

VHIP: A Prototype Haptic Environment for Fine Art Printmakers

Angela Geary*

Paul Coldwell†

Andrew Rashan‡

University of the Arts London

ABSTRACT

VHIP was developed as an accessible prototype computer application for printmakers, with a (touch-enabled) haptic interface in conjunction with a three-dimensional visual environment. Designed specifically for intaglio and engraved techniques, the system is intended to allow artists to engrave a virtual plate in a naturalistic manner, prior to committing to the physical manufacture of a real plate. VHIP is an interim creative platform that allows free experimentation without the need to expend materials and with the advantage of a physical ease of execution, facilitated by "soft" metal variable material characteristics. The virtual plates are output as data suitable for manufacture as physical plates by computer aided manufacturing technology, such as computer numeric control (CNC) milling or laser engraving. The manufactured plate is then used in the artist's production of the final print.

Keywords: haptic, art, printmaking, intaglio, engraving, virtual

1 INTRODUCTION AND CONTEXT

Artists' use of digital tools in the creation and production of their work is a well-established practice. However, the artists' physical interaction with traditional media and the natural constraints that this brings, remains a crucial aspect of practice that conventional, mouse-driven digital tools are not able to offer. Recent advances in haptic technology allow the possibility of innovations in digital tools for artists, which reintegrate this physicality. Clearly, the sense of touch and proprioception are significant to cognitive development and fluency in respect of the practical skills that artists apply. Furthermore, recent research [1] has established that, particularly in 3D environments, the absence of such interaction and the constraints of a traditional WIMP (Window, Icon, Menu, Pointer) interface has a negative impact on usability and, even expert, users' efficiency in a spatial task.

Previous research [2] and [3], has resulted in haptic sculpting environments, where the operator sculpts virtual clay using a haptic stylus, and haptic painting systems that allows users to feel the texture and response of a virtual canvas and brush [4]. In the field of CAD and industrial design, the commercial software application FreeForm™ [5] provides advanced haptic sculpting and 3D prototyping tools. However, such outcomes have been either purely emulative of traditional artistic mediums or focused on adding haptic interaction to existing CAD processes. Tools such as FreeForm are sophisticated, but are aimed principally at CAD specialists and industrial designers; the specific needs of fine artists' are not addressed in the interface design or application feature set. Although artist's can, of course, learn to use haptic CAD oriented tools and adapt them to their objectives, the application's emphasis presents a barrier to fine art users. This is partly about complexity, menu

structures and the semantic orientation of application features, but even artists who learn to use the application are still in a position where they must adapt their objectives to fit with the application. An important motivation for this project and our ongoing research, is the integration of haptic interface technologies into artistic practice and the exploration of how such tools could evolve the nature of practice its self. In the VHIP project, the aim was to prototype a simpler, user specific haptic application, targeting the particular niche of fine art engraved printmaking techniques.

1.1 Printmaking Techniques

In engraving, a metal plate is incised with a cutting tool called a "burin" (see figure 1). The burin is a narrow metal shaft with a "V" shaped profile at it's cutting edge. The shaft is mounted in a rounded wooden handle. This is held in the heel of the engravers hand and the shaft is guided between the thumb and forefinger. With substantial physical effort, the burin is driven into the metal to cut a groove in the plate, whilst the direction of the groove is controlled by manoeuvring the plate with the other hand. Engraving



Figure 1: On the left a copper plate is being engraved with a "V" shaped burin and on the right the burin tool is shown.

techniques and those of etching, where the grooves are "bitten" by exposure to acid rather than cut with a tool, are thought to originate from metal-working crafts, such as armoury, in the fifteenth century, where incising tools and acid were used to decorate iron or steel. The technique of printing emerged as a means of recording decorative patterns, by simply filling the indented lines with ink and transferring the design onto paper. The first prints on paper from engraved plates appeared by the middle of the fifteenth century [6].

1.2 The Benefits of Virtual Plate Making

Although the use of digital printing techniques is now commonplace, artists still desire the unique qualities that a physical print, made by intaglio or relief printmaking, can offer. However, the physical process of preparing the plate is laborious and requires considerable physical skill and time, particularly in the case of engraving. In conjunction with the usual benefits of working in a digital environment such as saving, undoing and layering, a haptic virtual environment offers advantages as an additional tool in the printmaking process. The physical difficulty of engraving metal plates is avoided by prototyping plates virtually, in a soft digital "plate" prior to manufacture. Engraving offers little scope for error - a mark once made, is permanent. Working virtually, artists have limitless scope to explore their ideas before committing to a physical plate. The range of plate materials available to the printmaker

*e-mail: angelageary@mac.com

†e-mail: p.coldwell@camberwell.arts.ac.uk

‡e-mail: a.rashan@camberwell.arts.ac.uk

is also widened by the integration of CAM processes to include additional metals and synthetic materials. Moreover, one plate design can be used in the production of multiple output formats. There is also scope to facilitate the practice of artists with disabilities, who may not be able to engage with a traditional printmaking process.

2 METHODS

Previous research [7], has established methods for creating "engravable" haptic materials. Building on such methods, and our earlier research involving plastic simulation for conservation training [8], the objective was to develop a realistic simulation of engraving and a mode of interaction analogous to that of the traditional technique, where the virtual plate is presented horizontally and is worked on and manipulated from above.

The spring-mass particle system model was used in the prototype to generate the deformable surface. In the mass-spring model, each vertex of an object's geometry has a mass and is connected to neighbouring vertices, or nodes, with a spring and damper that moves when forces are applied. The required plastic behaviour can be induced by manipulating the mass, velocity and acceleration properties for the nodes.

The broader remit of the authors' ongoing research is the development of cost-accessible haptic tools for a range of practice based applications in the arts. The low-cost OmniTM haptic device and the open source OpenHapticsTM SDK, both by SensAbleTM, were chosen as the development platform. OpenGL libraries were used in the development of the visual interface. Development was carried out on the Windows XPTM platform, but the application has also been successfully tested under Mac OS XTM. Any of the PhantomTM range of haptic devices can be used with VHIP. The prototype was developed on the basis of a visually co-located haptic interaction and, optimally, would be used in co-located displays such as the SenseGraphicsTM range of Immersive Workspaces or the ReachinTM display.



Figure 2: A virtual plate created in the VHIP prototype by collaborating artist on the project, Paul Coldwell.

The virtual plate data is output in ASCII format and can be readily imported to a range of CAD or 3D graphics applications (see figure 2) for preparation of the data in formats suitable for CNC milling. A range of computer aided manufacture methods will be tested with output from the prototype. Work is currently underway, in collaboration with the Engineering Workshop at Imperial College London, to produce plates using CNC milling in a range of materials.

2.1 Application Features

A comprehensive virtual engraving tool would deliver a convincing simulation of the real engraving experience with a full range of features that facilitate and enhance the process. A range of virtual plate materials would simulate substrates including wood,

metal and plastics, modelled on known values derived from materials property data, such as hardness and modulus of elasticity available from established indexes. However, in the scope of the prototype development, the following features were considered essential: real-time haptic interaction; a plastically deformable "soft" metal material; sufficient resolution in the deformable geometry to permit a minimum of acceptable detail; depth cues such as stereo viewing, shadow projection, file and state saving and tool shape and scale selection. Modulation of plate material characteristics, such as stiffness and friction, and resolution modulation, whereby the density of the mesh can be increased or lowered with a corresponding trade-off in haptic rendering efficiency, were included to improve usability. In response to artists' requests, we added support for semitransparent image-based overlays, such as drawn sketches, to be used as visual guides.

3 CONCLUSIONS AND FUTURE WORK

New, cost-accessible, haptic devices and consumer-level computers can convincingly simulate the complex material and tool interaction found in arts practice. Our application provides an additional tool that forms a part of an entire creative process, involving both digital and traditional analogue stages. It is in this iterative journey back-and-forth between digital and traditional creative methods that virtual environments can offer a valuable contribution to practice in the fine and applied arts and one that integrates with the ways in which artists actually work. The research also has implications for facilitating the practice of artists with disabilities.

We are working toward advancing the application's features to include 3D imaging staples, such as adjustable lights, multiple points of view and diverse tool shapes. There remains significant work to do in improving the efficiency of the haptic simulation of dynamically deformable plastic materials, particularly if high-resolution geometry and complex layered or anisotropic materials, e.g. wood, are to be supported. A substantial aspect of the value of working digitally lies in the power to enhance practice and extend it beyond the constraints of the real world. Potentially, "impossible" or hybrid plate materials, such as super-heated metals and random or patterned variable hardness patches, could also be supported by the implementation of a more sophisticated material tool-set.

4 ACKNOWLEDGEMENT

The VHIP project was funded by the Arts and Humanities Research Council.

REFERENCES

- [1] Silvia Scali, Mark Wright and Ann Marie Shillito. 3D Modelling Is Not for WIMPs. In *HCI International*, Crete, June 2003.
- [2] S. A. Ehmann et al. A Touch-Enabled System for Multi-Resolution Modelling and 3D Painting. In *The Journal of Visualization and Computer Animation*, Vol. 12, 2001.
- [3] Robert Jagnow and Julie Dorsey. Virtual Sculpting with Haptic Displacement Maps. In *Proceedings of Graphics Interface*, May, 2002.
- [4] Bill Baxter, Vincent Scheib, Ming Lin and Dinesh Manocha. DAB: Interactive Haptic Painting with 3D Virtual Brushes. In *Proceedings of ACM SIGGRAPH*, 2001.
- [5] SensAble Technologies Inc. <http://www.sensable.com>
- [6] Saff Donald and Deli Sacilotto. *Printmaking: History and Process*. New York: Holt, Rinehart, and Winston, 1978.
- [7] V. Savchenko. 3-D Geometric Modeller with Haptic Feedback: engraving simulation. In *Applied Simulation and Modelling, IASTED conference proceedings*, 2000.
- [8] Angela Geary. A Haptic Virtual Reality Training Tool for Paper Conservators. In *Proceedings of ACM SIGGRAPH*, 2003.