Purposeful Repurposing – The Tennis Puppet example

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ABSTRACT
Give life to a fictional character by repurposing objects into a puppet, is a pedagogical and entertainment childhood activity. We describe a concept to: easily and joyfully construct a puppet and program automatisms in it, aiming the promotion of the early computer programming education. We focused on the Tennis Ball Puppet use case to describe a construction proposal, a programming environment and to explore the concept. We envision advantages for the children's education, because this concept allows more leeway for creativity and a fun intro to programming.

Author Keywords
Puppet, Children, Repurposing, Storytelling, Tangible Interfaces, Toy, Programming, Motivation.

ACM Classification Keywords
K.3.2 **Computer and Education**: Computer and Information Science Education – *Computer Science Education.*

INTRODUCTION
Seymour Papert defended the use of computers and programming as means for teaching thinking. He stated that children learn by doing and by thinking about what they do, he envisioned the use of programmable robotics for children and observed that learning is more effective when children construct meaningful products [3]. Learning a programming language is similar to learning a language, the earlier the better. Nevertheless, learning to program has two barriers: the mechanics of programming and sociological factors of learners [1]. To lower the mechanical barriers to programming researchers investigated methods to replace the typical textual programming by creating specialized programming environments for children, e.g. Scratch [4]. To solve the second barrier researchers built systems to motivate children e.g. the storytelling system Alice [2].

Repurposing is like Re-engineering, it is a kind of first thinking in reusable modules and in algorithms. Repurposing everyday objects to create puppets is a creative activity taught in elementary schools and sometimes discovered by children in the simple act of playing. Create and interact with a puppet provides children with the opportunity to creatively build characters and worlds that express their imagination, thoughts and feelings. In fact a number of systems making use of dolls or puppets as tangible interfaces have been proposed in relation to children's storytelling. An example of this researching focus is the system voodoo [5] that allows the animation of virtual characters by manipulating action figures.

What if it were easy to children to program puppet reactions as a response to an interaction exerted over it? What if it were easy to a child who created a tennis ball puppet (TBP), to augment it with sensors, actuators and a control unit, with the simple purpose of hearing a "hello" whenever he squeezes the ball (moving the puppet mouth)? The purpose of this essay is to present a vision of an educational process aimed to promote the early education on programming and centered in the simple activity of create and interact with puppets. Focusing on a puppet as a target for a repurposing process can lead to numerous physical metaphors like for example a Sock Puppet, or a TBP. There are several features in a puppet that can influence and create different control metaphors and these can vary in complexity e.g. a) the sophisticated string control (Marionette or "string puppet"); b) the intuitive hand control associated with the Sock puppet. Due to this wide range of possibilities and inherent complexity we decide to focus this essay on the TBP use case (see Figure 1).

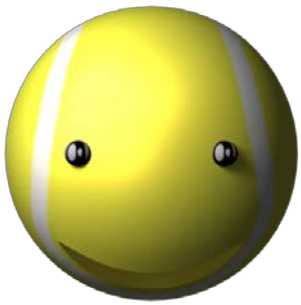

Figure 1. Tennis ball puppet.

The usage context of a TBP is the creation of a narrative, in this context the children create and gives life to the characters, the scenarios and of course the plots- the sequence of events that define the story. There are several possible activities when using TBP: a) dialogue between TBP performed by a child; b) dialogue between TBP and child; c) several children do an act together by controlling their own TBP. The acting may be the result of improvisation or the final result after training sessions, the scenario may be a physical construction or may just be a presence in the imaginary of children.

TENNIS BALL PUPPET

Construction

Before reaching the acting phase, the child has to construct the characters and therefore build the TBP. In this construction process the tennis ball is repurposed as a head - the ball is an elementary volume, which only defines the contours of the face. For the child it is like a white sheet waiting to receive the final drawing. It is expected that the child can add typical face elements (mouth, nose, ears, eyebrows, eyes) and other not so typical (glasses, hat, earrings, screws, etc.) to the ball. These elements may have an aesthetic functionality or may also a mechanical functionality. Among the typical elements the mouth, the eyes and the eyebrows should have a mechanical functionality (produced by the child or by TBP itself.), because they are essential for the verbal and non-verbal language representation. Of course other elements may have a mechanical functionality e.g. ears that can arise when the puppet wants to convey attention, the nose that can grow when the character lie. Typically, while repurposing to create a TBP, the tennis ball is cut to create a mouth and then by compressing the ball the mouth movement happens. As explained before, the mouth of the TBP is one of the most important mechanical features of the puppet, we want then explore this mechanical feature to understand how the TBP speech could be a programmable feature.

The most obvious and basic usage is: the TBP talks whenever it is compressed. For this simple operating mode we consider that it would be necessary a sensing system to detect the mouth movement, a single-board microcontroller, a speaker, an external storage (audio files), and a power supply (see Figure 2). However the simple reproduction of an audio track whenever the TBP is compressed is insufficient. It is necessary to create a programmable TBP, that allow programming when and what should be spoken by the TBP. To this end, we believe it will be necessary to add some elements to prior technical proposal. Essentially we need to provide the usage of a visual programing interface (via PC, smartphone or tablet). Within this environment the child shall be able for example to obtain or record audio files (speech or other sounds) and define a sequence of speeches that should be triggered whenever the TBP is compressed. In this new configuration it shall be added a communication interface to the TBP (Bluetooth LE low energy) to allow the TBP programming update.

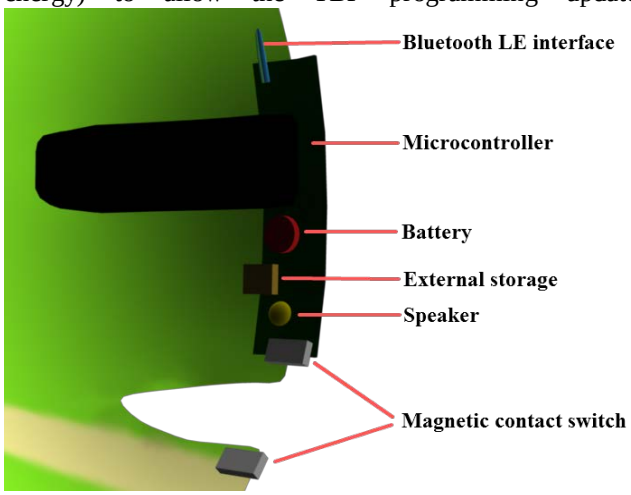

Figure 2. Tennis ball puppet inside component.

We consider also interesting the integration of two LED lights matrix to represent the TBP's eyes, thus enhancing the non-verbal communication of TBP (see Figure 3).

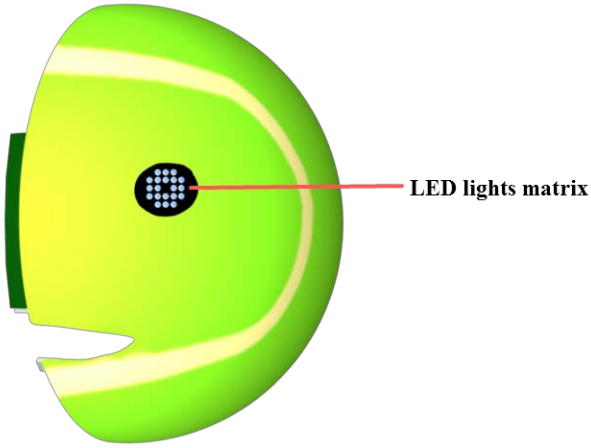

Figure 3. Tennis ball puppet LED lights matrix eye.

Due to the technological advances in the miniaturization of electronic components and the low prices of these components, the TBP construction is nowadays possible to any interested party. Femtoduino [6] (a ultra-small single-board microcontroller) is a very good example of a sophisticated low-cost technology. Thus the construction of the TBP can be divided in 3 simple steps:

1. Mouth and eyes Cutouts;
2. Stick one magnetic contact in the lower lip (inside the ball);
3. Stick the single-board microcontroller between eyes (inside the ball).

In the figure below, find all the electronic components embedded in the TBP.

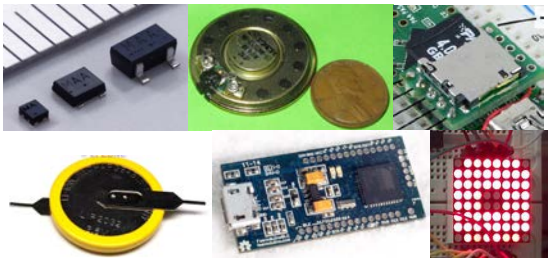

Figure 4. from left: magnetic contact switch; Small speaker; SD Adaptor board; LIR2032 Battery; FemtoduinoBLE; LED lights matrix.

Puppet Programming

As discussed earlier we propose using a visual programming interface to specify when and what should be spoken by the TBP. This programming environment will be obviously restricted by usage context i.e. the end result will always be the TBP actuation and therefore we shall consider it a single-purposed programming environment. In this environment children shall be able to 1) access to preset audio files; 2) record new audio file; 3) generate audio files via text to speech; 4) import audio file. Then the user has the possibility to construct a TBP actuation by dragging and dropping functional blocks (avoiding syntax errors). Running a TBP actuation offers a rich result, not only visual but also graspable, we maintain that this concept will joyfully empower children to program.

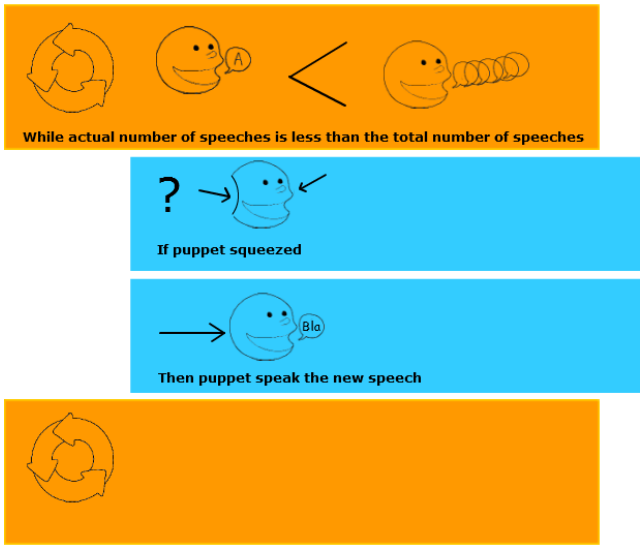

Figure 5. Drag-and-Drop block programming

CONCLUSION

We presented a vision of an educational process centered in the simple activity of create and interact with a tennis ball puppet. Imagine, materialize and give life to a character by repurposing a simple tennis ball can be an extremely rewarding activity for children. Enriching this activity with the possibility to easily/joyfully program automatism in puppet allows children to achieve more leeway for creativity. Moreover this enrichment can be a motivation and a fun intro to programming.

We describe here a technical proposal to construct and program the TBP. Although the general components and structure are clear, there are some questions left to solve. A few regarding the sufficient specifications of the technology we propose here. And other questions regarding the construction of the TBP and the limitations it induces on the imagination and invention possibilities of the child's.

We envision a good margin of progression to this concept. It depends on the possibility of embedding new actuators / sensors, e.g. detecting the proximity of other TBPs; 3D real-time positioning; cameras, vibration and other mechanical actuators. Also important is the exploration of new usage metaphors e.g. repurpose the environment sound to a specific narrative or the acting of various TBPs programmed by several children. Finally we consider also crucial the effort to achieve effectively a usable/flexible programming environment.

ACKNOWLEDGMENTS

This research was supported by the project "Mobile – Mobil im Leben" government-funded by the "Bundesministerium für Wirtschaft", under the program

"Von Tür zu Tür - eine Mobilitätsinitiative für den öffentlichen Personenverkehr der Zukunft".

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