Creativity Workshops for Visualization Design

Visualization is a creative problem and creativity workshops can help

- Creativity is the process of creating something that is both new and useful.

- New and useful aspects of vis design include [Munzner2010]:
  - Understanding between visualization designers and domain experts
  - Data abstractions and task analysis
  - Visual encodings and interactions
  - Algorithms and implementations

- Vis creativity workshops aim to explicitly stimulate creative thinking in an structured fashion with the goal of helping the vis design process [Goodwin2013].

- Creativity workshops have been used successfully to jump-start both the understanding and ideation of vis design [Goodwin2013,Kerzner2017, etc]. But there are no best practices for creativity workshops in vis design.

This work provides guidance for vis researchers to use creativity workshops

- This is based on reflection of experience and review of creativity literature.

- We contribute a vis design creativity framework, describing five stages of using creativity workshops in vis design.

- This framework provides scaffolding to our recommendations for applying creativity methods to vis design projects.

Outline

- Related work: defining creativity, challenges of creativity research, introducing creativity workshops
- The five stage framework for creativity workshops in vis design
  - Best practices for each stage
- Additional information about the plan stage – how to select workshop methods.
- Discussion and conclusion

Related work

An operationalized definition of creativity

- There has been extensive psychology, sociology and design research aimed at generating a refined and nuanced understanding of creativity, but these nuances aren't really useful.

- As Shneiderman et. al [2005] say in their workshop report on creativity support tools: "laboratory definitions of 'creativity' are often so tightly constrained that they do not capture more than a piece of a person, product or process."

- We're going to avoid this nuanced discussion by using an operationalized definition of **creativity as "generating ideas that are both new and useful."**

- Even with this operationalized definition, there are many challenges to studying creativity…

Creativity research is challenging

- There has also been extensive research to investigate whether creativity can be enhanced through various stimuli.
- There are no clear ways to measure creativity as the context and desired outcomes of applying creativity methods varies widely between projects.

- Rigorous experimental control is not feasible. There are often conflicting explanations for observations in uncontrolled environments.

- Despite conflicting empirical evidence on their effectiveness, methods for enhancing creativity are widely used in the business community (e.g., CPS). We have also successfully used similar methods in our own projects.

A model for fostering creativity

- Despite conflicting evidence, there is hope for fostering creativity. The following quotes are from Explaining Creativity [Sawyer2012], a survey of psychology research related to creativity: “creative products result from long, complex, involved processes incorporating networks of people and long periods of hard work, during which many independent but connected miniinsights take place. Yet creativity training rarely instructs people in how to schedule and design an extended project so as to encourage and then incorporate these many sequential, incremental small insights."

- “Psychologists have been studying the creative process for decades. They have several different theories about how it works, but most of them agree that the creative process has four basic stages: preparation, incubation, insight, and verification.
  - Preparation is the initial phase of preliminary work: collecting data and information, searching for related ideas, listening to suggestions
  - Incubation is the delay between preparation and the moment of insight; during this time, the prepared material is internally elaborated and organized.
  - Insight is the subjective experience of having the idea—the “aha” or “eureka” moment.
  - Verification includes two substages: the evaluation of the worth of the insight, and elaboration into its complete form.”

Introduce creativity workshops

- We want to encourage creativity by encourage open communication between everyone involved in the project, and supporting the four stages. Creativity workshops aim to explicit do this.
- Creativity workshops are structured use of creativity-supporting methods. They vary in length, format, inputs, participants, and desired outcomes.
- They are typically structured to support the four stage model: preparation, incubation, illumination and verification. *Though the interpretation of which stage a method applies to is highly subjective.*
- Methods to explicitly foster have been used in vis projects [Goodwin2013, Goodwin2016, Kerzner2017, Kerzner2013, Dykes2010, Walker2013, …]
- They have also been used in software requirements engineering [Horkoff2015, Maiden2004, Maiden2008, Jones2007, Jones2008, …]. They are closely related to co-creation and co-design [Sanders2008].

Best practices for creativity workshops from outside of vis research

- Dove, Maiden and Jones evaluated the use of creativity workshops in software requirements engineering and offered some recommendations for conducting workshops

- Many books exist that make recommendations for fostering creativity, typically in a business setting

- These best practices are useful, but do not necessarily account for the complexities of vis projects

What do best practices for creativity workshops in vis need to account for?

- **Vis process and decision models**: there are established process models for vis projects that account for the complexities of understanding a domain problem, designing visualizations, implementing those designs, and deploying the implementation. Discussions of workshops from design and business literature do not address these complexities that vis designers are accustomed to.

- **Project roles:** there are established models on the roles of individuals within vis projects. For example, there are vis designers who are conducting the visualization research and frontline analysts who are typically the users or focus of design studies. We'll argue that accounting for these roles in the process of planning, conducting, and analyzing workshops leads to more effective results.

- **Mutual influence**: collaborators and vis designers must learn from each other for a successful project. Successful vis projects recognize that neither designers nor analysts have enough knowledge to solve a problem. Vis designers learn about the domain to generate a solution and domain experts learn about visualization to use and give feedback on designs. In contrast, co-creation and CPS are about encouraging individuals to come up with their own solutions to their problems. Recognizing the respective expertise of designers and others involved in the project helps select effective methods for the workshops.

- **Data/task fuzziness:** vis is all about the data and tasks, which are often nebulous. Vis design is effective in projects with the right blend of task clarity and appropriate information location [Sedlmair2012]. Creativity methods from other domains can focus on crisp tasks while vis tasks tend to be between crisp and fuzzy. The most effective workshops account for the fact that vis projects fulfill the correct balance of task clarity and information location.

- **Data/task evolution:** successful vis projects often shape the way collaborators think about their data and tasks. This evolution of ideas is considered a key point of successful design studies.

Visualization creativity workshop framework

The vis creativity workshop framework

- We propose five stages for **scoping, planning, executing, interpreting** and **reflecting** on workshops and their outputs.

- Phases are like design activities in that they have a **motivation**, **input** and **outcomes**.
  - Motivation is the reason for the phase.
  - Input are the requirements for conducting a phase.
  - Outcomes are the desired effect of completing the phase.
  - Input and outcomes may be both tangible and intangible.

- The reality is that using workshops is a complex, messy and iterative process. These stages are dimensions to organize our discussion, reflection and best practices.

Five stages for vis creativity workshops

- **Scope** the workshop: focus, goals, participants
- **Plan** the workshop: methods, logistics, contributors
- **Execute** the workshop: run the workshop, generate artefacts
- **Interpret** the output: analyze output and act on analysis
- **Reflect** on the workshop efficacy: internally and externally

Scope the workshop and identify its goals

- Motivation: to evaluate whether a workshop would be useful for a project and, if so, to identify a scope and goals of the workshop that would be most useful

- Input: a visualization project with domain experts that is suitable for design study

- Outcomes:
  - **Focus** - design activities the workshop will aim to fulfill.
  - **Goals** – succinct project-specific reason for running the workshop
  - **Ideal participants** – individuals who will participate in the workshop

Scope the workshop and identify its goals

- Focus, ideal participants and goals are mutually influential.
  - Focus and goals should be used to identify ideal participants
  - Available participants should be used to set focus and goals

- The **focus** of the creativity workshop can match the **outcomes** of design activities in the DAF.
  - **Understanding** the domain problem; i**deating** on solutions to those needs; **making** those proposed solutions
  - Focus can be either broad or narrow
    - A **broad** focus is on the objectives of a domain or set of diverse analysts. Output sets direction for longer projects.
    - A **narrow** focus is on the objectives of an individual or set of homogeneous analysts. Output sets for direction for shorter projects.

- The **goals** of a workshop are the stated reason for completing the workshop
  - They are the domain-specific instantiation of the workshop focus
  - Ex [Kerzner2017] design study, the focus was understanding broad domain – the goals were "understand the needs of connectomics researchers"

- **Ideal participants** are individuals who will actually participate in the workshop
  - Casting the participants may help decide if they are appropriate for a workshop given focus and goals [Sedlmair2010]
  - Front-line analysts good for understanding
  - Fellow-tool builders good for ideating and making along with translators.

Scope – our experience

- Goodwin2013 – Creativity requirements
  - Focus: understand and ideate (broad)
  - Goals: “To identify ways of utilizing Smart Home data/technologies to help EON derive information and see more about their business”
  - Participants: energy analysts (narrow)

- Goodwin2013 – Design workshop
  - Focus: ideate on output from c/w workshop (narrow)
  - Goals: “To generate ideas that support the requirements identified by the first workshop”
  - Participants: vis designers with limited knowledge of smart home technology (more narrow than vis researchers)

- Kerzner2017 – Connectomics
  - Focus: understand (broad)
  - Goals: “understand opportunities for visualization in the field of connectomics and identify shared user needs”
  - Participants: connectomics researchers (broad)

- Goodwin2016 – Constraint programmers
  - Focus: understand and ideate (narrow)
  - Goals: “design performance profiling methods that can effectively support users in developing scalable, efficient optimization programs”
  - Participants: constraint programmers with aptitude for visualization (broad)

- Rogers2016 – Discovery Jam
  - Focus: ideate (narrow)
  - Goal: “Game Jam but for science – foster cross fertilization between vis designers and scientists. Lay groundwork for collaboration”
  - Participants: vis researchers (broad)

Scope – recommendations

- Is my project at a good point for a workshop?
  - Identified promising collaborators – see DSM. Also should be open to intangible results from workshops
  - Initial understanding of domain, vocabulary and what *could be the* focus---"not enough contextual knowledge in some cases." Though Goodwin2013 pointed out "contextual knowledge emerges"

- What should I consider in selecting a workshop focus?
  - Workshop should fulfill the current activity in the DAF. Ideation without understanding is a threat to validity.
  - Running an understand workshop without grounding is a threat

Plan the workshop to fulfill the desired goals

- Motivation: to identify promising activities for a workshop, recruit participants, and resolve logistics

- Input: workshop focus, goals, ideal participants

- Outcome should identify the following:
  - Recruited contributors – participants, facilitators, scribes
  - Logistics and venue – operational considerations, like physical location
    - Time (workshop duration)
  - Agenda and methods – the methods and materials that will be used throughout the day
    - Time (workshop methods)

Plan the workshop to fulfill the desired goals

- Contributors include facilitators, scribes, and participants. Participants can be filtered for their creativity [Goodwin2017], ~~their ability to translate [Rogers2016]~~, or for organizational diversity [Kerzner2017].

- Logistics include venue, time constraints. Should be chosen to foster creativity --- neutral, well lit, etc, not increasing cost or putting a burden on them. Time influences participation. Cost / benefit.

- Methods are the activities that will be used throughout the day.

- Contributors, methods and logistics are mutually influential. Logistics determines who can contribute. Methods influence the ideal location and contributors. Contributors influence the ideal methods and location.

Plan – our experience

- Goodwin2013 – Energy analysts
  - Contributors: professional facilitator, two vis researchers as facilitators, energy analysts
  - Logistics: neutral venue, offsite, full day
  - Methods: see paper, included two pilots

- Goodwin2013 – Vis designers
  - Contributors: vis designers
  - Logistics: half day
  - Methods: no pilot.
  - ~~Methods: what was done here? Was there a pilot?~~

- Kerzner2017 – Connectomics
  - Contributors: researcher as facilitator
  - Logistics: venue away from biologists daily work, full day + lunch
  - Methods: see [Goodwin2013], with some prompts adapted for biology. No pilot

- Goodwin2016 – Constraint programmers
  - Contributors: researcher as facilitator, Chris was co-facilitator
  - Logistics: neutral venue, full day
  - Methods: see [Goodwin2013], with some prompts adapted for constraint programming. No pilot.

- Rogers2016 – Discovery Jam
  - Contributors: vis designers acting as facilitators in tandem with domain experts
  - Logistics: vis conference, half day
  - Methods: creative-intro, scientist overview, open ideation, discussion. Multiple pilots with different scientists.

Plan – recommendations

- How should I recruit participants?
  - Be clear about goals of the workshop.
  - Recruit for creativity and engagement as in [Goodwin2017] or for role in the organization [Kerzner2017].

- What should I consider about workshop length?
  - Depends on logistics
  - 90 minutes is probably minimum for using an activity – see our experience in [Nobre2017].
  - Time for incubation and socializing is important -> either during lunch or in evening breaks as stressed by Jones and Rogers.

- How should I select methods to use in my workshop?
  - Should be selected as appropriate for the scope and goals.
  - Refer to SG's paper, thinker toys book, and RE literature.
  - Criteria from creativity support tools: low barriers, high ceilings and wide walls
  - Repeated application of the diverge converge structure has been useful.
  - Mix of active and passive activities as in Dykes' paper

- Should I run a pilot workshop?
  - Probably. Especially if the workshop format has not been tested before.
  - Rogers recommends absolutely using pilot workshops for ideating and making. This is necessary to iterate on the task and data abstractions that are input to the workshop.

- What should I consider about facilitating the workshop?
  - Domain experts may not be good at abstracting for ideation workshops (example is [Rogers2016])
  - Establishing a creative atmosphere requires trust and buy-in from participants

Execute the workshop

- Motivation: to execute the workshop plan so that the outcome successfully matches the workshop goals and scope

- Input: a scoped set of workshop goals and a workshop plan, including contributors, logistics and methods.

- Outcome: a successfully executing workshop which requires execution and post-execution (gathering artefacts)

Execute the workshop

- Workshop execution – run the workshop
  - Establish ground rules for everyone that is attending the workshop
  - Smoothly transition between facilitators and activities but allow for flexibility

- Post-workshop execution – gather artefacts after the workshop
  - Use materials that allow for storing output of activities --- we have found post-it notes and poster boards to be particularly valuable.
  - Digitizing the output makes it easier to work with later on, particularly if there is messy handwriting.

Execute the workshop – our experience

- Goodwin2013 – Energy analysts
  - Pre-workshop execution: reserved venue far from university, recruited energy analysts
  - Execution: used a professional facilitator
  - Post-workshop execution:

- Goodwin2013 – Vis designers
  - Pre-workshop execution:
  - Execution: no professional facilitator
  - Post-workshop execution:

- Kerzner2017 – Connectomics
  - Pre-workshop execution: recruited participants based on
  - Execution: no professional facilitator
  - Post-workshop execution:

- Goodwin2016 – Constraint programmers
  - Pre-workshop execution:
  - Execution:
  - Post-workshop execution:

- Rogers2016 – Discovery Jam
  - Pre-workshop execution: had to apply to workshop at conference, worked on materials extensively with scientists
  - Execution: half day at the vis conference --- this was not nearly enough time
  - Post-workshop execution: no formal methods to follow up with participants

Execute the workshop – recommendations

- How should I prepare participants for the workshop?
  - Discussion of homework for participants. Is it useful?
  - Prep them to be focused for the day and well rested

- How should I run the workshop?
  - Emphasize open idea sharing and interpersonal communication
  - Structure is useful – prevents awkward moments
  - Have a plan, but be flexible
  - Recommend resources for workshop management. (TODO)
  - Four stages of creativity – allow for breaks/mingling

- How should I record ideas during the workshop?
  - Full recordings are time consuming
  - Scribes are useful, but may be hard to effectively use
  - Encourage full sentences of ideas on post-it notes
  - Having vis designers record ideas ensures that they are translated to something useful, though handwriting is an issue [Nobre2017]
  - Recording ideas on moveable media makes it easier to transfer and record --- save posit-it notes on poster board instead of the walls

- How should I collect artefacts from the workshop?
  - We have gathered artefacts by the method they were generated in – the prompt is often useful to make sense of the ideas

- Should I collect participant feedback from the workshop? How?
  - Feedback can be useful to improve workshops (see the Reflect phase) or to elicit more ideas from collaborators
  - Participant feedback can be useful to elicit more ideas from collaborators
  - Dove's work on getting 'creative feedback ideas'

Interpret workshop output

- Motivation: to analyze the workshop artefacts and concretize the intangible workshop outcomes
- Input: a completed workshop, artefacts from workshop activities, notes from facilitators, and feedback from participants
- Outcome: actionable knowledge fulfilling the scope and goals

Interpret workshop output

- Output of the workshop will be dependent on the workshop methods, which were decided based on the workshop goals and scope. Interpreting the workshop output includes:
  - **analyzing** the artefacts and workshop notes to generate actionable knowledge;
  - **acting** on that knowledge in the visualization design project.

- Analysis involves aggregating, sorting, and characterizing ideas from the artefacts.

- Analysis should balance quantitative and qualitative methods – over quantification is a pitfall that we've run into. E.g., frequency of an idea does not equate to importance or impact

- Results of analysis can be acted on in various design activities:
  - Understanding - opportunities for visualization and identify new data abstractions or perspectives of tasks
  - Ideating (generative methods) – promising directions for designs [Goodwin2013, Rogers2016]
  - Ideating (evaluative methods) – constraints and considerations for the project [Kerzner]

Interpret output – our experience

- Goodwin2013 – Energy analysts
  - Analysis: collected all artefacts, analogies and know/see/do recorded and analyzed for common themes
  - Action: output fed into design workshop

- Goodwin2013 – Vis designers
  - Analysis: ?
  - Action: identified promising design ideas, realized them in prototypes, presented to collaborators

- Kerzner2017 – Connectomics
  - Analysis: collected all artefacts, performed open coding, identified opportunities, constraints and considerations
  - Action: opportunities were used to set direction of research, constrains and considerations used informally in parallel prototyping

- Goodwin2017 – Constraint programmers
  - Analysis: set of codes; 1 – 3 codes per artefact. Identified 22 themes grouped into 6 themes / tasks
  - Action: used to set direction for exploring design space, also requirements analysis is valuable contribution to the field

- Rogers2016 – Discovery Jam
  - Analysis: very little post-workshop analysis – this is going to change in the next iteration
  - Action: mostly informal changes to the scientists ideas

Interpret output – recommendations

- How should I make sense of the workshop output?
  - Goodwin and Kerzner used aggregation through open coding to make sense of workshop output – grouped ideas from the workshop into categories

- Should I involve my collaborators in making sense of the workshop?
  - Translators are particularly good at helping with making sense of workshop output
  - How did SG use participants to help make sense of workshop output?

Reflect on the workshop

- Motivation: generalize experience on the efficacy of workshop scope, goals, plan, execution, and interpretation.

- Input: a project that has had time to act on knowledge gains from interpreting workshop results

- Outcome: actionable knowledge and insights for other visualization researchers

Reflect on workshop

- Reflecting is where engineering turns to research
  - Identify what has worked and what did not work – share experience with other researchers

- Ideas for sharing should fall within this framework:
  - Example) new methods to use in the workshops, should be described in the context of a workshop scope and plan

Reflect on workshop – recommendations

- How should I evaluate workshop effectiveness?
  - Qualitatively! How did the workshop influence the design process? What kind of feedback did you get from the workshop?
  - Beware of over-quantifying – it is hard to quantify output, may lead to erroneous conclusions about workshop ideas
- How can workshops benefit my collaborators?
  - Goodwin's report for future work of constraint programming
  - Discovery Jam – scientist realized that he was looking at the wrong variable in data analysis
- How should I evaluate whether activities worked well or not?
  - Feedback from participants – did they find the activity useful?
  - Feedback from designers – did they find the activity output useful?
- How can we as a vis community use workshop reflections?
  - Explore best practices for workshop structure

Planning the workshop methods

TODO

Planning the workshop methods

- Successful and similar structure used in Goodwin2017, Goodwin2013, and Kerzner2017: one application of the diverge/converge cycle
- Repeated application of diverge and converge methods for structuring methods
- Reflection on the efficacy of various methods --- need to import from previous pre-paper talk
- Detailed discussion of activities from previous talk?

Discussion and future work

TODO. Key point: this framework and recommendations are neither exhaustive nor definitive. Researchers should be creative in their use of creativity methods.

Conclusion

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- In this work, we reflect on experience running and participating in creativity workshops for visualization design.
- We contribute a vis-design creativity framework based that describes five stages of applying creativity techniques to vis design.
- In addition for being a guiding process model, this framework frames our reflection to identify best practices for applying creativity methods to vis design projects.

Misc slides

Plan the **contributors** – recommendations

- What have we done to select participants?
  - Questionnaire to identify most creative individuals [Goodwin2017]
  - Inter-personal and logistical concerns [Jones]
  - Diverse roles in the lab [Kerzner]

Plan the **logistics** – recommendations

- How should I select a workshop length?
  - Depends on constraints of the project.
    - DiscoveryJam – half day to two-full days, depending on travel and availability of participants.
    - Goodwin, Kerzner – full day based on collaborator availability
    - Maiden and Jones – two days
  - Guidance: 90 minutes is likely the minimum amount of time. 2 days is likely the most time that people will be willing to commit.
  - Jones: overnight breaks are useful for incubation and intangible outcomes like relationships between stakeholders.
  - Ultimately depends on availability of participants.
- How should I select a workshop venue?
  - Neutral place that supports a creative atmosphere.

Plan the **methods** – recommendations

- How should I structure the workshop?
  - Poincare's four phases of creativity: preparation, incubation, illumination, verification. These correspond to the generative vs evaluative structure.
  - Past workshops have found generative -> evaluative to be useful for exploring a broad space of ideas and winnowing those ideas down to a narrow set of promising ones.
  - Many applications of the four stages of creativity are likely useful

- How should I select methods for the workshops? (This feels like an entire section. It will have way more depth than the other points discussed here)
  - Where can I find methods to use?
    - Methods from previous workshops
    - Methods from creativity literature, adapted for visualization
    - Methods that you create yourself (be creative!)

  - What does a good method look like?
    - Limitless possibilities for methods in the workshop.
    - The best methods will: encourage open responses, deep thinking, interpersonal communication, mini-insights
    - Be tailored to the goals of the workshop
    - They will output tangible artifacts (lots of post-it notes or scribe notes)

- How should I allocate time for the workshop methods?
  - In general, 60-90 minutes is likely ideal for exploring prompts deeply enough
  - Be prepared to move-on if activities do not work well, or stay on activities if they are yielding useful results

Plan the workshop to fulfill the desired goals

- Planning of logistics and transportation:
  - What workshop format should I consider? e.g., half day, full day, two days, etc.
  - How to select a workshop venue?

- Planning of participants, facilitators and scribes:
  - How should I select workshop participants, facilitators and scribes?
  - How should I prep workshop participants, facilitators and scribes?

- Planning the workshop activities:
  - How should I select workshop activities?
  - What should we consider about activities from the creativity lit?
  - What should we consider about activities w.r.t vis?
  - What activities have worked well in the past?