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Experiences in Involving Analysts in Visualisation Design

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ABSTRACT

Involving analysts in visualisation design has obvious benefits, but the knowledge-gap between domain experts ('analysts') and visualisation designers ('designers') often makes the degree of their involvement fall short of that aspired. By promoting a culture of mutual learning, understanding and contribution between both analysts and designers from the outset, participants can be raised to a level at which all can usefully contribute to both requirement definition and design. We describe the process we use to do this for tightly-scoped and short design exercises – with meetings/workshops, iterative bursts of design/prototyping over relatively short periods of time, and workplace-based evaluation – illustrating this with examples of our own experience from recent work with bird ecologists.

Categories and Subject Descriptors

H.5.2 [**Information interfaces and presentation**]: User interfaces—*User-centered design*

General Terms

Collaborative design.

Keywords

Design, prototyping, users, collaborative.

1. INTRODUCTION

There are calls for more human-centred approaches to information visualisation design that address needs of specific groups [6]. Involving such groups in visualisation design has obvious benefits, but the knowledge-gap between domain experts ('analysts') and visualisation designers ('designers') [14] often makes the *the degree* of their involvement fall short of that aspired. For information visualisation, this can be exacerbated by some analysts who overestimate their knowledge of the range of visualisation possibilities as information visualisation becomes more pervasive. This initial overestimation and subsequent knowledge-gap realisation, constrains the scope of analysts' requirements at the outset and makes it difficult for analysts to become closely involved in the design. This may result in designs that are more limited in scope than they could be and have not benefited from significant analyst input.

Promoting a culture of mutual learning, understanding and contribution between both analysts and designers, can raise all participants to a level at which *all can usefully contribute to both requirement definition and design*. This is done through: *(a)* meetings/workshops in which awareness of each other's work is raised and requirements defined; and *(b)* iterative, short bursts of design/prototyping [3] using analysts' own data punctuated by feedback sessions at which all parties can contribute and direct priorities for the next iteration.

Lab-based evaluations under controlled conditions are often used to assess the success of designs, but these often do not reflect reality for the analyst [13]. We, as others, find that more long-term evaluation techniques in which analysts make unsupervised use of the techniques as part of their job and after any initial excitement has abated, can be more valid [13, 10].

We outline a process that we have developed over several years [5, 2, 4] in which we have worked with various users. This process is best applied to *tightly-scoped design exercises*, outputs of which may include static images, simple tools or components of data exploration/analysis software. The most recent work for which we have used this process was a two-week 'scientific mission' [11] with ecologists (as the 'analysts') at the University of Amsterdam who track sea birds with GPS devices. They wanted to identify new ways of exploring their data and to characterise them in ways that were not previously possible for them. We illustrate our process with examples from this work.

2. PROCESS

User-centred approaches for visualisation design generally involve establishing context of use, requirements gathering, prototyping, refining and evaluating [12, 7]. Sedlmair *et al* [9] describe a 9-stage process for doing an entire design study, of which the 'core phase' – 'discover', 'design', 'implement' and 'deploy' and 'reflect' (steps 4 to 7) – relate specifically to collaborative design with users. Their experiences relate strongly to ours, some of which we will draw attention to. Although they present their framework as linear, they encourage jumping backwards to form iterative

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loops, noting for example that "the implementation of software prototypes and tools is tightly interleaved with the design process". Our process emphasises this observation strongly. Key to our approach is *visualisation awareness* [4] and *early prototyping* [8] with users' own data [5] which aim to reduce the knowledge-gap between analysts and designers. Another aspect we emphasise is the use of short iterative cycles over a short period of time, in order for the user context to stay current, momentum to be maintained and all parties to remain interested. Note that we emphasise short and tightly-scoped design exercises (rather than whole design studies) which may form components of design studies, making this feasible.

Documentation of activity is essential. Asking participants to record items on separate Post-it notes during structured activities and ranking these whenever possible has worked well for us [2]. Other note-taking is important and if possible, a dedicated observer and scribe is helpful as maintaining notes whilst participating in a workshop is distracting.

2.1 Visualisation awareness

Inevitably, those with limited experience of information visualisation have a limited view of the possibilities [14]. The *visualisation awareness* workshop [4] is designed to demonstrate a wide range of novel possibilities through example and commentary, "to prompt useful ideas and reactions that users might not otherwise think to offer" [8]. For example, the ecologists had not considered that interactive visualisation could be an interface to obtaining local statistics 'on-the-fly' through visual spatial and temporal selection. The examples that demonstrated this, prompted new ideas. In the visualisation awareness workshop, a suite of visualisation examples is presented along with commentary on how these help with data interpretation. Starting with examples that relate strongly to the analysts' data and moving towards examples that are rather less related helps broaden views, but we try to discourage participants from seizing on specific techniques because it may constrain the design process. Roth *et al* [8] are open to modifying existing prototypes, which, although sometimes appropriate, should not constrain the design process.

Although visualisation awareness is intended to stimulate ideas for subsequent stages, this may not always the case. We have worked with participants who chose not to continue after this stage due to a combination of reasons including lack of access to data, insufficient time and resources to take part or that it becomes clear that visual analytics is unsuitable for their interests. Sedlmair *et al*'s 'precondition phase' [9] has useful advice for identifying users to work with. Such an outcome is common where we have carried out a visualisation awareness workshop before users have committed to working with us. In these cases, the exchange of knowledge has likely been valuable to both parties to some degree and may help us improve the way we run workshops. For example, in one case, a contributing factor was the range of visualisation awareness examples was too narrow and none were seen as appropriate to the analysts' needs or data. We are now experimenting with the use of creativity exercises to help participants abstract ideas from the examples presented and reapply them in different contexts. In some cases, the stage has wider applicability – in the case of the work with the ecologists, some of these ideas became the basis for a subsequent piece of work.

2.2 Current practice

Here, the analysts explain what they currently do, how they do it, the limitations and what has been tried in the past. Allowing analysts to lead this session, after the designer-led awareness workshop, emphasises the equal footing of analysts and designers. It acknowledges that both groups can learn from each other and that knowledge-gaps need to be reduced from both sides. Analysts have commented that even *within* a group of analysts, there can be considerable differences in which techniques they use with their data. Discussion of current visualisation problems and their implications helps designers understand how sophisticated their use of information visualisation is and provides a useful starting point for subsequent stages. We found the bird ecologists were more experienced with interactive visualisation than we expected. They already had experience of multiple coordinated views in MatLab and R and had already commissioned a Google Earth based tool for exploring their GPS data. Deficiencies in these tools were apparent, however. It can also be useful to find out what analyst had tried in the past that did not meet their expectations. In the case of the bird ecologists, they had tried using '3D tours' in Google Earth to get a "bird's eye" perspective, but it became apparent that was of limited value.

2.3 Aspirations and requirements

This and the previous stages relate to Sedlmair *et al* 'discover' stage [9]. Since we usually run tightly scoped projects that lend themselves to being completed in a number of intensive iterative cycles, our problem domain characterisation is not as comprehensive as those in other frameworks. We gather high-level aspirations, followed by more specific pieces of required functionally, framed as 'tasks'. Aspirations are aimed to capture the 'bigger picture' that will influence the design, but may not come across in the way the tasks are expressed. For example, the ecologists aspired to having screenshots that were intuitive and self-explanatory, whereas tasks included identifying how long birds stay somewhere and which birds forage in which areas [11]. Tasks are scoped and expressed in such a way that they can be answered and the degree of success of a technique can be assessed, which is important for the evaluation. Tasks are discussed in the context of the available datasets, examples of which should be supplied to the subsequent phase. Using real data helps analysts engage with the output more effectively [5] and, importantly, is more likely to result in realistic patterns and structure, which may influence the choice of visualisation techniques. In our work with the bird ecologists, two datasets were supplied: one with nesting and foraging gulls and one with oystercatchers on mudflats.

2.4 Design/prototyping and feedback

The core of the process is an iterative loop intended to last about five days, where intensive design and prototyping are followed by a feedback session where ideas and prototypes are presented and discussed. These are either endorsed, modified or discarded and requirements and priorities updated for subsequent iteration. Influenced by ideas from Agile software development [1], requirements and priorities are modified as ideas evolve, ensuring that requirements and designs remain relevant, subject to designer advice on

what is achievable within the timeframe. Floyd *et al*'s [3] ideas on rapid prototyping facilitate this, in which highly interactive and novel prototypes are 'hacked together' using any suitable technology (HTML/SVG/JavaScript mashups and Processing are suitable technologies). Low programming investment should make these ideas easier to discard if necessary. Use of analysts' own data helps analysts assess unfamiliar techniques more objectively [5]. It is expected that designs with become more stable as ideas that work are identified. Each iteration includes some of Sedlmair *et al*'s 'design' and 'implement' stages [9] stages and their recommendations – including starting with a broad design space, finding good rather than optimal solutions, designing creatively, rapid prototyping and developing 'throw-away' code – are consistent with our experiences.

Two iterations were run for the work with the ecologists. The first produced a number of prototypes (distinct functionalities within one software prototype), but for reasons of time and complexity, not all the tasks were supported. The exercise that followed involved assessing the success of each task and then prioritising tasks by importance. It was decided that there was more value in exploring the foraging gull dataset in this way and a decision was made to concentrate on this. Some functionality was dropped (such as filtering by bird flight elevation), some was marked for improvement (temporal selection at a finer resolution) and more new functionality was requested (filtering by sunrise/sunset and annotation).

The length of the funded 'scientific mission' was the main constraint on the number of iterations we could run. Had we more time, we would not dropped all the tasks we did and would have run another iteration. Although we were pleased with the results of the two iterations, this highlights the fact that the implementation of this process may be subject to external factors.

2.5 Evaluation of design

An implementation suitable for unsupervised analyst use of the design is needed for evaluation because valid evaluation can only really be achieved when the analysts use it to explore their own data as part of their normal working activity without intervention by designers. This stage corresponds to Sedlmair *et al* 'deploy' stage [9] along with the evaluation (next section). It is likely to be based on one or more of the design prototypes, but must be sufficiently polished for analysts to use with their data and they must have confidence interpreting the outputs. Implementations may be paper printouts, static images, web-based interfaces or custom-built software applications, as long as analysts can test the design on their own, using the identified tasks and their own data. Since our process is intended for tightly-scoped design work, implementations will be similarly scoped.

For implementations that involve interaction, this stage may be difficult and time-consuming and may require multiple feedback iterations with analysts. There is often a temptation to add new functionality, but where the process needs to be kept within a short space of time, we need to try and avoid 'feature creep'. In our work with the bird ecologists, we refined the tool during the last two days of the visit and for a few days afterwards. Unanticipated problems are inevitable. In our case, an essential piece of functionality did not work properly on the analysts' computers due to platform differences; an unexpected hurdle that was finally resolved.

Since the supplied dataset has been studied intensively during the process, we asked for another equivalent (same data format) dataset for the subsequent evaluation stage so that tasks could be performed on fresh unexplored data. We ensured the tool worked with these new data.

2.6 Evaluation

We ask analysts to evaluate the *techniques* implementation against the original tasks. We remind them to focus on the techniques rather than the implementation, as the implementation is simply the means to develop, test and evaluate the design. Analysts need to be comfortable using the tool on their own and have confidence in the outputs. We welcome the trend towards work-place-based, more long-term evaluations [10, 13] that more realistically reflect the analytical process. We believe that evaluation can only really be valid when subjects use the tool in their own time, in a realistic work context without being openly observed or monitored, and in response to real interest in exploring their data. Asking them to use a fresh dataset aims to help and better demonstrate the utility of the methods. Unsupervised and unmonitored use of the tool requires analysts to self-document their views and findings. Sedlmair *et al* [9] cite a phenomenon in which analysts who work closely with designers tend to give positive feedback about their experiences by default. We try and reduce the impact of this by not involving designers in the evaluation and asking analysts to document what they did, what they found out to evaluate success based on these.

For our work with the ecologists, we supplied a Word document of questions, within which they could embed answers. The first part related to how effectively the techniques addressed the original requirements. The ecologists were able to carry out the tasks defined with varying levels of success, using a different dataset (birds from a subsequent year), scoring their success, producing descriptions of what they had done, how they had done it and illustrating their answers with screenshots. They reflected on the techniques independently from the software implementation, which is still in use. The second part asked them to rate and comment on the process helping us refine this user-centred process.

3. IMPLEMENTING THE PROCESS

The strong reliance on analysts' input to this process necessitates their significant commitment and this strongly affects how this process is implemented. One has to be flexible enough in session design and timing to accommodate the working practices of the analysts and to be compatible with their working culture. Where designers and analysts cannot be collocated throughout, email, phone and video conferencing may suffice.

We emphasise focused and intense activity over short timescales. The opportunity to be collocated, the regular content between all parties that this promotes, and high density of progress maintains momentum and helps keep all parties interested and involved. The emphasis on short bursts of intensive activity may help reduce participation barriers and the emphasis on working with current data and problems helps keep this relevant to current needs. Intensively working within a short blocks of time can be time efficient and encourages rapid progress to be made. However, there

are drawbacks. An inevitable drawback of working on short timescales is that this constrains what can be achieved and there may not be time at the outset to use a design space that is broad enough. We would have preferred the work with the bird ecologists to have lasted a little longer than two weeks because there were issues we had to drop due to time constraints (in this case, related to funding constraints). There are advantages to keeping the work focussed and it may be possible to run a series of new iterations at a later date in another burst of intense activity.

Getting analysts to commit to taking part in the first place is often a stumbling block and one that is dealt with by Sedlmair *et al*'s 'precondition' phase [9]. As stated, we have run visualisation awareness workshops before analysts have committed to taking part. A number of these sessions may need to be run in order to explore potential. It is helpful if a 'local champion' promotes the idea within the organisation, recruit and manage participants.

4. CONCLUDING REMARKS

This process reflects our position on designing visualisation techniques: that all parties must contribute meaningfully to the design process, that iterative short bursts of rapid prototyping followed by feedback produces effective solutions from novel ideas, and that evaluation needs to be work-place based and long-term. Prescribing the details of such a process too much is unhelpful – in our experience, such embedded processes need to be adaptable to local circumstances, but design over a short space of time and collocation is beneficial. This process has enabled us to produce creative and effective visualisation solutions to specific problems that have been deemed successful by us and our collaborators. In the case of the bird ecologists, their continued use of the tool is a testament to this.

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