

How to design for children

Methods and considerations for product attachment

Gunnar Eidsvik Tvedt
Department of Product Design
Norwegian University of Science and Technology

ABSTRACT

Products designed for young children are often unique in the way that they must appeal to humans at two very different stages of life. First they must get the attention or approval of the adult buyer, then maintain the attention of a rapidly developing child. This paper looks at the different factors such a product must inhibit to be successful for both parties. The focus is on how children experience objects compared to adults, and how one can intentionally try implementing emotional attachment in these objects. An evaluation of a traditional design process is then presented while emphasizing and explaining which stages should be prioritized and why.

KEYWORDS: Product attachment, children, parent, sustainability, design process

1. INTRODUCTION

There are several factors influencing how successful a product will be, some more obvious than others. Good design is often defined as pleasing aesthetics and smart solutions, but what makes us more attached to some products than others?

Statistics show that the global population is increasing rapidly with steadily growing birth rates. [1] More people means more products which also means higher production rates, more waste and increased emissions. With environmental alarm bells ringing louder and louder, industrial designers have a certain responsibility of designing for a more sustainable future. Embedding emotional attachment to a product might contribute to this goal. Using emotional attachment to create bonds between a user and an object will not only contribute to added personal value, but also most likely extend the lifetime of the object.

As measures are taken to create sustainable, recyclable products in a world rapidly growing with technology and efficient production methods, one might ask if the human aspect of affection is often lost in the process.

So how can we retrieve these “hidden” values? While many companies are starting to see the value of the designer’s role in a company structure, really understanding the user’s needs are becoming more relevant. For a product to be successful in ways that go beyond production methods and looks, these users must be incorporated from the very start of the product development.

Products made for children are in a category with room for improvement in terms of product life. Because the bodies and minds of young children are developing in such a pace, it is understandable that products are easily replaced. The question is how this can be avoided.

This article will first investigate how children interact with products and how they can be more attached to products with certain features and qualities. Further on, the process of identifying and implementing these qualities will be investigated and laid out as certain areas of focus. This will then be discussed by putting the parts together and looking at how they intertwine.

1.1 METHOD

This is a review article based on literature search and a project creating a sibling board for a baby stroller. This project was performed by myself for the company Stokke. The article and project have been completed in parallel. I have utilized this by using experiences and insights from the project to draw assumptions and conclusions in the article and vice versa. The base for the article is online literature and books related to how children see the world. The process of designing a new product for children will refer to my own experiences in Stokke, as well as additional literature review.

Both tasks are conducted as part of my degree in Industrial Design for the Norwegian University of Science and Technology in Trondheim.

Both this article and the Stokke project is focused on children in the age of 2-5 years. This is the age I will be referring to when children are mentioned in this article if not otherwise stated.

1.2 EMOTIONS

To implement certain emotions in a product requires an extensive understanding of the end user. One cannot expect every customer to act the same way, but knowing similarities and common factors among a group of key users is crucial.

According to Desmet, understanding how emotional responses to products are connected to aesthetical attributes in the product as well as

the end user experiencing the emotions is of high importance. [2]

“Designers, therefore, can only predict or manipulate the emotional impact of their designs when they are aware of the concerns of the particular person for whom they design these products.” [2]

Desmet also believes product emotions consist of three parameters; appraisal, concern and stimulus. These parameters and their interplay decides which emotion a product evokes.

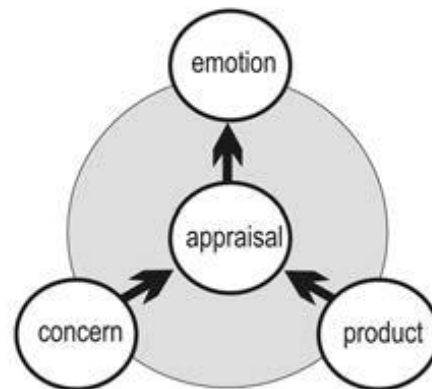


Figure 1: Basic model of product emotions

According to this model, emotions can be understood only by the person experiencing them. Desmet’s model is based on Frijda’s theory that behind every emotion there is a concern. The emotion is either beneficial or harmful to these concerns. [3]

“Why do I feel attracted to an umbrella? Because I have a concern for staying dry” [3]

This means that designers can only predict or manipulate emotions by understanding the concerns of the end user.

2. WHAT MAKES A PRODUCT APPEALING

When a child acquires a product, often this product is selected by a parent or another grown up. This means that the child will not always have

a say and can only react to the choice made by the person selecting the product. Based on this insight, a company developing products for children must choose a strategy on how to approach its target market segment. This approach must appeal to both child and parent.

2.1 Appeal

An appealing product is a product that communicates with people in a way that they can or wish to relate to. According to the Oxford dictionary, appeal is defined as “A quality that causes people to like someone or something”. [4]

Hassenzahl explains a user’s confrontation with an object as a process. When the user first senses the object, a first impression of the product character is constructed. This impression is the user’s own interpretation of the intended characteristic made by the designer. The next step will tie the apparent character of the product to the user’s current situation which leads to consequences. These consequences include a judgement of the momentary appeal of the product. [5]

“Appealingness weights and integrates perceptions of product attributes by taking particular situations (i.e., contexts) into account” [5]

The appeal of a product is very subjective. According to Hassenzahl, appeal is achieved if a product triggers positive emotional reactions in a person. He also states that appeal is made up from a group of a product’s attributes such as how attractive, sympathetic, pleasant, motivating, desirable and inviting it is. This makes it hard to design a product with a specific kind of appeal, as it will not attract people in one specific way. Since children will experience the appeal of something based on their own perception of these attributes, provoking the same reactions from adults will be a challenge. A product can however be appealing for the adult through the reactions of the child. If the child loves a product, the parent is more likely to be happy with it as

well, hence triggering positive emotions and a sense of appeal.

2.2 Aesthetics

To describe aesthetics for both children and adults, two separate interpretations must be used. Adults rely mostly on visual qualities while children make more use of physical attributes to decide what is aesthetically pleasing.

To give a better understanding, Alexander von Baumgarten’s three dimensions of aesthetics from “Aesthetica” (1750) can be used.

1. Aesthetics as general theory of beauty
2. Aesthetics as philosophy of art
3. Aesthetics as theory of sensual recognition and experiences [6]

An adults sense of aesthetics can be categorized as a general theory of beauty. This will be representative of the common use of the expression as a sense of visual satisfaction. Likewise, a child’s sense of aesthetic quality can be categorized as a theory of sensual recognition and experiences. This is because children find it harder to identify objects by the looks of it, simply because they know less about its context or function. This is why children have to rely on several sensual impressions to get a grasp of the attractiveness of a certain object. Touch and taste are often as important in this phase as the pure visual impression. These impressions will build up a knowledge of a certain object’s attributes, which later on can be distinguished by simply recognizing the looks of it. This is knowledge adults have previously built up the same way, which is why they are able to often gather the needed information from a product just by looking at it.

2.3 Affordance

J.J. Gibson introduced the term affordance as an object’s property of conveying information on how people can interact with it. This term was later taken on by Donald Norman who used it as a term to explain good design. Affordance refers

to the relationship between a physical object and a person or an agent. The presence of affordance is therefore decided by the quality of the object and the abilities of the agent. For example, a chair affords sitting, but it also affords lifting for people possessing the strength or ability to do so. However, if a person is unable to lift the chair, for that person the chair does not afford lifting. [7]

The term affordance also explains how children interact with objects. Because affordance is perceived by the user, this will build on previous experiences. For instance, a child that has never seen a ball will not necessarily think that it affords throwing. The child might as well try eating it.

To help people understand the possible ways of interacting with an object, Donald Norman also introduces signifiers. [7] Signifiers lets you know where to interact with the object. The screen of a smartphone affords touching, while signifiers tell you where to touch. Clever use of signifiers can be a valuable asset for creating products for children, as it can help them learn and understand the product's affordance.

3. WHAT GIVES A PRODUCT VALUE

"Value is the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given" [8]

3.1 Value

The value of a product is not decided by appeal and aesthetics alone. Think of that ugly fridge magnet you might have gotten in Greece a while back. Objects like these have no other obvious purpose than decoration, but are made to contain memories. This gives them a sentimental value. If an object attains sentimental value, it gets harder to let go of. You keep souvenirs like this around to remind you of that beautiful vacation when everything was perfect and worries were gone. Symbolic values like these makes the object representing them more

valuable than many other everyday items. A similar example could be used for wedding rings.

Sentimental values are also often found in children's objects. As children grow older they tend to hold onto certain objects that are treasured more than others. This will over time create memories that makes the object seem difficult to do without or get rid of. Teddy bears are regular items that create these bonds. For parents, this is also relevant because it ties the object to certain stages of the child's early years.

The pure function and quality of an object can also create value. Objects that simply do what they are supposed to over and over again are prone to create a connection to the user. If this object would eventually break, one will be likely to repair it instead of getting a new, similar object.

Another common factor of value is attained by desire. A person is often happier with a product that person desires to own, regardless of how well the product performs. This desire is often connected to such things as a higher price tag than similar products, branding or limited availability.

Gathering these arguments, it can be said that products of great value to the user are more likely to be passed on or kept for longer than other products. By consciously taking on this approach, a company could gain back the possible losses of less sales and higher production costs by making a franchise based on quality products with a higher price tag. This is usually the case with "premium products". If the right materials are used, this approach would also contribute to the environment in terms of disregarding the consumerism and quantum mentality often taken on by cheaper products.

"A user's perception of value represents a tradeoff between the quality or benefits they perceive in the product relative to the sacrifice they perceive by paying the price." [9]

An example of a product designed for a long life is the Stokke Tripp Trapp chair. The concept of the Tripp Trapp is to “grow with the child”, which means that it adapts as the child grows bigger. It can even be used by adults. This is done by creating a modular design allowing users to change the height of the seat and footrest, as well as the ability to clip on infant seats and food trays. These features make the chair part of the everyday life of a family, ideally for several years. This (if done well) ties connections between the product and user, which adds emotional values and an appreciation of the perceived quality. Products like these are seldom thrown away, and are likely to be passed on to the next generation when no longer needed. In fact, the Tripp Trapp’s biggest direct market competitor is the passing on of itself! [10]



Figure 2 : Stokke Tripp Trapp chair

4. HOW CHILDREN SEE THE WORLD

Imagine you were 1-2 years old again. How did you see the world? Most people cannot remember what it was like crawling around and taking their first steps while constantly trying to make sense of their surroundings. Regardless, this period in life creates a huge amount of memories in a very short time. These memories are transformed to skills and context based behavior which we constantly use in everyday life as an adult, even though we do not notice it. [11]

4.1 Conceptual models

In his book “The Design of Everyday Things”, Donald Norman talks about mental conceptual models. [7] These are models we create of an object based on previous experiences and a certain expectation of how that object behaves. To create such a mental model, affordance and signifiers come into play. As an example, headphones consist of two channels of sound. These are connected to separate speakers bound together by a headband. Because we know headphones are made to emit sound, the obvious thing would be to place them on your ears. The headband is an affordance as it allows the headphones to be worn on your head, where the earmuffs act as signifiers showing that the device should be covering your ears. As music is often recorded in stereo, the tracks have a left and right channel. This means that even though the headphones will work whichever way you place them, there is a right and left earmuff. This is often marked with yet another signifier telling you which way to put them on. As an adult, all this information makes for a pretty clear conceptual model of how the product should behave and how to use it.

When do children start forming conceptual models? Maureen A. Callanan investigates how parents influence the child’s ability to categorize objects through means of communication. [12] As our knowledge of objects are based on our perception of similarity, this categorization is essential for being able to recognize new objects and form anticipations through conceptual models. According to Callanan, children already have the ability to categorize objects on a basic level during infancy. To understand the hierarchy of objects and categories however, would be more dependent on the environment the child is brought into. This is a skill that may be learned faster and more efficiently depending on how the parent is labeling different objects for the child to understand. By sentences like “This is a car. A car is a vehicle” the child will eventually be able to distinguish the name of the object and the name of the superordinate category. As the child then

learn how a car behaves, it will start creating a conceptual model of how cars and eventually vehicles in general interact with the world.

4.2 Sensing

Classically, humans are said to have 5 senses; vision, touch, hearing, olfaction and taste. These senses help us experience the world around us, evolve and gain experiences. To be able to generate a sensual experience, a person must first generate a sensual impression. This impression is then processed in the brain to create an experience. Because adults have been through this process over and over, they recognize things through different forms, textures, sounds, smells and tastes. In most cases adults don't even have to use other senses than their vision. This is because a grown up person has created memories of what the world and a number of its objects and substances feel like. You no longer have to touch a piece of metal and a piece of wood to know that the metal will have a smoother surface. Likewise, when you see a specific kind of food, you can imagine what it tastes like. [11]

Children do not yet have these memories, hence they have to build up a certain collection of sensual experiences to be able to differentiate and recognize certain objects. As a child develops, this is done by the use of several senses. When a child is born, its eyesight is poor and does not fully develop until the age of approximately two years. This means that other senses, such as touch and taste are more useful for the child to understand the world, and therefore also more used in its first years. During childhood, the shift of focus changes as the child learns that certain things are not for tasting and other things are not for touching. [11]

4.3 Children's interaction with objects

When a child first starts developing sensory and motor skills, it is by exploring its own body and surroundings. Children are often prone to mimic

the behavior of adults. Research shows that sensual impressions of a movement is processed in the brain by the same section that is stimulated when performing a similar movement. This may therefore be looked upon as a center of intense development when interaction with the outside world starts. [13]

When confidence rises, the child starts to practice these skills by manipulating objects. This leads to further sense of accomplishment which is important for the child to experiment with more challenging tasks later on. Classic examples of more challenging tasks would be games such as fitting different shapes in the right hole and stacking building blocks.

Usually, this process of learning is seen as play. A child playing is often a child learning how to interact with the world. That is why play is such an important part of growing up. [14]

5. THE DESIGN PROCESS

A good design process is often the recipe for a well reflected final product. A design process is a methodical approach to problem solving. While guidelines exist, the process itself tend to be largely a matter of subject. The common denominator is that a problem eventually turns into a solution, while the steps in between will vary. A design process can be broken down to a loop of three steps; Ideate – Implement – Test.

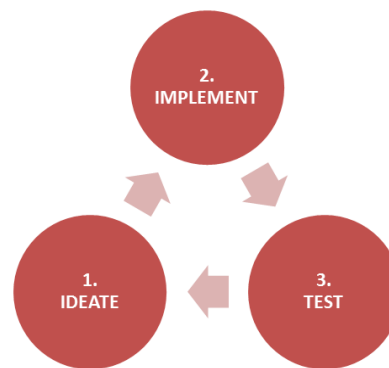


Figure 3: Basic steps of a design process

When an idea is created, this idea must be implemented in some way. Afterwards the designer or the team should evaluate the results of the implementation by testing. During this testing, new ideas will usually appear and the loop continues. Because the steps will often be repeated several times, the design process is seen as an iterative process. [15]

Based on literature review done in this paper and my own experiences designing for children with Stokke, I will elaborate three sub steps of such a process. These are steps I find particularly important when designing for children.

5.1 Design research

According to Haakon and Trygve Faste, research is generally defined as a systematic investigation that establishes novel facts, solves new or existing problems, proves new ideas, or develops new theories. [16] By doing traditional research, the mission tends to be finding solutions to well-defined problems. Research as part of the design process will on the other hand have the purpose of gaining a broader understanding of the problem at hand.

When designing a new product, gaining knowledge on similar existing products and understanding the reason why these products exist is crucial. This should also uncover why people would choose to buy your product over others when released to the market.

To find a good solution, it is important to acquire a solid understanding of the problem. That may involve talking to people who experience the problem or people that have general insight in connected areas. In the case of designing for children, parents are often good sources of information. They will have a general understanding of what their child likes and dislikes but can also provide their own preferences when dealing with products meant for the child. However, their thoughts on what

the child wants must be indicators rather than facts. It is important to remember that for a child to attain a certain product, it must first be approved and evaluated by its parent. Information on parent's considerations and thoughts on buying these products may therefore be of great value. Children's opinions are naturally of great importance as well. Making conversation with children can uncover preferences and trends towards certain features and qualities.

If possible, research should in addition include observatory insights. Ideally these observations will be made in settings as natural for the person observed as possible. This can uncover product related problems the user is not aware of because of habits and preconceptions. It may also uncover patterns of action that can be relevant when developing new products.

5.2 Physical models

As products are objects in space, they have tactile, physical and materialistic qualities that are hard to visualize without interacting with them. Adults can as mentioned often make assumptions based on similar products, but in most cases this is not sufficient for a proper understanding. A good way of working on products is to make several mock ups to gain knowledge on the spatial qualities of the object. As this is what first meets the eye, form and shape makes solid first impressions and start the process of our individual perception of the object. Because this visual impact will not necessarily have the same effect on children, prototypes purely exploring shape and size will not be adequate. Several stages of models must be created to give a good impression of how the product will appear and behave, but also which reactions it will cause amongst its target group.

In a research article by V.K. Viswanathan and J.S. Linsey, the value of using physical models in the idea generation phase was investigated. A number of people were instructed to solve a problem based on either sketching or making

rough physical models. The results showed that the groups basing their work on making models ended up having a larger amount of useful, working solutions to the problem. They concluded by stating that the use of physical models help the designer overcome the flaws of their mental models. [17]

When something needs testing, physical models usually rise to the level of a prototype. A prototype is an early sample or model of a product made with the intent to test a concept or process. Prototypes are quick ways of learning how a more developed model will behave and are therefore useful as a method of testing an unfinished product. Prototypes are often based on functionality, which makes them valuable when creating new mechanisms or testing such things as ergonomics, size, shape, possibilities and strength. [18]

An effective way of potentially grabbing the attention of a child is by the use of colors and familiar shapes. As mentioned, recognizable shapes will be limited to that of other objects the child has interacted with or otherwise observed. When the time has come, such aesthetical features can be experimented with and tested in more refined models. These models should be made after the functionality is tested properly to make sure form follows function.

5.3 User testing

Designers make products for other people to interact with. To predict how another person will interact with a product or which thoughts run through this person's head is hard, if not impossible. Designers make a lot of predictions based on research, experience and personal preferences, but to really get a grasp of how an object will be interacted with, possible end users must be involved. During the research phase, a user group should be stated to limit your possibilities and focus your actions. When user testing, an important element is to find people fitting the descriptions of this target group. It is also important that these people have no

previous experience with your product, and that you have not given any explanations on how to interact with and use the product beyond what needs to be known. This is to ensure the reactions and impressions are genuine and experienced for the first time.

During my time spent with Stokke, I based a lot of choices and decisions on the responses I got from user testing. Even though this approach can be quite tedious and unpredictable when designing for children, I found it very rewarding. Compared to adults, children can be difficult to involve in such a process in a number of ways:

- Children are in general easily distracted, which can make it hard to direct their attention to your product.
- Children are unlikely to give any analytical feedback, which means you will have to rely on their reactions and behavior to judge whether or not they are pleased with your product.
- Children have not yet gained the same experience as adults. This means that the designer needs to be careful before drawing conclusions as to what will happen when the child approaches and interacts with the product.
- If the child is not comfortable around you, the test would usually not be successful. This is because the child might not have the confidence to act like he or she would normally do in "safer" and more familiar settings.

To overcome these challenges, one must be aware of them. I experienced both children completely refusing to test my product and children that could not get enough of it. It is of course highly individual how the child will react, but some measures can be taken to better your chances:

- Spend some time before the test talking to the child. Asking the right questions might make them open up and become more confident in you.
- Let both parent and child know the purpose of the test. It is not the child that is tested but the product.
- Prepare beforehand to avoid spending time setting things up, adjusting and fine tuning your product while your test users are waiting. This can cause impatience and lack of focus.
- Perform the test in environments known to the child. If the child is familiar with the surroundings, the child might pay more attention to you.
- Be quick and effective while performing the test. Children are easily bored.

5. DISCUSSION

Through writing this article and performing the project for Stokke, it is clear to me that designing for children needs a modified approach compared to the classic process when designing for adults. However, such an approach could be universal. When doing searches for literature I have not been able to find much on the process of doing so, which might mean that this is an area that needs more focus. After all, children and adults do not have the same prerequisites for interacting with products.

Implementing a strategy that focuses more on understanding, interacting with and facilitating the subject at hand can be used for both children and adults. Especially when designing for children this will be elemental, as it can be harder to predict how they feel and what they care about. As mentioned earlier, a children's product must not only appeal to the child. If it does not also appeal to the person buying the product, chances are it will not be sold. Performing user tests with

children will also mean interacting with the parents, which effectively gives you feedback from both parties. This is why it is important to note the behavior of both the adult and child even if the testing is meant for the child. It can be argued that parents sometimes have too much of an influence on the child's decisions in such tests, but this is a compromise that is hard to get around. If this is a major issue, separate tests must be done for both parent and child.

By performing my research and project I have noted that product attachment and user interaction in the design process is closely related. To achieve a greater sense of what is required and expected of a product, regular contact with target users should be incorporated in all stages of the process:

- By interviewing relevant sources during the research phase, this input will be considered in the ideation phase which again will result in more useable ideas and concepts.
- While implementing ideas into models and prototypes, continuous feedback from users can make you focus on the right areas and differentiate good from decent.
- By testing a physical model on target users, valuable feedback and insight will be obtained and a new ideation phase can be engaged.

Picking a realistic number of the most relevant test users will, if implemented right, give insight and results far beyond consulting with colleagues and drawing conclusions based on assumptions.

The implementation of features and qualities to make a product more attractive to child and parent is often divided. The parent will always have certain requirements that the child in most cases would ignore. These are often based on safety, price and practicality. For the child, properties such as color, tactility and shape will

be more appreciated. The secret to prolonging the life of such a product will therefore mean making careful choices on which compromises to make and for whom these consequences will matter the most. It is also important when considering this lifetime that the child will go through rapid changes of interest, which gives less room for targeting specific ages. This will also exclude certain products from such objectives.

5. CONCLUSIONS

Product attachment is a result of several successive factors. These factors will be largely based on usability, longevity and sentimental value. If these factors are considered separately for adult and child a list of requirements can be made:

Adult/parent:

Usability

- Practical
- Reliable
- Convenient

Longevity

- Rigid

Sentimental

- Create memories

Child:

Usability

- Fun
- Understandable
- Challenging

Longevity

- Evolving/modular/timeless
- Form habits

Sentimental

- Create memories

If most of these attributes are incorporated successfully in a product, chances are it will create attachments at some level. The feasibility and form of incorporation will vary in terms of product type, and there is no way to make a blueprint for all children's products.

To conclude, the element of user involvement during the design process is key for creating a long lasting product with bonds to the user. The challenge here will be for a company to invest time and money to implement such a tedious process into their product development.

For further development on the subject, such methods must be proven to be effective. This will cause both people and companies to recognize the positive effects and support each other in the ever important battle against early disposal and bad design

REFERENCES

- [1] Prb.org. (2016). Human Population: Population Growth. [online] Available at: <http://www.prb.org/Publications/Lesson-Plans/HumanPopulation/PopulationGrowth.aspx> [Accessed 02 Oct. 2016].
- [2] Desmet, P. M. A., Hekkert, P., & Hillen, M. G. (2004). Values and emotions; an empirical investigation in the relationship between emotional responses to products and human values. In: Proceedings of Techné: Design Wisdom 5th European Academy of Design conference, Barcelona, Spain.
- [3] Frijda, N.H. (1986). The emotions. *Cambridge: Cambridge University Press*
- [4] Merriam-webster.com. (2016). Definition of APPEAL. [online] Available at:

<https://www.merriam-webster.com/dictionary/appeal> [Accessed 20 Nov. 2016].

- [5] Hassenzahl, M. (2003). The thing and I: understanding the relationship between user and product. In *Funology* (pp. 31-42). Springer Netherlands.
- [6] Guyer, P. (2016). 18th Century German Aesthetics. [online] Plato.stanford.edu. Available at: <https://plato.stanford.edu/entries/aesthetics-18th-german/> [Accessed 10 Nov. 2016].
- [7] Norman, D. (2002) *Design of Everyday Things*. MIT Press: London, England.
- [8] Zeithaml, V. A. (1988). Consumer perceptions of price, quality, and value: a means-end model and synthesis of evidence. *The Journal of marketing*, 2-22.
- [9] Grewal, D., Monroe, K. B., & Krishnan, R. (1998). The effects of price-comparison advertising on buyers' perceptions of acquisition value, transaction value, and behavioral intentions. *The Journal of Marketing*, 46-59.
- [10] Stokke. (2016). The original Tripp Trapp® high chair for babies, from Stokke. [online] Available at: <https://www.stokke.com/GBR/en-gb/highchairs/tripp-trapp/1001.html#functions> [Accessed 21 Sep. 2016].
- [11] Tinmannsvik, L. (2007). Children and Aesthetics - Exploring toddlers' aesthetic experience of everyday products, *Artikkelsamling PD9 fordypping*.
- [12] Callanan, M. A. (1985). How parents label objects for young children: The role of input in the acquisition of category hierarchies. *Child Development*, 508-523.
- [13] Arvema.com. (2016). *Rudolf Steinerhøyskolen – Lærerlinjen*. [online] Available at: <http://arvema.com/tekster/am-kropp-sanser.htm> [Accessed 17 Oct. 2016].
- [14] Mæhlum, T. K. (2012). *Medisign for Toddlers Sensory Product Experience in Hospital Care, Artikkelsamling PD9 fordypping*.
- [15] Curriculum.vexrobotics.com. (2016). 1.3: What is the Engineering Design Process?. [online] Available at: <http://curriculum.vexrobotics.com/curriculum/intro-to-engineering/what-is-the-engineering-design-process> [Accessed 12 Dec. 2016].
- [16] Faste, H., Faste, T. (2012) Demystifying “Design Research”: Design is not research, research is design. *IDSA Education Symposium 2012*
- [17] Viswanathan VK, Linsey JS. (2009) Enhancing student innovation: Physical models in the idea generation process. *Frontiers in education conference*. San Antonio, Texas.
- [18] Blackwell, A. H., Manar, E. (2015). *Prototype. UXL Encyclopedia of Science (3rd edition)*

FIGURES

Figure 1: Desmet, P. M. A., Hekkert, P., & Hillen, M. G. (2004). Values and emotions; an empirical investigation in the relationship between emotional responses to products and human values. In: *Proceedings of Techné: Design Wisdom 5th European Academy of Design conference*, Barcelona, Spain.

Figure 2: Stokke. (2016). *The original Tripp Trapp® high chair for babies, from Stokke*. [online] Available at: <https://www.stokke.com/GBR/en-gb/highchairs/tripp-trapp/1001.html#functions>

Figure 3: Curriculum.vexrobotics.com. (2016). 1.3: *What is the Engineering Design Process?*. [online] Available at: <http://curriculum.vexrobotics.com/curriculum/intro-to-engineering/what-is-the-engineering-design-process> [Accessed 12 Dec. 2016].