Written Reflection for Revisions

This exercise will generate ideas about how to improve our paper based on feedback from reviews. Be specific in your responses because we need to provide concrete examples of our experience.

Please complete it by June 17 so we have enough time to revise the paper. Also, I will anonymize and archive our responses in the audit trail.

To help me organize these ideas, please make a copy of this doc and put your responses in it.

Prompts

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2. **Where can we add concrete examples to the paper?** Suggest at least 3 examples from your experience that could strengthen the paper. This could include: feedback from participants (if allowed by the institution), interesting ideas that resulted from your workshops, your experiences integrating the workshop results into the design process, or your experiences doing applied research *without* using workshops.

3. **What are the characteristics of a successful workshop?** Suggest at least 3 ways to describe if a workshop is successful. Some questions to think about: Do all successful workshops result in a publication? If participants do not find a workshop interesting, could it still be successful? How would you describe the outputs of successful workshops?

4. **Based on your experience, what are pitfalls for visualization creativity workshops?** Suggest at least 3 pitfalls to avoid in running a *visualization workshop.*

5. **What do you think is missing from these prompts?** Suggest any other changes that we should make to the paper or supplemental material.

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i. Visual approaches to considering ideas (note that "*considering ideas*" is in the definitions)

I think we use visual methods to explore and prioritise suggestions - for convergence. E.g. post-it clustering on the wall is visual and classic Information Visualization - promotes visual thinking, as is using their color to encode information.

Fig 2 shows many VIS methods - clustered post its is InfoVis - emphasize this.

Sarah G may also have ideas - using a scatter plot (shrimps and whales) to communicate ideas with designers - emphasizing the visual.

In - Prepare to execute - prepare the space so that we can get to the walls and cluster post its. We are going to be doing **constructive collaborative physical visualization** here (cite HURON!). So the physical space needs to allow for this.
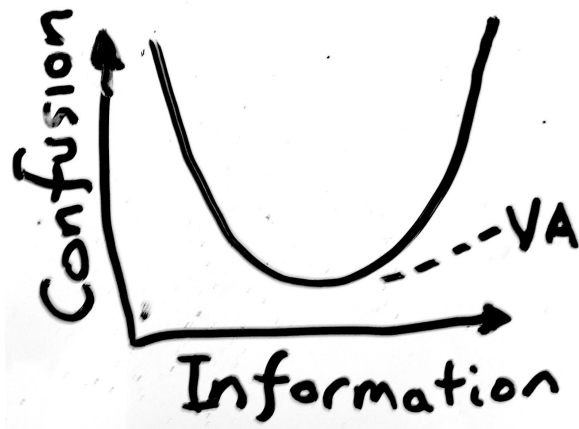
ii. Visual outputs and metaphors

We emphasize sketching , mind maps, storyboards and the like and could do more of this.
If instead of "*which animal ...*" we had a Dear Data style "*draw a graphic that shows us how you are feeling*" exercise, they would all be graphical. I like this - applying an idea from *Dear Data* to our workshops. Should we do this?

We asked the DIVA participants for one image that summarised their thoughts and approach at the start of that meeting and here's what one participant came up with.

Do others have examples of visual outputs and metaphors that we can add in here?

iii. Visual inputs and stimuli

The obvious one here is visualization analogy - but are there others?

Do we show exploration, examples, etc. in our workshops?

One example of participants showing us their visualization is MAMBA (see above), which we used as the basis for one of our current situation GOOD / BAD analyses: e.g. GOOD - open source framework, visual query interface, user friendly, rapidly linked views; BAD - "He's on there somewhere" (hard to find individual items), occlusion problems.

Certainly the WHOLE POINT of workshops 2 an 3 in the EDINA, DIVA and E.ON cases was to use interactive data sketches as the basis for feedback, discovery and idea generation. But these are not the workshops we have chosen to focus on here.

Consequently I think the only way we can really deal with this is to say that …

- in our experience (Design Jam) it's difficult to get interactive systems that contain domain data working in a single initial workshop and so the VIS inputs and stimuli are limited
- receiving data and then coding prototypes works well and so VIS can be the focus of subsequent workshops in a series
- as technologies progress, using data in initial workshops becomes more feasible and we see great scope for doing this (we say this quite nicely but quite late in 11: "*Technologies and approaches that may provide quick and reliable ways of using data in workshops are emerging, such as high-level visualization design tools, declarative visualization languages, and constructive visualization [24]*"

iv. Selection of visualization opportunities

If we go with the definition of creativity workshop that we have used in the paper, then "*selecting the more promising*" is an important part of all of this.
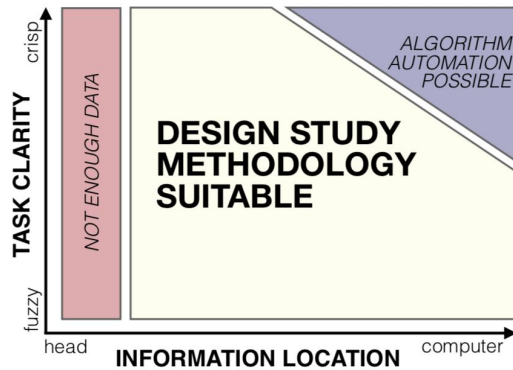
Fig. 1. The task clarity and information location axes as a way to analyze the suitability of design study methodology. Red and blue areas mark regions where design studies may be the wrong methodological choice.

Getting information out of people's heads - *moving **right** from red* in Fig. 1 of Sedlmair et al (2012, above) - and clarifying tasks - *moving **up** into blue* - allows us to identify possibilities in the yellow zone. We do this in VCRs and so should relate the processes that we have documented directly to this diagram as a means of establishing candidate focii for visualization.

E.g. DIVA - developed guiding principles that fit squarely into the yellow:
- Visualizing (presenting, reporting) at different levels of granularity (resolution) concurrently
- Visualization in context: not just the one thing I've selected, but how it fits into the whole set.
- Tools that act as a *lead generator*: i.e. you can delve into the data to find new things (multiple questions, probably concurrently)

2. **Where can we add concrete examples to the paper?** Suggest at least 3 examples from your experience that could strengthen the paper. This could include: feedback from participants (if allowed by the institution), interesting ideas that resulted from your workshops, your experiences integrating the workshop results into the design process, or your experiences doing applied research *without* using workshops.

I'm not sure quite what you are after here … can you be specific - examples of what?

In DAISY/DIVA the DSTL participants showed us some of the visualization work they had been doing. We considered their MAMBA component based system. First up, they showed it to us, we grimaced and then tried a few tasks with it to feed into our assessment of the current situation - PostIts from all participants indicating what was GOOD / BAD with current systems / data / processes.

In EDINA / VIZLEGENDS the prototypes that we developed (not at workshop 1) provided a really good focus for generating research questions and design ideas on the back of these. E.g. analytical questions – "*what proportion of Scotland is golf courses?*" "*What area of different counties are covered in roads?*" were asked directly, followed by some design ideas "*Use the legend as a 'spatial analysis sandbox'*" and specific ways in which this might be achieved "*Ordering legend by distance from mouse*". I offer these examples as there is a really nice interaction between data as displayed in design prototype, task (questions being asked) and then design principle and specific design idea. This is all data / visualization

driven. The **problem,** given our current context, is that this is an example in which data sketches / prototypes were used at a ***subsequent*** workshop and so may be out of scope. However, we could come back to this in 11 and provide a sentence / para that links to S3P2 where we limit scope as follows: *"We therefore narrowed our analysis to creativity workshops used in the early, formative stages of applied work or as the first in a series of workshops."* by saying that …

Sequences of workshops that provide time for prototypical visualization design work, or means of interacting with data directly in initial workshops (*as described in 11*) may make VCRs more visualization specific from the perspective of **Visual inputs and stimuli.** For example, in our second EDINA workshop we identified tasks, design principles and ideas as to how these might be instantiated in software interactions through data exploration e.g. (see above golf courses -> Legend as sandbox -> distance ordering)

3. **What are the characteristics of a successful workshop?** Suggest at least 3 ways to describe if a workshop is <mark>successful</mark>. Some questions to think about: Do all successful workshops result in a publication? If participants do not find a workshop interesting, could it still be successful? How would you describe the outputs of successful workshops?

I think that publication as measure of success is really bad - this is so biased towards our needs that it's almost unethical! I think we have to be much more sensitive to the needs of all participants when measuring success. If collaborators discover that we are a bunch of chancers who know nothing that can help them - success!

a. Participants know more about each other and each other's domains - levels of trust and understanding are sufficient to establish whether to make progress
b. Domain experts / data owners (DE/DOs) have better ideas about whether visualization can apply to their domain and the tasks in hand
c. Visualization researchers have better ideas about whether there are opportunities for visualization research in the project
d. If b and c are true ...
    i. DE/DOs have refined (extended, narrowed or prioritised) tasks;
    ii. Designers have identified priorities and opportunities for visualization design and have the information and data required to develop interactive prototypes;
    iii. Researchers have begun to identify possible knowledge gaps and can formulate provisional research questions and approaches to addressing them (note that these may be "*can I build a system to successfully support Task X in context Y*");

    … in ways that may not have been apparent at the start of the workshop
e. Participants from all backgrounds felt that they were able to make contributions that were both heard and influential, and that other parties understood their perspective.
f. People learned, and felt that the time was well spent.

4. **Based on your experience, what are pitfalls for visualization creativity workshops?** Suggest at least <mark>3 pitfalls</mark> to avoid in running a *visualization workshop.*

5. **What do you think is missing from these prompts?** Suggest any other changes that we should make to the paper or supplemental materia.

See below!

Other!

Definitions / Scope

I'm not convinced that we have the definitions and terminology quite right.

- **creativity** - "*a broad space of ideas are considered before selecting the more promising one*" [37]
- **creativity workshops** - "*deliberately and explicitly foster creativity*" [53]

These seem fine to me - so I would follow this with ...

- **visualization creativity workshop** - *a structured event designed to deliberately and explicitly consider a broad space of ideas for applying visualization to a domain and identifying the more promising opportunities*

… and argue that using visualization as part of the workshop may help with this - I think we do this quite a lot implicitly (see above).

In S 2.3 **creativity workshop** is the wrong term for a **VIS creativity workshop**. The paper loses its VIS emphasis. I think we have to go for **VCR** - it's memorable, consistent and emphasizes the **V**, which we need to do.

AUTHORS

S2.3P4 "We (the authors) have been involved with every creativity workshop described in this subsection" could be phrased as "*To write this paper we have collected together authors from all of those studies.*" This may be more convincing.

SUCCESS

S3P2 - "*It is challenging to analyze ...*" we don't identify criteria for success!
These might include ...

- "understanding of domain challenges" - ABSTRACT
- "concensus" - end of Para 1
- "selecting promising ideas" S2.1P1

... but see my other suggestions in section 3 above.

- know data better
- clearer specification of tasks
- make information explicit

- open communication channels
- focus, having considered many ideas
- have a better idea of possibilities for moving forward with mutually beneficial collaboration with VIS as a basis
- have mutually developed ideas for using visualization to problem solve

PITFALLS

Could these be associated with TACTICS? One each?

If these are useful, I can probably come up with examples.

Or maybe others can?

TOPIC - a sequence of irrelevant examples.

Ordering visualization examples is important - failing to make successive examples domain relevant may mean that you lose the interest of participants. You may have some fantastic examples that you want to show them, but be sure to mix evidently relevant examples with those that are more obscure.

AGENCY - not allowing motivated participants to change the plan.

Don't hold on to your plans too rigidly. Allow participants to change the rules of the game to give them agency and the motivation that can give them the space and permission to come up with ideas. If they ask to change something, see this as a success and show that you are willing to listen and accommodate their needs. Remember - no idea is a bad idea!

COLLEGIALITY - forcing cross-group communication at all times

At breaks or lunch, groups of colleagues who know one another may want to discuss what has been happening. It's important to allow this, so that ideas can develop. A well structured workshop will have given most participants time in groups with each other and focusing on individual activity, so time with colleagues during the breaks is likely to be important and effective.

TRUST - needing to know everything

You are an expert in your domain, but so are your participants, and acknowledging that they have expertise that compliments yours, as well as the limitations of your expertise will open up possibilities for communication. A well structured workshop and the focussed expertise that you have on visualization design will give participants confidence in your ability to contribute positively to the project. Pretending that you know or being creative rather than transparent in your answers may erode trust.

INTEREST - expecting everybody to be interested in everything

It's hard to predict what will interest your participants, and agency, challenge, topic and interest are delicately balanced. But it's a mistake to expect everybody to be interested in everything all of the time. Encourage participants to do their best in activities, and if they are not interested or question the relevance of an activity then listen to their view. They may be able to define activities, examples or lines of enquiry that are more interesting. "*How could we make this more interesting or relevant*" is a useful creative exercise that may help you and your participants learn about the domain and the workshop.

CHALLENGE - forcing participants to engage in challenging activities

We encourage you to vary the levels of challenge involved in activities throughout the workshop, but it's not always easy to predict who will find what challenging. Activities that involve visualization analogy or visual outputs may be difficult for some participants, and are likely to be more straightforward for you. If they would rather spend time sitting out, or participate in other ways, be flexible - see AGENCY above.

SPECIFICS ON READTHROUGH

S means section; P means paragraph (usually, may be PAGE if it's the first letter!), C means column,
So S3.2P2 means para 2 of section 3.2; P2C2P1 means page 2 column 2 para 1.

Be creative - during and after the workshop. For example, I have written before about the flexibility at EON when participants rejected the storyboard having seen the visualization and produced mind maps instead.

Visualization Awareness. Is awareness still an issue? Should this be reframed as "Visualization Analogy" which fits with the creativity literature more effectively.

S2.3P4 - "Failed" - did it fail to meet our success criteria or fail to maintain a relationship?
I think these are different and the term needs to be clarified or reconsidered.

SCP5 - "into a collaboration through analysis and action".
We need to be more specific here and align this with success criteria. Something along the lines of ...
"using the workshop outputs to identify whether possibilities for mutually beneficial collaboration exist. This is likely to involve identifying research questions, design possibilities, key collaborators, data sets and tasks to which visualization may be usefully brought ot bear."

S3P6 - use "was established" not "emerged".

S5.2P1 - Tactics
Re-reading ... this comes a little cold. Can we emphasize that this is about the use of creativity techniques (methods?) *within* workshops?
CHANGE : "that influence the engagement and creativity of workshop participants"
TO SOMETHING LIKE : "that likely influence the performance of workshop participants and thus success of the workshops" - once we have established what success is.

Capitalise TACTICs to get over the pluralization question.

AGENCY - this is about influence as well as (or more than) ownership.
Maybe "the sense of a participant's effect on the ownership and ownership of its outcomes." I don't think we need to mention "the research project" here.t

S5.2P1 - "reveals" suggests we are uncovering something that exists rather than PROPOSING SOMETHING NEW. So I think we can be clearer about research process and perhaps help people trust us and accept our claims more by subtly changing the language. I'd use : "allows us to identify | propose that we have found to influence ..."

P5C1B4 - "Where will the workshop be run"
We have to say something VIS specific about light and projection here as "well lit" does not suit the VIS context.

P7C1P3 - use of "seemingly" and "interpersonal leveling" twice!

Refer back to Fig 1 at the start of section 8. People will forget that this is part of the workshop process model.

P8C1 - "externalizing ideas on post-it notes and structured prompts has been effective in our workshops." Add other examples - from Sarah? Mind Maps, Sketches, etc.
Also "with context" - can we explain what this means? Example?

The start of 10.1 needs some work. In S3 we claim that "We therefore narrowed our analysis to creativity workshops used in the early, formative stages of applied work or as the first in a series of workshops" ... and then ... "These workshops typically focus on eliciting requirements for visualization software from collaborators. They support the understand and ideate design activities of the design activity framework [45] or fulfill the winnow, cast, and discover stages of the design study methodology's nine-stage framework [61]."
But we really broaden out very suddenly in 10.1.
What are "the results of research projects"? In [15] we were really talking about the applications and prototypes - but here we are talking about / focussing on "eliciting requirements for visualization software from collaborators".
I think this first para of 10.1 needs some thought.

We might try something like ...
\{The outputs generated and contributions made to applied visualization research projects are likely to be creative if preceded by a creativity workshop [15], but arguably all applied visualization work [broader than research] is creative as it involves generating design solutions and all visualization research is creative as it involves generating new and useful ideas. As such, we consider it likely that creativity workshops are an effective starting point for almost any applied visualization project*.}
 * do we mean research project, design project, applied visualization research project?
   I think we mean applied visualization project (research or design)

I think S10.2 is really good!

S10.1 final para - requireS

10.2P1 - "for example, it is nearly impossible to measure the usefulness of generated ideas or the influence of a workshop on a collaboration."
"for example, it is nearly impossible to measure the usefulness of generated ideas or the influence of a workshop on a collaboration, particularly when the collaborations and workshops are so diverse in terms of the subject areas, participants and applied contexts."

S10.2P3 - "we believe" -> "we argue"

FEEDBACK TO REVIEWERS

Can we emphasize that this is a meta-analysis that uses the methodology of critically reflective practice. They may have forgotten this.

OTHER IDEAS

Dear Data Postcard Kit

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7.4: we don't explain how these methods have been adapted and refined over the years in respect to piloting, visualisation needs changing and our reflection of our work. I think we can do emphasise this - and therefore the visualisation specific aspects of the workshops. But perhaps we don't need the analogy intro here. And we leave that for the supp material? Or describe how we could change to be more visual ??

In fact could we actually just have a header 'tailoring methods to the visualisation domain' and not describe the analogy or the additional resources much and refer to them in the supp material but really look deeper into these examples of ours and how we adapted the known activity and why we did.

Section 7 : establish visualisation theme and creativity early in opening of workshop. I think this can be emphasised more here.

Section 9: revisit I recommend reminding collaborators of the workshop outcomes during the project too and showing how these link to your design and thinking. I may have a few quotes on this. *Energy workshop*

Notes on this, before I looked into the paper itself..not sure if this comes across early enough in the paper

The driver for these workshops is to collaboratively elicit and prioritise requirements for visualisation with the domain experts. The areas are often really complex problem domains, with many opportunities for data analysis and visualisation. In one day we can cover a vast open area as well as a narrow design space. We can also identify conflicting needs and identify future opportunities.

Why Creativity? It adds a depth of new thinking from participants in what may already be a known problem area that has had lots of attention but not been necessarily focused on the right areas, problem or visual representation (CP), or an area completely new, so many opportunities and they just don't know where to begin (smart home). The workshop provides a fun and engaging collaborative environment and the outcomes are hopefully more novel than if we use alternative (not termed as promoting creativity?) methods as these try to push the boundaries of current thinking.

Why are our workshops Visualisation specific?
In order to get useable and useful outputs from the workshop which can drive and focus our design process we focus our input prompts for methods to ensure the outputs are data and vis specific. That focus to our design needs. Depending on the participants and goal, we often need to target the methods to get participants to think visually and about visualisation in different ways— both more broadly to their domain as well as providing quite specific feedback of current or other visualisations.

2. **Where can we add concrete examples to the paper?** Suggest at least 3 examples from your experience that could strengthen the paper. This could include: feedback from participants (if allowed by the institution), interesting ideas that resulted from your workshops, your experiences integrating the workshop results into the design process, or your experiences doing applied research *without* using workshops.

Introduction doesn't give enough of the why - perhaps even moving the first paragraph of 10.1 to intro could be good!

Section 5.3. Can we explain what differs in this vis specific process compared to non vis workshops ?

Section 6. Test,test, test - perhaps better 'Test and Refine'. We can then describe how we changed the initial activity for smart homes to make it more vis specific early - and forward link to sec. 7.4. After 2-3 pilots it now works so well we have used it in many of our workshops. Encourage using known techniques or adapting to vis.

Explore then Focus. Second paragraph seems like it is a footnote or side box. It seems to justifying our terminology rather than explaining the need for exploring and focusing.

Initial notes prior to rereading paper:
Include more quotes if we can. These are from CP, feedback survey...

Workshops (in general) allow everyone to step back and work together and find common ground

- *"I was surprised by how much overlap there was with the challenges I face in my own work and those faced by others"*
- *"I was surprised to learn that most of the issues I run into [   ] are also shared by researchers with greater levels of expertise"*.
- The workshop is *"A good way to stop thinking about technical issues and try to see the big picture"*.

Lack really highlighting the extreme pull of the visualisation awareness activities - this was a big driver for why people wanted to participate in this workshop (and others I have run)

- *"I enjoyed seeing all of the information visualisation ideas   [these were]   Very stimulating for how these might be useful in my work."*

I will seek out energy one.

3. **What are the characteristics of a successful workshop?** Suggest at least 3 ways to describe if a workshop is successful. Some questions to think about: Do all successful workshops result in a publication? If participants do not find a workshop interesting, could it still be successful? How would you describe the outputs of successful workshops?

Initial notes:
- Outcomes are useful and useable for advancing the design process - I.e. we decide on some exact specifics or we can use the outputs to brainstorm design possibilities - so artifices provide specific or general design requirements (we want to see this) or they can be used to evaluate the designs post implementation (we want to do or know this)
- Participants leave excited by the project, opportunities, prospects.

- Participants leave content that they have been contributed and have added value
- Participants learn about how very different visualisation methods could apply to their domain problem.

4. **Based on your experience, what are pitfalls for visualization creativity workshops?** Suggest at least 3 pitfalls to avoid in running a *visualization workshop.*

Not vis specific ...

- Ending too abruptly without clear clarity of next steps - participants can leave confused
- Not preparing the cofacilitors fully for what is expected during each activity - can mean the outputs are not as tailored or as structured as expect
- Defining guidelines at the start but not explaining why these are important (i.e. why creativity is important). So rules and guidelines are not followed as day continues.
- Not giving a clear definitive explanation Or illustrative example when describing new activities can leave some participants not sure of what they are doing
- Getting stuck in the technical details
- Not having a diverse enough group of participants (with real understanding of the domain)
- Not changing small groups up throughout the day to keep things interesting and different. Means not everyone gets to work together - and bring different perspectives to the discussions
-

Vis specific

- Vis examples should not be biased to our work. Show variety. Also examples should not be too complex, long or short descriptions.
- Get too involved in the detail of tech, colour, design, or data issues
- Getting too involved in technical issues and data quality discussions- distracts from the bigger picture.

5. **What do you think is missing from these prompts?** Suggest any other changes that we should make to the paper or supplemental material.

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Prompts

1. **What makes our workshops *visualization* creativity workshops?** Suggest at least 3 specific areas where we can emphasize that visualization workshops differ from those in other domains. Some ideas could include rewording the guidelines, adding details to guidelines, or adding details to the related work and discussion section.

In Section 7.2, change the guideline "*Elicit relevant ideas*" to "*Elicit visualization requirements and opportunities.*" More specifically, remove:

> \paragraph{Elicit relevant ideas.} We refer to the set of all ideas being considered in the workshop as the ideaspace~\cite{Biskjaer2017}. We select methods that focus the ideaspace on the \topic --- exploring the possibilities for visualization in a specific domain.
>
> In line with existing visualization practices~\cite{Sedlmair2012}, we use methods that ask participants about their problems, not their envisioned solutions. Example prompts of effective methods include {\it ``What would you like to see in your data?''}~[\ref{pro:eon}], and {\it ``What do you want to do with visualization software?''}~[\ref{pro:cp}]. Responses to these prompts help us discover interesting visualization opportunities.

And replace it with:

> \paragraph{Elicit visualization requirements and opportunities.} We select workshop methods to ask participants about their current analysis challenges, the characteristics of their data, the limitations of existing analysis tools, or the ways in which they would like to use visualization. This can be achieved by adding a visualization twist to existing design and workshop methods.
>
> For example, in one workshop [~\ref{wor:htva}] we used a method that {\it ``developed user stories, considered relevant datasets, discussed alternative scenarios and sketched solutions''} with our domain collaborators. In retrospect, this method shows a way to incorporate the \topic of visualization and data analysis into a more general workshop methods, user stories~\cite{Kumar2012}.
>
> More formally, we refer to the set of all ideas being considered in the workshop as the ideaspace~\cite{Biskjaer2017}, and we select or tailor methods that focus on the ideaspace on the \topic --- exploring possibilities for visualization in a domain.

Change the guideline "*Create physical artifacts*" to "*Create physical and visual artifacts.*" More specifically, remove:

> \paragraph{Create physical artifacts.} We select methods by how they encourage participants to write, to draw, or to otherwise externalize their ideas. Externalizing ideas has many benefits: 1) it creates artifacts for researchers to analyze after the workshop, 2) it aids creative thinking because expressing an idea forces the creator to elaborate it~\cite{Sawyer2006}, and 3) it promotes idea sharing, encouraging \collegiality.
>
> Post-it notes are a particularly useful form of externalization because they enable participants to group or rank ideas and potentially to discover emergent concepts in the

ideaspace~\cite{Dove2016}. We have used post-it notes to externalize ideas in almost all of our workshops. When using post-it notes, we use their color to encode information such as the method or specific prompt that generated an idea, which can help with post-workshop analysis by establishing how ideas evolved and were valued throughout the workshop.

Additional materials effective for externalizing ideas include handouts with structured prompts, butcher paper, and poster boards. Using whiteboards is tempting, but ideas are easily lost when boards are erased.

And replace it with:

\paragraph{Create physical and visual artifacts.} We select methods by how they encourage participants to write, to draw, or to otherwise externalize their ideas. Externalizing ideas creates artifacts for us to analyze after the workshop, aids creative thinking because expressing an idea forces the creator to elaborate it~\cite{Sawyer2006}, and promotes idea sharing, encouraging \collegiality. While selecting methods to create artifacts, we consider the material used to create the artifact as well as the form of the idea that will be recorded.

With respect to the material, post-it notes are particularly useful because they enable participants to group or rank ideas and potentially to discover emergent concepts in the ideaspace~\cite{Dove2016}. We have used post-it notes in almost all of our workshops, often using their color to encode information about which method or prompt generated an idea, which can help with post-workshop analysis by establishing how ideas evolved and were valued throughout the workshop. Additional materials effective for externalizing ideas include handouts with structured prompts, butcher paper, and poster boards. Using whiteboards is tempting, but ideas are easily lost when boards are erased.

With respect to the form of ideas, effective methods create artifacts relevant to the \topic of visual data analysis. In our experience, this includes the use of visual language (See: Wishful Thinking in Sec. 7.X) and encouraging participants to sketch or draw, such as storyboarding [\ref{wor:eon},\ref{wor:graffinity},\ref{wor:cp}]. We see a plethora of opportunities to invent new methods that encourage the creation of visual artifacts, or to use existing methods such as sketching with data~\cite{Walny2015} or constructive visualizations~\cite{Huron2014}.

Replace the guideline "Act creatively" with "Embrace results in the design process." Remove:

\paragraph{Act creatively.} Similarly, there are many ways to act on knowledge gained from the workshop. We have run additional workshops that explored the possibilities for visualization design [\ref{pro:edina},~\ref{pro:eon}]. We have applied traditional user-centered design methods, such as interviews and contextual inquiry, to better understand collaborator's tasks [\ref{pro:graffinity}]. We have created prototypes of varying fidelity, from sketches to functioning software [\ref{pro:graffinity},~\ref{pro:cp},~\ref{pro:lineage}]. And, we have

identified key aims in proposals for funded collaboration [\ref{pro:arbor}]. In all of these cases, the knowledge gained from workshops profoundly influenced the direction of our collaboration.

And add:

\paragraph{Embrace results in the design process.} Similarly, there are many ways to integrate the workshop results into the visualization design process. We have run additional workshops that explored the possibilities for visualization design [\ref{pro:edina},~\ref{pro:eon}]. We have applied traditional user-centered design methods, such as interviews and contextual inquiry, to better understand collaborator's tasks [\ref{pro:graffinity}]. We have created prototypes of varying fidelity, from sketches to functioning software [\ref{pro:graffinity},~\ref{pro:cp},~\ref{pro:lineage}]. And, we have identified key aims in proposals for funded collaboration [\ref{pro:arbor}].

In all of these cases, our actions were based on the reason why we ran the workshop and the workshop results profoundly influenced the direction of our collaboration. For example, in our collaboration with neuroscientists, the workshop helped us focus on graph connectivity, a topic that we were able to explore with technology probes and prototypes of increasing fidelity, ultimately resulting in new visualization tools and techniques [\ref{wor:graffinity}].

2. **Where can we add concrete examples to the paper?** Suggest at least 3 examples from your experience that could strengthen the paper. This could include: feedback from participants (if allowed by the institution), interesting ideas that resulted from your workshops, your experiences integrating the workshop results into the design process, or your experiences doing applied research *without* using workshops.

Change the guideline "Test, test, test" to "Test the methods and materials." Remove:

\paragraph{Test, test, test.} Piloting (i.e., testing) methods can ensure that the workshop will generate ideas relevant to the \topic while maintaining appropriate levels of \interest and \challenge. We have piloted methods to evaluate how understandable they are [\ref{pro:eon},~\ref{pro:graffinity}], to test whether they create interesting results [\ref{pro:lineage},~\ref{pro:arbor}], and to find mistakes in their prompts [\ref{pro:eon},~\ref{pro:graffinity},~\ref{pro:lineage},~\ref{pro:arbor}].

Replace it with:

\paragraph{Test the methods and materials.} Piloting (i.e., testing) methods can ensure that the workshop will generate ideas relevant to the \topic while maintaining appropriate levels of \interest and \challenge. We have piloted methods to evaluate how understandable they are [\ref{pro:eon},~\ref{pro:graffinity}], to test whether they create results that can be used in the visualization design process [\ref{pro:lineage},~\ref{pro:arbor}], and to find mistakes in their prompts [\ref{pro:eon},~\ref{pro:graffinity},~\ref{pro:lineage},~\ref{pro:arbor}].

Add details to the guideline "Analyze with an open mind."

Replace this:

> \paragraph{Analyze with an open mind.} Because the ideas in the workshop output will vary among projects, there are many ways to analyze this corpus of artifacts. We have used qualitative analysis methods --- open coding, mindmapping, and other less formal processes --- to group artifacts into common themes or tasks [\ref{pro:eon},~\ref{pro:graffinity}~--~\ref{pro:updb}]. Quantitative analysis methods should be approached with caution as the frequency of an idea provides little information about its potential importance.
>
> We have ranked the themes and tasks that we discovered in analysis according to various criteria, including novelty, ease of development, potential impact on the domain, and relevance to the project [\ref{pro:eon},~\ref{pro:graffinity}--~\ref{pro:lineage}]. In other cases~[\ref{pro:edina},~\ref{pro:htva}], workshop methods generated specific requirements, tasks, or scenarios that could be edited for clarity and directly integrated into the design process.
>
> We encourage that analysis be approached with an open mind because there are likely many ways to make sense of the workshop data that we have not yet considered.

With this:

> \paragraph{Analyze with an open mind.} Because the ideas in the workshop output will vary among projects, there are many ways to analyze this corpus of artifacts. We have used qualitative analysis methods --- open coding, mindmapping, and other less formal processes --- to group artifacts into common themes or tasks [\ref{pro:eon},~\ref{pro:graffinity}~--~\ref{pro:updb}]. Quantitative analysis methods should be approached with caution as the frequency of an idea provides little information about its potential importance. This is inline with existing visualization guidance, which emphasized the importance of qualitative analysis methods for understanding the context in which visualizations will be developed and used~\ref{Isenberg2008}.
>
> We have ranked the themes and tasks that we discovered in analysis according to various criteria, including novelty, ease of development, potential impact on the domain, and relevance to the project [\ref{pro:eon},~\ref{pro:graffinity}--~\ref{pro:lineage}]. In other cases~[\ref{pro:edina},~\ref{pro:htva}], workshop methods generated specific requirements, tasks, or scenarios that could be edited for clarity and directly integrated into the design process. We encourage that analysis be approached with an open mind because there are likely many ways to make sense of the workshop data that we have not yet considered.

The act of analyzing the results can rely on both evaluating ideas, such as through grouping and ranking, and generating ideas, to explicate incomplete or ambiguous concepts that appear in the artifacts. For example, in our collaboration with neuroscientsts, a common theme in the workshop artifacts was the need to visualize neuron connectivity~\ref{wor:graffinity}. Through iterative sketching and discussions, we discovered that, to our collaborators, connectivity meant the analysis of many short paths connecting nodes in a graph, potentially considering node and edge attributes.

Add details to the guideline "Mix it up."

Remove:

> \paragraph{Mix it up.} We consider the relationships among methods to be important as we strive to balance exploration with focus and activity with rest, while also using many materials for externalizing ideas. Considering methods that vary these factors can provide different levels of \challenge because, for example, methods that require drawing ideas may be more difficult than discussing ideas. Using a variety of methods may also maintain \interest because participants may become bored if too much time is spent on a specific idea.

Add

> \paragraph{Mix it up.} In addition to balancing exploration with focus and activity with rest, we also select methods that provide a balance of understanding and ideation. We select methods that encourage formulating problems in a variety of ways --- providing diverse perspectives that can help us to understand the domain challenges. We also select methods that elicit ideas about envisioned solutions, such as the characteristics of ideal interactive legends [\ref{wor:edina}] and the key aims of a grant application [{\ref{wor:arbor}]. We also select methods that provide different levels of \challenge to maintain engagement because, for example, methods that require drawing ideas may be more difficult than discussing ideas. Using a variety of methods may also maintain \interest because participants may become bored if too much time is spent on a specific idea. Hence, we select methods that provide appropriate variety in the workshop.

3. **What are the characteristics of a successful workshop?** Suggest at least 3 ways to describe if a workshop is successful. Some questions to think about: Do all successful workshops results in a publication? If participants do not find a workshop interesting, could it still be successful? How would you describe the outputs of successful workshops?

- Successful workshops can establish the importance of all collaborators being engaged with the visualization researchers. For example, in one of our projects, the senior members of the lab were unwilling to spend time with us early in the collaboration --- they told us to talk to their grad students and post-docs. But, after the workshop, the senior members of the lab were more

willing to meet with us, and to spend time doing user-centered design methods, like contextual inquiry because the workshop had demonstrated that spending time on the process would be valuable. [pro:graffinity].

- Successful workshops can help identify collaborations that might not work. For example, in our collaboration with population database analysts, we discovered --- through the workshop --- that most of our would-be collaborators were actually fellow tool builders, not front-line analysts. We have been calling this workshop a failure because it didn't result in active collaboration. But, could we frame this workshop as a success because it helped us to avoid a (potentially) doomed collaboration?

- Successful workshops can identify shared needs among seemingly diverse analysts. This is particularly useful when working with large organizations, which are characterized by highly specialized analysts who work together and rely on collaboration to achieve goals~\cite{Sedlmair2010}. Using traditional user-centered design techniques, such as interviews and observations, it require significant time for us to build a holistic understanding of such data pipelines --- we must sample the pipeline at different locations. Yet, successful workshops can help us to understand the perspectives of many individuals involved in the data generation and analysis process. For example, in our workshop with neuroscientists, we were able to understand shared visualization opportunities in many parts of the analysis pipeline, from data generation, through analysis, and presentation.

4. **Based on your experience, what are pitfalls for visualization creativity workshops?** Suggest at least 5 pitfalls to avoid in running a *visualization workshop.*

- Pitfall: materials have the wrong affordances. This pitfall is quite common in our experience, including: 1) in one workshop we bought post-it notes that were the wrong size, which allowed participants to write more than one idea on a note. This made it impossible to reorder or cluster ideas. 2) In another workshop, we used a method that required sketching ideas, but we provided pens with too small of a tip. This encouraged participants to draw details, when we intended for them to draw highly abstracted ideas. In both cases, testing the methods and materials would have avoided this pitfall.

- Pitfall: failed to set expectations of co-facilitators –during the first activity of the day, all collaborators and co-facilitators were engaged with activities. As the day went on, co-facilitators who were not actively participating took out laptops and phones. This spread to a handful of the participants too. The expectations of no laptops and phones should have been explicitly set.

- Pitfall: not knowing the roles of collaborators in the meeting. There was participant in one meeting who did not engage at all in some of the activities. We were bothered by this: why was she not participating? Was she just not engaged? Were we doing something wrong? It turned out that her role in the lab was to manage tissue samples. She did not work at all with data analysis, so it was entirely reasonable for her to not contribute to discussions about analysis

software. If we had known this before the meeting, we would not have been stressed by her not participating.

- Pitfall: presentation distracted from the task at hand – written prompts should be given for each activity. During some methods, we did not appropriately describe the methods or participants forgot the prompt. This had discouraging results in some of our methods. In visualization analogies, one response included: "this doesn't work with our data" while, we were hoping to get them to comment on what traits they likes or didn't like about the visualizations. In subsequent workshops that used this method, providing written prompts seemed to more appropriately keep participants on track.

- Pitfall: insufficient knowledge of domain vocabulary. Although we have become confident in our ability to design and execute effective workshops, it is easy to forget that effective workshops require that facilitators select methods that will elicit interesting opportunities and lead discussions about the domain topic. Both of these require a command of the domain vocabulary. In some cases, we have relied on collaborators to help us learn vocabulary. But, we have felt that certain workshops could have been more effective --- e.g., elicit more interesting ideas, establish stronger rapport with collaborators, ensure shared context --- had we been better prepared with the domain vocabulary.

5. **What do you think is missing from these prompts?** Suggest any other changes that we should make to the paper or supplemental material.

A. Rephrase the additional workshop constraints. Remove:

\item What are additional workshop constraints? Additional project characteristics may constrain the possibilities of our workshops. Examples from our experience include the inability of collaborators to share sensitive data with us [\ref{pro:htva},~\ref{pro:lineage}], as well as the funding available for workshop materials.

Add:

\item What are additional workshop constraints? Examples of additional constraints from our experience include the (in)ability of collaborators to share sensitive data with us [\ref{pro:htva},~\ref{pro:lineage}] and the funding available for workshop materials.

Written Reflection for Revisions

This exercise will generate ideas about how to improve our paper based on feedback from reviews. Be specific in your responses because we need to provide concrete examples of our experience.

Please complete it by June 17 so we have enough time to revise the paper. Also, I will anonymize and archive our responses in the audit trail.

To help me organize these ideas, please make a copy of this doc and put your responses in it.

Prompts

1. **What makes our workshops *visualization* creativity workshops?** Suggest at least 3 specific areas where we can emphasize that visualization workshops differ from those in other domains. Some ideas could include rewording the guidelines, adding details to guidelines, or adding details to the related work and discussion section.
   - What kind of visualization knowledge and experience is required of facilitators/participants to be effective, and why?
   - What kinds of visualization considerations are important while analyzing the outputs?
   - Could you imagine a workshop with no visualizations being successful for producing vis design recs? Or run by people with no visualization knowledge? These questions might help to articulate what things that are important considers/guidelines that lead to success for vis outcomes.

2. **Where can we add concrete examples to the paper?** Suggest at least 3 examples from your experience that could strengthen the paper. This could include: feedback from participants (if allowed by the institution), interesting ideas that resulted from your workshops, your experiences integrating the workshop results into the design process, or your experiences doing applied research *without* using workshops.

3. **What are the characteristics of a successful workshop?** Suggest at least 3 ways to describe if a workshop is successful. Some questions to think about: Do all successful workshops result in a publication? If participants do not find a workshop interesting, could it still be successful? How would you describe the outputs of successful workshops?
   - At the highest level I think that success means downstream action -- that the workshop resulted in some action taken by the participant group towards their data analysis goals
   - That the workshop resulted in artifacts that the primary is able to analyze and produce concrete visualization ideas/recommendations for working towards the goal
   - improve/establish interpersonal relationships with group, and in particular between the primary/facilitators and the participants

4. **Based on your experience, what are pitfalls for visualization creativity workshops?** Suggest at least 3 pitfalls to avoid in running a *visualization workshop.*

5. **What do you think is missing from these prompts?** Suggest any other changes that we should make to the paper or supplemental material.

Written Reflection for Revisions

This exercise will generate ideas about how to improve our paper based on feedback from reviews. Be specific in your responses because we need to provide concrete examples of our experience.

Please complete it by June 17 so we have enough time to revise the paper. Also, I will anonymize and archive our responses in the audit trail.

To help me organize these ideas, please make a copy of this doc and put your responses in it.

I don't think I will be able to make contributions at the fine-grained level that Ethan has done - apologies - I'm just not close enough to the content to do this, and don't have time to get that close before the end of today.

So, with the aim of contributing at least something in the time that I have, please find some thoughts below - I hope they are useful. Of course you can decide, Ethan, whether or not you want to use and/or include any of this in the audit trail - my suspicion is that much of it is not at an appropriate level for the stage we're at with revisions to this paper, and might be better used in thinking about future papers, but I'm very happy for you to make a call on this, and either use or completely ignore any or all of it as you see fit!

Prompts

1. **What makes our workshops *visualization* creativity workshops?** Suggest at least 3 specific areas where we can emphasize that visualization workshops differ from those in other domains. Some ideas could include rewording the guidelines, adding details to guidelines, or adding details to the related work and discussion section.

Fundamentally, though trivially, what makes the workshops we are talking about vis creativity workshops rather than any other kind of creativity workshops is of course the fact that the desired output(s) are ideas/designs for one or more visualisations, rather than requirements/ideas/designs for any other kinds of systems or services.

This has potential implications both in terms of the methodological framework in the context of which our vis workshops are conducted, and in terms of the content of the workshops - the specific inputs to and outputs from each workshop, as well as the activities we might propose take place within it.

In terms of methodological framework, the way we first thought about creativity workshops, in the context of developing complex socio-technical systems (eg in air traffic control) was as part of quite a

complex overall 'requirements' process, which we called the RESCUE process - shown below in the figure, and explained in eg Jones, S. and Maiden, N., 2005. Rescue: An integrated method for specifying requirements for complex sociotechnical systems. In *Requirements engineering for sociotechnical systems* (pp. 245-265). IGI Global.
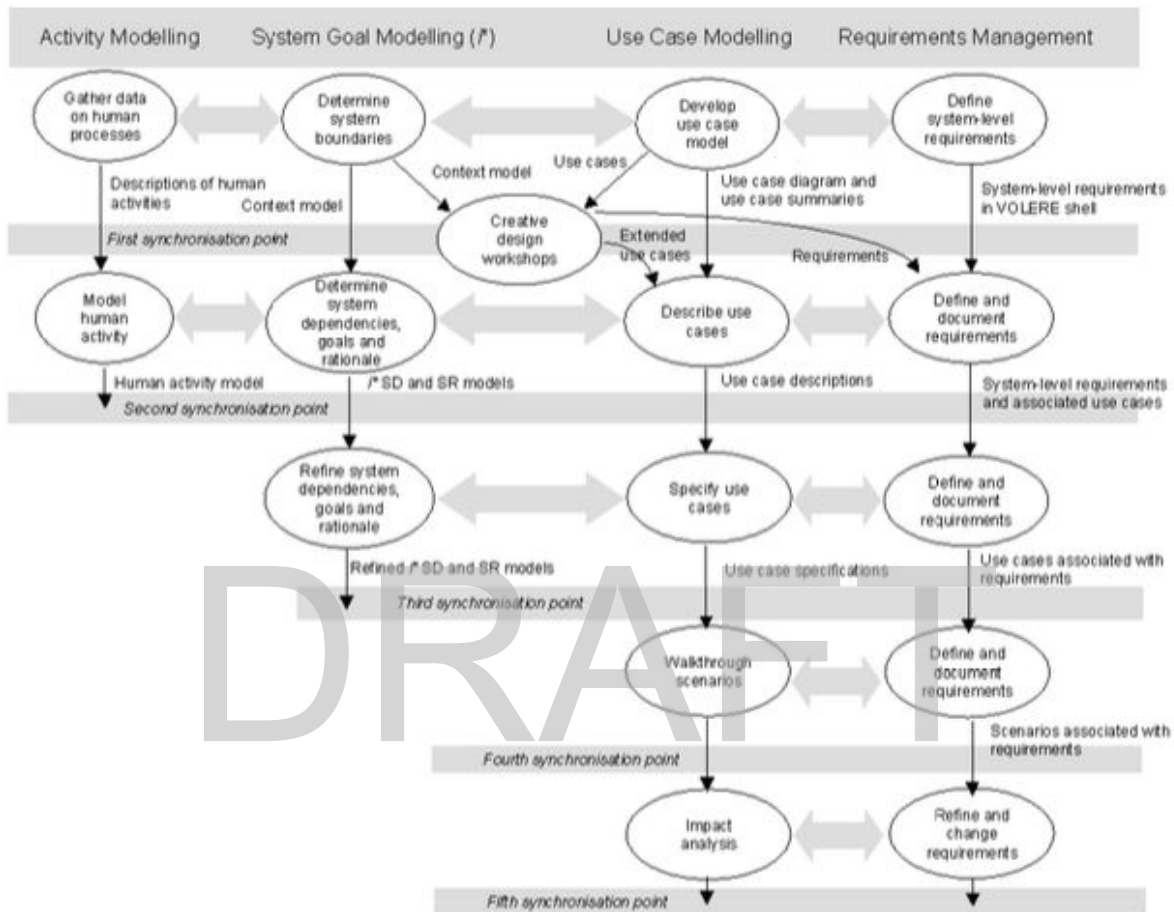

Figure 1: Overview of the RESCUE process

In this case we blended a number of different approaches to the early stages of the socio-technical system development process (represented by the 4 verticals in the figure) and situated our use of creativity workshops in relation to each of these. Unless I'm going mad (always possible …) I think as part of this work now, on vis creativity workshops, we began to produce a process diagram that showed a standard vis development process and the role of creativity workshops within that in a similar way, though I can't put my hand on a version of the paper with this in it at this moment…. Might it be useful to reconsider this as part of the framing in section 2 of the paper?

In terms of the workshop content - inputs, outputs and activities - I know we did some thinking about this in earlier drafts, and again, could be useful to revisit this for use in section 2? Three thoughts from me at this point would be:

- Activities designed to generate new ideas can be tailored to the vis context, as in, for example, the wishful thinking activity we have described which is not just a general purpose activity as described at http://www.icreate-project.eu/index.php?t=172 or http://www.brainstorming.co.uk/tutorials/wishfulthinkingtutorial.html , but tailored to our understanding of how users of the visualisations we're seeking to design may want to use them (seeing visualisations to find things out (know things) or analyse data in particular ways (do things))
- Activities in any creativity workshop might include those where participants are presented with elements of both the problem space (or domain challenge) and potential solution space, with the aim of catalysing combinational creativity - the bringing together of two or more existing ideas to produce one or more new and useful ideas - typically by using an idea from the solution space to address an issue in the problem space. In the case of a vis workshop, this might, for example, mean introducing visualisation analogies as examples from the solution space, and asking partciipants to think about how each form of vis could apply in their domain, as we describe in the paper. So this is another example of a commonly used type of activity (one designed to catalyse combinational creativity) being tailored for use in a vis design context.
- In creative workshops aimed at general system or service design, we would typically close with a storyboard, aimed partly at providing closure for the participants, but more importantly at focussing/converging and bringing together as many of the ideas generated in earlier phases of the workshop as possible (combinational creativity again) in a format - an externalisation - that could form the basis for designing the future system/service. In a vis creativity workshop, I assume you might naturally want to end with sketching potential vis designs? Or with storyboards outlining how visualisations might be used by the intended stakeholders? So once again, we can think of this as an example of how a commonly used generic activity/technique can be tailored for use in a vis-specific context.

2. **Where can we add concrete examples to the paper?** Suggest at least 3 examples from your experience that could strengthen the paper. This could include: feedback from participants (if allowed by the institution), interesting ideas that resulted from your workshops, your experiences integrating the workshop results into the design process, or your experiences doing applied research *without* using workshops.

Since I haven't been directly involved in any creativity workshops aimed at generating vis design ideas, I unfortunately can't contribute any ideas from my direct experience here. I'd have to go back to Sarah's paper ...I think others may be better placed to respond to this bit.

3. **What are the characteristics of a successful workshop?** Suggest at least 3 ways to describe if a workshop is successful. Some questions to think about: Do all successful workshops result in a publication? If participants do not find a workshop interesting, could it still be successful? How would you describe the outputs of successful workshops?

My suggestions on criteria for a successful workshop would be:

- Whether it leads to the generation of new and useful ideas. Ideas that are new and useful to the particular project in question are great - these would be examples of 'situated creativity' as in Sosa, R. and Gero, J.S., 2003. Design and change: A model of situated creativity. Even more desirable are ideas - eg ideas for new forms of visualisation - that are new to visualisation in general, which would be more likely to be closer to 'H creativity' (or historical creativity as in Boden, M.A., 1998. Creativity and artificial intelligence. *Artificial Intelligence*, *103*(1-2), pp.347-356.)
- Whether it leads to ideas that are later able to be actioned and implemented, as considered in Jones, S., Lynch, P., Maiden, N. and Lindstaedt, S., 2008, September. Use and influence of creative ideas and requirements for a work-integrated learning system. In *International Requirements Engineering, 2008. RE'08. 16th IEEE* (pp. 289-294). IEEE.
- Whether it elicits more ideas and/or more valuable ideas more quickly (in terms of elapsed time) and/or more efficiently (in terms of person hours) than the use of other techniques might
- Whether it leads to the development of trust, strengthened relationships between vis developers and domain experts, better team dynamics etc and/or gives participants (eg domain users/experts) a sense of ownership over the project/vis for which it is used, in the same way that any participatory or co-design approach would seek to do, though I would see this as a useful by-product, rather than the essential aim of a creativity workshop (which is about generating new and useful ideas)

4. **Based on your experience, what are pitfalls for visualization creativity workshops?** Suggest at least 3 pitfalls to avoid in running a *visualization workshop.*

Two thoughts:

- Providing inappropriate examples of visualisations in a vis analogy activity could lead participants down unhelpful paths, and result in workshop outputs that are not as new or useful as they might be.
- Becoming too focussed on the details of a vis design too early in a workshop can close down thinking too soon - its important to focus first on what any new vis is trying to achieve - the 'requirements' its trying to satisfy - before digging down into the details of how to satisfy these requirements through the use of particular designs.

5. **What do you think is missing from these prompts?** Suggest any other changes that we should make to the paper or supplemental material.

I think the issue about what is specific to vis creativity workshops is a really interesting, but potentially quite big one. I guess it relates to the general question of what is different about the design/development of visualisations, as opposed to other kinds of socio-technical systems, or services, so too big to tackle in this paper. Perhaps almost a cultural issue, of how things are seen in the vis community, as opposed to the software engineering community, or the service design community etc … I'd be happy to chat more about this if you think useful, but my instinct would be to leave this for now, and focus on more detailed revisions that will (all being well) satisfy this particular set of reviewers.