

Computational Support for Creativity via Capture and Access

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ABSTRACT

In this position paper, we argue that capture and access technology can provide a key form of computational support for the creative process. We will illustrate this claim using several examples from our previous work on projector-guided painting and sculpture systems. We describe additional work on the creation of a process model for (a) the creation of a collaborative children's mural and (b) the creative planning of new paintings in the style of a specific series of paintings by abstract expressionist Richard Diebenkorn. Challenges we faced in the evaluation of the projector-guided system are presented. Finally, we discuss our vision of the art studio of the future and how capture and access will play a central role in leading to its success in empowering creativity.

Author Keywords

projector-guided painting, sculpture, creativity support, process models, capture and access

ACM Classification Keywords

H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

INTRODUCTION

We believe that the key to computational creative support is to *capture* and model the creative processes in a computational manner and provide *access* to these models through domain-specific capabilities such as the interaction modes of our projector-guided painting and sculpture systems.

Three years ago, we designed a novel interactive system for guiding artists to paint using traditional media and tools [2]. The enabling technology is a multi-projector display capable of controlling the appearance of an artist's canvas as illustrated in Figure 1. Artists are guided by this display-on-canvas to paint according to a process model we designed to solve 3 common problems with novice painters. The artist paints according to a linear process of painting in layers and, within each layer, a set of colors. Each component of our model of the painting process has an associated interaction mode. Preview mode shows the entire layer as the current painting goal. Blank mode reveals the state of the painting. Color selection mode displays where to paint a target color. Color mixing mode shows how to mix it and orientation mode shows how to paint it. These interaction modes enable the novice to focus on painting sub-tasks in order to simplify the painting process while providing technical guidance ranging from high-level composition to detailed brushwork.

*This research was done while Skeels was a student in the Computational Perception Lab at the Georgia Institute of Technology.

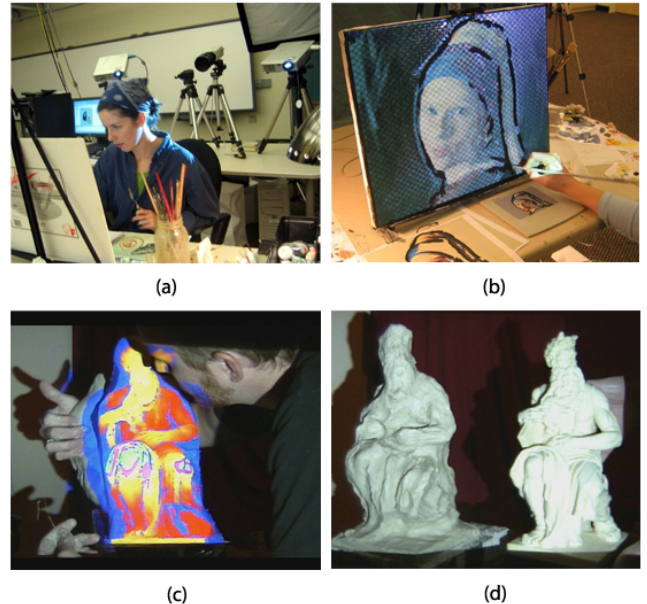


Figure 1. We support the creation of oil paintings and sculpture by modeling their processes for creation and embedding access to the model via a display projected on the creation. (a) Multiple projectors and a camera create a display capable of augmenting a painting in progress. (b) The display shows how to paint in a layer-by-layer process. (c) Projected displays on sculpture show where to add and subtract clay. (d) The final sculpture is on the left and model sculpture is on the right.

In a second related project called Shapeshift, a projector-camera system was applied to support the creation of sculptures [4]. By augmenting a projector with 3D scanning capabilities and projecting surface aware guidance on to the sculpture material, users can construct 3D sculptures. Using a 3D model as the sketch of the sculpture to be built, the scanned surface of the physical material is compared to the sketch. The guidance is then projected in the form of depth changes needed to make the sculpture in progress more like the 3D sketch. This provides automatic and comprehensive information similar to the current sculpting practice of using rulers and calipers to check proportion and perspective.

In this position paper, we unify our previous work in projector-guided art creation into a more general theme of computational creativity support via the capture and access of the creative process. We support our belief that capture and access is important for computational creativity support by explaining how both projector-guided painting and sculpture systems

follow this theme. We also present how a process model was captured and applied for (a) the creation of a collaborative children’s mural and (b) the creative planning of new paintings in the style of a specific series of paintings by abstract expressionist Richard Diebenkorn. Challenges we faced in the evaluation of the projector-guided painting system are presented. Finally, we discuss our vision of the art studio of the future and how capture and access will play a central role in leading to its success in empowering creativity.

CAPTURING THE CREATIVE PROCESS

What does it mean to capture a creative process? It may be useful to distinguish two scenarios: (1) The static recording of intermediate artifacts produced during the creation of a work of art, and (2) a more dynamic creation process that benefits directly from the capture and manipulation of an evolving art work. Historically, there are many examples of the first form of capture, such as the numerous sketches and studies that accompany a finished painting. We are particularly motivated, however, by the second form. A recent example of such a dynamic “capture and access”-based artistic method is the practice by solo live musicians of laying down tracks which continue to play in loops. By gradually building up a song, one track at a time, the song iteratively progresses in a manner that would be difficult to reproduce otherwise. The character of each track depends on how the previous and now looping track sounds.

We have found both painting and sculpture creation can benefit from the ability to recall, or access, intermediate artifacts such as painting layers and sculpture forms. Therefore, we characterize the capture of a creative process as a means for storing and organizing (using a process model) the intermediate artifacts created along the way to the final product.

The theme of capture and access of live experiences is already prevalent in ubiquitous computing research [1]. However, most previous work concerns the capture of live experiences that aren’t traditionally considered to be creative processes, such as lectures and meetings. We now discuss how we capture and access the creative process for painting and sculpture.

Capture and Access for Layer-Based Painting

The design of our projector-guided painting system is based on the following two assumptions about the process of painting in acrylics and oils:

- We assume that paintings will be planned out in advance of execution and decomposed into a series of layers that can be applied to the canvas in linear order (back to front).
- When painting each layer, we assume that the artist will want to apply paint to the canvas in an orderly, sequential manner and will base their palette on the color scheme for the layer and the desired amount of manipulation.

Under these assumptions, a painting consists of the execution of a series of layers. Therefore, our system adapts a layer-based representation. In painting each layer we assume that the artist will mix one or more desired paint colors,

select an appropriate brush or knife, and load it with paint. The artist then chooses a region of the layer corresponding to the selected color, applies the paint, and manipulates it until the desired effect has been achieved. Thus a layer is painted region-by-region until it is complete. The interaction modes provided by our system supports each of these tasks and constitute the access capabilities of our system.

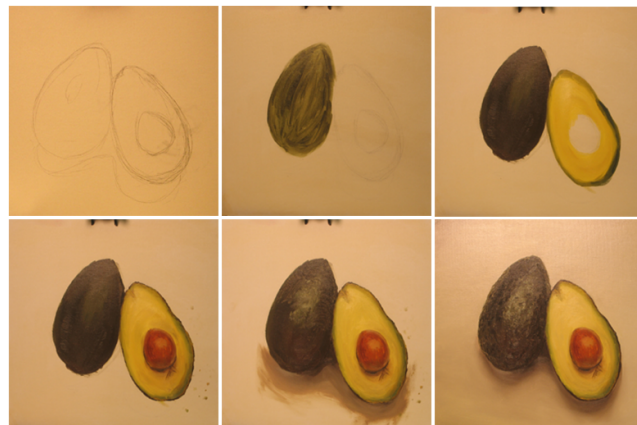


Figure 2. Photos captured during the process of creating an original oil painting. These layers are accessed to assist novice painters using our projector-guided painting system.

The layers which our painting model requires can come from a variety of sources. One possibility is to capture the painting process of an experienced artist as shown in Figure 2. In addition, layers can be scanned in from painting manuals and registered. We can also use painterly rendering techniques to create layers automatically from photographs or 3-D models.

Capture and Access for Sculpture

When using ShapeShift, our projector-guided sculpture system, an initial amount of sculpting material is placed on the work table, for example a block of modeling clay (Figure 1d). The surface of the material is scanned in 3D and the depth differences between the material and a pre-scanned reference 3D model is computed. The depth differences are then transformed into graphical contours that differ in color depending on the type of depth difference (Figure 1c). For regions where material must be removed, a continuous color range from red to yellow is used with red meaning remove a lot and yellow meaning remove a little. For regions where material needs to be added, a green to light blue range is used with green meaning add a lot and light blue meaning add a little. For regions where the sculpture matches the depth of the reference 3D model, the color purple is used. For regions where the material is outside of the model, a royal blue color is used. The sculptor then adds and removes material according to the projected guidance contours, which are accessible at any time during the sculpting process.

When the sculptor is satisfied with the changes made, the surface is rescanned and new depth contours are projected. The new guidance contours incorporate the sculptors changes as well as show the remaining areas to modify, thereby

advancing the iterative process closer to the final sculpture. When the sculptor wishes to work on a different area of the sculpture, the material is rotated on a revolving platter. The system is aware of the platters rotation to allow depth difference computation for any view the sculptor wishes to work on, e.g., the back or sides.

In contrast to our painting system, the only input required by the sculpting system is a final 3D model sculpture and not a series of intermediate models (similar to painting layers) captured during creation of the model sculpture. However, the process model imposed by the sculpture system encodes how sculpting material should be added or subtracted from the work in progress. Rather than present intermediate “layers” of the creation as done in our painting work, the intermediate layers are computed on the fly by scanning the sculpture at intermediate points in time and computing differences between it and the final 3D model. Therefore, the capture of the creative process consists of not only recording representations of artifacts (images for painting, 3D models for sculpture), but also the construction of a model or means of organizing the creative process (layers to brushstroke colors and orientations for painting and a 3D model sculpture to additions and subtractions from sculpting material).

PROCESS MODELS FOR PLANNING PAINTINGS

As further examples of computational support for creativity via the capture and access of a creative process, we describe (a) how we captured the creative process of planning a children’s mural painting and (b) how we captured and modeled the structure of a specific series of paintings for planning the execution of new paintings of the same style.

Planning a Collaborative Children’s Mural

As an experiment in using our projector-guided painting system for multi-user collaborative paintings, we arranged for 4 children aged 5 to 8 to paint a 6’ mural together. The question we explored was: Does projector-guided painting organize the process enough for children to make a collaborative mural? Our hypothesis was that children would have a hard time converging on a pre-planned painting without the computational support for creativity provided by our system.

Before starting the mural, the children were tasked to plan the design of their painting. Getting four children to draw or paint an initial model painting for input into the projector-guided painting system was too challenging as they needed the ability to compromise on the visual elements. We decided to have the children use construction paper, scissors and glue to create their model painting (Figure 3). This enabled conflicts over content to be resolved by moving cutout pieces around until they were satisfied.

Planning to Create an Ocean Park Painting

While scanning construction paper was a successful means for capturing the creative process of planning a collaborative children’s mural, we wanted to experiment with a method for capturing and modeling the planning phase for a more complex style of painting.



Figure 3. Left: Four children planned their mural using construction paper. Right: The finished mural executed using our projector-guided painting system.

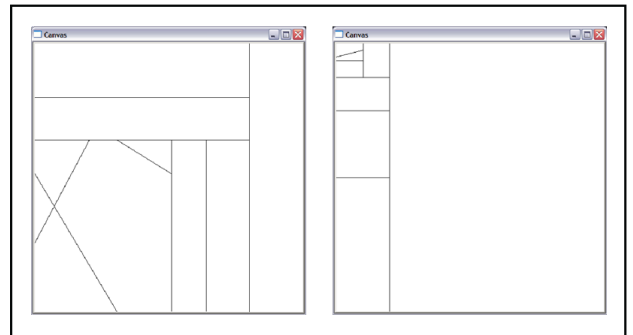
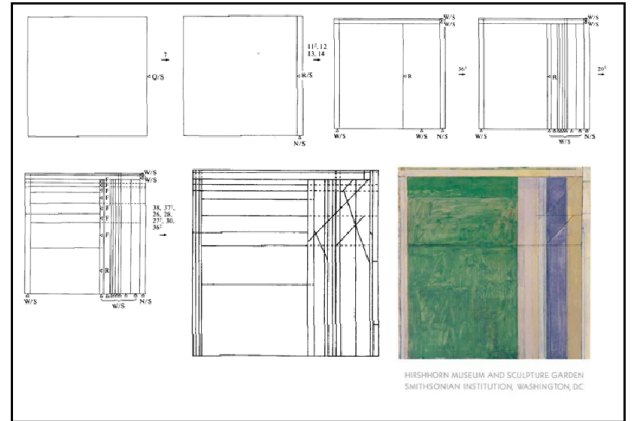


Figure 4. Top: Series of productions used to synthesize Ocean Park 111. Bottom: Two novel Ocean Park-style painting plans generated by our shape grammar interpreter.

In the representational class of paintings, the paintings usually express stylized depictions of real-life subjects such as faces, cathedrals and gardens. Since the underlying structure of these paintings are usually given by the objects being represented in the painting, the properties describing the painting style are generally surface details such as color and texture. In the non-representational class of paintings, this underlying structure is created by the artist. The artist’s creation of underlying structure, instead of choice from subjects in the world, is the property of style that this experiment focused on.

We experimented with *shape grammars* for planning a specific series of non-representational paintings. Shape grammars were first presented in 1972 by Stiny and Gips as a formal method for creating and understanding designs [5]. They are

suitable for design because the components of the grammar are shapes such as points, lines, planes, and volumes instead of text and symbols as with traditional language and programming language grammars. They are powerful because the rules of the grammar enable the creation of infinite designs (nondeterministic).

Kirsch and Kirsch [3] developed a rich shape grammar to describe the Ocean Park series of paintings by the contemporary artist Richard Diebenkorn. Diebenkorn painted about 135 very large abstract oil paintings between 1967 and 1983 in this series. As part of this investigation of shape grammars for supporting creativity in painting, we wrote a program to interpret a simplified version of the Ocean Park grammar developed by Kirsch and Kirsch. Figure 4 shows two example painting plans which may be input to our projector-guided painting for support in the execution of the painting.

EVALUATION CHALLENGES

We now discuss challenges faced in the evaluation of our projector-guided painting system. We frame two classes of challenges in the form of the following questions:

- How should we evaluate novel creativity support systems when there are few or no appropriate baseline systems for comparison?
- What are the appropriate evaluation methods for assessing the support of the planning phases versus execution phases of creativity?

The first question addresses difficulties in avoiding the dangers of making a “straw man” comparison of a new technology to the traditional creative process. In our projector-guided painting work, we conducted a formal user study to quantify the benefit that our system can provide to a novice painter, relative to a standard art projector. In one study component, a population of twenty subjects was asked to paint copies of a model painting. Each of the subjects was given a canvas containing an initial sketch of the desired shape (as produced by a standard art projector) and printouts of the model painting. Ten of the subjects served as a control group and produced their paintings without the use of our system. The other ten subjects had full access to our system. Using before and after questionnaires, we assessed and compared the impact of novice painting experiences between the two groups in terms of confidence in ability to paint. We took measures to pre-sketch the canvas and provided layer printouts for both groups in order to make more fair comparisons. Should others take similar measures in evaluating their creativity support systems? If so, are there standard questions or principles that system evaluators may use to ensure fairness?

The second question we pose concerns the challenges of measuring quality in performing a creative process. What do current painting and sculpture professors do to grade their students’ work? Should similar methods be applied in assessing creative works that are computer assisted? To evaluate our painting system’s impact on a user’s ability to execute a painting process (as opposed to planning), a group of three

experienced painting professors filled out two questionnaires to evaluate each of the twenty paintings completed by the novice users. They were also asked to rank their top ten paintings in terms of overall quality and overall similarity to the model painting. This evaluation method enabled us to validate our claim that our system can help novice painters to produce higher-quality artifacts than an art projector alone. While the study evaluated the execution properties (quality of brushwork, shading, etc.) of painting, we did not investigate the planning phases of creating paintings. What would be an appropriate user study methodology for comparing methods for planning a painting?

ART STUDIO OF THE FUTURE

In conclusion, we describe our vision of an art studio as a location with multiple workstations outfitted with projector-camera systems for painting, sculpture, and other fine arts. In comparison to present-day art studios, which are filled with student creations, books and teachers, the art studio of the future will provide intermediate artifacts captured at the workstations during the creation of art and organized using process models. The usefulness of this kind of creativity database hinges on both the capture and access capabilities of creativity support systems. If our projector-guided painting system was capable of capturing not only the process of a painting as a set of layers, but modeled the color, pressure, trajectory and paint consistency of every brushstroke, the system could potentially assist a painter at these brushstroke levels via newly designed interaction modes. Furthermore, artists may receive lessons or collaborate over a distance by networking these creativity support systems together.

We believe that the key to making progress towards the art studio of the future, which will empower artists by providing tools to support their creativity, is to *capture* and model the creative processes in a computational manner and provide *access* to these models through domain-specific capabilities such as the interaction modes of our projector-guided painting and sculpture systems.

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