# Three Themes of User Experience in Haptic Application Design

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## Abstract
User experience theory have the potential of improving haptic design. Reflections from applying haptics in medical applications will be reported and related to theory grouped by identified themes. The potential of knowledge creation in light of these themes will be argued for.

## Author Keywords
user experience, interaction aesthetics, design, haptics

## ACM Classification Keywords
H.5.2 [User Interfaces]: Theory and methods.

## Introduction
In this paper, UX as a *field of study*, with it's purpose of developing design and assessment methods[18], is investigated as a potentially valuable approach to bring more successful haptic applications into existance.

The haptic sense helps humans to understand the world by touch. To perceive weight, hardness, shape and temperature of an object, different exploratory procedures are used [11]. The handle of a haptic interface (figure 1) can be moved in free space, basically acting as a 3D mouse. A haptic rendering algorithm can read the device's position (and orientation), detect collision in a virtual environment and calculate a force to be displayed by the

**Figure 1:** Two common haptic interface devices. Both can read position and output a force. Sensable Phantom 1.5 (above) can also output rotational forces. Force-Dimension Omega 3 (below) could arguably still have higher desire factor.

device [20]. The combined hardware, algorithm and virtual environment enables haptic exploration of virtual objects.

The reason why haptic applications still are rare might have to do with ill-defined purpose (what value does haptic feedback actually add, besides special effects) or poor implementation (e.g. unwanted vibrations) [23]. Haptic interfaces have previously been evaluated by their hardware characteristics such as friction in free space as well as traditional quantitative usability metrics and users feeling of presence. In addition realism is commonly referenced; what you feel should be what you see, referred to as transparency [19]. Little is reported about how the possibilites and limitations propagate to user experience in a way that is helpful for application designers. There have been attempts at directly deriving design guidelines from psychophysical theories [6], but its actual usefulness to designers is not verified. The guidelines tend to be either obvious or leave the reader without actionable advice. In addition, the underlying assumption of guidelines is that design knowledge can be packed for later extraction by less experienced designers, who in the extreme case are reduced to mere operators [21]. Alternatively, it has been proposed that the only way for designers to master haptics as a design material is to work through it [15].

## Three themes

A literature study was performed in search for theories relevant to the author's own practice of haptic application design. Themes of UX theory was identified as potentially useful in articulating requirements, assesments or in other ways help improve the outcome of a design task.

*Envisioned experience (and purpose)*
What a product can help you accomplish, maintain human connections, and form identity influences how "cool" the product is perceived [8]. Envisioned experience deals with the overall UX including the anticipated experience, the recalled post-interaction experience and the reflective long-term built up experience [18].

For a surgery simulator it is easy to envision that the design goal is to convey to the user the experience of real surgery. A virtual environment is however not limited to reality, and may e.g. visualize a nerve through translucent bone. Only using operating room observations to guide design might not only raise unachievable expectations but miss opportunities. Scenarios and mock-up prototypes are valuable (though limited [1]) representations for exploring the concept and interaction experience with an envisioned product, but should be balanced with knowledge about how and if the product actually would work, to avoid the imminent risk of creating "cargo cult design" [7].

Oral surgeons use plaster models for planning certain procedures. Why so, when software for the purpose is available? One factor could be Borgmann's irony of technology, that human involvement disappear with transformation of a "thing" (plaster model) to "device" (software) [5]. When a surgeon cuts the plaster model and adjust the jaws to get not only a medically acceptable result, but also an aesthetic look of the patient, the surgeon is partly an artist exercising her craft. The reliability and tactility the plaster model provides can in this perspective be a challenge to provide with conventional desktop software.

*Quality of interaction*
Despite successful identification and implementation of critical features such as the ability to haptically distinguish bone from teeth, the haptic rendering might be shaky and the colors blurry. Quality of interaction deals with the direct experience of interacting with the product, or *joy in*

*use*[8]. This includes the *hassle factor* changing, e.g. from chemical hassle to object rotation hassle.

During a demonstration of a colleague's work on haptic rendering, a device capable of rendering position plus rotation forces was briefly compared with a device capable of only position forces (figure 1). Despite the richer feature set (rotation forces), the device did not feel as good as the position-only device, where interaction was more stiff, crisp and with less friction. This device clearly generated a higher desire factor among the group. The experience can be compared with Donald Norman's comparison of turning of a smooth knob with one that is imprecise and has dead regions [17], and Buxton's juice press, where the mechanics is cautiously designed to a delightful perfection [2]. Feeling matters, and the designer should strive for good *visceral* design [17].

While recognizing that the HCI field has changed it's emphasis from quantitative to qualitative approaches, Law [10] justifies the need of measuring UX with Lord Kelvin's dictum "If you cannot measure it, you cannot improve it". Regardless if measuring is required or not, articulating aesthetic interaction qualities such as pliability can be useful in providing designers with actionable knowledge [14]. In addition, professional *interaction criticism* could potentially very well capture what we desire of evaluation without the limitations of *representationalism* [1].

*Re-negotiation of experience*
As the designer learns more about the properties of the digital material [13], such as haptics, she might realize that the envisioned product can not be built with sufficient quality. Instead of replacing the material, she might try to reformulate the problem. Sundström et al [22] reports on how they after initially struggling with the limitations of short range radio successfully started treating the technology as a material with properties shaping the design work along other factors [22]. When working with clients, designers might not get contributions in form of requirements, but in queries to what might be possible. The designer's understanding, through facts or tacit knowledge of the material properties (as a repertoire[12]) represent here a resistance in the negotiation of the system's requirements [3].

## Discussion

The reaction of the so called third wave HCI to the past generation's commitment to users at the expense of the designer's role [5] could be a useful force in framing the UX field of study. In this sense can a revival of the technically knowledgeable (software) designer [9] be seen. The purpose of theory in the field of UX is not only to help understand the subject, but also to build consensus on what constitutes a scientific contribution. In the field of information visualization, the value of design studies[16] has won increased acceptance. Other forms of knowledge communication such as inspirational patterns [12] and bits [22], as well as design material (technology) potential [13] could be very valuable in this respect. In addition, knowledge about process such as sketching, regardless of material [2, 15, 3] is certainly useful. Both design-oriented research and research-oriented design [4] can be instrumental in the UX field of study, but since products need to be implemented to be fully experienced, the latter may have a higher weight.

## Conclusion

In the UX white paper, UX is explicitly stated to not be "technology driven, but focuses on humans" [18]. However, to achieve a good interaction experience, appropriate focus must be placed on technological development and implementation. Instead I propose

foregrounding technology as a design material with properties that informs design and suggest reformulation of design problem so that it can truely benefit from the unique experience that (haptic) technolgy can provide.

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