# Pot à Musique: Tangible interaction with digital media

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## Abstract
We describe the conceptualisation, design and prototype development of a tangible gesture-based interface for the control of a music player. The device takes the form of a pot, augmented with inertial sensing and model-based vibrotactile feedback, which it is envisioned will encourage a more playful form of interaction for a richer interactive experience with our increasingly dematerialised digital media.

## Keywords
Tangible, interface, interaction, vibrotactile, feedback, inertial, media

## ACM Classification Keywords
H.5.2. User Interfaces: Interaction Styles; H.5.2. User Interfaces: Haptic I/O; H.5.2. User Interfaces: Input devices and strategies;

## General Terms
Human Factors

## Introduction
One of the reasons for the rapid acceptance of tilt-based and gesture controlled interfaces is that they offer a more natural form of interaction to users [1]. Humans are playful or 'ludic' creatures and enjoy the

**figure 1**. the pot a musique.

**figure 2**. SK7 inertial sensing device.

creative exploration of their environment [2] so it is proposed that encouraging users to playfully explore the limits of gesture-based interaction can help to facilitate its further acceptance and development. Gaver *et al* [2] propose that ludic activity is enhanced by the promotion of curiosity, openness and ambiguity in the interaction design. In order to achieve this we propose that the interface must also afford basic cultural references both giving the user a suitable starting point for the interaction and enabling the interaction designer to take advantage of the user's already well defined intuition of the effects their interaction may have.

In recent years there has been a rapid movement towards the use of digital media but with this we experience a corresponding loss of tangibility due to the subsequent dematerialisation of this media. This, for some, indicates a loss of embodiment and familiarity [3] but from higher level standpoint it means a loss of playfulness in the interaction.

Tangibility is one way to create a more playful form of interaction. Here we describe the development of a tangible user interface, which takes the form of a pot (fig 1), used in this instance as a mechanism for interacting with digital musical media and the control of a media player. The tangibility of an interface can also be enhanced by the use of appropriate feedback. The visual and audio modalities currently dominate but the use of vibrotactile feedback, we propose, is critical to both aid interaction and provide an increased sense of tangibility and playfulness to the user, further aiding the acceptance of gesture-based interfaces.

## Previous work

Tangible interfaces were originally referred to as graspable interfaces by Fitzmaurice with his ground breaking work, which aimed to enable the control of electronic virtual objects through the direct manipulation of physical artifacts [4]. Ishii [5] expanded on this with "tangible bits", which enabled users to grasp and manipulate virtual bits or objects by coupling them with everyday physical objects. He presented a number of prototype systems, concluding that the use of graspable objects would lead to a much richer multi-sensory experience of digital information.

Tangible interfaces, as they later became known, have since expanded to many forms for many different uses. Feltham *et al* [6] describes the design process and iterative development of 'tangible artifacts' with the aim of encouraging playful interaction between grandparents and their grand children. They describe 3 different interfaces including a 'seed and pod' and a 'magic bottle', designed to take the form of a container. They find, after one unsuccessful iteration, that strong semantic and cultural references (in this case to containers) are important for the encouragement of exploration of the interaction. Cameron describes the Audio Shaker device that sound to be 'trapped' inside a container, where it takes on an 'imagined yet tangible physicality'. It becomes possible to shake and pour out sounds, creating a rich and intuitive experience through familiarity[7].

The design of gesture-based remote controls has also been investigated. Ferscha *et al* [8] looked more generally at the use of gestural 'short cuts' as a way of interacting with ever increasingly complex remote controls. They designed a cube-based remote control

**figure 3**. Pot rotation for volume control.

**figure 4**. Pot rolling for scanning back and forward through a track.

which emulated basic RC functions via the use of simple gestures. Similarly, Hoppman *et al* [9] describe the implementation of their tangible drag and drop remote control, which aimed to enhance interaction with dematerialized digital media by enabling users to move data from one screen to another using simple gestures. They found that this was a natural way to interact with digital media.

Previous work on feedback in this area has concentrated primarily on the use of audio and visual feedback with little work conducted on the use of vibrotactile feedback. Shoogle [10] enables the sensing of abstract concepts via the shaking of a device. Users are able to perceive the number of new sms or the remaining battery power of their device, for example, something that was previously restricted to graphical display.

Our '*pot à musique*' implementation, while similar to those systems described above, concentrates on the affordances of the form of the pot and through specifically designed model-based vibrotactile feedback, which it is envisioned will aid the playfulness and exploration of the interaction.

## Pot a Music

Developing a desirable tangible and physical interface usually requires an understanding of how users build an intimate relationship with an object [3]. When objects are left on a table, for example, people tend to grasp and play with them. They turn them, roll them and perform different gestures with them, with the range of gestures performed generally dictated by the form of the object [9]. The object must call to be touched and handled. It must suggest via its shape, movements which appear instinctive. We should desire to play and interact with the object to discover the range of interactions available.

So, a pot is an everyday object, which at least affords us a general form. It enables a simple and instinctive use since all the interaction takes place using gestures already present in the collective conscience. It was chosen as it is an object that may rest on a user's desk, promoting a more incidental and computer-free form of interaction through casual manipulation and imparts the image of a container, not dissimilar to that described in [6], in which we can store our abstract digital media. It was designed with a vase like form opening at the top to enable the emission of audio as illustrated in figure 4. Rotating the pot, as in figure 3, imparts an image of projected curvature, rousing childhood memories of a spinning top and enhancing the feeling of play with the object. And a jutted base enables both the pot to be rolled linearly on its side like a rolling pin (figure 4) and affords an orientation of the pot for it to be lifted and shaken or tipped upside down. Via these simple manipulations and the use of accelerometers and gyroscopes, it is now possible to impart a new degree of tangibility to the abstracted digital media.

With these potential manipulations in mind, the initial design method first required the identification of exactly how these kind of movements would be mapped to the functionality of the music player. It was decided that the main functionalities should be mapped to suitable intuitive metaphors. For example, turning the pot upside down stops the audio output, effectively blocking the audio from coming out, a rotation of the pot enables the control of the volume (as we would

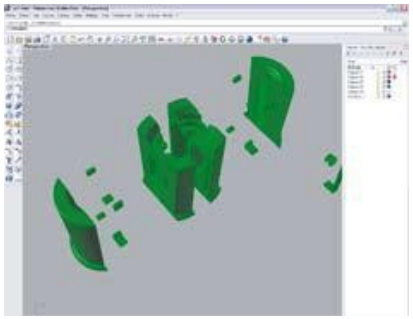

**figure 5**. Design of the pot

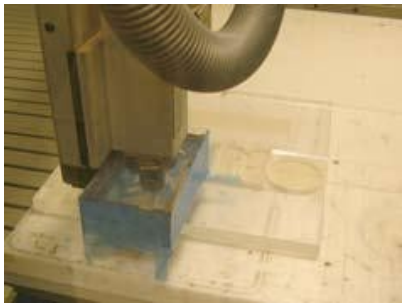

**figure 6**. Fabrication of the pot.

**figure 7**. Addition of electronics.

experience with the turning of a volume knob on a hifi) and rolling the pot along the table moves forwards or backwards through the song, effectively moving along a virtual time line on the table.

In order to encourage the users' further exploration of this interface beyond the obvious gestures it was also decided to include several more abstract gestures. The discovery of these gestures becomes part of the exploration process for the user, aiming to increase the overall playfulness of the interaction. The full range of interactions is illustrated in figure 9.

## Hardware

The pot was created using polymethylmethacrylate, fabricated using a digital mill as illustrated in figures 5-7. Device movements are sensed and transmitted to a base machine via Bluetooth using a Shake SK7 device (figure 2), which contains the accelerometers, gyroscopes and vibrotactile motor required and audio was produced from a Bluetooth hands free speaker system disassembled and fitted to the form of the pot. The speaker system also contained a microphone for the introduction of further blowing interaction and voice control as illustrated in figure 8.

## Feedback

Feedback design is an important part of the project and for the interactive experience overall. In order to provide an increased sense of tangibility to our interface a metaphor was used similar to that described in [10], which enabled the user to shake the device and feel if there were currently any songs 'inside' the pot. Feedback is rendered every time a music file virtually impacts with the side of the pot, sensed using the accelerometers and a physical simulation.

Another metaphor was used for the twisting and rolling interactions. A rotative spring or 'twisting knob' metaphor was used (figure 8), similar to that described in [11], which enables the user to gain a sense of exactly how much of an effect their interaction was having on the system. This is important in the case of volume control, for example, where there is a maximum and minimum volume, but no actual limit to the amount of rotation that can be performed. Clear feedback at these points is important to inform the user of the effects of their actions.

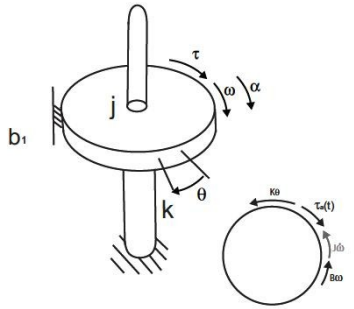


**figure 8**. One-Disk dynamic system. The overall force perceived as we twist the disk is a function of the displacement, , the angular acceleration and velocity, and , the spring constant, *k,* and the friction, *f,* which can be treated as a non-linear function.

This kind of metaphor is also important as it mimics the underlying physical system of twisting a dial imparting an increased sense of realism to the user.

## Future Work and Conclusions

We have demonstrated that delivering tangibility to increasingly abstract digital media is one possible way to encourage the exploration of the potential

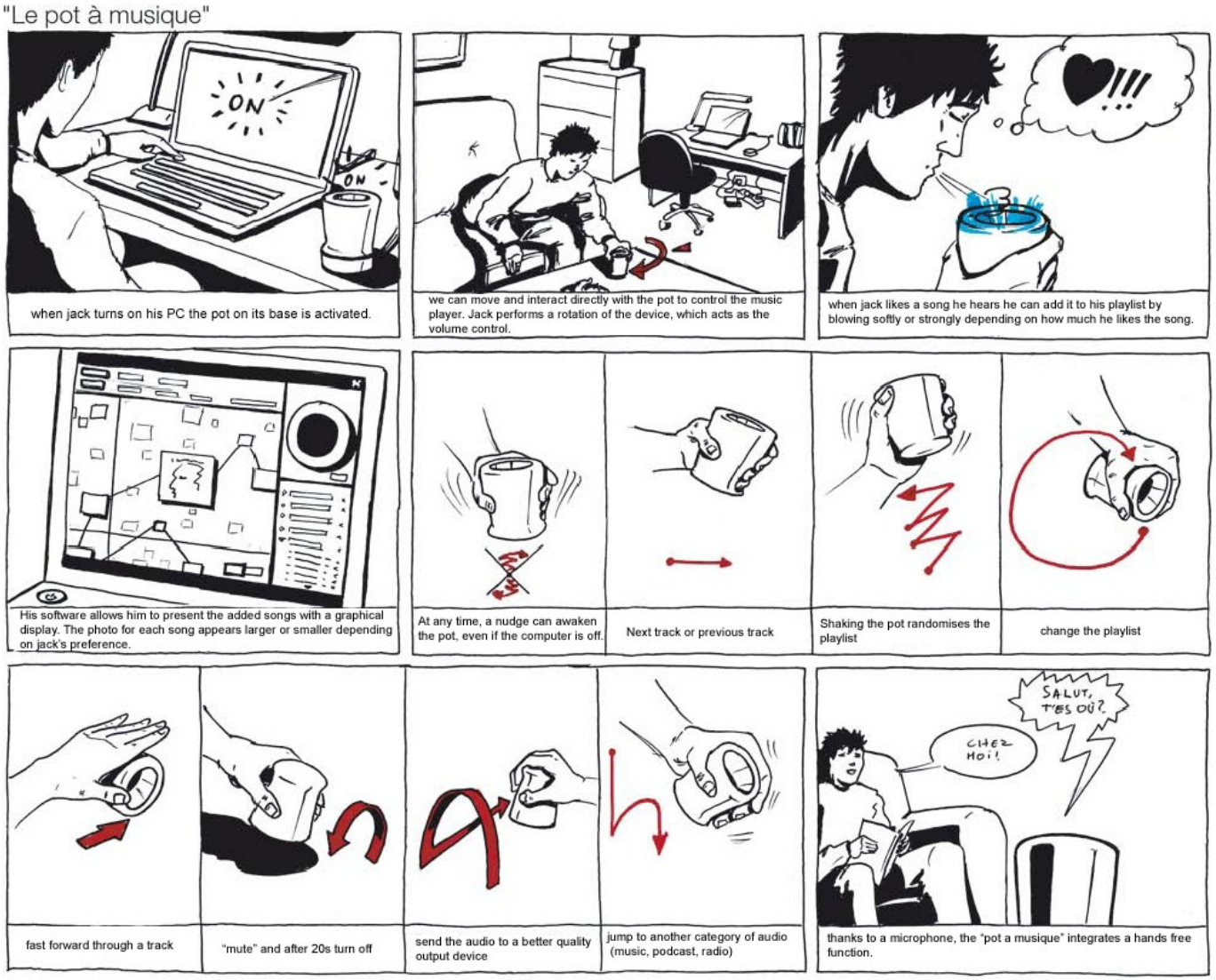


**figure 9**. The full range of available gestures for use with the pot a musique.

functionality of a device in a playful manner. As the playfulness of the interaction becomes more important, gesture-based interfaces become increasingly ubiquitous and as such tangible interfaces become important as a means to facilitate not just the acceptance of these forms of interaction but also to encourage the user to also explore the limits of this interaction. It is envisioned that the addition of model-based vibrotactile feedback should encourage and enhance this exploration whilst also adding an extra layer of tangibility.

Future work on this project will include both further development of the feedback mechanisms used and studies designed to both demonstrate the usability of this kind of interactive object for the tasks described and to validate the hypothesis that well designed feedback can aid the development of a tangible interface and increase the overall playfulness of the interaction.

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