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ELECTRICTY, WHAT'S BEHIND THE SOCKET?

I would like to presente the children's exhibition Electricity from two different angles:

The first deals with "Why":
What are the guiding principles? And what were the intentions behind the design and production of this exhibition?

The second deals with "How":
What behavior, what attitudes, and what knowledge-building makes this a popular exhibition with young visitors? (Presentation of research findings)

A FEW FACTS

- This exhibition has been open to the public since October, 1996
- It adheres to the Cité des Enfants' museal philosophy of pleasure and hands-on activity, through observation, action and experimentation.
- It is intended for children from 5 to 12 years old and for accompanying adults
- Floor space: 700 m^2
- 51 interactive exhibits
- Budget: 8.5 million French francs, incl. tax
- Daily staff: 3 visitor assitants and 1 technician
- An average yearly attendance of 110,000 visitors
- There is a 250 m^2 traveling version available (8 of which are presently being shown in the world)
- 3 spin-off products are for sale in the museum shop:
  - "Cité doc" (documentation for teachers describing the exhibition and offering activities for before, during and after the visit)
  - "Petit voyage en électricité" ("A Short Trip into Electricity", a videocassette with the 24 AV elements of the exhibition in humorous cartoons of 1 or 2 minutes each)
  - "L'album" ("The Album", a small catalog for children detailing the exhibition's contents)

WHY THIS THEME

A subject that is both scientific and technological which fits perfectly well into CSI's mission**.**
It deals with people's every-day lives.
It is part of primary and junior high-school curricula.

CONSTRAINTS IMPOSED BY THE THEME

Prior to each of our exhibitions, we always analyse rigorously the museological considerations of the exhibition's theme. With the Electricity exhibition we came up with 5 key considerations:

Electricity is an abstract phenomenon

In real terms we can only observe electricity's effects. To understand the why and how of these effects we must necessarily pass through the discovery of complex models of physical theories. These abstract models are not within the grasp of younger children.

Electricity is an invisible phenomenon

How, in other words, can you put on an exhibition on the invisible? There is a danger of not knowing what to observe because the phenomenon is hidden by the effect.

Electricity is a dangerous phenomenon

This exhibition encourages children to do things which in daily life are not "well advised". How can we, through hands-on museology, get the paradoxical message across to children of the potential dangers involved and urge them to be careful?

Electricity is seen as a banal phenomenon

Our research has shown the children's conceptions of electricity are very far from physical reality. For kids who have only ever known "comfort", electricity is perceived as an imposed fact of life, a phenomenon that is self-evident and gives rise to little curiosity.

Electricity is a hard phenomenon to stage

Electric objects and material, batteries, wires, light bulbs and plugs are such ordinary, objects that they are hard to dramatize. How can we invite visitors to come "see" and "handle" these "insipid" objects?

All of these considerations were very engaging for starting the exhibition. Furthermore, it targeted children from the ages of 5 to 12, an age group with a lot of diversity (physical growth, intellectual development, schooling, knowledge…). So it was essential to design elements that could be grasped by all ages.

CONTENT CHOICE

Limiting ourselves to the notion of energy

Given the extent of the subject and the amount of available floor-space, we decided to limit our content to the notion of energy. We identified 10 basic messages and some thirty key words.

Diversifying approaches

So that each visitor might find a key for entering this very complex subject according to their interests, age and level, we treated it with a multi-disciplinary approach.
The exhibition is built around 5 themes:

- A technical approach, "How does it work?": three emblematic objects of electricity are explored: the light bulb, the battery, and the engine
- A physical approach: "Taming electric current", discovering the physical principles of electric current and its working conditions

- An historical approach: “Electricity changes the world”, a small theater of inventions highlighting objects and people who talk about their discoveries and their social impact
- A day-to-day approach: “On either side of the socket”, start from the daily experiences in the home and “climb back up the current” to the industrial world of the power station
- A scientific approach: “Electricity in nature”: the presence of electricity in the sky, the human body, in various forms and degrees of power.

“Electrons” as resource

It struck us as very difficult to give material form to the basic question of “what is electricity” via interactive exhibition elements without inducing wrong representations. We therefore chose to tackle it through short films in the resource terminals.

MUSEAL INTENTIONS

Stagecraft to “re-enchant the electric world”

To keep from presenting electricity as something very ordinary, we wanted to create a space that would combine wonder, joy and conviviality. Several criteria contributed to enlivening the exhibition’s staging:

- Creating a warm, festive and unusual atmosphere by playing with color, scale variations and the treatment of light.
- Creating distinct worlds for strengthening the diversity of approaches: the theater of inventions, for example, in its very old-fashioned style, is different from the “toys laboratory” devoted to physical experiments or the electricity-production room and its authentic objects.
- Making use of the glass walls to let people on the outside see what’s happening inside the exhibition. Near the glass walls giving onto the building’s public area are the main elements, or “hero exhibits“.

The importance of the design

So as to get beyond the constraints imposed by a theme (an ordinary, dangerous phenomenon or one hard to stage) it seemed essential to include a designer in the team as early on as possible, so that form and content evolve together. Several criteria went into the job:

1 Place the “dangerous” objects in the “ fake ” domain. Two solutions were used:

- A change of scale: children pull the cord out of a giant socket in reference to Alice’s “false” world in Wonderland, or to Little Nemo.
- The use of a toy like look when it comes to trying the electricity.

2 Include real objects (generators, spools, magnets and transformers) in the exhibition elements that talk about producing electricity.

3 Invent a mascot, Electrototo, that can be used as a tool for measuring electricity:

- Electrototo opens his eyes wide when he “feels” tension at the circuit terminal (tension/volts);
- Electrototo sticks out his tongue when he “feels” electric current circulating (intensity/amps).

This emblematic object was associated with all experiments relating to the scientific and technological approaches (22 in all). Through repetition, he was meant to make children aware of these two very complicated notions (tension and intensity).
Evaluation shows that our starting goal was not achieved. Electrototo is mainly seen by children as an indicator of the “right action”, and as a pal who encourages them in their exploration. It is only the 11- and 12-year-olds who begin to make the link between Electrototo and measuring electricity.

Balance in the exploration modes

For each visitor to get the most out of this exhibition we decided to vary the approaches and exploration modes. The exhibition is composed of four major elements:

- Strong personal involvement through feelings and emotions, e.g. the lightning chamber, the inventions theater.
- Elements where physical activity and the body are paramount, e.g. the industrial generator, what’s behind the socket?, how many children have to pedal?
- Elements where investigation and problem solving are essential, e.g. experiments on circuits, the principles of the engine.
- Elements where the visitor is both the subject and the object of the experiment, e.g. my body as a conductor, feeling electricity.

We were also keen to have a balance between activities of a mostly individual nature (e.g. experiments on batteries, light bulbs and engines) and those of a more collective nature (e.g. the electric city, the house, lightning sculpture).
We wanted to facilitate exchanges and interaction among visitors. Many elements are individual in nature, but the space around them encourages interaction and exchange between visitors, for example, the circuit experiments.

Texts at different levels

We deliberately chose to do all of the graphics in black and white on metal plates (as on industrial signage), which sets off the information they contain from the colored design, and makes the text an object in its own right.
We also decided to limit the exhibition's texts to a strict minimum and to make them hierarchical since our audience is for the most part non-reading. We defined three levels of written information:

- Short and summarizing key-sentences are integrated into the exhibition space with a view to communicating the exhibition’s intentions.
- Individual labels are included in each exhibition element with a view to communicating intentions, instructions for how to use each element and a short explanation.
- Name tags on objects or parts of objects.

The role of the education staff

We felt that this exhibition has a particular need of human presence. The vast, complex and abstract subject matter called for reformulating. This is necessary to name, create links, and understand causal effect.
We chose to design a "demonstration and activity station" where people could "mess around" for real. The activity station is considered to be an exhibit. It is a place that gives children the chance to do experiments using scientific methods. The visitor assisstants leading the activities help them structure their discoveries, and make links. Thus, children build their own knowledge.

Integrating works of art

To mark a period of time and enhance subjects through very different points of view and sensitivities, we decided to use works by artists in the exhibition: the poetic sculptures by Pablo, the "+" and "–" by Jean-Louis Lhermitte and the morbid dioramas by Gilles Ghez.

GOALS OF THE EXHIBITION

To introduce children to the phenomenon electricity:

- Awaken their memories and their curiosity,
- Stimulate the evolution of their ideas on the subject,
- Provide them with keys for building their own knowledge…

To serve as a training space and a teaching tool for teachers

IMPACT

The exhibition has been the subject of numerous studies and technical research in the fields of science and cognitive psychology.

One study[1] looked into the evolution of children's conceptions about electricity after a visit to the exhibition. 300 children were involved in the study, the majority of whom were between 9 and 11.
The results are convincing and very encouraging in a perspective of scientific data-learning at exhibitions. They do, however, remain fragile and dependent on element design and scripting.

[1] Doctorat d'université de Veronique Fest Tetedoie , Laboratoire de cognition et didactique, Université Paris 8

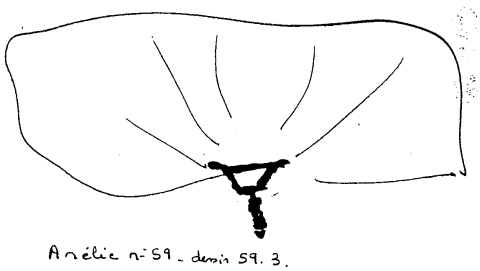
- **A conceptual evolution**

100 children were interviewed before and after visiting the exhibition. They were asked to draw a light bulb, a battery and an electric circuit. A comparison of these before and after drawings clearly demonstrated a very real development in their representation.

Batteries and light bulbs

A comparison of the drawings before and after the visit demonstrates that the post-visit drawings were much richer. The drawings are more realistic and filled with more detail. For example, the two poles of the battery are drawn in most cases, and the filament in the light bulb is often linked to something underneath. The post-visit drawings sometimes get quite technical

PRE-TEST



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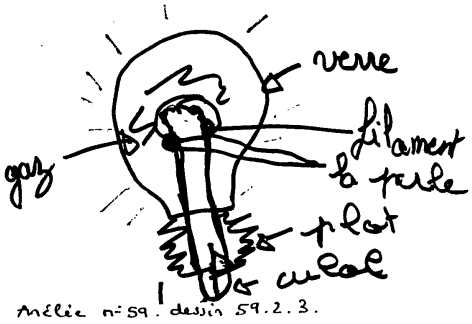

LIGN BULB

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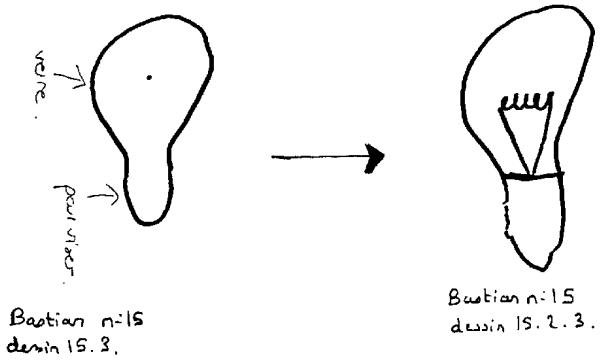
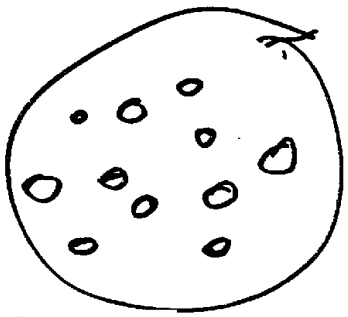


POST-TEST

BATTERY

PRE-TEST



Ali n°47. dessin 47.2.

Ali n°47 dessin 47.2.2.

POST-TEST

PRE-TEST

Clémence n°57 dessin 57.2.

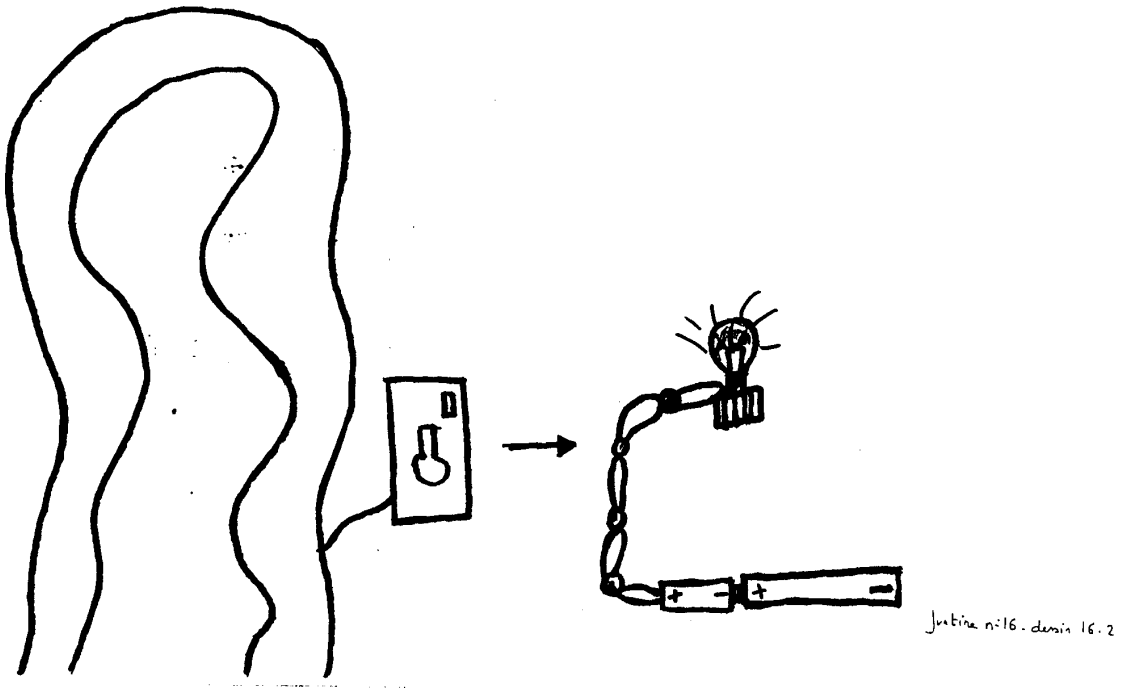
Clémence n°57 dessin 57.2.2.

POST-TEST

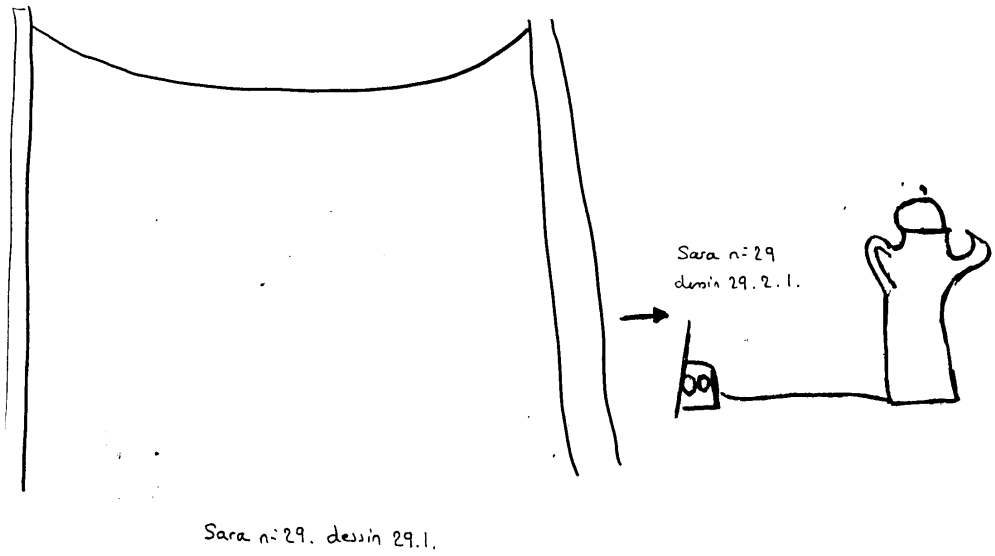
The electric circuit

A visit to the exhibition clearly shows that there is an increase in the number of electric circuit drawings and that there quality improves. There are several different categories :

1. Those who start with a vague idea of the subject (drawings of wires or car circuits…), who afterwards draw very real connections: a light bulb connected to batteries (Justine) or a coffee machine plugged in (Sarah).

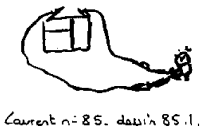


PRE-TEST **POST-TEST**



PRE-TEST **POST-TEST**

2. Those who, prior to the visit, draw or diagram experiments they have done in class (battery + wires + bulb). After a visit to the exhibition, some children broaden their perception of an electric circuit : transportation, for example, or the production and consumption of electricity…



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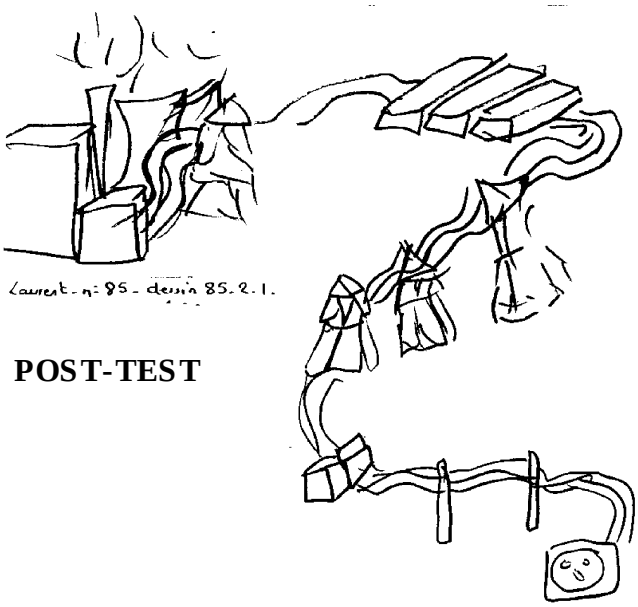

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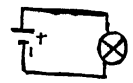
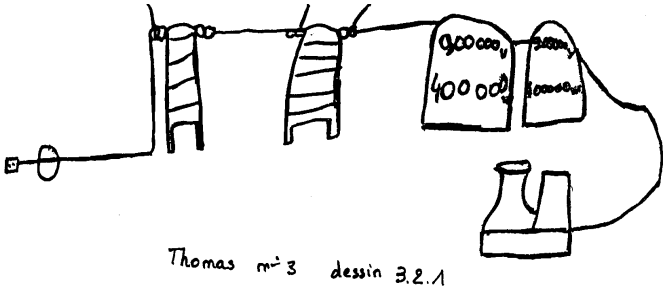
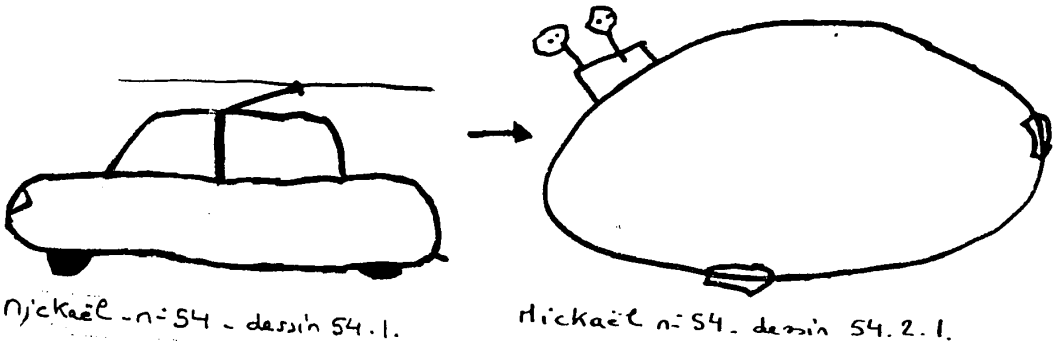


PRE-TEST

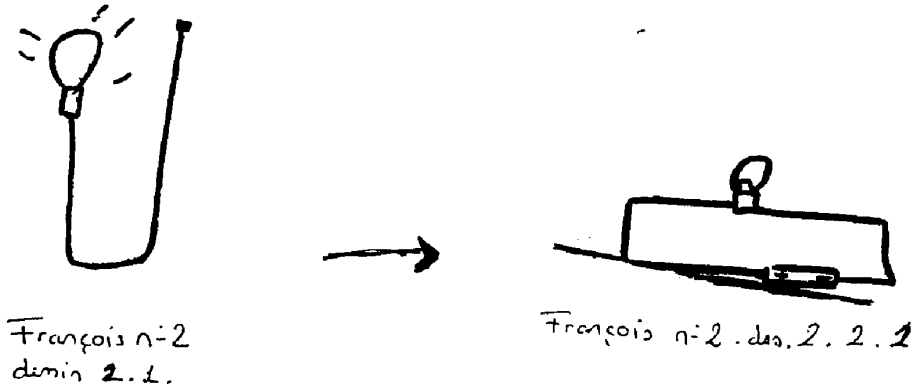


POST-TEST

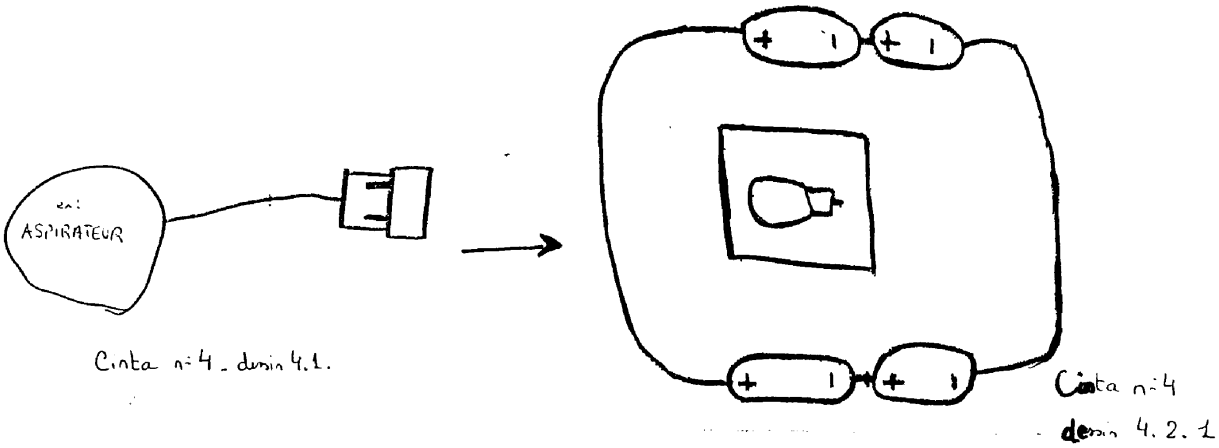
3. Those who start by drawing familiar electronic appliances such as lamps, vacuum cleaners or coffee-makers connected to a plug and who, after a visit to the exhibition, make more abstract drawings, for example, electric circuits made up of wires, batteries and sometimes light bulbs. Most of the electric circuits drawn are closed, and very close to being diagrammatic.



PRE-TEST **POST-TEST**

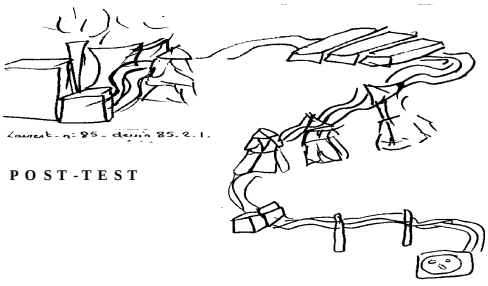


PRE-TEST **POST-TEST**



PRE-TEST **POST-TEST**

- We observe that the post-visit drawings are very influenced by the exhibit elements. It would seem that a few elements have appealed to their imagination



Does the design slow down or accelerate the evolution of conception?

After using an exhibit, in most cases children are able to explain what they have just done. Analysis of their statements confirms that the model of electricity circularity seems to have been understood in 67% of the cases.(Circular model: electricity travels in a loop, leaving one pole of the battery to get to the other pole.)

We think that the shape, volume and approach to the object influences the evolution and acquisition of scientific and technological data.
Two elements in the same series were studied and compared. The findings are eloquent. One facilitates understanding, while the other hampers it. Yet these elements were created by the same designer.

- The exhibit “Pour que le courant passe… il faut relier l’appareil à la pile” « For the current to get through… the device has to be attached to the battery » leads to a circular conception in a majority of answers. This element asks children to build the circuit wire-by-wire by connecting them to the battery. Several parameters here contribute to their acquiring the notion of the circular model: the topology, symbolization of the circuit and the way in which the child is led to act on it.
- On the other hand The exhibit “Pour que le courant passe… il faut relier l’appareil à la pile” « For the current to get through… the device has to be attached to the battery » leads to conceptions of unifilar current, in a majority of answers. (Unifiliar model: electricity leaves one pole to go to a lamp or an electrical appliance. The children don't conceive that it goes back to the battery). Upon investigation we notice that the circuit and scenario typology lead the child to pay attention to only one side of the battery. Moreover, the circuit wires in this element were symbolized by “fat cables”, which were seen by the children as “pipes”; (« The pipe with the electricity, the electric pipe, the pipe through which the current passes… »). Such phrases express the “metaphor of moving fluid”, which distorts the representation of the electric circuit. This leads to sequential reasoning, which is not generally accepted nowadays in scientific circles.

All of these findings stress the acute importance of the scenario, the design and the organisation of the exhibit’s parts in the evolution and acquisition of scientific and technological notions.

The exhibit « For the current to get through… the device has to be attached to the battery »

The exhibit « For the current to get through… the device has to be closed »

EPILOGUE

Some statistics

- 79% of teachers are very favorable to the exhibition. They use it as a teaching tool either to illustrate their curricula, to develop and experiment with ideas they have worked on in class or as the first step for introducing this subject.
- The exhibition's elements are well understood and handled effectively. (ie: the ability to make the exhibit work). A mere 13% of children are not able to understand an element's main goal.
- Most children have an active discovery process. Faced with an exhibit they try, organize their actions, induce, deduct and create projects by using their own reasoning processes.
- After hands-on experience, 87% of the children are able to explain what they've just done. Some even try to conceptualize certain physical phenomena.
- 64% of the written comments placed in the suggestion box are positive, with such observations as "it's fun,good-looking and interesting". Other words like "wonderful", "super" and "brilliant" are not infrequent. Negative comments are more concerned with details

In conclusion

All the whole of these findings show that the museological goals at the start were reached. There are many teachers who come with their classes and seem to use it as a teaching tool. Children spend an hour and a half having fun andgetting involved through active exploration. The exhibition has attained its goals: being a memorable experience and improving the representations on the subject.

Nonetheless, there is still a lot to learn if we want our exhibitions to be places of learning, where scientific and technological notions can be acquired. The blend of scenario and design is fundamental, right down to the very smallest details. Everything is important: color, shape, substance and the organisation of the exhibit's parts. It's a hard challenge to meet. But formative evaluations on prototypes are a powerful tool that we should use more often to design our exhibitions.