Co-adaptive Tools to Support Expert Creative Practice

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ABSTRACT

I am interested in designing interactive systems to support expert creative practice. During my thesis I will propose novel tools grounded on creative professionals' processes, that will allow them to explore complex creative concepts. With this goal in mind, I studied the practices of designers, and built a tool called *StickyLines*. *StickyLines* allows users to appropriate the concept of alignment and distribution relationships in graphical layout. My main focus for the rest of my thesis is on choreographers, as they work not only with spatial but also temporal and more general relationships, presenting an interesting challenge from a Human-Computer Interaction (HCI) perspective. I interviewed contemporary choreographers about their creative process and conducted workshops to explore how they express creative ideas. As a result, we proposed a framework for articulating the high-level patterns that emerge from their practice, and presented a set of implications for the design of interactive tools for choreographers. I am currently prototyping *Knotation*, a tool that will let them explore their choreographic ideas by sketching and linking multimedia files, at different levels of abstraction. I plan to iterate the design with users in the frame of participatory design workshops and to evaluate it through qualitative studies.

CCS CONCEPTS

• **Human-centered computing → HCI theory, concepts and models**; **User studies**; **Graphical user interfaces**;

KEYWORDS

Creativity Support Tools; Appropriation; Technology Design; Choreography; Dance

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1 INTRODUCTION

Creative professionals such as designers and choreographers, are extreme users who push the limits of technology and reveal innovative ways of exploring and expressing ideas [7, 17]. My approach seeks to enhance the interaction between users and their personal representations of creative ideas, providing a mix of user-defined constraints and flexibility.

I am particularly interested in designing for appropriation[14], i.e. favouring situations in which the users adapt the tools in unanticipated ways beyond the designer's mental model, since this encourages user innovation while increasing the expressive power of the tools. I argue that these interactive tools should be co-adaptive: Users should be able to *adapt* the system to their own needs, but also *adapt to* the system as they master it [14].

The goal of my work, then, is to explore how co-adaptive tools can support the cycle of creative activity. To accomplish this, my thesis triangulates between theory, design and observation[16]. Its theoretical foundation draws from theories and methods in HCI –mainly Instrumental Interaction [2, 4], Substrates [9], Generative Walkthroughs[13]–, and from dance research[1]. I follow a user-centred design process [15] that includes several qualitative and quantitative methods (critical object interviews, semi-structured observational studies, low-fidelity prototyping, participatory design workshops, controlled experiments, etc.).

After a review of the main related work, I present my findings with designers and choreographers. I then describe my work in progress with *Knotation* and conclude with perspectives for the remainder of my thesis.

2 RELATEDWORK

In [19], Shneiderman suggests that creativity support tools should facilitate exploratory search, support generation of multiple alternatives, enable collaboration, provide a rich history, and allow users to revert to previous states as needed. Both him [18] and Hewett et al. [10] argue that researchers need to start by observing the creative practice, identifying problems to address, and then design prototypes (typically low fidelity) before developing the actual solution. Qualitative and quantitative evaluations should follow, comparing the novel tools with the current practice, and analysing their use in real-world scenarios.

After studying designers' practices, Maudet et al. [17] showed that designers lack tools to support the sophisticated ad-hoc strategies they use to define spatial and temporal properties in their designs. In the particular case of spatial relationships, users still struggle with the complex nature of graphical alignment and distribution, and –except for a few approaches reported in [6]– systems rarely make them visible and directly manipulable, giving little room for co-adaptation to happen.

Choreographers, on the other hand, still lack access to software tools that support their creative process, particularly in its early phases. Moreover, most existing systems are highly idiosyncratic, limited to a specific dance style or choreographic method, and thus hard to generalise (a comprehensive review can be found in[1]).

Knotation, the tool I am currently prototyping, is inspired by *Knotty gestures* [21], a technique for interacting with paper, consisting in small circles that users add to any pen gesture in the flow

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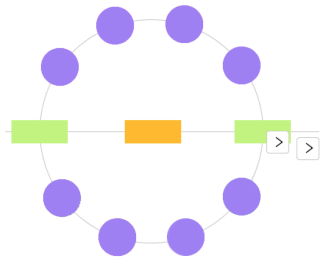

Figure 1: Spatial relationships reified as StickyLines: Linear and circular guidelines.

of writing. *Knots* encapsulate interaction, and their meaning can be revised and reassigned at any moment. The authors mention several applications for the knots, e.g. triggering an audio recording (or playback), defining a line as the scope of a table, performing mathematical functions, etc. InkSeine [11] proposes ways to link annotations to virtual objects and interact with them in context. However, it was not designed to support the choreographic process, but for augmenting note taking. The TKB project [8] provides choreographers with video annotation, a valuable feature that for now is not in the scope of *Knotation*.

3 DEFINING SPATIAL RELATIONSHIPS WITH STICKYLINES

I started my thesis by observing how both designers and non-designers create graphical layouts. My first observational study [6] showed that users struggle when establishing spatial relationships between graphical objects, finding the alignment and distribution commands in current systems cumbersome. Users need these spatial relationships to be persistent, easier to control, and more general –for example, being able to align objects along a circle–.

However, current tools lack concrete representations of alignment and distribution. We argued that both should be represented as first-class objects on screen, i.e. entities that are dynamically created and accessed, with their own settings and properties –such as position, size, colour–, that users can manipulate directly. The process by which an abstract concept is turned into a first-class object is called reification [4]. We proposed to reify alignment and distribution into guidelines, based on Beaudouin-Lafon's Magnetic Guidelines[3].

Grounded on our observations on how designers and other users define graphical layouts, we created *StickyLines*, a tool that treats guidelines as persistent, interactive graphical objects that users can manipulate directly (Fig. 1). Objects can be attached and detached from a guideline, and moving a guideline moves the objects attached to it. StickyLines relies also on the reification of objects' bounding boxes and ad-hoc adjustments ('tweaks'). Guidelines are *polymorphic* instruments[4] since they can be applied to different types of objects, for example, images, icons, geometrical shapes, and ideally, any object that has a visual representation on screen. We conducted a controlled experiment that demonstrated that, for complex layouts, StickyLines are up to 40% faster than alignment and distribution commands, and reduce the number of user actions by up to 49%.

My first study had showed that designers have stronger accuracy requirements than non-designers, so we ran a structured observation with six designers. The study pointed out how designers can quickly adapt to and appropriate StickyLines. They proposed innovative uses of the tool, including the creation of complex guidelines and using them for not only spatial but semantic grouping, establishing more general relationships between objects.

StickyLines illustrated how the principles from Instrumental Interaction[4] can improve how designers and other users establish spatial relationships, leveraging on appropriation. I am also interested in exploring how these principles –combined with those used in Generative Walkthroughs[13]– can help choreographers, who have to deal with more subtle and complex spatio-temporal and semantic constraints.

4 STUDYING CHOREOGRAPHERS' CREATIVE PROCESS

My goal is to create interactive systems that support the early creative phases of choreography, augmenting choreographers' existing practices and letting them personalise and appropriate the technology to meet their needs. This is a considerable design challenge, given the complexity of the choreographic practice and its inherent idiosyncrasy: Choreographers' creative processes are purposely unique, and we cannot expect them to adopt tools that enforce another choreographer's practice. To design such systems, I first needed to understand how choreographers concretise their ideas.

I conducted story-centred interviews with six contemporary choreographers, who guided me step-by-step in the creation process of a recent piece they had choreographed. Together with my advisors, we identified six categories that reveal emerging patterns in the stories I collected: *choreographic objects*, *creative phases*, *representations*, *operations*, *specificity*, and *focal points*. We created a framework that articulates these categories [5].

4.1 Framing Choreographers' Creative Process

We found that choreographers represent their ideas by applying a set of *operations* onto *choreographic objects*.

Choreographic objects represent the choreographic ideas manipulated along the process, formalised at various levels of abstraction. Some examples are inspirational symbols and high-level concepts (e.g. 'beatitude'), constraints ("dancers will dance on a piano's surface"), and concrete dance sequences. We found that all choreographers started from an initial idea, from which the elements in the final piece were born. Participants expressed their choreographic objects using *drawings*, *text*, *diagrams*, *video*, and some of them *formal notation* (adapted from existing or created from scratch).

Operations are actions applied to choreographic objects. We report four subcategories: *transforming*, *structuring*, *abstracting*, and *transmitting*. *Transforming* is about editing existing choreographic objects, for example, changing the body part for a certain sequence. *Structuring* implies combining them to give structure to the piece, for example, ordering sequences and establishing a seamless transition between them. *Abstracting* a choreographic object is the act of 'zooming out' from it, i.e. focusing on a less detailed view to get a global sense of the object and its context and relationships. For example, drawing a summary of the scenes in the piece. *Transmitting*

a choreographic object refers to *showing an artefact* to dancers and collaborators (for example a sketch or video), *doing* (performing the movement), *telling* (giving oral instructions or explanations), or combinations of these strategies.

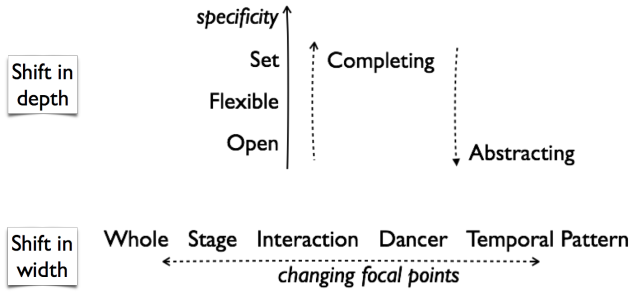

Figure 2: Top: Choreographers vary the specificity level of choreographic objects by applying completing and abstracting operations. Bottom: Choreographers shift among different focal points.

Choreographers express their choreographic ideas within a continuum of *specificity*: They constrain certain aspects of their objects and operations, and let dancers interpret the rest. A choreographic object can be characterised as *open*, *flexible* or *set* (top of Fig. 2). Participants often leave some choreographic objects open (or flexible) throughout the whole process: 'open' does not necessarily mean 'unfinished', it can be purposely 'incomplete'.

We found that choreographers compose by shifting between different *focal points* (bottom of Fig. 2). They define choreographic objects with the attention in the piece as a *whole*, in the *stage*, in a particular *dancer*, in an *interaction*, and in *temporal patterns*. Choreographers use their intuition, choreographic skills, and memory (their own and the dancers') to map the elements in different focal points.

Choreographers define, modify, and transmit choreographic objects and operations, constantly shifting across levels during the process. They rely on artefacts to complement bodily and oral instructions. I wonder why do they document so few changes when they compose a piece and why is a considerable part of their decision-making process implicit and sometimes unarticulated. One reason could be the absence of tools for easily capturing and manipulating their material. Our findings also suggest that formal notation is not enough to represent choreographers' ideas, even after they adapt the notation system to their compositional needs.

4.2 Implications for the Design of Interactive Tools for Choreographers

In [5] we proposed a set of implications for design, that I later iterated and refined:

Knowledge availability: Make the accumulated knowledge about the piece easy to reuse.

Multiple representation of ideas: Track links between artefacts generated at each level of abstraction or focal point, visualising the choreographic objects and operations, as well as their relationships.

Incompleteness: Provide ways of capturing incomplete choreographic objects and operations.

Distributed cognition[12]: Support choreographic knowledge distribution and collaborative decision-making.

Situated action[20]: Take into account the context in which the tool will be used (e.g., studio with dancers versus home).

5 DESIGNING A CO-ADAPTIVE TOOL FOR CHOREOGRAPHERS: KNOTATION

Given our results from the previous study and our implications for design, I chose the Apple's iPad Pro™ as the interactive device. It can be easily brought into a studio, and it is big enough to allow sketching and showing videos to a certain number of people without the need of extra screens. In our own observations and while reviewing the literature, I found that some choreographers already use iPads at work, mainly to record videos and show them to dancers, take pictures, and make annotations. In addition, the Apple Pencil™ provides a precise pen interaction with pressure and angle sensing, which gives us interesting opportunities for interaction design.

I envision *Knotation*: a minimalistic, non-obstrusive tool that provides ways to make choreographic objects interactive. I do not want to interrupt choreographers' flow of thinking, or force them to make premature decisions. My priority is to build a highly appropriable tool, given that each choreographer's process is unique, and that they are already highly creative people. Finding a good combination of learnability and discoverability is another design challenge in this landscape. I expect to achieve this by leveraging on the principles of Instrumental Interaction [4]: Users should be able to define their choreographic objects, and to apply reified, polymorphic instruments on them that will favour the reuse of both their input and output. Moreover, I propose that users define their own palette of instruments while interacting with the tool.

5.1 Defining Spatio-Temporal Relationships with Knotation

I propose to apply the concept of a *knot* on a digital environment, where recognition accuracy is not a problem anymore. In fact, we do not need the user to actually *draw* the knots, they could be created by, for example, long-pressing the pen on the device surface, which would also favour discoverability. Knots would be now digital, so we could treat them as first-class objects that the user can duplicate, move, delete, or hide. Users could deliberately change a knot's appearance to reveal more information about its meaning, for example, displaying it as a video icon to indicate it will trigger a video playback.

Knotation will let choreographers sketch, annotate, and link their choreographic objects on an iPad Pro. Users will add knots to the choreographic objects to make them interactive. Knots will have *attributes* (e.g. speed, energy, movement quality), whose values will be set via a *controller* (e.g., a number, a slider, or even the live data from sensors in the dancers' bodies). The details about a knot's meaning would only be shown when interacting with the knot, to avoid information overload.

For example, a choreographer might want to sketch a floorplan, i.e. a diagram with dancers' trajectories in space seen from above, and attach a video of a rehearsal of that particular part of the piece. It would be enough to define a knot on the floorplan border, and

link it to the video file. Next time the user taps on the knot, the video would be played. The user may also explore changes in the speed of the trajectories: By defining a knot with a *speed* attribute, and attaching it to a proper controller –for example, a slider–, the choreographer could then *play the floorplan*, and *Knotation* would animate the trajectories based on the current value of the speed.

Choreographers could link the same controller to several attributes: A geometrical pattern or curve (controller) could represent, for example, the variations in both speed and energy (attributes) during a certain part of the piece. Similarly, the same attribute could be linked to several choreographic objects.

Knotation will have support for some well-known choreographic objects –such as foorplans and keyframes (diagrams that show the location of dancers at a certain point in time, seen from above)–, and also for more general instruments called *timelines*, that will define time intervals and will have whatever shape the user decides to draw, for example, straight lines, curves, etc. Timelines could be linked with other choreographic objects, media files, or concatenated in different ways to explore the flow of the piece. Still, choreographers could sketch their own choreographic objects and assign them custom behaviour by appropriating the knots and the links between objects.

Interacting with choreographic objects and knots would support the operations that we identified in our framework. For example, in the category of *structuring*, the operation of *ordering* could be done by simply moving objects on the screen. In the *transforming* category, *reusing* would be achieved by duplicating objects or knots. *Abstracting* a choreographic object could be as simple as defining a knot as a 'portal' to a less detailed view of the object. The knot in this new view would then act as a portal to the original (and more detailed) one. This would be useful to manage the shifting in levels of abstraction that choreographers do, and facilitate the transmission to dancers and collaborators. Additionaly, by linking objects, choreographers could keep track of the several focal points they work with.

My goal is to allow for meaning to emerge along the process: Choreographers should be able to change their mind about what an object means, delay this decision, and explore different combinations by linking objects, controllers and attributes with each other.

In terms of output, *Knotation* could also animate transitions between keyframes, given user-defined constraints. For example, the default could be a straight, linear transition, but the user could set spatio-temporal constraints to shape it. The choreographer could specify a type of movement that needs to be performed during a certain interval of the transition (for example, 'circular movement'), or more complex relationships such as: "dancers need to always be at less than 50cm from each other but without colliding". In the following months I will explore the expressive and computing limits of *Knotation*.

6 CONCLUSIONS

The goal of my doctoral work is to explore how co-adaptive tools can support expert creative practice, with a focus on appropriation. I want to enhance the interaction between users and their objects of interest, with a mix of user-defined constraints and flexibility that allows them to explore complex creative concepts.

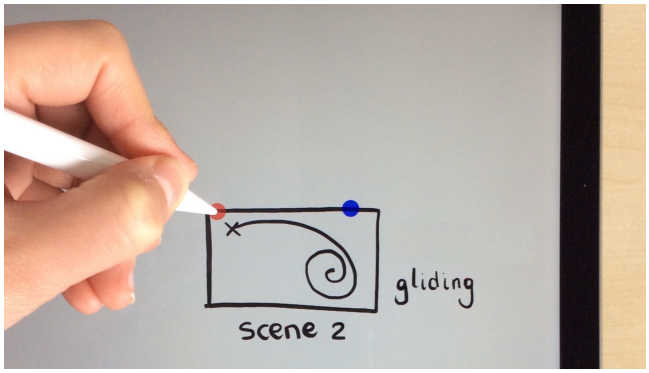

Figure 3: User tapping a knot on a floorplan in Knotation.

I first studied the practices of designers, and built a tool called *StickyLines*, which lets users appropriate the concept of alignment and distribution relationships in graphical layout tasks. The remainder of my thesis is focused on choreographers, as they have to deal not only with spatial but also more general relationships. I presented my study of choreographers, and the theoretical framework derived from the results. Based on our implications for design, I proposed a tool called *Knotation*.

6.1 Current Status

So far, I have designed a set of *interaction points* (specific situations in which the user interacts with the system), videoprototyped a design scenario that illustrates them in a coherent user story, and prototyped a simple system where the users can sketch with the Apple Pencil, create knots by long-pressing anywhere in the canvas, and select both knots and sketched objects (Fig. 3).

6.2 Future Work

I am currently planning another participatory design workshop with choreographers where I will explore how participants would record their choreographic objects and how would they express spatio-temporal constraints. The next natural step will be actually building the tool. I would like to evaluate *Knotation* with choreographers in studies such as structured observations, expecting to find qualitative data on how they appropriate the tool, and what could be improved.

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