

Extending Recommendations for Creative Visualization-Opportunities Workshops

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ABSTRACT

Participatory design is an approach in human-computer interaction that involves all relevant stakeholders coequally in the design process. A recent participatory method for visualization design is the creative visualization-opportunities (CVO) workshop, which is used to efficiently develop visualization design requirements in the early stages of applied visualization work. In this paper we report on our experiences of running four CVO workshops in different domains with diverse participants to explore new methods and variations of workshop variables. Through reflection on our experiences, we propose two contributions that extend existing guidance for planning, executing, and analyzing CVO workshops: a set of 12 pragmatic recommendations that extend and complement existing ones; and a recommended method for analyzing workshop results, called user stories. Additionally, we report on the outcomes of our successful workshops to provide evidence for the efficacy of CVO workshops.

Keywords: Participatory design, visualization workshops, qualitative analysis

1 INTRODUCTION

One of the most important parts of the process of developing effective technology is the initial requirements analysis phase, which has historical roots in software engineering methodologies [7]. This phase is critical to get right as it establishes the basis for all other design, development, and deployment efforts that follow [17]. When developing visualization tools, working closely with domain experts who will use the system regularly is considered a crucial part of requirements analysis [21].

A common approach for conducting requirements analysis is via interviews in multiple sessions with multiple stakeholders, which can be lengthy and time consuming. To reduce the time and effort of developing visualization design requirements, Kerzner et al. propose a participatory approach, called creative visualization-opportunities (CVO) workshops [6]. CVO workshops minimize the time needed for the initial requirements analysis through the use of structured activities that encourage creative, group brainstorming between domain experts and visualization experts. The CVO workshop framework emphasizes that creating an effective workshop is a design problem because practically infinite combinations of various workshop variables and methods are available. To provide actionable guidance, however, the framework includes 25 guidelines and pitfalls, and an example workshop schedule based on the authors' experience of running 17 of them.

In this paper we report on our experiences running four CVO workshops to provide further, pragmatic guidance for using this approach in a diverse set of contexts. Our workshops targeted a broad set of domain problems and participant backgrounds:

- tracking students' academic progress; with students, faculty, and university administrators from the University of Vienna
- tracking the international drug trade; with field officers from the United Nations
- analyzing modern and historic social networks; with digital humanities researchers from two research institutions in Paris
- measuring the influence of politicians on language change; with linguistics researchers from the Austrian Academy of Sciences

We used these workshops to try new methods and explore variations of workshop variables. Through reflections on our experiences, we learned about important considerations for success that were not explicated in the original framework, and we also found surprising challenges due to the different social contexts of our workshop participants.

The first contribution of this work is a set of 12 pragmatic recommendations for planning, executing, and analyzing CVO workshops that extend and complement existing guidance [6]. These recommendations bolster interpersonal dynamics, improve the efficacy of activities, and enable richer post-workshop analysis. A second contribution is a recommended method for analyzing workshop results, called *user stories*, that supports developing visualization requirements based on emergent workshop themes. This method fills the gap within existing guidance on how to analyze the diverse data and ideas created during a CVO workshop. Additionally, this paper reports on three successful workshops that directly led to visualization prototype development, providing evidence for the efficacy of CVO workshops in practice.

In the remainder of this paper, we first describe related work in Section 2, followed by our research methodology in Section 3. We then present our recommendations for the planning, execution, and analysis of future workshops based on our experience throughout the four workshops in Section 4 and elaborate on the user stories method for developing visualization design requirements in Section 5. We conclude with a discussion in Section 6.

2 RELATED WORK

Participatory design emerged in the 1960s as an activist approach that includes future users of a product in the design process, making them active and coequal design team members [15]. Muller et al. [14] define participatory design as a set of practices that operate in a third space in human-computer interaction, located between the domains of the user and the technology developer. A number of research papers report on these practices [3, 9, 16, 22, 23] and Kyng [8] shows how participatory design evolved over the years by differentiating early and recent participatory design. In their survey of 102 research papers submitted to the Participatory Design Conference over the course of ten years, Halskov et al. [4] highlight the diversity of participatory design approaches and categorize them into five contributions. A variety of outcomes can result from participatory design projects: Whittle [23] classifies tangible outcomes of six participatory design projects into seven main types (e.g. academic papers, digital prototypes), and Bratteteig et al. [1] report on how outcomes can be described and evaluated.

Targeting visualization design practices, Kerzner et al. [6] propose creative visualization-opportunities workshops as a participatory

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design approach for identifying domain problems and exploring visualization opportunities. These workshops bring visualization experts and domain experts together for up to a day of focused brainstorming efforts. The CVO workshop framework is based on the authors' reflective analysis of their experiences conducting 17 workshops, and includes an example workshop consisting of a set of structured activities meant to encourage and facilitate creative, group brainstorming. These suggested activities are:

- *Analogy Introduction*: Participants and facilitators introduce themselves and answer an icebreaker question to establish a friendly and trusting environment.
- *Wishful Thinking*: With the workshop theme in mind, the participants brainstorm on what they want to know, what they want to do, and what they want to see of their data.
- *Barrier Removal*: Participants identify potential barriers to their 'know', 'do', and 'see' ideas, and the what possibilities might exist if those barriers were removed.
- *Visualization Analogies*: Analogies are a passive activity to present related work and existing visualizations to the participants that encourages them to think outside the box.
- *Storyboarding*: Participants sketch ideas of a (possibly interactive) visual data representation that supports ideas generated earlier in the workshop.

The framework also includes recommendations and pitfalls for planning, executing, and analyzing workshops, characterized by a set of key factors important for success. These factors are referred to as TACTICs, capturing the importance of ensuring the participants stay focused on the topic of the workshop; building the participants' agency in the workshop and resulting outcomes; establishing collegiality and trust for effective communication and collaboration during the workshop and beyond; and maintaining interest and managing challenge throughout the activities. We characterize our recommendations in Section 4 by these TACTICs.

Several theoretical papers recommend CVO workshops as a useful method for visualization design projects [12, 13]. Additionally, Bressa et al. [2] report on conducting multiple visualization workshops, which are related to CVO workshops, offering a set of pragmatic recommendations; these recommendations, however, focus on sketching approaches and materials for design. No papers have further reported on explicit guidance or insights for running or modifying workshops for developing visualization design requirements, however. This paper provides these details from our experiences of running four workshops in a diverse set of contexts.

3 METHODS

Our recommendations are based on four workshops we conducted over the course of one year. In this section we detail our process of planning, executing, and analyzing each workshop, which took approximately three months for each; the domain themes and participants for each workshop; the variations in the workshop structures that we explored; and outcomes of each workshop.

3.1 Process

We conducted our research using an iterative process in which each iteration is divided into three phases: preparation, execution, and analysis of each workshop. In the preparation phase, we defined the workshop theme according to the domain and the questions that we wanted to answer. The first step was to gather information about the domain and the data we wanted the participants to work with. We conducted initial, individual meetings with collaborators from our four partner institutions (University of Vienna, United Nations, Université Paris-Saclay, and the Austrian Academy of Sciences) to define the focus of the workshops. We obtained example data sets to get a better understanding of what data they are working with. Based on this information, we decided on the workshop activities

that we thought would help us best to answer our questions about the domain.

After the initial meeting and planning, we then invited prospective participants who were preselected based on different criteria, such as diverse stakeholder needs and backgrounds. We also recruited facilitators to help during the workshop. The last part of the preparation phase was to conduct a pilot workshop in which we defined the role of the facilitators and tested all the activities to get a common understanding of what we wanted to get out of the workshop.

In the execution phase, we conducted the workshop based on our planning from the previous phase. Each workshop was conducted on site at our partnering institutions. The participants were given an introduction to the workshop and the upcoming activities. During the different activities, the participants were guided and supported by the workshop leader and the facilitators. Additionally, we observed how the participants responded to certain activities, how they worked together as a group, and how their motivation varied throughout the workshop. To help with the analysis afterwards, we took notes as well as captured audio recordings and photos with the permission of the participants.

Each iteration concluded with an analysis of the preparation and execution phases. This analysis was done immediately following the workshops to ensure a good recall of facilitator observations. We transcribed audio recordings of the discussions in the workshops and combined them with the photos we took to richly capture discussion contexts for potential further analysis. We focused on analyzing the different tangible (e.g., storyboards) and intangible (e.g., ideas) outcomes of the workshop; challenges we faced during the workshop and the preparation; observations on the workshop day; and lessons we learned from the workshop. To support our analysis, we conducted a survey at the end of the first and second workshops to get feedback about the participants' experiences during the workshop. Additionally, we maintained a reflective journal [18] about our experiences throughout our research. The results of each analysis were used to improve and vary the design of the subsequent workshop.

We also created detailed reports on the workshop findings, which we provided to our partner institution for further development. These reports contained a detailed summary of all activities and their results. Additionally, we derived multiple project proposals from the results and gave recommendations on how to structure and implement them. These reports were used in three of the four workshops for subsequent development of visualization systems. This paper's supplemental material contains information on the structure, content, provided materials, and outcomes of each CVO workshop.

3.2 Workshop Themes

For each of our four workshops, we worked with a different partnering institution. An overview of the structure of the workshops is shown in Table 1. For reasons of clarity and comprehensibility, we will use the workshop id to reference the different workshops in the upcoming sections.

The first workshop (W1) focused on analyzing the students' academic progress in order to improve specific administrative processes and was done in cooperation with the University of Vienna. The goal was to find out what insights from the student data (records of every student including registered courses, grades, etc.) can be used in order to improve processes (e.g., registration, course planning) and to support students (e.g., visualizing their academic progress).

The second workshop (W2) was about tracking the international drug trade to understand when, where, and how drugs are moved across borders in order to interdict. This was done in cooperation with the United Nations (UN) in Vienna, and involved field officers working in different countries. Our collaborators at the UN provide and maintain a number of secure communication platforms that allow for the exchange of information, intelligence, notifications, and alerts related to precursors, chemicals, equipment, and new psychoactive

	Workshop 1 (W1)	Workshop 2 (W2)	Workshop 3 (W3)	Workshop 4 (W4)
Participants	14	11	8	15
Facilitators¹	3	2	6	3
Duration	Full-day	Half-day	Full-day	Half-day
Data Set	Student data	Drug incident data	Historical data	Political data
Partner	University of Vienna	United Nations	Université Paris-Saclay	Austrian Academy of Sciences
Location	Vienna	Vienna	Paris	Vienna
Language	German	English	English and French	English

Table 1: Summary of the four workshops

substances between governments. User interfaces rely on simple queries to provide results as lists on a screen or in spreadsheets. The systems do not allow for the integration of other potentially relevant sources of information, which may be valuable for analysts and investigators, such as individual drug seizure sources. User interfaces do not allow field officers to visualize any of the incident data or information to which they currently have access. The goal of the workshop was to find out how visualization could help field officers with their daily work.

The third workshop (W3) was prepared in cooperation with our partners at the Université Paris-Saclay. We invited digital humanities researchers from École des hautes études en sciences sociales and Centre national de la recherche scientifique in Paris who work on modern and historic social networks. They analyze these networks to find new insights (e.g., social communities) or validate prior hypotheses about the data. These networks are often large (hundreds of nodes) and dynamic (they change over time). The goal was to find out what about a network is interesting to them and what requirements they have in order to develop a visual tool to support their network analysis.

The last workshop (W4) was conducted as part of a research project, where contemporary media corpora and parliamentary speech data are analyzed by linguists and digital humanities researchers in Vienna. Funded by the Austrian Academy of Sciences, the research project aims to gain insights into the dynamics of the Austrian German lexicon in the last 20 years and to measure the influence of politicians on language change. Two corpora are used for this analysis: the collection of speeches in the Austrian Parliament and the collection of journalistic prose in the Austrian media. One of the goals of this project is to develop a web-based interactive tool that retrieves the constructed lexical networks and allows us to explore, analyze, and visualize them. In this workshop, we aimed to gather ideas about the possible functions and features of a visualization tool, which would be built following a user-centered design approach.

3.3 Workshop Structures

For each workshop, we strove to invite stakeholders from different departments and backgrounds to ensure a rich set of ideas and outcomes. The number of facilitators relative to the number of participants in W3 was higher than in the other workshops because our partnering institution included visualization collaborators on the project who also served as facilitators. Two of the workshops were half-day workshops (W2, W4), and the other two were full-day workshops (W1, W3), which allowed us to explore how different workshop lengths affected the workshop results.

Each workshop consisted of multiple consecutive activities designed explicitly around the workshop theme. We tested different variations of the activities between the workshops to see how such variety would affect the dynamics and outcomes. We refer to the supplemental material for more information on the workshop structures. We found many successes in our variations, but also a number of failures; these informed our recommendations detailed in Section

¹Does not include the workshop leader.

4. Each of the four workshops started with an introduction to the workshop theme, the structure of the workshop, and some creativity guidelines. Additionally, all participants and facilitators introduced themselves and answered an icebreaker question to encourage a friendly and trusting environment.

In every workshop, we used the activities suggested in the example workshop from the CVO workshop framework [6], which we briefly described in Section 2, with the exception of barrier breaking. For the half-day workshops, we planned to omit one activity due to time constraints; thus in W2, we let the participants decide whether they wanted to do barrier breaking or storyboarding. In the end we had to extend the workshop by 90 minutes because they wanted to do both. We decided to omit barrier removal in W3 because we wanted to extend the time for storyboarding and in W4 due to the time constraint of a half-day workshop. The detailed schedule of each workshop can be found in the supplemental materials.

3.4 Workshop Outcomes

The workshops focused on exploring visualization opportunities. The analysis of the workshops resulted in high-level understandings of the tasks and visualization needs of our application partners. All workshops were successful in terms of supporting visualization experts in characterizing domain problems and gathering requirements from the participants. Furthermore, the analysis results from three of the four workshops were subsequently used by our partner institutions for developing the designs of new prototypes of visual analysis tools in close collaboration with the future users of the systems. Pretorius et al. [20] argue that not only is it important to look at what the user wants to see, but also at what the data want to be. We agree that understanding the data in detail was crucial for planning, executing and analyzing the workshops. Multiple meetings with data experts from our partnering institutions during the preparation phase helped us gain insights into the data. Another important challenge they report on is that what end users look for in the data is often fuzzy. The workshop activities were designed to avoid this problem and to help participants articulate their ideas more easily. The results from three of the four the workshops were used by our partner institutions for the iterative prototyping of new visual analysis tools in close collaboration with the future users of the systems.

Based on the results of W1, the University of Vienna is implementing a new course registration interface for students that visualizes their progress and helps them plan their semester. The goal is to support them in their organization in order to improve efficiency. In addition, a planning tool for courses is being developed to help the university staff. This tool allows the staff to plan courses in upcoming semesters through analyzing data from previous semesters and calculating predictions.

The United Nations has developed a tool for visualizing international drug traffic based on the results from W2, which is now in use. We found that analyzing international drug trafficking data is a complex task that requires significant cooperation among multiple agencies from different countries. This tool provides a common interface with geospatial and temporal parts visualizing the data from several systems that report on drug incidents. The workshop

was also successful in terms of identifying important aspects such as security considerations and inconsistent data, which are being considered carefully during the development process.

After W4 was conducted, the collected output of the workshop was digitized and analyzed. Based on this analysis, primary user profiles were defined, and user stories, as described in detail in Section 5, were formulated. Following these definitions, a user story map was drafted, and this map is currently being used by the designers and developers to advance the high-fidelity prototypes to the next iterations of the visualization tool.

4 RECOMMENDATIONS

The CVO workshop framework [6] proposes guidelines for every stage of planning, executing, and analyzing workshops. We frequently referred to these recommendations as we designed our own workshops, but found ourselves with many open questions about details not covered in existing guidance. Additionally, we confronted different social contexts with some of our participants from those in the original set of workshops the framework was built from. As a result, we developed new pragmatic guidance for running CVO workshops in diverse contexts that complements and extends existing recommendations, which we detail in this section. We relate the new recommendations to the **TACTICS** introduced by Kerzner et al. [6] to highlight the various ways in which these recommendations contribute to the success of workshops (see Table 2).

Be on a first-name basis (R-1). A successful CVO workshop requires a friendly and open environment to ensure `collegiality` and `trust` across the participants. It is important to establish this environment from the beginning of the workshop. We experienced multiple factors that can negatively influence the atmosphere and feelings of equality during the workshops: hierarchical cultures that value formality and emphasize honorifics; hierarchical work environments such as university accountants versus rectorates; and different ranks such as frontline officer versus department heads. We recommend having participants wear name tags with only their first names to promote equality as well as mutual respect. Especially in W1, we could see the positive effect of these name tags on the group dynamic as the participants from various university departments and service units with different ranks were more open in communication during the workshop than we experienced in other meetings.

We also recommend formulating an icebreaker question for the introduction of the participants and facilitators related to the workshop theme, such as *"If you could go back in time and redo your studies, what study program would you choose?"* in W1, and *"If you could travel in time, which year/era would you travel to and why?"* in W3. This approach encouraged participants to open up and personalized the workshop `topic`. We could see the positive effect of the icebreaker in three of our workshops (W1, W2, W4).

Plan space for sharing ideas (R-2). In addition to having a friendly environment, ensuring a physical space that facilitates the creative process encourages `collegiality` and lowers the `challenge` for participants is important. We recommend providing a seating arrangement that allows for discussions where participants face each other without having any barriers between them. We used U-shaped (W2, W3, W4) as well as circular arrangements (W1) of the seats in the workshops. U-shaped seating arrangements, shown in Fig. 1, allowed the speaker to present at the open end of the formation where every participant has an unrestricted view to follow the presentation, as. Additionally, sitting participants next to others who do not work with them led to interesting and insightful discussions during small group brainstorming. Finally, the room should provide enough space for individual subgroups to work uninterrupted in separate parts.

We also recommend keeping clear instructions for each task visible during the respective activity so that participants can refer to them if something is unclear. This recommendation is based on our



Figure 1: The physical workshop space should facilitate the creative process: The u-shaped seating arrangement allows for discussions where participants face each other without having any barriers between and allows the speaker to present at the open end of the formation where every participant has unrestricted view to follow the presentation. Moreover, the workshop room should provide enough space for individual subgroups to work uninterrupted in separate parts.

experience from W3 where participants repeatedly misused sticky notes due to instructions being not easily accessible throughout the activities.

Conduct full-day workshops when possible (R-3). We conducted two full-day (W1 and W3) and two half-day workshops (W2 and W4). Based on our experiences, we advocate for doing a full-day workshop whenever possible to have enough time to work on the `topic` and address the participants' `interest`. A full-day workshop affords enough time to expand activities that can require more time, such as wishful thinking and storyboarding. Due to increased time in these activities, full-day workshops can result in a very rich and abundant set of ideas and outcomes. Keeping participants motivated throughout the day, however, can be challenging. We recommend at least one big break, such as lunch, and multiple short breaks in between tasks to allow participants time to refocus and recharge. Full-day workshops are also recommended if more than 10 participants are in attendance.

Half-day workshops, however, can benefit from a compact timeframe in which participants maintain focus. They are useful to conduct focused tasks in a short amount of time if the participants are not able to spend a full day at the workshop or if very specific information is needed. The risk, however, is not having enough time to go into detail about interesting ideas or that some activities have to be cut short. Additionally, half-day workshops usually generate fewer ideas and outcomes than full-day workshops, and, thus, activities should be planned accordingly.

Think outside the (data) box (R-4). For several of our workshops, we realized through planning phase discussions that the existing structure, representation, and storage of data was a barrier for our partners in imagining new and innovative ways to work with their data, similar to the findings of others [20]. Thus, we prepared a data abstraction for each workshop (included in the supplemental material) to provide a common `topic` and to encourage participants to brainstorm without being constrained by a particular data representation. We introduced these data abstractions in the beginning of the workshops. For example, we learned that analysts at the United Nations use data from three systems for their analysis process. These systems store similar kinds of data but are completely different in structure and level of detail. Therefore, for W2 we abstracted the data for drug incidents. This data abstraction allowed participants to focus on a concept with which they are all familiar and helped us adapt the workshop to the domain.

Use participants' native language (R-5). Successful CVO workshops depend on active participation and vibrant discussions. Therefore, using a language with which participants are confident

and comfortable is important. We experienced that at least half of the participants in W3 seemed to be very hesitant to talk in English. They switched to their native language of French at certain points, which made facilitating the workshop difficult since some facilitators did not speak French. We did not identify this problem in the other workshops because participants were very comfortable speaking in German (native language) in W1 and speaking English (working language) in W2 and W4. Evaluating which language to use based on the proficiency and willingness of the participants in advance is crucial. We recommend using the language that participants most often employ at work for effective communication that encourages collegiality and decreases the challenge of engagement.

Protect the group dynamic (R-6). Ensuring a good group dynamic throughout the workshop is essential for maintaining agency and collegiality, and to ensure a rich set of ideas and outcomes. We found in one workshop that a dominant participant who did not consider the input from others narrowed the space of ideas. We recommend having facilitators manage group dynamics by actively ensuring equal speaking time for each participant.

In another workshop, we had one facilitator actively participate in the discussions, pushing the group toward their ideas and similarly narrowing the workshop outcomes. We recommend that facilitators actively limit their input to workshop discussions, and intervene only to guide participants if they go off track to keep them focused on the topic.

Have participants, not facilitators, aggregate ideas (R-7). In some activities such as wishful thinking and barrier removal, participants are required to write their answers down, share them with the group, and cluster them into higher level themes. In W1, the facilitators collected all of the participants ideas by writing them down on a whiteboard and taking the lead of clustering them into themes. The results led to some disagreements with the participants and had to be later revised. In subsequent workshops, we gave participants sticky notes, shown in Fig. 2, for writing down their ideas, and we encouraged them to collectively discuss and cluster the sticky notes on a whiteboard to promote agency as well as collegiality. We had the participants vote on their clustering results, which gave us an indication of the importance of each theme. Having the participants lead the effort of aggregating ideas into themes not only increased their agency within the workshop, but also resulted in better consensus regarding important themes. Additionally, we recommend providing markers with large tips to encourage participants to abstract their ideas to key phrases, increasing the challenge of the activity.

Be aware of priming effects (R-8). Considering how the workshop and its outcomes could be affected if participants are primed toward specific ideas is important. We have seen different effects of priming in our workshops. In W3, we presented examples of different visualization tools closely related to a specific domain problem (clustering of networks). This priming caused the ideas and themes found in wishful thinking to be very narrow and specific. On the contrary, we presented a very diverse set of visualization examples from different domains that are not directly related to the workshop theme in the other workshops. This approach resulted in participants thinking creatively and outside the box, thus leading to a richer spectrum of ideas than in W3. We argue that a potential priming of the participants depends on the use case and should be planned according to the workshop topic and goals.

Set expectations for storyboarding (R-9). We presented example storyboards — which we created prior to the workshop — to give participants ideas of how a storyboard could look. In W1, we created different examples of storyboards during the pilot of the workshop; in W2, W3, and W4, we used storyboards from the previous workshops as examples. After W1, we received feedback that some examples were intimidating to the participants as they were done with a high level of fidelity that was not possible to achieve



Figure 2: For group activities such as wishful thinking and barrier removal, we suggest using sticky notes to gather ideas and find themes. This approach allowed us to collect the sticky notes with different category colors and group them on the whiteboard. Rearranging sticky notes is easy and makes the finding of themes a very dynamic process. Additionally, we let people vote on the derived themes, which gave us an indication of the importance of each theme.

in the given time. We recommend providing quick sketches instead of high-quality productions to decrease the intimidation and challenge of participants approaching storyboarding activities. The storyboards which were created in the workshops are included in the supplemental material.

Try a VisKit (R-10). In contrast to promoting low-fidelity by sketching ideas, we simultaneously wanted to provide participants the opportunity to increase the fidelity of their storyboards through a visualization kit (“VisKit”). After seeing how much time people needed to create a storyboard in W1, we wanted to make the activity even more effective and efficient. The VisKit facilitates the task of creating a storyboard by providing basic charts and plots that can be cut out and pasted on the cardboard. Additionally, we provided cutouts of the visualization tools we presented in the visualization analogies. All the cutouts were available in different sizes and without axis labels so they could be adapted in any way the participants wanted. We refer to the supplemental material for further information on the VisKit. Providing the VisKit to the participants was a great success since it reduced the time needed to create the storyboard and made the storyboards even more clear. We highly recommend using a VisKit for storyboarding to give participants support for decreasing the challenge of the activity.

Bolster storyboarding capabilities (R-11). Storyboarding usually ends with participants presenting their ideas to the group, talking through conceptual interactions with their static storyboards. In W3, we wanted to incorporate interaction more directly into the creation process of the storyboard to give the participants more possibilities for their presentation while decreasing the challenge. We decided to use cameras to capture a short video showcasing the functionality of the dashboard. We adapted the concept of *video prototyping* [10, 11], which had been used by our partners previously. We used tablets containing an original video editing software from our collaborators in Paris for capturing the video, which was specifically programmed to support video prototyping. We also made sure that the participants did not have to interact with the software to save time and let the facilitators — who were introduced to the software in advance — capture the video. Video prototyping encourages participants to consider interaction in their design choices and gives them the opportunity to showcase different use cases in multiple scenes. Additionally, a structured prerecorded video makes communication back to the larger group easier. We recommend using video prototyping if interaction is of additional interest, but we argue that it should be used only in full-day workshops since it is more time

ID	Recommendation	T	A	C	T	I	C
R-1	Be on a first-name basis			x	x		
R-2	Plan space for sharing ideas			x			x
R-3	Conduct full-day workshops when possible	x				x	
R-4	Think outside the (data) box	x					
R-5	Use participants' creative-native language			x			x
R-6	Protect the group dynamic	x	x	x			
R-7	Have participants, not facilitators, aggregate ideas		x	x			x
R-8	Be aware of priming effects	x					
R-9	Set expectations for storyboarding						x
R-10	Try a VisKit						x
R-11	Bolster storyboarding capabilities						x
R-12	Record audio and take pictures	x					

Table 2: 12 recommendations for planning, executing, and analyzing CVO workshops with reference to the TACTICs for effective workshops introduced by Kerzner et al. [6]. TACTICs refer to topic, agency, collegiality, trust, interest and challenge.

consuming than traditional storyboarding. The video prototypes that were created in W3 are included in the supplemental material.

Record audio and take pictures (R-12). Each workshop produced various tangible and intangible outcomes. Even though the original CVO workshop framework [6] does not advocate for audio recording, we decided to try it in our first workshop. We analyzed the outcomes (e.g., sticky notes, storyboards, video prototypes) of W1 in the first days after the workshop but sometimes still could not recall some of the context in which participants' ideas were created by just using the tangible artifacts and our memory. We found it helpful to be able to listen to the audio recordings of the discussions about the `topic` for recalling the missing context during the analysis process. Additionally, we found it very useful to take pictures during the workshop to capture the setting of the different activities for comparing different workshops and to enrich the analysis reports.

5 USER STORIES FOR ANALYZING WORKSHOP OUTCOMES

Analyzing the artifacts created during a workshop — sticky notes, aggregated themes, sketches, storyboards, photos, audio recordings, facilitator notes — is a messy and challenging problem. The CVO workshop framework recommends organizing the artifacts into a corpus, and performing qualitative analysis to extract meaningful design requirements. But what kind of analysis? And what are the resulting outcomes?

For each of our workshops, we analyzed the workshop artifacts and generated documents of visualization design requirements for our partners, but we did so in different ways. In workshops W1 and W2, we conducted a reflective analysis and produced written reports that documented both the workshop structure and provided suggested visualization opportunities. In W3, we reflectively analyzed and documented the outcomes with our collaborators. Although these analysis results led to the development of new visualization tools by our partners, we opted to try a different method in W4, that of *user stories* from agile software development. The result was a structured transition from the requirement analysis to design and implementation phases in the project, in which we produced various low-fidelity and high-fidelity prototypes based on the user stories. The software development for the visualization tool is currently progressing while using the user story map as a blueprint.

User stories are a core component of agile software development, one of the leading approaches for software development. The aim of user stories is to briefly describe a granular feature of the tool from the user's perspective [5]. Kalbach [5] argues that using user stories can make development more manageable; however, it can have the side effect of teams losing the big picture of what they are building, because focusing on single features can give them tunnel vision. To avoid this negative effect, Patton [19] proposes a technique called *user story mapping*, which allows the project team

to have an overview of all user stories and to align development tasks with the intended user experience. Based on these methods, our approach was to extract user stories from the workshop results and position them on a user story map. We applied user stories and user story mapping approaches from agile development as a means of analyzing the workshop outcomes for W4. We recommend user stories as an analysis method for future CVO workshops, and detail a workflow for creating them based on our experience in this section.

Step 1: Analyze the workshop materials. As the first step, we suggest having an initial workshop analysis meeting with the workshop facilitators and project team, where the collected workshop materials (photos, videos, voice recordings, sticky notes, sketches, etc.) are transcribed, digitized, and annotated. Some actionable steps here are removing the duplicate items, aggregating the similar notes and materials into common ideas, and grouping the workshop output based on the activity that they were created within.

Step 2: Define user types. Using the analyzed workshop materials, we suggest defining primary target user types. Finding these user types can be achieved by going through the collected material, such as sticky notes and storyboards, and grouping them based on the profile and background (e.g., academic or professional) of the participants. At this stage, considering the diverse set of people the tool is going to be designed for is important.

In W4, we identified the following target user types: linguist, media researcher, and digital humanities student.

Step 3: List and label user actions. Using the output from the wishful thinking activity, define the most important actions ('know', 'do', and 'see') for each theme cluster. Next, label each of the defined actions with a user type(s). We found that using the characteristics of participants who suggested and prioritized various actions to be a useful indicator of which user type to assign to the actions.

Step 4: Create user stories. Formulate user stories for each theme cluster and each user type using the following template: "*I'm a [type of user], I want to [goal to achieve], so that I can [reason for the action].*"

Several user story examples from W4 are:

- I'm a linguist. I want to compare the similarity network of a word from one year with another, so that I know if there is a change in the usage of the word.
- I'm a media researcher. I want to search for a politician and see the distribution of sentiment scores in the media, so that I can see if different media sources report with different sentiments towards certain politicians.
- I'm a digital humanities student. I want to compare the networks of target words that I think which are synonyms, so that I know if different words are used for the same concept.

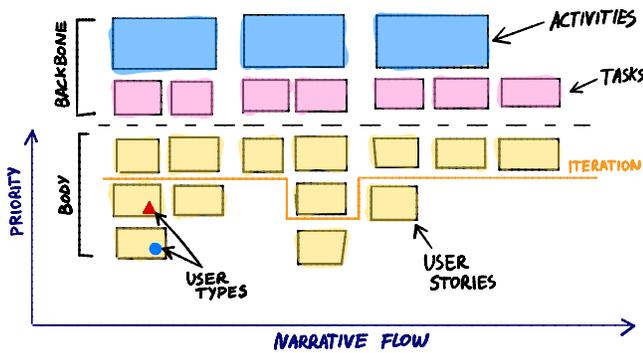


Figure 3: A user story map example: Backbone section contains a sequence of user activities and their more granular descriptions as user tasks. All items follow a horizontal narrative flow from the user’s perspective while using the tool. Body section contains the user stories, which act as detailed subtasks belonging to the respective task and activity from the backbone section. User stories can be tagged with user types and grouped by development iterations. The high-priority user stories are placed vertically higher and inside earlier iteration groups.

Step 5: Place the user stories on a user story map. A user story map, shown in Fig. 3, gives an overview of all user stories and aligns them with the development tasks. The first section of the user story map, the backbone, contains a sequence of user activities and their more granular descriptions as user tasks. The body section of the user story map contains the user stories, which act as detailed subtasks belonging to the respective task and activity from the backbone section. All items follow a horizontal narrative flow from the user’s perspective while using the tool. User stories can be tagged with user types and are grouped by development iterations. The high-priority user stories are placed vertically higher and inside earlier iteration groups.

Based on the user stories we defined in the previous step, we create a user story map with activities, tasks, and subtasks. At this stage, the project team is encouraged to have discussions about the priorities of different user stories and realign them on the board. The final alignment of the items can be used to define a group of user stories to be implemented in the first iteration. The remaining items can be saved in the backlog for further iterations.

Following the user story map and consulting the sketches produced in the CVO workshop, the designers can create initial prototypes, which will then follow the conventional design, development, and evaluation cycles as the design study progresses. The user story map is a dynamic board that can and should be revisited and edited as the project progresses. This overview reference allows the team to have the big picture of what they are building while working on the smaller chunks of the software.

6 DISCUSSION

We found CVO workshops to be an effective method for the initial visualization requirement analysis across a diverse set of domains and participants. Building on our successes, we are encouraged to continue using these workshops as these projects further develop. How might we use, or refine, CVO workshops for iterations further along in a design project for ideating on design decisions? Can they be used to evaluate visualization tools? Could they be a mechanism for getting buy-in from project gatekeepers to invest resources in developing visualization tools? We have not yet explored these opportunities, but are interested in understanding the potentials and the limits of CVO workshops for contributing to these aspects of visualization design, development, and deployment.

Despite our successes and desire to continue using CVO workshops in the future, we also experienced that planning, organizing, and conducting a workshop comes with a high cost in terms of invested time of the organizers and participants, invested money for the materials, and the required reservation of an available space. These resources might not be available for every visualization design project and in every setting. If the requirements and goals of a design are already relatively clear and the costs for the workshop are not viable, then designing and implementing with the available resources could be wiser. However, as the diversity of stakeholders in the design project increases and the requirements become fuzzier, we suggest conducting a CVO workshop whenever the scope and the resources of the project allow for it.

Almost half of our recommendations are related to *collegiality*, which matches our experience that setting the tone of the social atmosphere is a critical element of success. The selection of the participants is an important factor to be considered when planning for *collegiality* within a CVO workshop. Kerzner et al. [6] recommend recruiting diverse and creative participants, and we agree that workshops thrive if the participants are from diverse backgrounds, each having different views on the *topic* as such diversity can reveal new ideas that otherwise may never have been found. However, we also found it important to consider the potential *interest* that the participants would have in engaging with the workshop activities. Several participants in two of our four workshops did not seem to want to participate in the activities. Fortunately, this lack of participation did not have an obvious negative effect on the results of the workshop, but it did have a negative effect on the group dynamics, which we needed to contain quickly and on-the-fly as the workshops progressed. The constraints and realities of visualization projects can often dictate that people are invited for reasons other than their qualities of being a potentially great participant. In these situations, we suspect we need to inform potential participants about what the workshop will entail to ensure everyone has appropriate expectations going in.

Maintaining *collegiality* as well as addressing many of our recommendations, however, can be difficult for facilitators. We have experienced that different facilitator factors can support the implementation of challenging recommendations: having experience from previous workshops helps with facilitating future workshops (R-3, R-7, R-9, R-10, R-11); being aware of different participant types helps with customizing the workshop (R-1, R-4, R-5); and having perceptive and motivated facilitators is important for a successful workshop (R-2, R-6, R-8, R-12).

7 CONCLUSION

This paper reports on our experience of running four CVO workshops targeting a broad set of domain problems and participant backgrounds. We build upon the original framework for CVO workshops [6] to provide further, pragmatic guidance for future CVO workshops by trying new methods and exploring variations of workshop variables. Our first contribution is a set of 12 additional practical recommendations for planning, executing, and analyzing CVO workshops based on an extensive reflection on our experiences. We provide supplemental material for further information on the workshops and the collected artifacts (e.g., storyboards, video prototypes). Our second contribution is a recommended method for analyzing workshop results using the concept of user stories [5]. We give a description of our user stories analysis workflow consisting of five steps that can be used as a guideline for the analysis of future workshops.

All our workshops were a success in terms of supporting visualization experts in characterizing domain problems and gathering requirements from the participants; currently, three of them have already led directly to the development of new visual analysis tools. Building on these successes, we are interested in exploring how

CVO workshops can be used, or refined, to inform other stages of visualization tool design, development, and deployment. In terms of future work, an interesting avenue to explore would be how CVO workshops can be adapted to run in a virtual environment. What are the hardware and software requirements that would be needed to implement a virtual workshop? Which of our recommendations are still useful in this context, and which ones have to be adapted? How can we ensure a creative environment, motivate participants, and establish collegiality over distance? These are some of the critical questions we are interested in exploring as we look towards running virtual CVO workshops during the COVID-19 pandemic, and beyond. Additionally, the recommendations we give in this paper are based on our experience of workshops that took place in different locations in Central Europe. With virtual workshops that could connect participants globally, it would also be interesting to further explore how the recommendations would need to be adapted to other social contexts, taking into account factors such as different participant demographics and social norms. We speculate that, like our discovery of the importance of using a native language, other interesting factors will emerge from running CVO workshops in more diverse social contexts.

ACKNOWLEDGMENTS

We wish to thank all of the participants, facilitators, and partnering institutions for their time and participation in the workshops, as well as the anonymous reviewers for their helpful feedback. This work was partially supported by the Interactive and Visual Analysis of Networks (IVAN) project, which is funded by CHIST-ERA (together with FWF, SNSF, ANR) and the Diachronic Dynamics of Lexical Networks (DYLEN) project, which is funded by the ÖAW goldigital Next Generation grant (GDNG 2018-020).

REFERENCES

- [1] T. Bratteteig and I. Wagner. What is a participatory design result? In *Proceedings of the 14th Participatory Design Conference: Full Papers - Volume 1*, PDC '16, p. 141–150. Association for Computing Machinery, New York, NY, USA, 2016. doi: 10.1145/2940299.2940316
- [2] N. Bressa, K. Wannamaker, H. Korsgaard, W. Willett, and J. Vermeulen. Sketching and ideation activities for situated visualization design. In *Proceedings of the 2019 on Designing Interactive Systems Conference*, pp. 173–185, 2019.
- [3] L. Cortés-Rico and G. Piedrahita-Solórzano. Participatory design in practice. In J. Abascal, S. Barbosa, M. Fetter, T. Gross, P. Palanque, and M. Winckler, eds., *Human-Computer Interaction – INTERACT 2015*, pp. 518–525. Springer International Publishing, Cham, 2015.
- [4] K. Halskov and N. B. Hansen. The diversity of participatory design research practice at pdc 2002–2012. *International Journal of Human-Computer Studies*, 74:81 – 92, 2015. doi: 10.1016/j.ijhcs.2014.09.003
- [5] J. Kalbach. *Mapping Experiences a Guide to Creating Value through Journeys, Blueprints, and Diagrams*. 2016.
- [6] E. Kerzner, S. Goodwin, J. Dykes, S. Jones, and M. Meyer. A framework for creative visualization-opportunities workshops. *IEEE Transactions on Visualization and Computer Graphics (InfoVis '18)*, 25(1):748–758, 2019. doi: 10.1109/TVCG.2018.2865241
- [7] B. Kovitz. *Practical Software Requirements: A Manual of Content and Style*. Manning Pubs Co Series. Manning, 1999.
- [8] M. Kyng. Bridging the gap between politics and techniques: On the next practices of participatory design. © *Scandinavian Journal of Information Systems*, 22:49–68, 01 2010.
- [9] A. Light and Y. Akama. The human touch: Participatory practice and the role of facilitation in designing with communities. In *Proceedings of the 12th Participatory Design Conference: Research Papers - Volume 1*, PDC '12, p. 61–70. Association for Computing Machinery, New York, NY, USA, 2012. doi: 10.1145/2347635.2347645
- [10] W. E. Mackay. Using video to support interaction design. *DVD Tutorial, CHI*, 2(5), 2002.
- [11] W. E. Mackay and A. L. Fayard. Video brainstorming and prototyping: Techniques for participatory design. In *CHI '99 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '99, p. 118–119. Association for Computing Machinery, New York, NY, USA, 1999. doi: 10.1145/632716.632790
- [12] M. Meyer and J. Dykes. Criteria for rigor in visualization design study. *IEEE transactions on visualization and computer graphics*, 26(1):87–97, 2019.
- [13] M. Meyer, J. Dykes, and M. Tory. Reflection on reflection in applied visualization research. *IEEE computer graphics and applications*, 38(6):9–16, 2018.
- [14] M. Muller and A. Druin. Participatory design: The third space in human-computer interaction. *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications*, pp. 1125–1154, 01 2012.
- [15] M. J. Muller and S. Kuhn. Participatory design. *Commun. ACM*, 36(6):24–28, June 1993. doi: 10.1145/153571.255960
- [16] M. J. Muller, D. M. Wildman, and E. A. White. Taxonomy of participatory design practices: A participatory poster. In *Posters and Short Talks of the 1992 SIGCHI Conference on Human Factors in Computing Systems*, CHI '92, p. 34. Association for Computing Machinery, New York, NY, USA, 1992. doi: 10.1145/1125021.1125053
- [17] T. Munzner. A nested model for visualization design and validation. *IEEE transactions on visualization and computer graphics*, 15(6):921–928, 2009.
- [18] S. Nadin and C. Cassell. The use of a research diary as a tool for reflexive practice: Some reflections from management research. *Qualitative Research in Accounting & Management*, 3:208–217, 09 2006. doi: 10.1108/11766090610705407
- [19] J. Patton. *User Story Mapping: Discover the Whole Story, Build the Right Product*. 2014.
- [20] A. J. Pretorius and J. J. V. Wijk. What does the user want to see? What do the data want to be? *Information Visualization*, 8(3):153–166, 2009. doi: 10.1057/ivs.2009.13
- [21] M. Sedlmair, M. Meyer, and T. Munzner. Design study methodology: Reflections from the trenches and the stacks. *IEEE Transactions on Visualization and Computer Graphics*, 18(12):2431–2440, Dec 2012. doi: 10.1109/TVCG.2012.213
- [22] J. B. Weinberg and M. L. Stephen. Participatory design in a human-computer interaction course: Teaching ethnography methods to computer scientists. In *Proceedings of the 33rd SIGCSE Technical Symposium on Computer Science Education*, SIGCSE '02, p. 237–241. Association for Computing Machinery, New York, NY, USA, 2002. doi: 10.1145/563340.563431
- [23] J. Whittle. How much participation is enough?: A comparison of six participatory design projects in terms of outcomes. In *Proceedings of the 13th Participatory Design Conference: Research Papers - Volume 1*, PDC '14, pp. 121–130. ACM, New York, NY, USA, 2014. doi: 10.1145/2661435.2661445