
Embodied Material Guidance: Augmenting Material for Carving

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Abstract

When learning a new skill, video tutorials are often the first choice to get help. For creative domains like carving, this is often not sufficient as the desired expression require reacting on changes in the form constantly. A crucial part of the making process is a close observation of the material. Looking at various domains we have chosen wood carving, to propose new forms of interactions that can support creative learning processes. Instead of focusing on tools we aim to augment the material for the novice carver. The concept aims to reduce the fear of learning by replacing traditional carving material (like wood) with 3D printed material. Guides on where to carve are part of the printed base material and form embodied guidance. We assume artistic self expression as an additional goal for carving and provide added levels of randomness to the material structure through variable colors and material densities while using Virtual Reality (VR) to provide a change in perspective.

1 Introduction

The success of numerous online tutorials for making indicates how people gather first hand insights in learning a new skill. Free online platforms for learning such as edx.org, coursera.org or others offer a variety of courses for both hands-on and theoretical knowledge building conveyed through video. Often tutorials allow for copying a stepwise process to achieve a certain goal. For artistic activities like painting, clay modelling or wood carving static videos – which don't adapt to the learner's context – are only of limited help. For painting different interactive systems have been created that have the potential to support the learner by enhancing brush and/or canvas by digital components (Otsuki et al., 2010, Vandoren

et al., 2009). Also, for crafting three dimensional models, hybrid approaches that combine digital and physical components are being developed (Golsteijn et al., 2013, Oe, Shizuki & Tanaka, 2012). However augmenting or enhancing the craft material itself is not very well explored. Often the main focus is to support building digital models by interacting with physical material (Reed, 2009, Smith, Thomas & Piekarski, 2008). In our work we focus on the craft's material itself and how a user can be supported in shaping the material. The context is carving where we assume that 3D printing material suited for carving can be created. In a different context researchers are already working on wood-inspired 3D printed material (Compton & Lewis, 2014).

2 Research & Ideation

2.1 Ideation Workshop

In order to better scope the project we invited design students to participate in an ideation workshop revolving around the question of how the future home can be a place for collaborative making and learning through making. During the 45 min workshop, six students of the Master's programme in Interaction Design at the Umeå Institute of Design were asked to follow a set of tasks involving reflecting on hobbies and their tools and how the tools will change in the future. Some participants found it difficult to force features onto tools that should enable creativity. During the final discussion a common point of view was created stressing that tools should be enablers rather than means for creativity. By not focussing on the tools we were inspired to think about the material instead. Hence we decided to take an approach of augmenting the medium i.e, the carving material.

2.2 Research on Tutorial Videos for Making

To identify the issues that the hobbyist carver faces, we reviewed tutorial videos on the web (Farnsworth, 2014, Schrettl, 2014) trying to place ourselves in the mindset of a beginner in that field. Our reflections towards these videos helped us identify a few issues. When staying in the virtual world, support through video

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seems to work effectively e.g. for digital tools such as creative software (Photoshop, 3DS Max). We assumed that the flat representations on the screen perform inadequately when it came to learning with actual tangible material. Videos are sufficient for defined tasks or step-by-step instructions. However, videos do not work as well for artistic expression such as carving due to the fact that the material in the user’s hand will always be perceived differently than the one displayed. The biggest challenge for the novice carvers seemed to be in the ability to understand when to stop carving.

3 Concept

“Every block of stone has a statue inside it and it is the task of the sculptor to discover it” — *Michelangelo Buonarroti*.

In the same way a blank page can be a barrier for a writer a block of wood can be an issue for a sculptor. Once this issue is overcome, the process of turning this block of wood into a small figurine without using machinery requires both craft skills and skills for creative expression. In our concept we propose using 3D printing to create a specialized base material for carving embodied guidance. In this way we want to guide the carver towards a shape that is already part of the carving block and foster a dialog with the carving material through this augmentation. In addition we use VR as part of supporting creative reflection.

3.1 Scenario

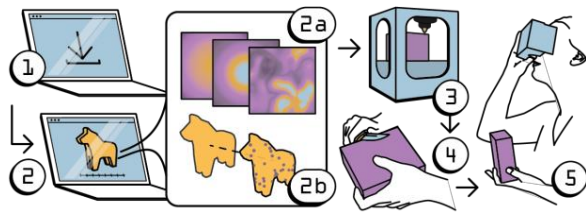


Figure 1: Diagram showing the different steps of the concept from downloading a 3D model to carving it out and using VR to change perspective

The user is inspired to carve out the iconic Swedish Dala horse (Swedish: Dalahäst) and downloads or builds her own CAD model (see fig. 1.1). In a software similar to current 3D printing software, she imports the model that is embedded in a virtual cube (see fig. 1.2). Control elements let her choose how much of the horse should be visible when later cutting through the

material. This is defined through 1.), contrast in color between the horse and the waste material and 2.) through guiding dots aligned with the edge of the horse (see fig. 1.2a, 1.2b and fig. 2). The user should also be able to add additional color gradients (see fig. 1.2a). A sensor unit is embedded in the print, able to communicate with a VR headset. After the block is 3D printed (see fig. 1.3) she can carve the print immediately (see fig. 1.4). The more she cuts, the more guiding dots appear making her aware where to carve away more material. As the color of the material changes while cutting she is inspired to modify the final shape for aesthetic reasons. To achieve a better understanding of the proportions of the object inside, she can use the sensor unit in her workpiece to connect to VR headset using wireless technology. By switching to VR she gets to see her work from a different perspective (see fig. 1.5).

3.2 Embodied Guidance: Guiding Dots, Color Gradients and various Levels of Material Density



Figure 2: Left: Cut out of the 3D printed material, middle: guiding dots at the surface of the horse, right: color gradients to indicate proximity to the final shape

When creating a drawing people use techniques like tracing paper as support. The supporting techniques for a novice carver creating 3D shapes are limited. Often carvers draw guiding lines on the workpiece that are carved away immediately, hence using 2D solutions for a 3D problem. When interviewing makers we discovered that – especially for beginners – there is often the fear of carving away too much from the carving material. By printing guiding dots in the base material, drawing lines becomes obsolete and confidence is fostered. As the novice carver starts to carve out the printed block, a visual imprint of the horse inside the block emerges. This acts as feedback that helps the carver to stop carving in time, thus overcoming the challenge of carving in too deep. Further for intermediate users we envision various levels of support by limiting the guides indicating the border of the shape adjusted in software (see fig. 2,

center image). In this way we aim to support the learning process. We also envisioned embedding a color gradient changing the color from a surrounding boundary box to the object inside. When the novice carver sees the change in color, she is made aware that the enclosed object is starting to surface (see fig. 2, right image). Other ways of showing when the carver gets close to the object could be to use variable densities of material, a property that can be set for 3D printers. By increasing the density of the object inside (the Dala Horse) as compared to the surrounding carving block tactile feedback can be provided.

3.3 Creative Reflection on the Material

We focus on the relationship between the user and the material, almost trying to allow for a reflective conversation, where the material provides rich feedback on how it is treated. To achieve this, we propose change in material through adding randomness in the color gradients and providing the option to change perspective in VR.

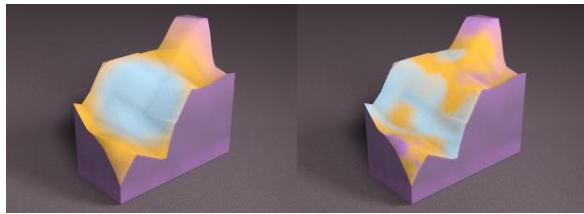


Figure 3: Different turbulences within the gradient



Figure 4: View from the inside of the carving block

3.3.1 Fostering Creativity by adding Randomness

As described before guides can be printed in form of guiding dots or color gradients. However the guiding color gradient doesn't have to be linear. By enabling the user to add gradient turbulences, the embedded object becomes slightly distorted. A low level of color

turbulences will lead to uniform coloring. Higher levels of turbulences will cause multi-color 3D gradient patterns (see fig. 3). In the same way material density could change as well. This is an attempt to mimic natural material qualities characteristic to wood. The same way the wood's growth direction can inspire the wood carver to carve different shapes, artificial randomness can hint towards a shape that the creator has not thought of before.

3.3.2 Changing Perspective: Using Virtual Reality

In a last step we experimented with the virtual representation of the initial shape using VR. A good practice in (abstract) painting is to physically step back from the painting to see how the latest brush strokes have changed the overall composition. It is a state of observation and reflection that allows for constant acting and reacting on the painting. Other than this example of a two dimensional canvas, the 3D object allows us to explore the material also from the inside.

With the help of a virtual reality headset the user can place herself inside the box with the object in front of her. This makes her aware of the parts that are not carved out yet and may open up for changing the direction she wants to pursue. By adding a small inertial measurement unit (IMU) the workpieces orientation can be tracked and transmitted to a VR headset using wireless technology. The physical model acts as controller for the user to navigate in 3D space, where the user can move around the virtual environment by moving the physical object (see fig. 4). We created a prototype in Unity & Arduino to communicate ways to navigate in virtual space and presented it to people (see next section). Since the user holds the partially carved out object in her hand she gets rich tactile feedback while at the same time seeing the model from the inside. This disruptive experience might encourage the user to change the way she thinks about the workpiece. After establishing the experience of the inside view, the user will return to the physical world continuing to carve, having the possibility to revisit the virtual space at any time during the process.

4 Evaluation & Reflection

4.1 Interviews

We proceeded to interview four makers to gain qualitative feedback on our concept. The interview participants were chosen based on their background

and skill in craftsmanship. We interviewed a teacher for making physical prototypes, a product design student and passionate maker, a prototyper in a design consultancy who likes to tinker in his free-time, and an owner of a 3D printing shop. The participants were asked questions around their personal experience with making at the beginning of each interview. Some recurring topics in all the conversations were:

Sources of inspiration and the reason for making including: Solving a specific problem through making, inspiration by different materials or inspiration through finding interesting projects (online). We also learned that the **tool plays different roles for different people** ranging from being the center of the activity to being mere means to achieve a goal. Lastly we got to know different drivers for making that can either be **outcome driven vs. process driven** as well as making as purposeful vs. making as artistic expression. Especially the distinction between drivers has implications for our design, as our concept is not meant to focus on creating to fulfill a need but is a learning tool for expression in 3D physical objects. When presented with the concept the interviewees saw great value in the material having an embodied object and agreed that the concept could definitely work to train and encourage people to carve. The concept of variable gradients as a guide to stop carving and start sanding was highlighted positively. While the prototyper and the product designer saw value in using VR to gain a different perspective, the teacher did not agree and stated that the shift in medium causes disconnect and the user should not be made to leave the material at any stage of the carving process. The print shop owner suggested that the density of material should also vary along a gradient along with the colors.

4.2 Technical Limitations

Adding the virtual reality feature would lead to multiple problems. The first one concerns the sensor unit embedded in the work piece. To our knowledge it is currently not possible to print the sensor at the same time as the carving block. One way to work around this could be to add the electronics manually in the printing process. The second problem is the changing shape of the module that cannot be tracked easily with available sensor technology. However research in this direction has already been conducted (Reed, 2009, Smith, Thomas & Piekarski, 2008).

To our knowledge there is currently no material available that supports carving. However, when interviewing an 3D printing expert he felt confident

that this material could be manufactured easily. Also research suggests that this kind of material can be produced (Compton & Lewis, 2014).

4.3 Beyond Carving

We feel confident that there are advantages in augmenting material by adding additional information as part of the manufacturing process. Changes within the material can provide extra information e.g. considering abrasion and wear of material or inside predetermined breaking points. We hope that this concept inspires others to explore new possibilities on how to physically augment material.

5 Conclusion

In this paper we present a concept to support novice to intermediate skilled people interested in carving. As a main incentive to carve we assume artistic self expression and the learning/ skill building of carving as handicraft. Our proposal focuses on the dialog between the learner and the material and how the material can be augmented to be more expressive. We show this in three parts of our concept: First, the materialization of guidance manifested in a 3D printed block (embodied guidance). This allows the user to fully concentrate on the material and the learning process. The embodied guides aim to reduce fear of making mistakes and to encourage training, since the final product is already part of the workpiece. Second, to support for more creative exploration of the material we envision the functionality to change the inner structure (color gradients and density) of the material by adding randomness. Both embodied guidance and the creative reflection with the material allow learning how to carve by making use of the digitally enhanced material while staying in the physical world interacting with it in a tangible way. Third, we offer a way to use the digital realm for changing the perspective to see inside the physical workpiece using VR. We created prototypes used in discussions with four makers. In those discussions we found that the makers were generally enthusiastic regarding various levels of support and they could see value in random changes of the material structure. However, not everyone agreed on the importance of switching between VR and physical world while carving.

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