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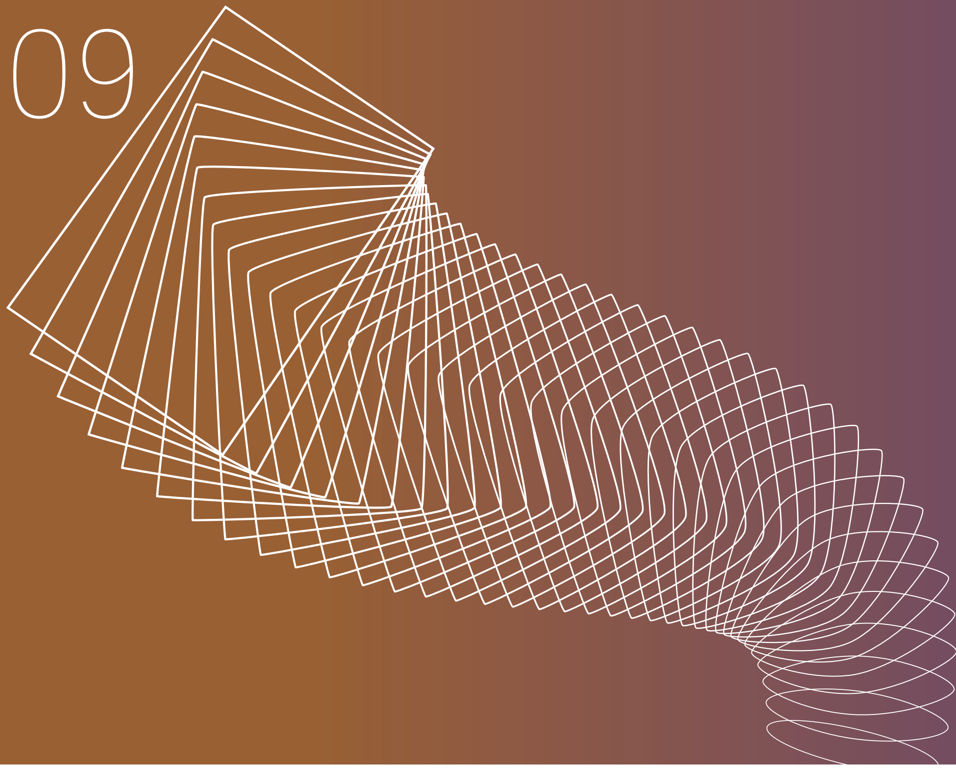

Petra Černe Oven

THE CHALLENGES OF DEVELOPING METHODS OF VISUALISATION IN DIGITAL HUMANITIES PROJECTS AND WHAT THE DESIGN PROFESSION CAN CONTRIBUTE*

Introduction

This paper provides insights into the area of design that deals with the visualisation of science. It has become clear that in the modern society, in which science plays an important role in the development of many different fields, the power of knowledge depends equally on its presentation and dissemination as on other aspects of its production. To ensure that scientific discoveries are presented in an understandable way, scientists need to use suitable channels, and do so in a way that makes content accessible to a certain target audience. Often, this is the general public, which lacks in-depth knowledge on the particular domains that are the subject of the communication. It is the responsibility of the researchers to convey their findings in an understandable and credible manner, since detailed presentation of the subject matter is a vital component of scientific communication. These challenges have recently intensified, especially when it comes to the natural sciences. Expert opinions struggled for traction on the social networks and in the public media and often ended up losing out due to unclear

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messaging, which resulted in pseudoscience and conspiracy theories causing a lot of harm.

In science, too, the increasing recognition recently of the fact that humans are visual creatures has led to scientists beginning to increase the share of content that is communicated visually. After the last three decades in particular, with digitalisation leading towards the democratisation of media and tools and consequently to the increase in the use of visual means of communication, it is thus imperative that visual means of knowledge representation in science are deeply understood, methodologically developed and professionally applied. Robert E. Horn went so far as to define the integration of words, images and shapes into a consolidated unit of communication as an entirely new language that he called *visual language*. He singled out the increasing complexity of the world, with mounting problems, along with the ambition to solve them, as well as the development of media and technologies in the 1990s, as the forces driving the development of this language.

The aim of the paper is not to present the historical achievements in the area of visualisation, which is something the author has written about in detail elsewhere, but to try to present the potential problems that can arise when introducing visualisation concepts in the humanities. In doing so, the author hopes to prompt reflection within the framework of the research project "Models and practices of international cultural exchange of the Non-Aligned Movement: researching the spatio-temporal cultural dynamics", which also encompasses the development of a visualisation tool that will facilitate the analysis of the material being examined. With technology playing a major role, the historical principles and methods of visualisation were completely different from what we have today, and this is the origin of the difficulties we face in the visualisation process. The insights can aid in the establishment of a new methodology in the field of digital humanities covered in the project (design, visual arts, architecture and cultural/art history) and, in the process of thorough examination, indicate some of the problems that can arise in the process.

The Case for Visualising Complex Topics

It makes sense in the beginning to ask ourselves whether we are capable of identifying those types of information that are particularly suited to visual presentation and those that are better conveyed verbally. Certainly, the field of rhetoric continues to be highly relevant, especially when communicating concepts that cannot be visualised in any meaningful sense, or in cases where visualisation might even be an unwelcome distraction. In a society that keeps us

overwhelmed with information and in which modern digital tools and means of communication offer access to virtually unlimited amounts of data, the answer is, of course, right in front of us. As early as October 2008, Hal Varian, the chief economist at Google, said in an interview that:

> **The ability to take data [...] to visualize it [...] that's going to be a hugely important skill in the next decades, not only at the professional level but even at the educational level for elementary school kids, for high school kids, for college kids. Because now we really do have essentially free and ubiquitous data. So the complimentary scarce factor is the ability to understand that data and extract value from it.[1]**

Scientific journals—*Nature*, for instance—have likewise long been publishing calls promoting the use of visuals in science, arguing that a clear and convincing image is "of crucial importance in science communication".[2]

The neurological basis and the dominant role of visual information in perception and understanding

In modern society, we strive to research, understand, stimulate and utilise all the senses. Neuroscientific findings, however, have long ago confirmed that visual information plays a dominant role in human cognition. Half of the neural fibres in our brains are associated with vision, and when our eyes are open, vision accounts for two thirds of the brain's electrical activity. The brain needs a mere 150 milliseconds to recognise an image, and only 100 more to ascribe meaning to it.[3] There are studies claiming that the human brain is capable of fully processing an image seen for a mere 13 milliseconds. In a study, the researchers showed the participants a series of pictures that were visible for 13 to 80 milliseconds each. The viewers successfully identified scenes such as "picnic" or "a laughing couple" despite the incredibly short time they were shown for.[4] David Rock (of the NeuroLeadership Institute) likewise demonstrated that using visual images reduces the energy required to process information and consequently maximises the energy available to think and act effectively.[5]

This is about more than just perception, of course. Information presented visually instead of through words or numbers is more

1 Manyika and Varian.
2 Cheng and Rolandi, Graphic design for scientists.
3 Raworth, *Doughnut Economics*, p. 13.
4 Potter et al., Detecting meaning, p. 270.
5 See Rock, *Your Brain at Work*.

readily processed by the brain. The right hemisphere recognises shapes and colours. The left hemisphere, by contrast, processes information analytically and sequentially and is therefore more active when people read or examine spreadsheets. Whereas studying a number table demands considerable mental effort, information presented visually can be understood in seconds, since the brain recognises patterns, relations and relationships between visual values.

Since at least as early as the Enlightenment, vision has been recognised as the most objective of the senses and thus associated with the mind, reason, rationality and logic. Vision is our dominant sense, and our perception of the world is primarily visual.

> **More than just sight is measured in terms of visual acuity; vision is the process of deriving meaning from what is seen. It is a complex, learned and developed a set of functions that involve a multitude of skills. Research estimates that eighty to eighty-five percent of our perception, learning, cognition, and activities are mediated through vision.[6]**

This paper is dealing with a very specific area: the deliberate transfer of information and understanding. We can therefore stick to the premise that visual perception is extremely important in the field of science.

Visualisation in the field of digital humanities

While pioneering work in the field of visualisation has been done by individual authors in the past, the field is developing continuously under the influence of technology (digitalisation) and social changes (democratisation, the struggle for minority rights, the environmental catastrophe, political movements). Likewise, disciplines making use of visualisation—as the most potent tool in the age of social networks—may be driven by business interests, in addition to transmitting new knowledge or empowering society. Use of infographics is universal in the modern media (*New York Times, The Guardian, Reuters, Corriere della Sera, USA Today*, to name only those most awarded), and there are numerous awards and institutions that raise awareness and educate on the subject (examples include Information is Beautiful, with its website, educational books and the eponymous awards, and the Malofiej Awards for infographics in newspapers). We are also witnessing the emergence of a new profession: "visual journalism".

Many companies, too, have made remarkable progress, if we look at the use of charts in annual reports in the 20th century, and

6 Politzer, Vision Is Our Dominant Sense.

now build their arguments in a visual way. Even in politics, rhetoric is increasingly combined with visual elements. President Obama, for example, in his annual State of the Union Address in 2015, combined rhetoric with visualisations for better results. For certain data, the best—the only, even—way it can be presented to the public is through moving, interactive kinetic visualisation.

Major breakthroughs in the understanding of statistics through interactivity in modern times were made, for example, by the physician, academic and lecturer Hans Rosling (1948–2017) as part of his *Gapminder* project.[7] Examples such as these demonstrate that one of the key influences in the field of visualisation over the last 30 years has been technological progress: the development of information technologies has enabled the development of tools that have had a profound impact on the field of visualisation, allowing both active participation and innovative data processing.

Visualisations allow users to look at quantitative and qualitative data from a different perspective, encouraging interpretation of data in ways that a textual presentation cannot. Diagrams, charts and other forms of visualisation can stimulate comparative interpretations, model new ways of understanding and indicate emerging categories, patterns and potential deviations from the expected, thus facilitating new insights.

The development of what can broadly be defined as the *digital humanities* has led to a number of pioneering explorations into the possibility of using digital tools in the humanities. As this is the field covered by the project this paper is a part of, it is logical to include a reflection on innovative ways of integrating visual material based on the tools offered by the digital realm.

Digital humanities cover many different fields. Each of them is covered by many of the commercial and open-source tools available in the modern world: from text analysis (Voyant, Juxta, HathiTrust, LitViz), spatial analysis (CartoDB), network analysis (Onodo, Gephi, Palladio) and image analysis to timeline generation (Knightlab Timeline, Tiki-Toki), map generation (StoryMapJS, MapHub, MyMaps), infographic generation (Piktochart, Canva), and data visualisation (RAWGraphs, Mondrian, Many Eyes, Tableau Public, Prefuse). Many tools also exist that facilitate basic programming without previous knowledge of programming (Processing, Scratch). Some of these tools are already integrated into operating systems (e.g. Excel, Numbers, Google Docs, OpenOffice). Others, likewise aimed at the lay user, are available on the web (e.g. Venngage.com and Visme.co).

7 See *Gapminder*.

As mentioned in the second section of this paper, visualisations can be a very powerful aid in creating understanding. If this knowledge is supported by the ability to create visualisations relatively easily, their usage, of course, increases immediately. Drucker cautions that we are, in fact, too trusting of visualisations occasionally: "we seem ready and eager to suspend critical judgment in a rush to visualization",[8] continuing

> At the very least, humanists beginning to play at the intersection of statistics and graphics ought to take a detour through the substantial discussions of the sociology of knowledge and its developed critique of realist models of data gathering. At best, we need to take on the challenge of developing graphical expressions rooted in and appropriate to interpretative activity.[9]

Controversial as it may sound, the use of freely available visualisation tools can (as is the case with all tools that are potentially not in the right hands) also raise the problem of data transparency and thus the possibility of misinterpretation. In the modern era, when everyone is free to interpret information and knowledge, the key question is how to establish visualisation methods that will follow the concepts and comply with the standards in the field of humanities research. Naturally, this must be backed up by theoretical considerations and argument-based decisions. Recognising that all knowledge is interpretive in nature and that the visual representation itself must be consistent with this is already a positive step in this direction. There is no ultimate truth—the visual expression is a particular interpretation that someone has augmented through graphical/visual means. This negates the common notion regarding the display of quantitative information, namely that it represents "the truth".

The Difficulties and the Non-Objectivity of Visualisation

One of the most basic examples of bias or even deliberate exploitation of mistaken notions regarding visualisation are charts. Charts employ simple (albeit often misleading) geometric shapes suitable for producing easily legible comparisons of values and relationships, as well as displays of a change in state through time. Lines, bars, columns and pie charts are common and familiar examples of such shapes. While capable of depicting quantitative relationships in a transparent way, they can also completely distort the

8 Drucker, Humanities Approaches to Graphical Display.
9 Ibid.

underlying data. A chart might show the increase or decrease of a particular value on a timeline, but in interpreting it, we rely on our pre-existing knowledge. If the author of the chart reverses the timeline so that it progresses from right to left (in cultures using the Latin alphabet, we are used to reading from left to right), so that we are actually looking at a decrease rather than an increase in a given quantity, the audience is of course being misled. Such examples abound, especially when it comes to political coverage in the media.

The phenomenon of time itself can also serve as a good example of something we have to pay attention to if we want to maximise the utility of visualisation. Time can be conceived of as something given, as a space in which individual events happen by chance, or it can be conceived of as a web of causally interconnected events. In our project, we opted for the latter approach. In doing so, we encountered a potential problem: in order to produce a successful visualisation, we would need to show the temporal relationships between documents (their dates of origin) of quite heterogenous nature (articles have a story, some of the documents are more notable than others, some reflect time to a much greater extent than others). Since the research team consists of many members, with each trying to cover their own field, the temporality of historical events does not always coincide with the timing of the documents (*when* is it that an influence of something is seen, and *what* is affected). In addition, the interpretations found in the documents are themselves influenced by the times in which they were produced (which cannot always be accurately evaluated in retrospect, nor can they be assigned all the necessary variables or information for the database). In network visualisation in particular, the choice and application of selection filters, as well as their presets, can have a crucial impact on how effective and understandable the visualisation is.

Data visualisation and information design

The broader field that we discuss in this paper could be termed *information design*.[10] This is an umbrella term for an area of visual communication that centres on clear and comprehensible presentation of data-derived information using visual tools (example:

10 In 2009, on the occasion of the 22nd Biennial of Industrial Design, the Museum of Architecture and Design, in cooperation with the Pekinpah Association, organised a series of lectures on information design featuring lecturers from abroad, and the exhibition *Service and Information Design: Examples of Good Practice.* They also published a book of the same name (Černe Oven, Predan, 2010) on the subject. In our texts at the time we already stressed the importance of good data visualisation in light of the general information overload in society.

an underground railway diagram). We all encounter situations every day where the information we need is not conveyed in an unambiguous way. This is especially often the case when it comes to complex information. Information design is therefore an activity in which disorganised and unstructured complex data is translated into useful and understandable information. In the process, we prioritise the readability and comprehensibility of the documents, along with their usability for the end use.[11] While the field of information design is by nature very broad, a common thread can easily be identified. Information designers make decisions about the selection, structuring and presentation of the message, whose delivery must be consistent with the reasons, knowledge, experience, preferences and circumstances of the intended users.

What is it, then, that links information design and data visualisation? In data visualisation, we typically make use of databases far larger than would be practical in an analogue presentation, and the tools used for data visualisation are nearly always tied to particular software. This allows both static and interactive displays, where processes are presented in relation to the time in which they take place, and the viewer can take an active role in the process—even manipulating the visualisations according to their own information needs.

At this stage we can employ another useful definition, which indicates the function of the visualisation. F. Frankel and A. DePace divided visualisations into explanatory and exploratory ones. Explanatory visualisations communicate findings (answers to research questions), pointing out patterns, exceptions and concepts. Exploratory visualisation, by contrast, invites the user to explore the information on their own, providing an individual perspective and giving insight into the data. This can stimulate thinking about the subject of the research and offer new research questions.[12] When understanding depends on the observer—even when based on data—the observer can generate conclusions that are entirely their own. This can be a double-edged sword, since observers may bring different perspectives into the process: the intent behind the interpretation, as well as their initial knowledge of the topic, may vary, or they might have a different level of visualisation ability.

Information design projects could therefore mostly fit into the "explanatory" category, with most data visualisation projects conversely fitting into the "exploratory" category. In the context of the latter, the openness of entry into interaction and the possibility of

11 See Černe Oven, Predan, *Service and Information Design*.

12 Frankel and DePace, *Visual Strategies*.

different perspectives or views on a topic are extremely important. In any case, both information design and data visualisation transform data into a visual whole through the use of a visual language.

Even experts such as Lev Manovich admit that it is not an easy task to formulate a definition that would apply to all types of data visualisation projects emerging today, yet at the same time maintain distinction from other related fields such as scientific visualisation and information design.[13] He defines information visualisation as "the mapping between discrete data and their visual representation".[14] This is why information visualisation also includes artistic projects whose interest in displaying data is not in understanding or explaining information and concepts, but in using the data purely as aesthetic parameters and experiments to create attractive or interesting visualisations (which do not necessarily have the objective and informative content that we attribute to information design).

We typically distinguish between two- and three-dimensional visualisations (the latter are often interactive). Manovich explains that two-dimensional visualisations often belong to the field of information visualisation and were developed in the 1990s in the field of design. They received a marked boost with the democratisation of the use of personal computers and later, around 2005, with the emergence of social networks and freely accessible databases, which served as the basis for the generation of visualisations, and with new programming languages. Information visualisations use graphical elements (points, lines, curves and other geometric shapes, often combined with textual information). Three-dimensional visualisations generally fall under scientific visualisation, are often interactive and were developed in the 1980s alongside the field of 3D computer graphics.[15] At that time, large computer systems—specialised graphics workstations—were already relatively powerful, but not yet accessible to individuals for personal use. In the last ten years, the situation has, naturally, changed somewhat, so the precise definition, implementation and functionality actually depend on the individual project.

The conceptual approach and deciding the type of visualisation on the basis of intent

Research on how people read (and misread) various types of visualisations helps identify which types and features of visualisation are best at conveying information understandably and effectively.

13 Manovich, What is Visualization.

14 Ibid., p. 2.

15 Ibid., p. 4.

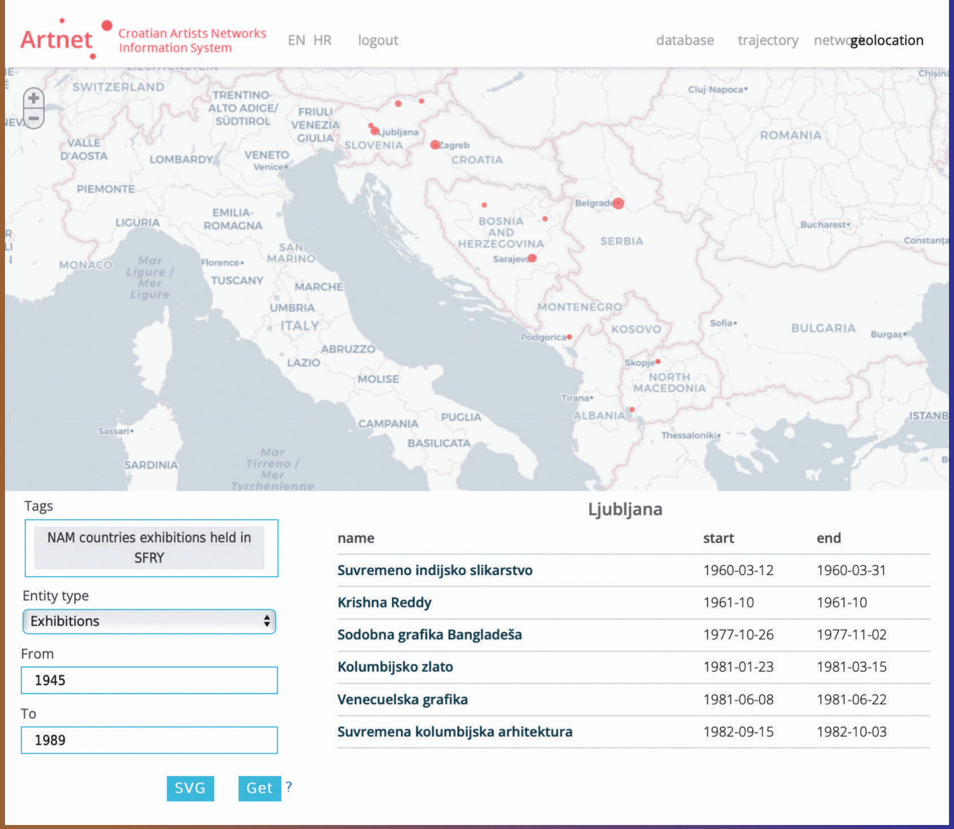
Interpreting overly complex information requires considerable cognitive effort. For this reason, it's important to know the intent of communication, as well as who the intended recipient is and what kind of reaction the communication is expected to engender.

In exploratory visualisation—where the viewer is invited to discover the information they're interested in on their own—the visualisation itself must make clear what possibilities it provides to the user, both on the level of the user experience and in terms of data acquisition prior to that. In the case of explanatory visualisation, by contrast, what is essential and what is additional information included at the secondary level needs to be decided prior to designing the visualisation. It is only on this basis that we can start deciding on the tools, methods and type of the visualisation. The visual elements or visual building blocks (more on those later) will depend on our content-level priorities.

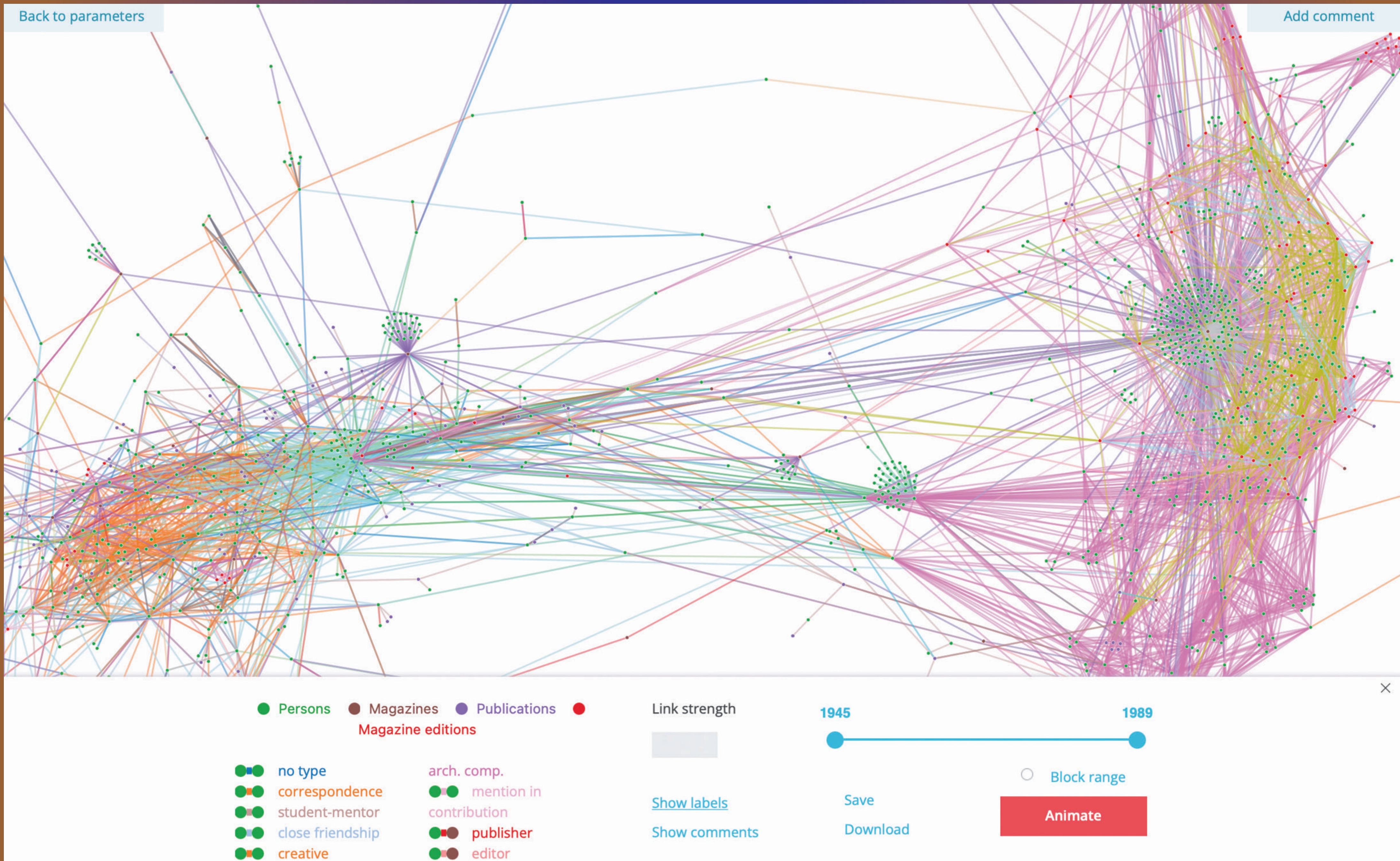
In addition to the database, the project "Models and Practices of Global Cultural Exchange and the Non-Aligned Movement: Research in the Spatio-Temporal Cultural Dynamics" offers visual display of geolocations and networks of related content from the database.

Changing the size of the grid can help us understand the data differently. When the user zooms out in order to view the entire network, they can access the nodes at the centre of the network comprised of the interconnected people, institutions, and other variables. The user can thus work out the desired information quickly. By zooming in, we can either explore many of the smaller nodes or pan across the structure to examine overlapping between the points. Users can also select individual nodes to access additional information on the link, or move a node across the grid, rearranging the grid so that it is most useful to them.

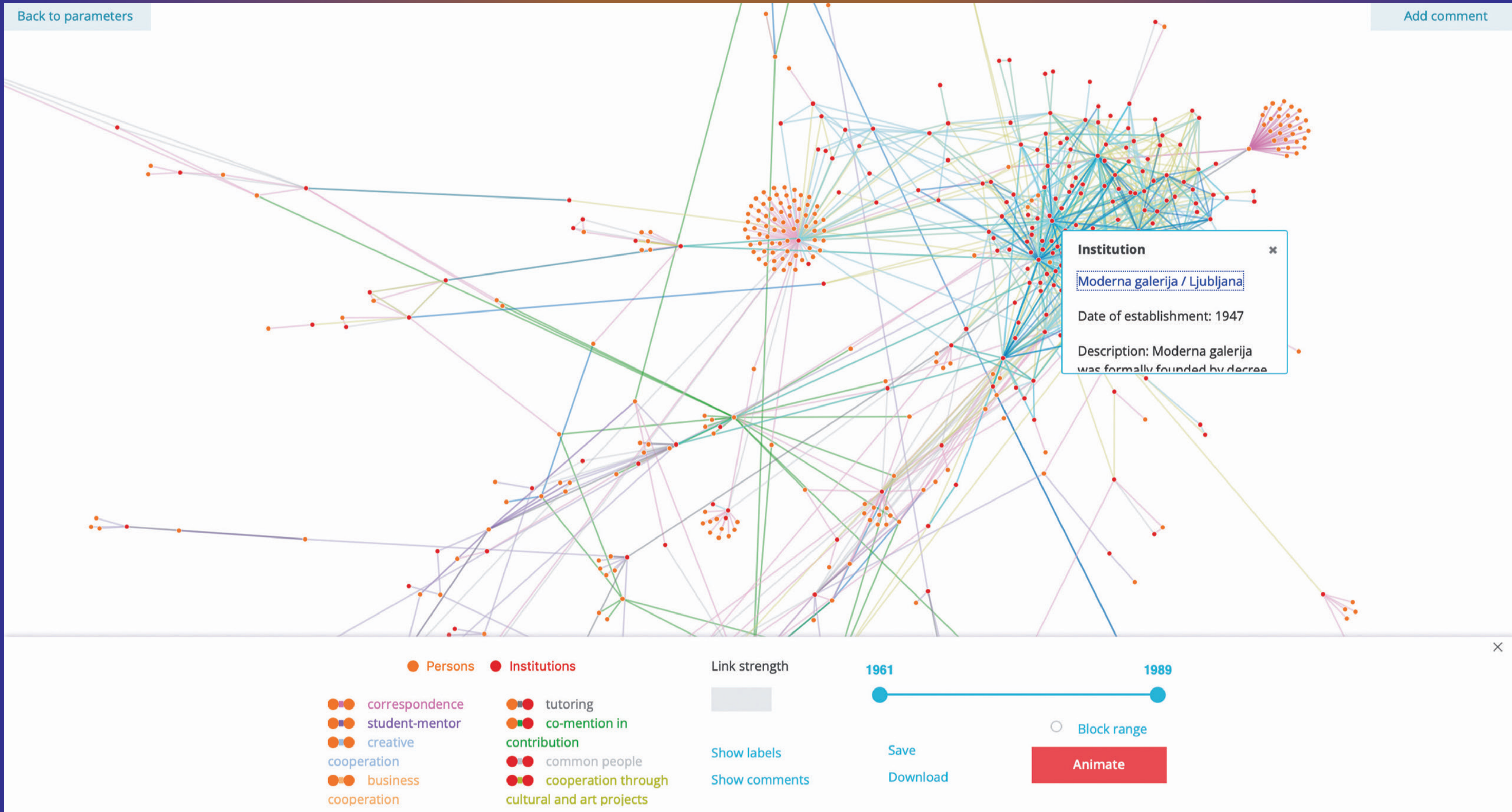
Visualisations help us discover patterns that cannot be discerned from textual inputs of empirical data which cannot by themselves provide insights into the theories that could be developed from them. Visualisation can thus facilitate sensory access to tangible representations of locations, time, historical perspective and, above all, the links between particular events, places or even periods in history. The so-called exploratory method of visualisation was used, which at the same time allows for subsequent generation of new understandings, provided that this transformation of data takes place at the level of many users and a large amount of data.



Geolocations of exhibitions in the Non-Aligned Movement (NAM).
Based on project database. (screen capture, author's personal archive)



Network visualisation showing persons, magazines, publications and magazine editions.
Based on project database. (screen capture, author's personal archive)



Network visualisation showing persons and institutions.
Based on project database. (screen capture, author's personal archive)

Methods, types and attributes of visualisations

Data visualisation aids understanding and improves effectiveness. The human mind learns quicker from visual content than from text and tables. As in the case of speech, one of the dimensions of visualisation is persuasiveness, as it often aims to influence people's ideas, beliefs and attitudes. It is more than just a communication tool, since it can use the form of the message to create meaning. Visualisation can thus combine aesthetic and strategic aspects, since it has both a narrative and a functional level. New methods are being sought that combine a planned, staged approach to project management with the iterative, intuitive and creative approach of designers. The most important method, which can already be evidenced in historical visualisations, is *reduction*.

Reduction

Although data visualisation is the most discussed topic in today's technology-dominated world, and we will look at it in more detail in the context of the project for which this methodological framework is intended, it is important to underline the fact that there are many types of visualisation. Common to all of them is the method of reduction, which is evident in scientific illustration, charts, infographics and data visualisation (it is also found, of course, throughout the wider field of art history in the form of mosaics, frescoes, stained glass artworks, on geographical maps, woodcuts, engravings and so on). It might sound counterproductive, but reduction already takes place during the selection and acquisition of data. This is because the diversity of visualisations will depend on the research question of the viewers or users of the database. If there are many of them, or if they have different requirements, we need to use a small quantity of curated data, or the data need to be displayed in a functional way, with their relationships reflected, or evident, in the structure of the display. Selectivity with respect to data is also important due to the technical limitations of databases.

Spatial dimensions

The second most important tool for visualising information according to Manovich are *spatial dimensions*, which, in human visual perception, are privileged over other visual attributes (colour, tonal value, opacity, texture, symbols and so on).[16] While this fact could have neurological underpinnings, it could also be—as has been the case throughout history—a consequence of technological evolution. Since colour printing used to be an expensive rarity, the

16 Ibid., p. 5.

spatial components, widely used in thinking about and conceiving messages, gradually became dominant. Spatial variables (position, size, shape, movement) are central to the development of the research question we are trying to construct, as well as to the planning (design) of the visualisation itself.

Despite having roots in statistics, the field of visualisation is inherently associated with visual presentation—with the presentation of the visual elements, to be more exact, also referred to as graphical elements due to the historical development of the field (media used to be in print). These also serve as the basic tools of graphical design, which is part of the broader field of visual communication design, alongside photography, illustration and typography. Each of these areas are, on the one hand, a subject of visual art theory and perception, and contingent on the medium and the technology through which the visualisation is present on the other hand. The field of information visualisation in its entirety must thus combine information technology, science and design. Especially important in the segment of the field that includes design is the theory of perception, which makes use of Gestalt psychology and visual art theory, the latter includes the theoretical laws relevant to visual components in general.

A quick analysis of the principal morphological elements of visual language, which include words (individual words, phrases, sentences, bodies of text), shapes/graphical elements (points, lines, abstract shapes, negative space) and images (illustrations, photographs—images that carry semantic meaning) tells us that all these elements feature diverse attributes that are controlled by variables: thickness, texture, colour (hue, saturation, value), orientation, size, position within 2D or 3D space, motion, etc. Combined into a whole, these elements constitute a *visualisation*. Variables are supremely important; in addition to their inherent value they also influence one another. Accordingly, they must be chosen sensibly, both in terms of their functional transformation and their visual image.

Elements of visual language can roughly be categorised into static (largely, but not exclusively, two-dimensional, for example icons, pictograms, diagrams, charts, maps, spreadsheets, infographics) and interactive (allowing us to better utilise three-dimensional space; examples include interactive graphics and data visualisations). Depending on the intent and/or the research question, a lot of information can be displayed through visualisation: when something started, the position of something in time, how long something took; the quantity of something, what proportion each quantity represented in relation to the whole; we can show the order, the sequence of things; we can categorise them according to specific parameters or show them in a hierarchy; we can arrange them in space (geographical, political, cultural); we can show the trajectory, the process or the development of a particular movement, as well as the causal relationships between the elements we are interested in.

Interdisciplinarity

Indeed, it is in the field of science that we can often spot very basic errors in the use of colour, form and hierarchy. These errors stem from a lack of familiarity with visual language, so it is crucial that such projects are approached in an interdisciplinary way. It is also true that even scientists are increasingly aware nowadays of how important it is to be familiar with the tools used to create quality visualisations. This is evidenced by the publication of articles on art and art theory in natural science-focused journals. One such article was published in the journal *Nature Communications*. It discussed how colour maps can visually distort the data due to uneven colour transitions, or how they cannot be used by people with deficits in colour vision.[17] Different media (digital, analogue, spatial) demand different areas of expertise, which necessitates collaboration by interdisciplinary teams. This is likewise important in the field of data visualisation, which combines visual aspects with statistics and art with science. The visualisation envisioned within the framework of the research project "Models and Practices of Global Cultural Exchange and the Non-Aligned Movement: Research in the Spatio-Temporal Cultural Dynamics" will therefore necessarily have to involve at least three fields of expertise: building, managing and maintaining databases (architecture, design, art history), maintenance of digital databases and algorithm development (information and computer sciences), and the field of visual communication (information design, which develops visual elements of user interfaces and ensures the readability of the data collected, based on the definition of the users). Only through collaboration will we be able to visualise the patterns and structures contained in the data obtained in the project (people, institutions, locations, dates), as well as the relationships between these elements. The visualisation should ideally permit the comparison, matching, distinguishing, arranging, aggregation by variables and adding new connections between elements.

17 Crameri et al., The misuse of colour.

Criteria of excellence

In general, the same criteria apply to data visualisation as to visual communication in general. They can be divided into three groups according to: relevance (how well does the result serve a specific purpose), which is also about functionality; excellence of individual components; and excellence of all the elements as combined into a whole. The criteria can be subdivided further according to the three phases of the process: design, planning and execution/implementation.

In design, it is important to analyse the problem thoroughly and plan the concept sensibly based on the content that we want to convey; to choose the medium of communication based on the context; to ensure originality, innovativeness, inclusivity and sustainability in planning and to be as thorough as possible in managing data. As each dataset in the research project could potentially be incomplete, we need to introduce certain safeguards, or have suitably customised sets of research questions ready. In the absence of input data, certain research questions may not be correctly presented, or may be incomplete or even incorrect.

During planning, we can evaluate aesthetic and artistic consistency, adherence to genre and support of content, quality of individual elements (e.g. legibility of typefaces, appropriateness of other visual elements/graphic elements, potentially illustrations and photographs), the consistency of the combination of pictorial and typographic language, linguistic appropriateness, functionality of the design (clarity, rationality), navigation through the material and its hierarchical structure, appropriateness of the testing methods, and the quality of the iteration, or refinement, of the prototype.

In the execution phase, we focus on technical quality (user experience, quality of the user interface in terms of functionality, complexity of the application) and the use of interdisciplinarity.

Possible Further Steps

The truth is, unlike analogue printed books, a digital project, even once published, is never truly finished. It can always be built upon, new layers added. New information can always expand the field of understanding. Here I will outline some options for future developments or approaches that ought to be taken in similar projects.

The project as it stands is not externally linked. Interaction with other databases created in similar projects and the interconnection between them is something that should probably have been considered before the project started, as that is when many of the factors for capturing, recording and visualising data were being defined.

An extended testing phase would also be necessary—if researchers were given more time in advance in the project programme to use the tool in-depth over a longer period of time, they would be better able to observe the interaction and give better feedback to the tool developers and designers on what is needed. The result would be an even closer alignment of the tool with the research objectives of the project. In an even more ideal scenario, during the course of the project, the interactive visualisation could already allow the project participants to adjust the research process and enrich the individual teams of researchers during the process.

Opening up the access to the visualisations to other potential scientific users would also be welcome, as a broader view would allow interdisciplinary enrichment of the task. To make this possible, a different project design would be required, which would financially allow the construction of two different models that could be tested with different users. They would look at the models, use them and reflect on their experiences and potential improvements in informal focus groups. The improvements would then be integrated in collaboration with the users active on the project.

The process of collaboration itself could be improved by eliminating the jargon that is so pervasive in professional silos, especially in the field of information and communication technologies. Especially in international collaborations, it can be a distraction, complicating ongoing communication. In addition, the introduction of plain language[18] into the interactive environment is of paramount importance, as verbal components, regardless of their visual design, are a key carrier of information for the user.

It is clear that well-conceptualised content is one of the key elements of a project's success. It is the same with visual content design: if clearly conceived in the first place, the results will be better and the project more usable. As for the conceptual approach to the whole project, many of the conundrums we have mentioned could certainly easily be solved by an effective co-design approach. This approach has long been present in design, and as Barbara Predan writes: "the numerous practices, methods and tools can be used as a basis for establishing an operating framework and instructions for tackling the individual steps in the process of collective

18 Abroad, the terms for easily understandable language used in information design literature are "clear language", "plain language" and "simple language", and are used to better communicate with a variety of users, but largely in the administrative and legal environment of government institutions. In Slovenia, however, the term *lahko branje*, "easy-to-read," is gaining ground, especially in the field of special needs and pedagogy (See: A. To. 2021).

co-creation and co-design and how to continually adapt them to the situation at hand".[19] It is precisely because of this apparently open approach that co-design can be effective in interdisciplinary projects like ours.

Part of the principle of rational planning is that it links design with science, which in modern times likewise has an extremely important responsibility to communicate clearly and understandably both to professionals and to the general public. Considering that it might well be visual language that is their common point, which "increases learning speed", "decreases learning errors", "contextualises interpretations" and "allows for more complex expression",[20] I see careful planning of all steps in interdisciplinary projects of different professions as the only possible approach.

19 Predan, A Discussion of Processes, p. 4.
20 Horn, *Visual Language*, p. 249.

SOURCES AND LITERATURE

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