

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



---

## **Toy Design Methods: A Sustainability Perspective**

---

Denis A. Coelho and Sónia A. Fernandes

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/52858>

---

### **1. Introduction**

The challenges of sustainability are already guiding today's scientific and technological progress, and because environmental awareness should necessarily be fostered from birth, toy design was selected as a field of inquiry for this contribution. The connection between toys and environmental sustainability is explored in this chapter in two main areas which complement each other. On the one hand, eco-design of toys is considered "tout court" (pure and simple). In this respect, the ecological aspects of the objects that support play (toys) should be considered at the level of the materials used, the expenditure of energy in their production and transportation, as well as in what concerns other issues related to the lifecycle of the product and for a combination of recreational, educational, and pedagogical purposes. On the other hand, children may also be actively educated to develop their environmental awareness. It is believed that these two approaches are complementary and that in an ideal scenario the toys for leisure activities given to children by their relatives, and those provided by nurseries, day-care centres, pre-schools, primary schools and even urban equipment available for kids in playgrounds should reconcile these two aims: minimizing environmental impacts (associated with pro-active eco-design, considering the whole life cycle of the recreational-educational product) and education for civic development in view of responsible citizenship with great emphasis on the foundation of environmental awareness and protection of ecosystems and the legacy for future generations.

To contextualise and underpin the development of this work, it proceeds with an initial gathering of information about the child's cognitive development, which is presented in the reminder of this section. The following sections seek to answer the questions raised as a result of the proposed aims along with the presentation of design results.

## 2. Stages of child development

A child is a human being in the "cradle" of her or his development. Childhood is the period from birth until about the 12th year of a person's life. It is a time of great physical development, manifested by progressive increase in height and weight of the child. It is also the period when the human being develops psychologically, and during which changes occur in behaviour and the foundations of personality are developed. Regarding the maturity of all species that inhabit the Earth, the human being is the one with the slowest growth and development rates of all. The human is a rather slow developing species; for example, in the time that a child learns to walk and run with sufficient equilibrium, other species reach full maturity, as is the case of rats, who reach sexual maturity in only 15 days.

According to Wallon (1981), the human being is determined physiologically and socially, subject to internal arrangements (affective), and external situations (sensorial-motor). In this way the study of human development must consider the subject as grounded in its relationship with the environment. This author considers the following five stages of development: impulsive-emotional - 0 months-1 year (the predominant affection); sensor-motor and projective - 3 months-3 years (dominated by intelligence); personalism - 3-6 years (formation of the personality of the individual and self-awareness); categorical stage - 6-11 years (development of memory capacities and voluntary attention); stage of adolescence - 11-16 years (physical and psychological changes). However, the stages of human development do not cease in adolescence, as, according to Wallon (1981), the learning processes that occur throughout life involve crossing a new stage of development.

Jean Piaget considered that the development of children also occurred in stages, however, according to Piaget and Inhelder (1995), the key is the sequential order of stages and not the age at which each one arises. To make up a new stadium, one must have passed through and overcome the previous stages. Jean Piaget believed that there are four stages of development, which he detailed in his Cognitive Theory. These stages are: the sensor-motor stage - 0 months-2 years; preoperative - 2-7 years (egocentricity); stage of concrete operations - 7-11 years (integrated mental organization); and stage of formal operations - 12 years and over (development of abstract thinking operations).

### 2.1. Observation of children at play

The previous section, aimed at contextualizing the work in this chapter, which is centred on children, presented the stages of their cognitive development (psychosocial and emotional). In order to support this contextualization, a set of observations of children at play, presented in Table 1, were made, as a form of recognition in practice of the concepts presented. These observations also allowed inference of the type of activities, the duration thereof and the reactions of children during play. Especially in the cases where two children of different ages were observed playing together, the observed states of the children are different in some cases. These result from the diverse stages of development of the children and the adequateness and appeal and complexity of the activities being carried out.

| date          | time  | actors (age)                       | Description of activities                                                                                                                     | General impressions per child                                                                        |                                                                                                              |
|---------------|-------|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| 24-12<br>2010 | 17:12 | Leandro (23 m.)<br>Leonor (4 y.)   | - hide and seek (33min)<br>- sketching and colouring (1h14min)<br>- clay moulding of dolls (25min)                                            | Leandro<br>- interest or joy<br>- "difficulty"<br>- indifference                                     | Leonor<br>- energy or joy<br>- concentration<br>- tiredness                                                  |
| 26-12<br>2010 | 14:46 | Leandro (23 m.)                    | - ball play (24min)<br>- tricycle riding (14 min)<br>- looking at pets (caged birds) (12min)                                                  | Leandro<br>- joy or motivation<br>- joy or motivation<br>- apprehensive or fearful                   |                                                                                                              |
| 28-12<br>2010 | 15:30 | Vasco (14 m.)                      | - looking at books with sounds and colours (12min)<br>- puzzles and cubes (40min)<br>- playing with the dog (15min)                           | Vasco<br>- concentration or joy<br>- interest or concentration<br>- joy or satisfaction or happiness |                                                                                                              |
| 02-01<br>2011 | 10:53 | Catarina (3 y.)                    | - looking at books (38min)<br>- using paint and scribble books (45min)                                                                        | Catarina<br>- interest<br>- happiness                                                                |                                                                                                              |
| 15-01<br>2011 | 14:25 | Tiago (12 y.)<br>Alexandra (10 y.) | - playing playstation (1h)<br>- ball games (35min)<br>- pretending game (20min)<br>- reading (30min)<br>- playing with dolls and cars (15min) | Alexandra<br>- indifference<br>- joy<br>- "imagination"<br>- interest<br>- "imagination"             | Tiago<br>- concentration<br>- energy or satisfaction<br>- "imagination"<br>- indifference<br>- "imagination" |

**Table 1.** Observation of children at play (several children interacted with the second author in a family setting).

### 3. Education for sustainability

In order to find a point of connection between sustainability and education for sustainability a search was initially made for concepts and needs within sustainable development. Subsequently, an analysis was made of the universe in education for sustainability and a letter from the Earth is presented, which is a declaration of fundamental principles for building a society that is fair, sustainable and peaceful.

#### 3.1. Sustainable development

Enough for everyone, forever. These words resonate with the ideas of limited resources, responsible consumption, equality and equity and a long-term perspective, all of them corresponding to important concepts of sustainable development (Portuguese Ministry of

Education, 2006). Sustainable development involves meeting present needs without compromising the ability of future generations to also meet theirs. The concept of sustainable development involves not only fostering positive impacts locally, but this should be thought in global terms, giving rise to the sense of universal responsibility. Hence, sustainable development is all about a joint effort carried out between different areas, whether social, economic, ecological or political, thus trying to strike a balance between economic growth, social equality and the preservation of natural resources and habitats. Ensuring that the people from all over the world are able to satisfy their basic needs, while assuring that future generations can have the same quality of life is at the core of the sustainable development agenda.

### 3.2. Education for sustainable development

The early childhood years are the most significant and when the greatest developments in the life of a person take place and are generally regarded as the foundation upon which the rest of an individual's life is built (Mustard 2000; Rutter, 2002). Children, viewed beyond their genetic heritage, are influenced by the environment around them and by their relationships with their parents and with other people, so when considering the formation of emotions in children, one must look at all the ways in which the child responds to all persons with whom he or she crosses, and all the images she or he sees. The education of children is the greatest responsibility of parenting, with the aim to create "adulthood" and not perpetuate childhood, parents should bet early on in showing their children the emotional realities with which life confronts everyone, sooner or later.

As is well known, children follow the examples of parents and of all those who are part of their reality. It is however up to parents to ensure the safety of small children that are not yet able to assess the dangers that surround them, and to educate them to become citizens of a just society where everyone can exercise their rights to equality and solidarity. One ought to never forget that home is the real trainer of people. Values such as education and personal development must be transmitted within the family, however, in current times, and with the economic and social situation most people are confronted with today, it becomes increasingly difficult. Parents spend less time with their children, thus hindering the teaching of personal and social values which includes education for sustainable development. To compensate this, the school seeks to fill the gaps in education by the family, but there is still a need for restructuring at the curriculum level. The school curriculum structure does not necessarily facilitate the task of educating for sustainable development. For example, experimental teaching activities can be a real challenge when teaching is confined to a classroom. Furthermore, the assessment systems are, often, based in a competitive model in which individual grades become the main goal of the students. This is, in fact, an environment that hinders the promotion of values central to the notion of sustainable development, such as 'participation' or 'cooperation' (Portuguese Ministry of Education, 2006).

The call for a rampant consumerism that translates into large discharges of toxic waste and garbage are two major global problems. Through early education for sustainable develop-

ment it may be possible to modify consumer relations and ensure environmental sustainability of our planet changing the current situation.

| Section                                 | Principles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I - Respect and care for community life | Respect Earth and life in all its diversity.<br>Care for the community of life with understanding, compassion and love.<br>Build democratic societies that are just, participatory, sustainable and peaceful.<br>Conserving Earth's bounty and beauty for present and future generations.                                                                                                                                                                                                                                                                                                                              |
| II - Ecological Integrity               | Protect and restore the integrity of Earth's ecological systems, with special attention given to biological diversity and natural processes that sustain life.<br>Addressing the prevention of environmental problems as the best method of environmental protection and in case of insufficient recognition, taking preventive measures.<br>Adopt patterns of production, consumption and reproduction that safeguard Earth's regenerative capacity, human rights and the welfare of communities.<br>Encourage the study of ecological sustainability and promote the free exchange of knowledge and its application. |
| III - Social and economic justice       | Eradicate poverty as an ethical, social and environmental problem.<br>Ensure that economic institutions at all levels promote human development in an equitable and sustainable manner.<br>Affirm gender equality and equity as prerequisites to sustainable development and ensure universal access to education, health care and employment.<br>Defend, without discrimination, the right of everyone to a social and natural environment, by promoting human dignity, bodily health and spiritual well-being, with special attention given to the rights of indigenous peoples and minorities.                      |
| IV - Democracy, nonviolence and peace   | Strengthen democratic institutions at all levels, and provide transparency and effective governance to ensure inclusive participation in decision making and access to justice.<br>Integrate knowledge, values and skills for a sustainable way of life into formal education and lifelong learning,<br>Treat all living beings with respect and consideration.<br>Promote a culture of tolerance, non-violence and peace.                                                                                                                                                                                             |

**Table 2.** Earth Charter - basic principles (Portuguese Ministry of Education, 2006).

**3.3. Analysis of the educational universe in the area of sustainability**

In Portugal, there are a set of pedagogical guidelines to support education for citizenship, which are published in the booklet entitled "Guidelines for Education for Sustainability", developed jointly by the Directorate General for Innovation and Curriculum Development, Ministry of Education and the Portuguese Association for Environmental Education (AS-PEA). Its realization is based on the Earth Charter (Table 2), which was published by UNESCO in 2000 and approved by the UN in 2002. Published in 2006, this guide aims to foster and support primary school teachers in the arduous task of educating for sustainable development, and in serving as a basis for curriculum and civic education of children and youth. "The authors believe that the school, among other institutional actors, plays an invaluable training role that must be exercised and enjoyed in large areas, including not only formal knowledge and curriculum (...) "(Evaristo, 2006). Making the school a hub for pro-



duction and dissemination of information on education for sustainable development for students and parents is one of the objectives of ASPEA.

The Earth Charter is a reference to relevant and unique training programs that aim to develop learning processes in students for a more just, sustainable and peaceful society, (Portuguese Ministry of Education, 2006).

The literature review of concepts related to education for sustainability and sustainable development, contributed significantly to the design phase of this work. In Portugal there was already a breakthrough in early education for sustainable development, which seeks to instill values such as early environmental sustainability in school children. However, authors can see that this whole journey tends to occur mostly at the theoretical level, neglecting the practical part as a crucial incentive. It is worth highlighting the commitment and positive attitude of the Ministry of Education to prepare a script that aims to guide teachers in the arduous task that is education for sustainable development.

#### **4. Methodology for toy design**

The literature review carried out to meet the goal set for this work, of reviewing existing methodologies for the design of toys, was not successful, since it fell through without attaining literature references covering this matter. The authors proceeded to propose a methodology for designing new toys (based on the systematic process of design and taking into account the stages of child development) that is the following:

1. Recall the stages of physical, cognitive, sensor-motor, social and emotional development of children.
2. Given the context of playful activities, proceed to carry out an exploration of activities that may contribute to the development of the child in one or more of the spheres covered above (1).
3. Find one or more metaphors that may form the basis of concepts for the creation of toys or recreational objects.
4. Evaluate the concepts of toy or object triggered as a result of the previous stage in satisfying a set of requirements generally applicable to toys or objects of play (e.g. low toxicity, safety regarding self-inflicted injury) and select those that satisfy the general requirements and that are configured as original proposals, potentially motivating their use by children (by selecting different age groups) and clearly support one or more activities that promote psychosocial development, development of sensory-motor skills and of physical ability in the child users.
5. Develop and set, based on knowledge of the context of child development and the concept selected, a specification in order to guide the design of the toy or playful object. At this stage market objectives should be considered, including costs, packaging, distribution and consideration may also be given to objectives of another nature.

6. Proceed to the development of the detailed concept and produce prototypes enabling testing under controlled conditions of safety, initially with adults and ensuring no hazard is presented by the prototypes when seeking to involve children in their use. (Note: at this stage children should be able to keep the prototype toys).
7. In this process the results of usability testing can motivate changes to the project description and a new iteration of design refinement and testing, reiterating until the development team is satisfied with the results, or the resources allocated to the development have been exhausted.
8. Development of production processes and of release, distribution, and marketing documentation.

#### **4.1. Evaluation of the proposed methodology**

Since there was no published methodology found alluding to the subject discussed in this chapter with respect to the design of toys, authors opted for the generation of a new methodology. The assessment of this proposed methodology was achieved through the implementation of projects based on it. Table 3 describes the strengths and weaknesses found in the pursuit of the conceptual design phase, which includes the first four steps (Table 3).

Given the academic nature of the development of plans to evaluate the proposed methodology, steps 5, 6, 7 and 8 could not be tested fully. However, step 6 was partially implemented, given the production of two prototypes, without adopting the colours, materials and the final dimensions of the toys that were designed.

Not having found a published methodology, the authors chose to develop a methodology for designing toys focused on the stages of psychosocial and emotional development of children from an early age. One of the most prevalent weaknesses of the methodology relates to the initial survey to be carried out about the stages of physical, cognitive, sensor-motor, social and emotional development of children, which may be considered as limiting creativity. As strengths, the proposed methodology's capacity to foster iteration and improvement after the prototyping phase is highlighted.

#### **4.2. Toy design methods considering sustainable design goals**

The sustainable design methodologies proposed by Fuad-Luke (2004) and Ryan (2009) were taken as a basis on which to develop a proposal for toy design satisfying sustainability goals. The former is rather more detailed than the latter, with a high level of detail given to the process, which is deemed easy to follow. As a strong point in Ryan's (2009) proposal, authors emphasize the fact that not only does it cover a perspective focused on the product but it also encompasses product and service systems with strategic orientation towards sustainable design goals. Both methodologies share the common goal to create products or artefacts that safeguard the continuity of the planet's resources, thereby creating a combined economic, social, and environmental solution. The concern with the product life cycle is also a common point in both methods. Fuad-Luke (2004) presents a methodology for the eco-plu-



ralist designer, easy to understand, so that designers can design more sustainable products aimed at the continuity of future generations. Ryan (2009) proposes, on the other hand, a more elaborate method dealing with systems and that, as such, can be adopted and used by companies. Considering the initially proposed methodology for toy design (Table 2) and the contributions reaped from Fuad-Lake (2004) and Ryan’s (2009) methods, the toy design methodology proposed was enlarged towards being geared towards sustainability goals and towards fostering the development of environmental awareness, taking the form presented in Table 4.

| Step of the proposed methodology | Strengths and Weaknesses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Step 1                           | <p>Strengths: With the implementation of this step, one gets a very comprehensive view of the stages of child development.</p> <p>Weaknesses: Once you start the development of this methodology with a focus on literature, from the standpoint of design activity, creativity is a bit on standby as it is not part of the realization of sketches. Instead of only collecting data from literature, it might be more stimulating and creative to simultaneously consider the relevance of designed objects to interact with children.</p>                                                                                                                                          |
| Step 2                           | <p>Strengths: Given the focus of activities that contribute to the development of specific capabilities of the child, the methodology can be used many times by various designers giving rise to very diverse projects.</p> <p>Weaknesses: Since the methodology focuses on specific activities related directly to child development, the results may be relevant only to a very narrow age span, challenging the duration of the interest of the child in the toy over an extended period, which may undermine the objectives of sustainability.</p>                                                                                                                                |
| Step 3                           | <p>Strengths: The use of metaphors opens up almost unlimited possibilities. The simultaneous use of more than one metaphor is intended to prevent that a metaphor may predominate and the subject may become too literal if using only one metaphor. The crossing and the combination of several metaphors is a way of stimulating creativity, enhancing innovativeness of results.</p> <p>Weaknesses: If the designer is not careful, the project may become too literal in relation to the metaphor, so the designer must be aware and avoid over-literality.</p>                                                                                                                   |
| Step 4                           | <p>Considering the initial proposed methodology of the concept generated is a way to avoid that the project goes much forward before judging its relevance, which contributes to increase the efficacy of the methodology and to reduce costs ( for example in prototyping), and time spent by the designer, or by the design team, in creating the toy.</p> <p>Weaknesses: The focus on specific activities and sensory-motor skills as well as on differentiation into age groups may not be possible given that the concepts generated have been from the outset (in Step 2) directed to a specific activity focusing on one age group and supporting the development thereof.</p> |

**Table 3.** The authors’ evaluation of the proposed methodology for toy design.

| Step | Activities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Review the stages of physical, cognitive, sensor-motor, social and emotional development of children to meet real needs rather than needs related to passing fashion or driven by the markets.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 2    | Given the context of the design project being developed, carry out exploration activities that may contribute to the development of the child in one or more of the spheres covered above (point 1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 3    | Generate concepts for one or more activities that can underpin the creation of toys or recreational objects, directing creativity to issues that foster awareness of environmental sustainability in an educational manner: <ul style="list-style-type: none"> <li>a - Do not waste materials, energy, food ...</li> <li>b - Respect ecosystems.</li> <li>c - Preserving the planet for future generations.</li> <li>d - Adopt the idea of the three R's - Reduce, Recycle, Reuse.</li> <li>e - Strengthen the relationship between economics, technology, society, politics and the environment.</li> <li>f - Enter the challenge of "moving from concept to action".</li> <li>g - Recover and develop values and behaviors such as trust, mutual respect, responsibility, commitment, solidarity and initiative.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4    | Evaluate the toy or playful object concepts triggered in the previous stage against a set of requirements generally applicable to toys or playful objects (e.g. low toxicity, safety against injury) and select those that satisfy the general requirements and are configured as original proposals, potentially motivating their use by children (selected according to different age groups), and that satisfy in an obvious manner the support of one or more activities that promote the development of psychosocial and sensory-motor skills as well as physical ability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 5    | Set, based on knowledge of the context of child development, a specification of the concept selected in order to guide the design process of the toy or playful object. At this stage market objectives should be considered including cost, packaging, distribution and consideration may also be given to objectives of a different nature, including sustainability, and such as: <ul style="list-style-type: none"> <li>a - Designing to minimize the ecological footprint of the product, material or service, that is, reduce the consumption of resources including water and energy.</li> <li>b - Designing to take advantage of renewable energies (solar, wind, hydro or wave), instead of using non-renewable natural capital such as fossil fuels.</li> <li>c - Designing to enable separation of the components of the product, material or service at the end of their life-cycle in order to encourage recycling or reuse of materials and, or, of the components.</li> <li>d - Designing to eliminate the use of toxic or hazardous substances for humans and other life forms in all stages of the life cycle of the product, material or service.</li> <li>e - Designing to engender maximum benefits to the intended audience and to educate the client and the user and thereby create a more equitable future.</li> <li>f - Designing to use locally available materials and resources whenever possible (think globally but act locally).</li> <li>g - Designing modularly to encourage and allow sequential purchases, as required and according to financial availability, in order to facilitate repair and reuse and improve functionality.</li> <li>h - Designing to create more sustainable products, materials and services for a more sustainable future.</li> </ul> |
| 6    | Review the existing product market, including environmental and social features.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 7    | Developing a picture of the profile outlined by the environmental impact of the new product.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

| Step | Activities                                                                                                                                                                                                                                                                                                                             |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8    | Proceed to the development of the detailed concept and produce prototypes enabling testing under controlled conditions of safety, initially with adults and ensuring no hazard is presented by the prototypes when seeking to involve children in their use. (Note: at this stage children should be able to keep the prototype toys). |
| 9    | In this process the results of usability testing can motivate changes to the project description and a new iteration of design refinement and testing, reiterating until the development team is satisfied with the results or the resources allocated to the development have been exhausted.                                         |
| 10   | Development of production processes and of release, distribution, and marketing documentation.                                                                                                                                                                                                                                         |

**Table 4.** Methodology for the design of toys that promote awareness of environmental sustainability.

Starting from a methodology proposed for toy design with 8 steps (Table 2), a new methodology in 10 stages was proposed in Table 4, by agglutination of steps aimed at reducing environmental impacts and at promoting awareness of environmental sustainability. Environmental considerations were introduced in step 5 (which is new), in the sixth step (which was previously step 5) and in step 7 (new). The methodology for toy design presented is aimed at promoting awareness of environmental sustainability. This is based on a systematic design process, including steps to lead a process of sustainable design of toys with inclusion of actions meant to integrate themes closely linked to education for environmental sustainability.

**4.3. Toy design - 1**

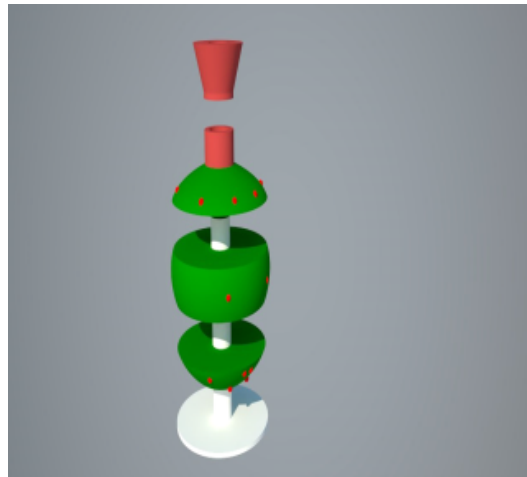
In applying the new methodology for the design of ecological toys, a concept was generated and implicitly chosen that underwent several iterations in order to adapt it and make it compatible with the safety requirements associated to these kinds of objects. The authors opted for the choice of children aged from 1 to 2 years, which is regarded as a phase of great sensory and cognitive development of the infant. The activity on which to focus the project on which the authors decided to implement the proposed methodology was the activity of fitting between parts, for which a preferred order is defined which will be a secondary challenge (the primary challenge is the realization of the fitting). In the project developed, authors also considered the learning activities leading to colours identification.

The authors considered several metaphors in the development of the project, having been incorporated in the foreseen interaction of the user with the toy, the fitting of cups and throwing rings into a pole, as well as a fruit tree.

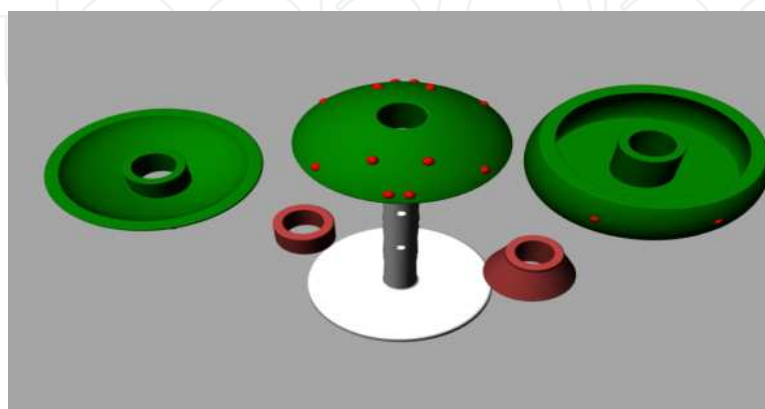
The initial concept renders are presented in Figures 1 and 2. After the smoothening of sharp edges was done, and after creating empty spaces to make the parts lighter and less bulky, the same concept evolved and gained the aspect that can be appreciated in Figures 3 to 5 (the smoothening of edges aimed at satisfaction of the requirements associated with safety against damage to kids made by themselves).



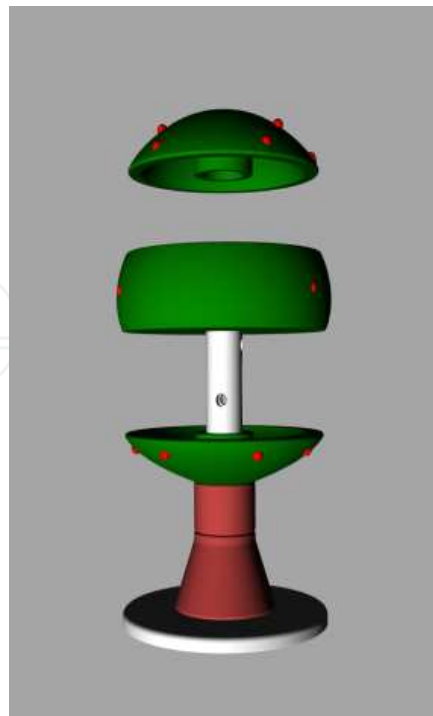
**Figure 1.** Initial concept renders (a) – toy design – 1.



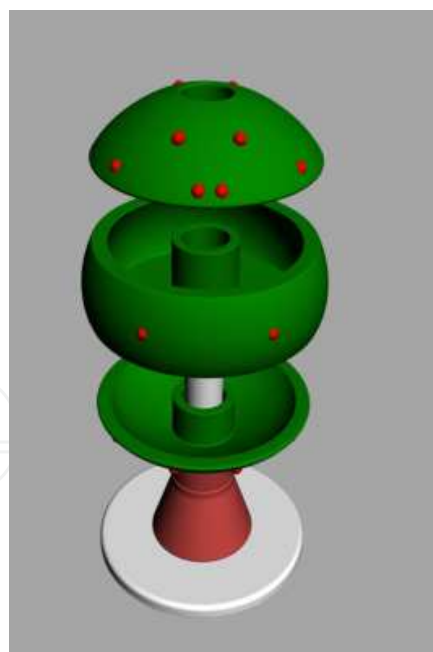
**Figure 2.** Initial concept renders (b) – toy design – 1.



**Figure 3.** Evolved concept (a) – toy design – 1.



**Figure 4.** Evolved concept (b) – toy design – 1.



**Figure 5.** Evolved concept (c) – toy design – 1.

For the actual manufacture of the toy it was decided to select a biodegradable material such as natural latex. This is a flexible material, it does not hurt upon hitting it suddenly and there is no risk of falling as toys are spread into the room. Its production is carried out by

moulding and casting, followed by curing in oven drying. For the colouring, non-toxic water-based pigments were chosen.

The prototype of the first design outcome of the project was produced by a three dimensional printing process (based on gypsum) and was made on a scale consistent with the capabilities and limitations of the 3D printer available to the authors. Figures 6 to 8 are images of the results of prototyping.



**Figure 6.** Model (a) of toy design – 1.



**Figure 7.** Model (b) of toy design – 1.





**Figure 8.** Model (c) of toy design – 1.

The first project aims to be an example of green design features due to its biodegradable material. It is also looking into cultivating small children's early sensibility to care for Nature and for our planet. Despite their young age, most child users are already able to recall small actions and replay them later.

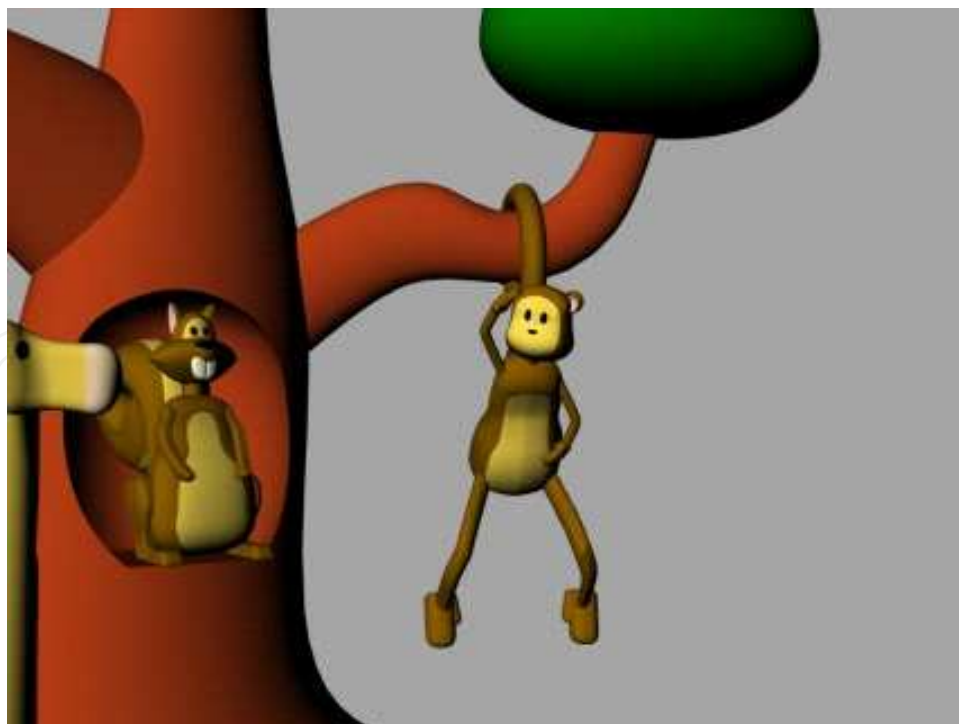
#### 4.4. Toy design - 2

The second project, which is based on methodology that aims at education for awareness of sustainability, incorporates the principles of respect for ecosystems and development of behaviour and values. This toy consists of a small tree that is inhabited by four different animals, and seeks to show that everyone is entitled to their space. Actions such as deforestation often cause the extinction of animal species and natural habitats, and as such, it is intended with this toy that the little kids become interested in the continuity of the planet.

According to the approach presented in Table 4, the authors proceeded with the development of project activities aiming to design a toy for children seeking the development of environmental awareness. The stage of cognitive development targeted was from 3 to 5 years and the activity triggered was the development of recommended levels of membership and association through stimulating of the recognition of the compatibility of symbiosis, including engagement between peers. For the generation of concepts, respecting ecosystems and recovering and developing values and behaviours such as mutual respect and commitment was specially taken into account. Over several drafts and sketches the authors explored various ideas for this project. The concept that came to be developed was based on the idea selected from among many ideas generated. The prototype was performed in 3D printing of high quality ceramic material. In the following images, the prototype is represented as image renders of the 3D model (Figures 9 and 10) and photographs of the prototype (Figures 11 and 12).



**Figure 9.** Render of concept (a) – toy design – 2.



**Figure 10.** Render of concept (b) – toy design – 2.



**Figure 11.** Model (a) of toy design – 2.



**Figure 12.** Model (b) of toy design – 2.

## 5. Conclusion and future work

In this chapter, design as a driver for education for environmental sustainability and the need for application of ecological concepts in the production of new products, in this case in what concerns toys, have resulted in the creation of new toy design methodologies.

The methodologies presented in this chapter were the result of a lengthy and elaborate research about early childhood education, environmental sustainability and sustainable development and of research on products already produced and which are available.

The methodologies for the design of toys and ecological design for education awareness for environmental sustainability are the result of an amalgamation of three methodologies, thus trying to bridge existing gaps in literature.

The chapter concludes with presentation of two toy projects that are expected to contribute to the aims set forth in the introduction.

In the process of assessing the design results for validation of the methodologies reached at, it is proposed for future work to conduct a survey collecting empirical data through questionnaires, which may give rise to the creation of empirical models relating the properties of objects created with the judgmental impressions of parents and other relatives of the child-users. In this way, one may determine if the methodologies proposed and implemented giving rise to the design of toys are effective towards attaining the objectives that guided their creation.

It is also proposed for future studies to carry out a test phase with prototypes embodied in latex, since the prototypes shown were made in gypsum, thus postponing the confirmation and analysis of the properties and the strength of the material proposed (latex).

## Acknowledgement

Parts of the research presented in this chapter were developed as part of the second author's Master of Science thesis in industrial design engineering, supervised by the first author.

## Author details

Denis A. Coelho and Sónia A. Fernandes

Universidade da Beira Interior, Portugal

## References

- [1] Evaristo, Teresa (2006). Educação para a Cidadania, Guião de Educação para a Sustentabilidade-Carta da Terra' [in Portuguese- Citizenship Education, Guidelines for Education for Sustainability- Earth Charter], Ed. Ministério da Educação, 39 pp
- [2] Fuad-Luke, Alastair (2004). 'The Eco-design Handbook', Thames & Hudson, 352 pp.

- [3] Mustard, F. (2000). Early childhood development: The base for a learning society', Chapter presented at the HRDC or OECD Meeting, December 7, in Ottawa, Canada.
- [4] Piaget, Jean and Inhelder, Barbel (1995). A Psicologia da Criança' [in Portuguese-'Citizenship Education, Guidelines for Education for Sustainability- Earth Charter'], 2nd ed. Porto: Edições Asa
- [5] Portuguese Ministry of Education- Ministério da Educação (2006). Educação para a Cidadania, Guião de Educação para a Sustentabilidade- Carta da Terra', Ed.: Ministério da Educação, Direcção-Geral de Inovação e de Desenvolvimento Curricular, 59 pp.
- [6] Rutter, M. (2002). The interplay of nature, nurture and developmental influences: The challenge ahead for mental health', Archives of General Psychiatry 59, (11), 996-1000.
- [7] Ryan, C. (2009). Design for Sustainability- a step-by-step Approach, Part II Chapter III A 'Quick-Start' approach to D4S, United Nations Environment Programme, Delft University of Technology.
- [8] Wallon, Henri (1981). A evolução psicológica da criança' [in Portuguese- The Psychology of the Child], Lisboa: Edições 70, , 144.

IntechOpen