schools. In this paper, we will present the methods used in this learning process. We will discuss how the visual arts and science are connected and how they can work together to help us understand, create, and design educational content and teaching aids. We will define scientific illustration and its place in the field of illustration. We will explore its forms and expressive techniques. We will touch upon established codes and conventions in depicting images. Our focus will be on the use of illustration as a method in pursuit of a learning outcome. We will introduce the drawing method used in teaching natural science illustration. The process of working on the project Marine Organisms for the Blind and Partially Sighted, where we created tactile illustrations for the blind and partially sighted, will be presented in detail. In this project, we also involved expressive techniques that had specific properties which had the potential to achieve the desired final result.

SCIENCE – SCIENTIFIC ILLUSTRATION – FINE ART

Science and art have always inspired each other, even intertwined at times. This is beautifully illustrated by the still popular book Art Forms in Nature (*Kunstformen der Natur*, 1899–1904) by Ernst Haeckel (1834–1919), which has both scientific and artistic value.

It was made possible by the scientific invention of the microscope, which gave the author an insight into the world of the microorganisms he then painted. Many artists of the time were inspired by his work. Among them were Wassily Kandinsky (1866–1944) and Paul Klee (1879–1940) (Prezelj, 2019, 92–102). Even though the works belong to the field of scientific illustration, as they faithfully reproduce reality and document biology, a new, aesthetic way of systematizing forms emerges here. Haeckel's popularity coincided with the dramatic industrialization in the West, which caused artists to look to nature for inspiration in an increasingly urban landscape. Thus, his work became a reference for the Art Nouveau movement. Artists such as Émile Gallé, the famous Catalan modernist architect Antoni Gaudí, the "father of the skyscraper" Louis Sullivan, the designer Louis Comfort Tiffany (Tiffany's) and the architect René Binet, who designed the monumental gates of the 1900 Paris World's Fair, all looked to Haeckel's illustrations for inspiration (Kazior, 2021).

Scientific illustration has become an inspiration for other genres of fine art in the aforementioned cases, but it is also a genre of fine art itself, found in business, science, and art (Sedmak, 2014, 3).

FICTION AND NON-FICTION ILLUSTRATION

Illustration belongs to the field of visual communication (Male, 2019, 9). Its creation involves a multi-layered design process. In addition to an excellent knowledge of the subject matter and visual language, one must take into account the interests of the client and the level of visual literacy of the target audience. At the same time, illustration is an open art form, allowing for original authorial approaches and enhancements to the themes covered.

Basically, illustration can be divided according to the subject matter it deals with. The most basic division is between fiction and non-fiction illustration. The former is in dialogue with fiction and the latter with non-fiction literature. The former is clearly focused on the creative expression of the illustrator, the latter on the precise presentation of information. The facts presented in non-fiction illustration must be accurate and well explained; the illustration merely reflects them in another language – that of the visual arts.

Let us think more broadly about illustration and try to define it in terms of its roles. These cover the different fields that the illustrations pertain to. These are: storytelling, documentation, education, reference, commentary, advertising, and identity, which are considered as the basic categories of illustration according to illustrator, academic, and professor Alan Male (Male, 2017). According to this interpretation, non-fiction illustration would fall under the documentation, education, and reference categories of illustration.

In the book *History of Illustration*, they highlight four categories: to document (to visually record a thing or person), to narrate (to explain as well as to entertain), to persuade (to establish, maintain or discredit ideas), and to embellish (to enhance life or to concretize it through decoding) (Doyle, Grove, Sherman 2018, 17).

Non-fiction illustration covers all genres of literature that primarily deliver knowledge: non-fiction, professional literature, informational literature, scientific and popular science literature, and instructional literature. Non-fiction literature has its own laws regarding content delivery, but the artistic value of the author's storytelling could also classify some of these works as fiction. But this is not its primary purpose; these are essentially works that offer knowledge about the world, and the author's style, when providing the readers with information and explanations, can be helpful in understanding the subject (Bilban, 2024, 20–25).

The same applies to illustration that accompanies such texts. It has the role of conveying information, and its aesthetic value can at best aid this informative function, but this is not the primary purpose of illustration. Often, when we read information from an image, we do not pay attention to the aesthetic aspect at all, or we only note it in passing – so if we are not distracted by anything, all is well. The authorial or aesthetic value of a non-fiction illustration is most noticeable when it is taken out of its educational context. When the original illustration created for a botanical handbook is displayed on a gallery wall, its artistic value may be more prominent, while its educational function will be in the background.

AREAS OF NON-FICTION ILLUSTRATION

Depending on the content that the illustration depicts, several further divisions can be made. Non-fiction illustration is divided according to the sciences it covers: exact and natural sciences, technical (engineering) sciences, medical sciences, agricultural (biotechnical) sciences, social sciences, humanities, and arts.

Depending on the target audience for which the illustration is intended, we speak of scientific and popular science illustration. When the content, and therefore the accompanying illustration, is explicitly intended to communicate scientific content to a wider audience, we can speak of popular science illustration.

FORMS OF ILLUSTRATION DEPICTING REALITY

Scientific illustration, when naturalistic, can show a typical specimen (of a plant, animal, mineral, etc.) and not necessarily a random one, as a photograph can do perfectly when created by a skilled documentary photographer. When it is informative in nature, it can become purely schematic and focus on individual parts (morphology, anatomy, layers, etc.), usually explaining these in words next to indexes or in a legend alongside the illustration, using letters or numbers in the image. When explaining a temporal sequence, it uses a sequence of pictures—similar to a comic strip—thus depicting the progression. Using this method, an illustration depicting the life cycle of an amphibian, for example, can use sequences to show a temporal progression, development, and growth all in one picture. Conceptual illustration is perhaps the

NON-FICTION (scientific, popular science illustration)

AREAS	→ EXACT AND NATURAL SCIENCES: mathematics, logic, cybernetics, physics, mechanics, astronomy, chemistry, biology, botany, zoology, genetics, biochemistry, biophysics, ecology, geology, meteorology, geophysics, geography. → TECHNICAL (ENGINEERING) SCIENCES: metallurgy, mining, mechanical engineering, civil engineering, electrical engineering, electronics, computer science, aeronautics, chemical technology, textile technology, geodesy, civil technology. → MEDICAL SCIENCES: medical science, microbiology, dental medicine, pharmacy. → AGRICULTURAL (BIOTECHNICAL) SCIENCES: agronomy, forestry, wood science, food technology, veterinary medicine. → SOCIAL SCIENCES: political science, economics, statistics, informatics, communication studies, sociology, history, archaeology, geography, ethnology, anthropology. → HUMANITIES AND ARTS: philosophy, aesthetics, philology, linguistics, psychology, pedagogy, didactics, literary and art history, musicology.
ROLES	→ DOCUMENTATION → REFERENCE → EDUCATION
EXAMPLES	Educational posters, textbooks, workbooks, teaching materials, board games, manuals, technical monographs, lectures, technical manuals, dioramas, medicine packaging, graphic summaries of scientific papers, etc.

Table 1: The table shows the different areas of non-fiction illustration, what its roles are and some practical examples of illustrations.

most challenging form of non-fiction illustration. In such a case, one must summarize an entire research project, or an entire article, in a single image. This type of illustration is multi-layered and requires the author's in-depth knowledge of both the subject and the visual language, together with all its codes of understanding. Illustrators use conceptual illustration when creating graphic summaries of content.

ILLUSTRATION TECHNIQUES

Nowadays, without thinking too much, we have to say that digital techniques are the first choice among expressive techniques for illustrators. Vector and bitmap drawings have been joined here by 3D modelling. Illustrations are also still made using classical painting techniques such as pencil, crayon, watercolour, ink, tempera, gouache, acrylics, oil paint, pastels and oil pastels, or in combinations thereof. In the past, but less frequently today, illustrators have used graphic techniques such as woodcut, etching, or lithography. In the past, these were of particular interest because of their reproductive value and have strongly influenced the field of illustration throughout history. Reproductive techniques have also dictated the form of illustrations, their appearance, and the methods of reduction and stylization. Illustrations can also be made using image-capture techniques. In his book *The Scientific Image*, Harry Robin calls this method auto-illustration (Robin, 1992). Photography, as well as other image capturing devices (e.g. X-ray, MRI, radar, etc.) can be an excellent tool for creating a non-fiction illustration in a work that intends to display a naturalistic image from the environment or a snapshot of a circumstance, a measurement. In all other cases, we are closer to reality using the other illustration techniques.

CODES AND CONVENTIONS IN SCIENTIFIC ILLUSTRATION

From the perspective of today's visually overloaded world, the historical example of colour coding for artists and scientists detailed below is perhaps unusual but extremely interesting.

In 1814, a very interesting booklet entitled *Werner's Nomenclature of Colours* was published in Edinburgh. It was reissued in 1821, with additions, and adapted to be particularly useful to artists and scientists. It was written by Abraham Gottlob Werner (1749–1817), an eminent mineralogist and geologist. He is also known for his book on the external characteristics of fossils and minerals, published in 1774. In this book, he creates a scheme for identifying minerals by key characteristics, especially colours. Werner's pupil Robert Jameson (1774–1854) linked colours to specific minerals, which served as a starting point for art teacher Patrick Syme (1774–1845), who named and described colours for the colour charts in the aforementioned book published in 1821. The nomenclature is a system, arranged in a table, that numbers, names, and arranges the colours in a colour pattern and then describes them using animals, plants, and minerals. Today it is hard to imagine why this would be so important, but in the days before photography, scientists and illustrators dealt with very different problems than today. They were on research expeditions recording and describing new findings and they needed a system that would provide a common language, even when it came to colour. The specimens they brought back from their expeditions often faded over the years and had to be described precisely. The nomenclature was widely used by artists and scientists of the time, including the young Charles Darwin (1809–1882), who took a copy of the booklet with him on his voyage on the HMS Beagle in 1831–36. He used it to help him with the terminology used to describe his discoveries. He wrote that he consistently compared colours using the booklet in order to portray them as accurately as possible. The use of the nomenclature also marks his writing style, with phrases such as "hyacinth red" or "chestnut brown" (Syme, 2018, 4–51).

Visual codes in science have almost always evolved to meet practical needs. Unlike the previous example, which describes colours consistently according to a realistic image, colours can also deviate from reality. As an example, the distinction between veins and arteries in medical illustrations is made using blue and red. We know that in reality all blood vessels look very much alike. In photographs, it would be difficult to distinguish them. But that is exactly why in medical illustrations, which sometimes also depict surgical procedures, it is even more important to use an illustrative colour system that leaves no doubt: the cool blue against the warm red is accurate in interpreting the positions of veins and arteries. If veins are blue and arteries are red, what colour will the nervous system be, what colour the lymphatic system, and so on? The colours in the codes are usually based on reality but deviate when they are given an additional purpose of differentiation.

In addition to colour codes, we also have texture systems. An example of this can be found in geological illustrations. On geological maps of the surface, one can see areas marked with different patterns that indicate different geological materials on the Earth's surface. The patterns represent the usual lithology of rocks. Geological maps use systematized patterns for rocks such as sandstone, shale, mudstone, conglomerate, granite, breccia, volcanic ash, or limestone. They vary from parallel lines, dashed patterns, crossed lines, point patterns, patterns with circles, or curves. Again, this is an agreed use of artistic language within the discipline. Here, new meanings and content are attributed to the patterns according to convention.

ADAPTATIONS OF ILLUSTRATIONS FOR THE BLIND AND PARTIALLY SIGHTED

When creating illustrations for a specific target audience, we need to pay attention to their needs. In the case of designing or illustrating for the blind and partially sighted, we have adapted the material to a system that some of them are already familiar with and used to, which means that the experience will be easier for them. And that is the braille writing system. It already has set rules that we can follow when designing illustrations. One of these is the thickness of the line we use. So, the thickness of the line comes from the diameter of the dot in braille. The image can be read by touch with the help of relief. For those who can still perceive light to a certain percentage, it takes into account the contrast of the image. The greatest contrast is achieved with black against white.

When designing illustrations for the blind and partially sighted, the starting point was the previous Kaverljag summer schools, which resulted in two tactile books *Dotakni se ptice* (Touch a Bird) and *Žuželke od blizu* (Insects Up Close), where they also came up with some useful and measurable results in workshop formats.

If most visual codes in science have developed gradually, out of practical needs and by convention, here rigorous testing with users is crucial. They tell you how much detail they can still sense by touch and what helps them in perceiving and understanding the image.

INTEGRATING DRAWING AS A LEARNING METHOD IN INTERDISCIPLINARY PROJECTS

For many years now, as an introduction to the field of non-fiction illustration, I have been using a quick drawing-by-description exercise in which I give illustration students a brief description of a plant or animal, which they then try to summarize in a sketch based on the description alone. For example, in an introduction to botanical illustration for third year illustration students, we do this exercise using descriptions of plants. We focus on plants that are familiar to us on account of their everyday use, such as food crops, fruit plants, or herbs. I deliberately do not disclose the name of the plant in the description – I merely give the students a description written by experts. It refers to the plant's size, the arrangement of its leaves and their shapes; to its flowers, fruits, stems, and also to the underground parts, if necessary. The descriptions have about 1000 characters (including spaces). They can be read quickly and students can refer back to the text as they draw.

When students start reading the descriptions, they first notice that they are not familiar with the terminology of botany. They try to figure out what the words mean from the context, as they have to focus on drawing. For example, what does it mean that a plant is right-handed, what are glaucous leaves, what is a rosette on a plant, where is the pistil located, etc.? They try to draw what they understand, the way they understand it. They try to interpret the words they read and link them into a logical image based on their general knowledge of plants.

The results are always similar. The "mistakes" they make in the interpretation create completely new plants – imaginary plants. Looking at the actual plant next to the students' drawings, we often have to laugh. Horseradish turns into beetroot, tomatoes into berries. They realize that, beside knowledge, good observational skills are crucial when creating scientific illustrations.

After the exercise, students listen to a lecture on botanical illustration, and are introduced to historical aspects of the development of botanical illustration, as well as examples of plant depictions through time. These include depictions of plants in early pharmacopoeias. One of the best known is the pharmacopoeia by Pedanius Dioscorides (ca. 40–90 AD), *De Materia Medica* – also known as the first botanical book. The book was reproduced and circulated among researchers from 78 AD onwards and is considered to be the forerunner of all botanical books. From the sixth century onwards, illustrations can be also be found in the transcriptions of his manuscripts (Lee, 1999, 20).

The first illustrated manuscript based on Dioscorides' work is dated before 512. It is considered to be the oldest version, presenting almost the entire text, which is accompanied, among other things, by original illustrations of plants. The manuscript is known by several titles, deriving from its ownership, which has changed several times over the centuries; Codex Aniciae Julianae, after its first owner, the Byzantine princess Juliana Anicia (died 527), Codex Cnastantinopolitanus, Codex C, Codex Byzantinus, after Constantinople or Byzantium (today's Istanbul, where the manuscript was kept for almost a thousand years), and finally Codex Vindobonesis or Vienna Dioscorides after the Austrian city of Vienna, where it has been kept since 1569 (Lack, 2018, 22–24).

The book, which was translated and later copied and printed in many languages, is mostly accompanied by illustrations. However, the authors of these illustrations created them purely on the basis of the descriptions, losing the educational, documentary role of the illustrations and sticking to a purely decorative one. If we want to capture information of an educational nature in an illustration, we need in-depth knowledge and understanding of the subject, only then can we depict it. Only later annotated reprints of the *De materia medica*,

Figure 1: Drawing marine organisms from descriptions alone
(Petra Černe Oven, project archive, 2024)

Figure 2: Illustrations of marine life: scientific illustration and graphics
(Nik Erik Neubauer, project archive, 2024)

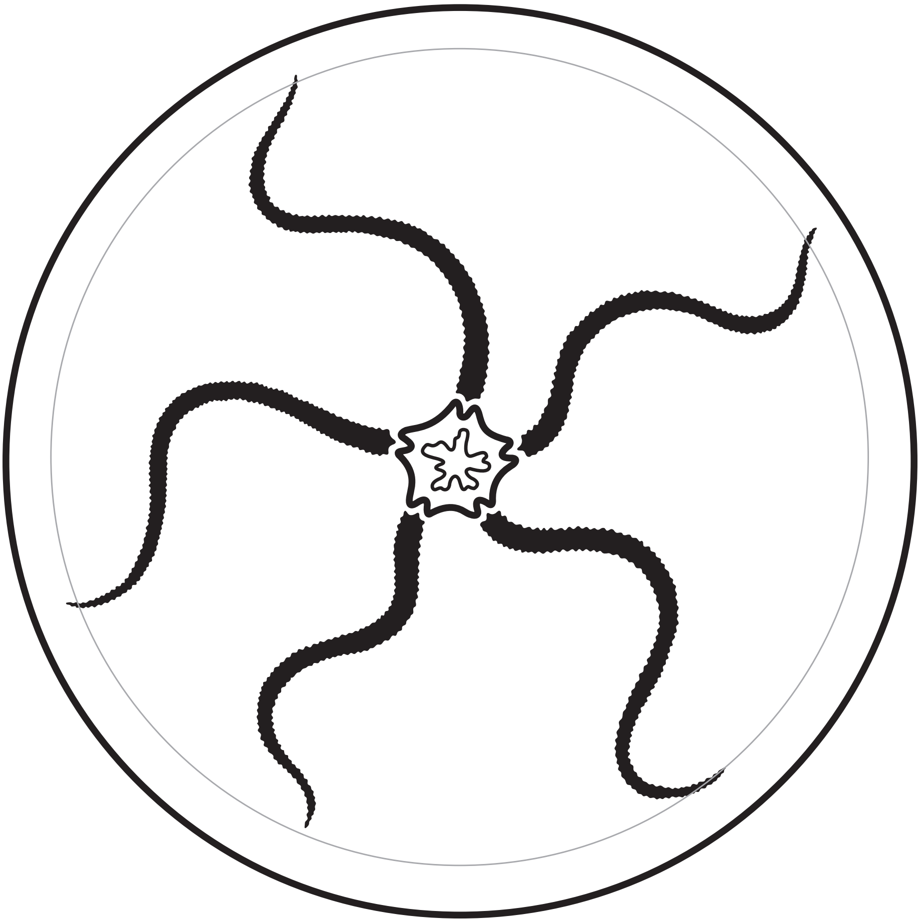

Figure 3: Vector drawing
(Ana Turičnik, project archive, 2024)

Figure 4: Illustrations in 3D print
(Petra Černe Oven, project archive, 2024)

such as that of Pietro Andrea Mattioli, are accompanied by illustrations, which have a documentary, educational, even taxonomic role (Aitken 2007, 57–60).

The exercise of drawing from descriptions, which seems logical in the training of illustrators entering the world of scientific illustration, can be applied to students who have no drawing background with quite similar results. I carried it out with a group of biology and landscape architecture students. The results were quite similar, even though some students had more botanical background and less drawing background and others had knowledge in both areas. I carried out a similar exercise with a group of professors and students of education, this time using descriptions of insects. The results are always similar.

In these exercises, the participants learned that description alone does not provide enough information to identify plant and animal species – let alone to be able to depict them scientifically. This requires more in-depth knowledge. If you know the plant or animal and are provided with a description, it's a bit easier, but it's still difficult to be precise. We are sloppy observers, and this is even more apparent when we try to draw something from memory. Participants who were experts in botany or entomology or marine organisms also reported that drawing requires a completely different kind of attention compared to observing or learning. Once they have learned to draw something based on observation and study, they also have a different attention to detail or a different focus when observing, leading to a keener eye for detail. Because without the necessary information, drawing is mere guesswork. Although the drawings depict plants and animals, the illustrations are more fiction than reality, even though they are based on descriptions by experts. Thus, through a practical example, we realize that in order to create a realistic non-fiction illustration, we need to go a few steps further. The basis is, of course, a background in art. In addition to the textual description, we need to know the subject in detail. It is best to observe it in nature, in the field. Where this is not possible, we can visit greenhouses, zoos, museums, and herbariums, analyse specimens, and compare our work with existing illustrations and photographic material. When drawing, we can consult experts in the relevant field. This is the only way to pay attention to the key elements that make an illustration professional. It may also happen that during the drawing process we highlight a detail that an expert has maybe not yet noticed and thus investigates it further.

The exercise is certainly useful for future scientific illustrators, but it is also interesting for researchers. In fact, processes occur during drawing and depicting that help in understanding and remembering content in a different way.

WORKING METHODS FOR CREATING ILLUSTRATIONS OF MARINE ORGANISMS FOR THE BLIND AND PARTIALLY SIGHTED

In the project Kaverljag International Summer School, where we worked on depictions of marine organisms for the blind and partially sighted, we tried a variety of depiction techniques on the way to the final results. Why?

Careful planning helps you achieve your goals faster and with greater precision. Sketching with pencils allows us to take quick notes when learning about organisms and studying them in the field. Gouache and watercolour are considered time-consuming techniques, but they allow the artist time to think while creating. They also allow a high level of detail, which helps to study the subject in detail through painting. Understanding detail is key in the simplifications and stylizations of forms that are required in graphic depictions. The chosen graphic technique of linocut forces us to reduce/simplify shapes and at the same time allows us to convert lines and shapes into relief form. In our case, it also serves as a sketch for conversion into a vector drawing, which is the basis for modelling in three dimensions. In this case, printing in three dimensions is the final technique used for creating the illustrations, as it allows us to reproduce them easily.

Context and Preparation Through Research

Already before the summer school began, a small group of students had started researching topics in biology and design for the blind and partially sighted. At the summer school, an extended group first learned theory by attending lectures, field trips, and by way of experiential learning with a typhopedagogue, and then got down to practical work – illustration.

A Quick Exercise in Drawing from Descriptions to Get into the Topic

Before getting into scientific illustration in both the theoretical and practical sense, we carried out the aforementioned quick exercise in drawing from descriptions. Just like in the case with plants or insects, the descriptions outlined visible features but did not reveal the name of the animal, this time a marine organism. Students from various design, art and biology disciplines (both first and second cycle) took part in the drawing exercise. Again, we realized that we would need to delve deeper into the subject matter if we wanted to create illustrations of marine organisms.

Learning About Organisms by Sketching and Study Drawing

Two biology students drew up a list of organisms found in the Mediterranean Sea. From this list, the participants then chose which marine organism they wanted to illustrate. Our work also included observations in the field, in this case at the seaside. There, we were able to study some of the organisms in more detail. Although we saw most of them in the aquarium in their recreated natural environment. Already at this stage, we began with visual recording – sketching, in addition to observation and note-taking. The result were study drawings that outline the basic shapes of the marine organisms, interesting details, and their habitats. The key to learning about animals is to observe how they behave in their natural environment, even when they are random specimens. But our aim is to depict a typical representative of the selected species.

Exact Depiction with Scientific Illustration

After the study drawings, we moved on to scientific illustrations of the organisms. Here, we learned about their typical features from reading the descriptions. We paid attention to what was written and took this into account in the reduction we made when drawing. With the help of reduction, we emphasized details that have an important differentiating advantage. The aim was to create a taxonomic illustration that would help us identify species. In practice, this means that we have to identify the organism shown in the illustration in the field, despite potential deviations. We therefore looked for averages between several organisms of the same species and highlighted key features that would help in recognizing certain species.

Reduction and Stylization for Easier Shape Identification

This is usually where the work of the scientific illustrator ends, because they arrive at a result that gives a consistent, factual picture of reality in a documentary way. But in our case, we had to translate the image in such a way that the information it contained would be understandable to people with or without visual impairments. In order to adapt the illustration in this direction, additional stylization was needed.

We carefully considered which were the most characteristic features we wanted to depict and focused on them. We consulted an expert and checked anatomical and other biological aspects to consider in the depiction of the specimens.

Reflecting on the Tactile Through Graphic Technique

In pursuit of the result, we used the graphic technique of linocut printing. Linocut is basically a more modern version of woodcut – historically one of the earliest rendering techniques for illustrations in reproduced books. Letterpress printing is closely linked to the development of scientific illustration, but the reasons for its use in this case were of a more practical nature. The creation of the linocut produced a matrix with deep incisions which was tactile in itself. It allowed us to print in colour or in relief when printing on damp paper. We also chose linocut because the use of special tools such as carving knives and linoleum material forced us to simplify the shapes. Even when transferring the image on the matrix (linoleum), it was necessary to simplify the shape and to make it monochrome. Once the image was drawn, it was then cut into the material. It is a process that takes time, but also allows for reflection. The tool itself led us to a specific type of stylization inherent in the letterpress technique. In our case, we cut out the image and not the background, so when we print it on paper, we get a protruding line, which is also tactile. In the case of linocut, therefore, it is possible to trace both the matrix and the print using the sense of touch – both of which we exhibited for visitors and test groups of blind and partially sighted people. We created a print with black ink and a print without ink where only the relief is visible.

Continuation of the Project in a Smaller Group

In total, the workshop produced 13 sets of illustrations of organisms, which were later exhibited. Participants of the summer school depicted a marine organism in colour—either as a habitat or a scientific illustration—and then executed it in a graphic technique with two prints – one in relief without colour and one in black and white.[1]

So, the summer school provided us with the starting materials for further work on the project. This was again carried out with a small group of students, consisting of three illustration students, an industrial design student, and two biologists. Our aim was not just to create depictions, but to find solutions to make them as accessible as possible to our target users.

1 For more information on the illustrations, see the article Kaverljag International Summer School 2024, p. 64 in this publication. (editor's note)

We have selected illustrations of five typical but diverse marine organisms: the seahorse, the crab, the chiton, the cuttlefish, and the brittle star. The biologists have prepared unified descriptions of all five organisms, highlighting typical features, which we have taken into account in the final illustrations.

The stylized images of the animals already provided an excellent starting point for conversion into a digital vector format. The basic building block of a vector drawing is the Bezier curve.[2] This is essentially a line defined by mathematical models. Most such curves consist of open points called anchor points, which are controlled by control arms that represent a tangent to the line (Caplin, 2003, 73). The lines of the drawings in the illustrations are further refined using vector lines. This helps to unify illustrations by different authors through the technique of illustration.

At this stage, we meet again as a group and define uniform parameters for all five illustrations. These include scale, defining the thickness of the lines in the dots, defining the plot to line ratio, unifying the common elements of several illustrations (e.g. the eyes of organisms), a unified artistic approach to similar situations (how to show the knuckles, how to attach the limbs to the body, etc.). We technically define the format and the position of the illustration within it. To make orientation within the format easier, we have placed the illustrations in a circle, and the realistic snippets, depicting a part of the organism without stylization, in a smaller square. The positions of the circle and the square are the same in all five illustrations, as uniformity helps blind and partially sighted people to orient themselves.

The illustration was then converted into a protruding relief shape that can be printed using a 3D printer. Here again, technical adjustments were needed as the edges of the drawing were

2 Bézier curves are named after Pierre Bézier, a French engineer and mathematician who developed the method in the 1960s while working for Renault.

too sharp in the transfer to a relief and would not have provided a positive experience for the user. The students further reworked the illustrations by skimming the edges and making them more pleasant to the touch.

The resulting illustrations are suitable for test groups, who answer a series of questions using guided questionnaires to help us refine our starting point in developing guidelines for creating scientific illustrations for the blind and partially sighted.

The tests have provided us with results that can be used to transform each scientific illustration into a tactile form.

CONCLUSION

Illustration can be created in a wide range of traditional and digital techniques, it can be an original or a printed image, and it can be in two or three dimensions, depending on what it is communicating. The “WHAT” (content) and the “HOW” (medium) are not the determining factors, it is the “WHY” (role, purpose) that determines whether an image is an illustration (Doyle, Grove, Sherman 2018, 17).

The role of the illustrations we created during the project is distinctly educational and places the illustrations we created within the scope of natural science illustration.

The main goal of the project Marine Organisms for the Blind and Partially Sighted is not only to raise awareness about nature conservation, but also to find new approaches in visual communication in the field of scientific illustration. Non-fiction literature is accompanied by non-fiction, scientific, and popular science illustrations. With various projects on the same theme, we have pursued the goal of establishing a model that could be used to adapt scientific illustrations for educating the blind and partially sighted. Using the example of marine illustration, we have got much closer to this goal. We defined the steps, including procedures and techniques, that can be usefully applied in teaching future scientific illustrators, with the aim that they will help us create functional and accessible collections of educational illustrations. We know that illustrated books for the blind and partially sighted are a rarity and we want to expand the range of content available to them. The rapidly developing 3D printing technologies and the availability of such printers in libraries are opening up new opportunities. With a foundation of properly prepared material, such educational content could be accessible on demand, extending learning opportunities for the blind and partially sighted.

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