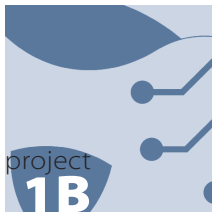


IERoKi
Innovative Entertainment Robot for Kids

ABSTRACT

In this project we faced for the first time the world of entertainment from a different point of view, not as customers, but as creative designers and engineers. We proposed and realized a new toy, that we expect to become a hit with young kids. For this reason, we decided to write this article in a different way, compared to the engineering books we have studied so far in our university courses.

It is Christmas morning and a child is opening his presents. His eyes shine by discovering that he received the toy he has desired for so long time: caterBOT, his favorite character from the IERoKi series. Just few seconds to take off the packaging and the toy is ready to be used. It looks like a thirty-centimeter long caterpillar, with a green plastic body and four wheels fixed to the base.

The packaging contains some green plastic leaves too. In less than a minute the child places them on the floor next to the caterBOT, and turns it on. The toy starts moving towards the closest leaf, passes over it and turns left. After detecting the second one, the caterpillar changes its direction and once it reaches the new leaf, it lights up. Leaves act as signals and can be placed freely on the floor. Their position can be changed even while the caterpillar is moving.

Not only the toy looks nice in its appearance, but also it as many features. It can play sounds, switch its colorful lights on, and of course follow the instructions it gets from the child through the signals. It can turn right, left, it can speed up and even stop until the button placed on the rear is pushed. No external direct command is needed, the toy moves on the floor as if an invisible hand could guide it!

The name of toy is IERoKi, an acronym that stands for Innovative Entertainment Robot for Kids. The toy presents autonomous behaviors, since it's able to interact with the external environment recognizing the items provided inside the packaging and acting differently according to the specific signal. All this is possible thanks to the use of RFID, a wireless technology that enables the identification of a tag by using electromagnetic waves. In fact, the caterpillar shell hides beneath an antenna, which can detect the so called RFID tags contained in the leaves. Tags have been previously endowed with an identification code, so that after their activation by the electromagnetic field of

TASKS & SKILLS

The presence of different backgrounds in our team represented a fundamental resource for the development of the robotic device. In detail, the competences we could rely on during the project are specified below:

Raouf Barboza was responsible for all the hardware components of the project, optimizing problems related to the interface among the different electronic devices.

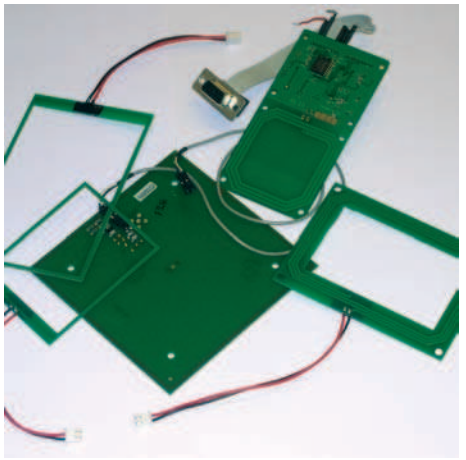
Luisella Borra took care of product ergonomics and usability, she designed the mechanical structure and the external shell of the toy.

Maria Beatrice Criniti gathered information about the state of the art and the legal discipline related to the technologies adopted in the project, moreover she managed most components buying activities.

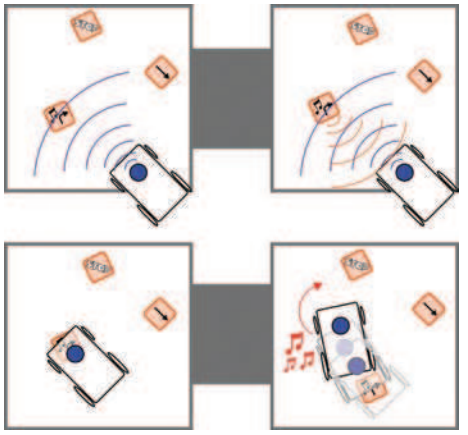
Luigi Malagò designed and implemented the firmware for the microcontroller, he defined the overall software and hardware architecture of the toy.

Marco Rossi was project manager, responsible for internal coordination, economic project analysis and documents editing.

1 *Scenario for the concept*



2 *RFID antenna and transponders*



3 *Description of the functionalities of the robot*

UNDERSTANDING THE PROBLEM

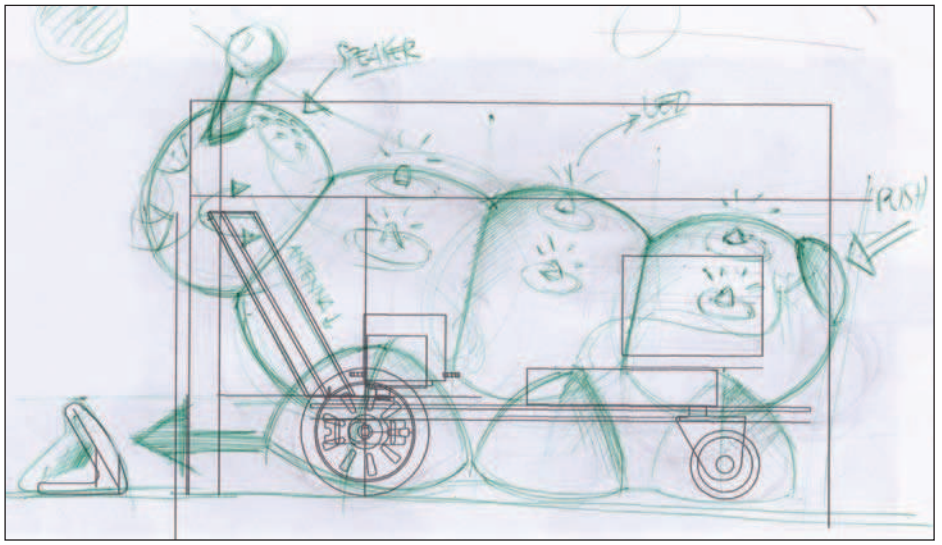
Imagine five students taking part in an adventure. They don't know each other, speak different languages and even come from different continents. It is not a pleasure holiday on a Caribbean island, but a two-year long trip rich of troubles, difficulties and problems students have to face.

We like this comparison because it well reflects our experience in this project. We had to realize an autonomous mobile robot for services applications, all summarized by the acronym AMoRoSA, which was the name of our project. We received even a series of constraints our robot had to respect, in particular flexibility, modularity, usability, market orientation and last but not least innovation, in the sense that our robot should have to be different from already existing devices, in terms of functionalities and technologies.

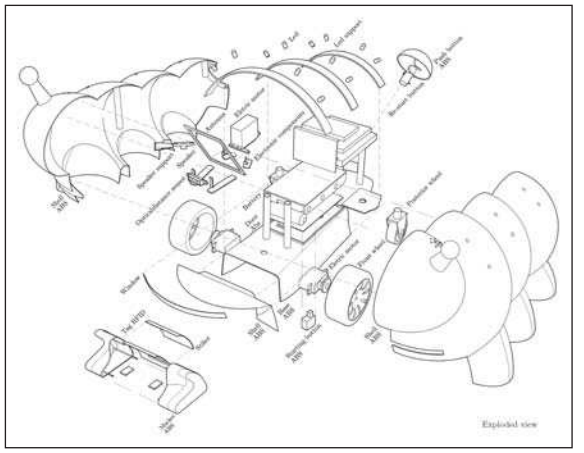
After understanding the meaning of all these concepts, we organized several brainstorming sessions. Once we obtained a sufficiently rich list of ideas, we tried to assess them with the support of our tutors. Final we set the field of our project: children entertainment.

EXPLORING THE ALTERNATIVES

We conducted a market analysis to realize which technologies, strategic positioning and tendencies characterized existing products. At first we tried to understand how entertainment robotics evolved in the last decades, through many researches on the Internet and reading product catalogues released by entertainment companies, we identified current most successful products. We tried to assess them on two variables: selling price and performances. After mapping this information in a simple performance-price chart we identified market segments and products positioning. The state of the art analysis concluded with the study of market trends, in order to judge the profitability of the field we were about to enter. We analyzed entertainment robot market past trends in terms of value and units sold, considering in the end experts' expectations about future evolution. In few words, we wanted to provide children with a toy that could possibly fulfill their great expectations, and that could attract their attention as long as possible. In order to reach this goal we adopted a sort of stage-gate approach. In reality our project evolution was not so linear as it could appear from the previous description. In fact it was characterized by several loops caused by arising unexpected troubles and even by better understanding of aspect related to chil-



4 *First drawing of the external shell*



5 *Exploded view of the toy*

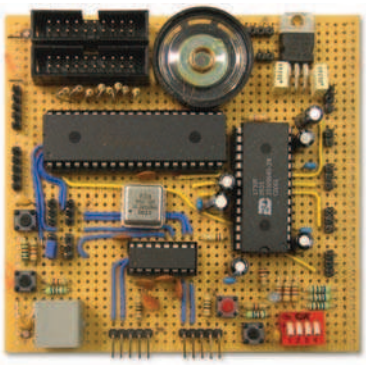
dren behavior. Another great issue was related to impossibility of implementing some chosen technologies, owing to the lack of specific competencies in the team. During the early project stages for example, we decided for different reasons to change more than once the size of the toy and the technologies to be used in order to better interact with the external environment.

GENERATING A SOLUTION

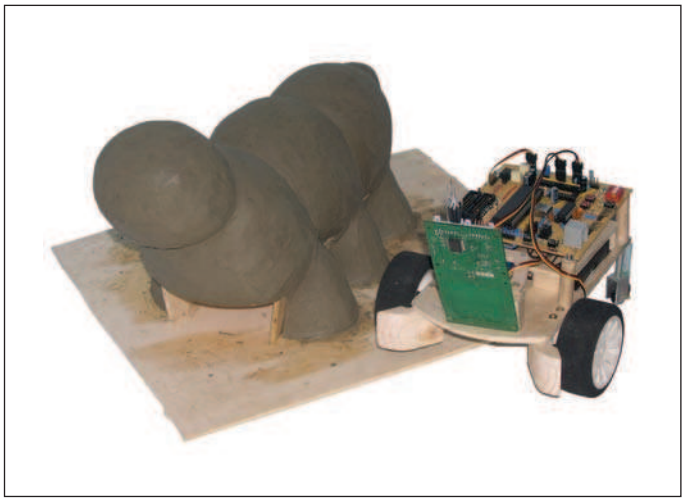
We decided to explore and bring forward two different solutions, which seemed to be equally interesting. The first one was an autonomous racing car moving along a circuit build up in a domestic room with standard modules to be assembled by the child. In our scenario the car should have been able to follow the path thanks to the on-board sensors, register it and then compete in the same circuit with another racing car guided by a child through a radio controller. In our mind this toy fulfilled many of the project requirements such as flexibility, innovation and of course autonomy. On the other hand we identified some problems, in particular concerning technological aspects of the robotic device. Beyond technological difficulties related to significant speed required to the cat, there was the threat that some potential consumers could be prevented from buying it owing to limited indoor available spaces.

The second solution was a sort of small train able to follow a line freely drawn by the child on a floor or on other kind of surfaces. This idea was characterized by a lower speed compared to the previous one, and so targeted to younger users. The child could paint some signals along the path to be recognized by the toy. We were able to identify some difficulties related to the choice of the support on which drawing the line or to the correct identification of the signals. Owing to these critical and serious aspects common to both solutions, we decided to interface directly to the children world. We organized a meeting with two experts in the field of youth entertainment, in order to integrate information we got previously from books and manuals. One of the most important contributions they gave us was about the limit associated to a two-dimensional game environment. They provided us with enough information to conclude that the toy train idea was not completely able to represent a good source of fun for our target. Moreover we decided to discard even the racing car toy, since after consulting with our academic and

6 *Electronic components on the control board*



7 *Final rendering of caterBOT with external markers*



8 *Prototype of the robotic base with the RFID antenna and model of shell*

external tutors, we realize that the technological problems we would had to face were beyond the reach of this project.

In order to change our approach towards a three-dimensional game we needed a technology that could let our toy to identify an object in a three dimensional space. We chose RFID, a technology widely used but rarely applied in the entertainment field.

The game standard scenario is very simple and will be now briefly described. The toy moves in a domestic environment thanks to two driving wheels. When it moves, it is able to use a RFID antenna as a kind of radar, in order to detect tags in the nearby. Tags are contained in signals, which cab ne freely places by the child on the floor, for example forming a path along which the toy will move. Each RFID tag is associated a specific identification code, so that when it will be recognized by the toy, this will behaves in agreement with it. The toy can perform some basic actions, such as turn left, right, play sounds, and so on.

Several different higher level behaviors can be implemented by the toy and most of them will depend on the specific external shape that will be delivered. Different versions of the toy have been conceived beyond caterBOT, for example the same device could be easily adapted to behave as learnBOT, the personal teacher that helps children to learn a foreign language or fableBOT, a friend that will tell a new story according to the sequence of the events created by the child with the markers.

The software and hardware architecture of the toy have been designed in order to be as much modular as possible, for this reasons, not only different behaviors can be easily implemented, but also they can be extended to other types of toys beyond IERoKi.

Finally, we also prepared a business plan, imaging of forming a society with our project tutors. For a series of economic reasons we supposed to sell our robot to kindergartens with the help of a couple of agents and through a web site. We considered a lot of aspects: production site choice, production techniques, delivery strategy, cost analysis and marketing strategy. After computing the best selling price through benchmarking and mark up techniques, we supported qualitative considerations with an estimation of cash flows. Regarding the first three years and with our given assumptions we estimated a positive profit since the half of the second year.