Creative Paper Recycling

*An Interaction Design Endeavor toward Developing Eco-ethical Culture Amongst After-school Children*

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Abstract:

With the intention of empowering children and guiding them towards sustainable habits at an early age, the empirical findings in the chosen international school pointed towards a heavy use of paper. A study was carried out to understand the various factors related to paper use. Interviews, experiments and workshops were conducted to probe further into the variety of insights that were gathered.

The scope of the project was to use interaction design techniques to understand and address the issues through creating small design interventions using three main strategies of a) placing appropriate affordances, b) designing for transparency and hence creating awareness of the use of resources, and c) by attempting to instill a culture through direct involvement that supports eco-ethics.

An effort was made to conceptualize and design an artifact that was in line with the mood and disposition of the specified section of the school. A metaphorical concept prototype was created to test the effect of the proposed artifact. Moreover, the overall culture of the school affected the behavioral patterns and hence a separate strategy was employed to address the awareness in the entire institution.
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Disclaimer: Please note that the author of this document has the permission from all the parents of the children to publish their pictures in this thesis purely for academic purposes. However, unauthorized copying and republishing of these pictures shall be considered unlawful and may be subject to prosecution.
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1. Introduction:

Creative paper recycling and paper-making

“We are obliged to act…as intelligently as possible in a world in which…we know very little, in which, even if the experts know more than we do, we have no way of knowing which expert knows the most. In other words, we are obliged to live out our lives thinking, acting, judging based on the most fragmentary and uncertain and temporary information”. - Holt, 1970

There are many layers to sustainable behavior. There is also a lot of information regarding eco-friendly behavior that is ambiguous and debatable. It has been observed so far that it is difficult to bring behavior change by separately providing environmental information and education about sustainability. This view has been supported by Holt (1970).

Learning about practical issues is related to reality as it presents itself. Learning is an active process and hence it is important to establish the crucial link between the generalized sense of environment and specific daily actions. To be able to achieve the goals towards sustainable behavior change and developing an eco-ethical culture it is important to focus on how people connect their lives to the environment. As an example Holt (1970) points at the way, young children relate to their environment. In his opinion, children built a mental model of the world according to the reality as it presents itself to him and continually checks it, tears it down modifies it or rebuilds it as necessary based on the circumstances.

The focus of my observation in this thesis is children in the Fritids (Swedish term for recreational activities or an after-school program in reference to a school) environment of a school. The behavior of these children is based on the culture around them; hence, their understanding and habits will be cultivated from all the factors surrounding them. A study was undertaken to understand this environment and based on insights from workshops and empirical findings, a child friendly machine prototype was designed with a special focus to involve children to recycle waste paper into exclusive art paper that supported the fun and creative milieu of the Fritids.

Please note that this project is not just about paper recycling but mainly addresses an interaction design based hypothesis towards the overall goal of sustainability which is more than just recycling. Nonetheless, within the chosen design context and the milieu of the after-school (Fritids) section of the school appropriated an artifact that recycled paper.
1.2 The Research Question:

Designing for Transparency

My research question is … how can we embed the culture of sustainability in children through design of eco-ethical artefacts.

Behaviour change towards the goal of sustainability is a daunting task. A variety of approaches has been adapted to tackle the issue. In the capacity of a designer, it is possible to create artefacts that enable interactions to correct the behaviour of the user rather than trying to change it.

I would like to give some examples from the affordance theory that are designed in artefacts towards the goal of sustainable behaviour and thereafter place my argument in the landscape of these theories.

The theory of affordances as outlined by the ecological psychologist James Gibson (1979, pp.127-143) and developed by Donald Norman (1988, pp.9-11), focuses primarily on user perceptions of the affordances available to them, and culminates as to how a designer can improve product and interface usability by understanding this aspect of design. For example, Norman (1988, through Lockton, Harrison and Stanton 2008, pp.3) describes “various behavior-shaping constrained affordances by making it impossible or difficult to proceed until the error is corrected; in a sustainable engineering context these can be compared to the Japanese mistake proofing technique; these can allow ‘inefficient’ operating procedures to be prevented. For example, automatic lighting and water taps that only operate when a user is present. Moreover, light fittings can be designed to only fit approved low-energy components.”

On the other hand, Lockton, Harrison and Stanton (2008, pp.5) propose in “Making the user more efficient” that to be able to create eco-ethical affordances, “it is imperative to involve the planning and strategic manipulation of the affordances of a system”. This means, by consciously thinking about the actions or functions, which are offered or presented to the users. That is by “making things visible” (Norman, 1988, pp.99) for the user to be able to consider the possibilities provided by the system. In this way of creating eco-ethical affordances, it is the manner in which the affordances of a system are presented to the users, and in which possible actions are made more prominent. For example, devices where unnecessary or excessive energy and water use are very common, such as electric kettles, could require users to make a choice about the amount of water that needs to be heated before starting. In many cases, as explained by Lockton, Harrison and Stanton (2008, pp.5) “extremely simple information and descriptive feedback or easily visible markings or calibrations on a product have the potential to make it easier for users to be more efficient. Electric kettles marked in ‘cups’ or ‘mugs’ in addition to milliliters’ and fluid ounces would seem to make it easier for users to fill up the correct amount of water for the task.”
In some cases, first the user is presented the affordance to encourage an eco-ethical behavior and as a default setting, the constraint kicks in if the user does not make the eco-ethical choice. For example, toilet flushes that have the option of half and full tank to save water maybe can also recommend the suitable option by sensing how soiled the toilet pot is. In case of motion censored toilet flushes - by adding a constrained affordance that will draw only so much water by additionally sensing how soiled the pot is.

In all of the above strategies, it is perhaps the intelligence of the design that guides the user to be eco-ethical. In other words, the user is led by hand and guided to be eco-ethical, however he does not always participate actively. Not always through his willingness and his knowledge. The user himself thus becomes passive, maybe even a puppet in the hands of a designer. This may help the overall goal of sustainability, however my argument to these strategies of design is that conscious behavior change is possible only if the design simultaneously also explains the overall history and a “complete why”. It is important to empower the user with the knowledge of eco-ethics if they are also expected to be the ambassadors into developing an eco-ethical culture. For example, if in case of an electric kettle the eco-ethical affordance is presented to the users by marking ‘cups’ to use the water correctly, it can additionally also present the information of the use of electrical energy in heating the water. This tiny bit extra information makes the process transparent to the user and the choice hence made is based on both knowledge and responsibility. The user is consequently, not just guided to an eco-ethical behavior but empowered with the knowledge of why he should behave in an eco-ethical manner.

The Merriam Webster online dictionary defines the term “transparent” as follows:
1a : having the property of transmitting light without appreciable scattering so that bodies lying beyond are seen clearly : pellucid : allowing the passage of a specified form of radiation (as X-rays or ultraviolet light) b : fine or sheer enough to be seen through : diaphanous
2a : free from pretense or deceit : frank b : easily detected or seen through : obvious c : readily understood d : characterized by visibility or accessibility of information especially concerning business practices
I use the term transparent; especially in the context of making the “process obvious” (Merriam Webster definition 2b) to the user. I propose that the designer must be sensitive to both the user needs and the responsibility to cultivate an eco-centric culture. Hence, the designer through his design should be able to nudge the user to interact with the artifact in a manner so that the eco-culture seeps into the day-to-day life styles. This attitude of design of building knowledge of sustainability by creating transparency of processes has a special relevance towards embedding eco-ethical culture at an early age in children, which is the focus of my study.

1.3 What is eco-ethical?

The term “ethics” is usually referred to as standards or rules of right conduct. In environmental philosophy however, philosopher and cultural ecologist Abram D. (2006) also the founder of “The Alliance for Wild Ethics” explains the term “ethics” as, “it is more to do with an attentive openness toward the manifold beings that compose the living world”. Although David’s use of this term is with reference to the living world, he also furthermore philosophizes the contents of the world as, “While the rational intellect may view the world as a set of inert objects and mechanical processes, to our sensing and sentient bodies the earth presents itself less as a collection of inanimate objects than as a dynamic collective of animate subjects.” He says, “our full-bodied awareness encounters the world around us as a tangle of elemental powers – even as a complexly entwined society of beings, with each being exerting its own active influence upon those around it.” In his opinion, “Every entity – whether oak tree or thundercloud, raven, river or rock – seems to have its own agency, its own spontaneity, its own enigmatic life. To our most direct, bodily experience, every aspect of the world is alive” (Abram, 2006 AWE).

In the light of this theory, the non-living objects are regarded with the same level of attentive openness as the ethics or the rules of conduct between the living beings.

Environmental ethics or eco-ethics are terms described in environmental philosophy (Online Wikipedia), which extends the boundaries of human conduct with the non-human world, i.e. the ecology. The ecological system typically consists of a biological (living) community together with its abiotic environment, interacting as a system. “Ecosystems are defined by the network on interactions among organisms, and between organisms and their environment. They are linked together through nutrient cycle and energy flow” (Online Wikipedia). Researcher Kinne (2003) from the Eco-Ethics International Union, describes the concept of eco-ethics as, “human thought and conduct to what is beneficial or destructive for the total ecological system.”

In my argument of “designing for transparency”, this term of eco-ethics is especially relevant as an effort is made to develop a culture of responsibility in everyday actions and hence develop a positive human conduct towards the ecology. The understanding of eco-ethics and the responsibility attached with it has special connotation when striving to ingrain an eco-centric culture amongst children. A distinct understanding of eco-ethics is hence crucial to bring about the knowledge and empowerment within this age group.
2. Preliminary Studies

In this section, I address the motivations for my choice of the target group of children between the ages of 6-9 years and my choice of the Fritids section of the chosen school as my design context.

I take you through a journey of my understanding of the school culture, the environment and the background of parents and students. It is interesting to observe a plethora of social and cultural diversity converge into a single institution. The active involvement of parents in both the school and the Fritids environment is another important factor, which sets the school apart. The unique IB league of teaching methodology also determines the way I ought to address this age group of children within the design context.

These understandings become an essential backdrop for developing a user sensitive design.
2.1 Motivations for selecting children as the target group:

I have chosen to work with children in this project as my target audience because there has been evidence and insights from my professional experience in the advertising industry of the potential that children present in influencing and resonating their choices on adults. I would like to draw this analogy from my earlier profession and try to use interaction design methodologies through selecting this target group.

Soni and Upadhyay (2007, pp. 313) talk about the “Pester Power effect of Advertising” and how children have been a major influence in marketing products. According to them, “children influence family purchases ranging from cereals to handhelds. Companies have often targeted the juveniles to become their marketing vehicles.” In advertising industry, the term that is often in use is “Kidfluence” and “Pester Power”. Advertisers and marketers not only find in children the potential of pestering parents to enforce their current brand preferences, but also see them as early adopters and build brand loyalists by “catching them young”. “One can hence imagine the vast untapped potential that lies hitherto” (Soni and Upadhyay, 2007).

Moreover, the children of today might be direct recipients of the consequences of their own unsustainable habits in the years to come, hence, in my opinion it is vital to involve them in this behavioral change.

According to the Social Policy Report (2005, p.17), the age group of 6-9 years is considered to be very responsive and receptive in the developmental cycle of children. Often referred as the “Incredible years”, these formative years of a child are important to determine future behaviors.

An effort is hence made in this project to understand the psychology of this age group. McKenzie-Mohr (2000) in their article “Promoting Sustainable Behavior” suggest that, “Children perceive objects and environments around them differently from adults. The development of their understanding is intuitive and passive. They often do not like to be told what to do, but if the environment playfully inspires them into a desired action, there may be a possibility to make an impression on them. Where advertising/marketing efforts alone may have failed to appeal perhaps, a manipulative approach may be required to instill good sustainable habits at an early age.”
2.2 The Design Context:

An International school based in Malmö, Sweden has been the reference to my empirical observations and ethnographic studies. My area of focus was the Fritids section of the school with children in the age group of 6-10 years. The school under observation is unique in many ways; the culture of the school weighs a heavy influence on children’s behaviour. Hence, it was important to understand the overall philosophy and practices of the school.

Bladins International is an IB (International Baccalaureate) league school that especially caters to the needs of globally mobile students. The medium of learning is English.

Bladins International operates under a foundation governed by a board composed of parents. The school encourages parent involvement to support their children’s education through involvement in classroom activities, in the PA (Parents Association) and in the Board.

The school places high emphasis on an all-round development and growth of students in terms of emotional, intellectual, physical and moral potentials.

The IB curriculum is designed so that the school encourages ethical attitudes towards work and social relations. They provide environment that supports a culture to think and act critically, creatively and independently. Students learn how to learn, discover the joy of learning and develop the capacity to solve problems independently. Besides, the school grooms the students to be responsible individuals in society, to respect the value of others, and just as importantly, have high personal values.

The background of the children and parents is eclectic; they come from a variety of countries and cultures, and have multilingual parents. Most children as a result would be acquainted with at least three languages. The constant and heavy flux of students is another unique factor of this school.

2.2.1 Practiced ideals:

The school has many interesting attitudes that support creativity and sustainability. I noticed the use of natural materials for arts and crafts and reinventing and recycling of old objects through artistic ways.

Moreover, the parent community actively supports the events and functions in the school through community catering, businesses and markets. They also organize fundraisers through sports and entertainment activities from time to time for social causes such as the ‘The Hunger Project’ or for the children in Africa. Many of the parents work in the school hence they travel together with their children. The parents also help with the paper recycling once a week by personally taking it out to the recycling station.

Besides, every summer the school organizes a flea market as an opportunity for all the travelling families to recycle their children’s toys, books, clothes etc. [Fig.9]
2.2.2 School as a place:

School as a place signifies many things besides being a temple of education. It is an institution of social upbringing, rhetoric of embedding culture, habits, hobbies and trends. It is a place of personal and social development. It is an establishment of building relationships, making associations and connecting to networks. It is an action ground for emotional highs and lows. Perhaps a place that factors in maximum influence during the growing up years for children.

2.2.3 Learning and Fritids:

Bentley (1998) in his book ‘Demos’ suggests that “we need to re-conceptualize education, as an open, living system whose intelligence is distributed and shared among all its participants. Schools and colleges according to him need to become network organizations, to establish themselves as hubs at the center of diverse, overlapping networks of learning which reach out to the fullest possible range of institutions, sources of information, social groups, and physical facilities.”

The definition of learning is wide and broad. We learn in different ways when we listen to stories, when we do things with our hands, when we ponder deep questions on our own, perhaps in the bath. We learn when we participate in group projects in the real world. We learn when we make music and do art.

The Fritids section of the schools in Sweden especially focuses on the social and cultural aspect of the child's learning. This separate section has a very interesting effect on the children's psyche. In spite of being located within the same premises, the Fritids section loosens them up after the “official learning” routine is over from the regular school hours. This is a place, which inspires children to relax themselves, to pursue their hobbies, to connect with their friends and to freely express themselves. Their personal space within this section is relaxed to a level that is more than that when they are in school but maybe less than when they are back home. [Fig.2]

![Figure 2. Personal space in Fritids](image)

The age group of children in Fritids ranges between 6 to 10 yrs. There are three large rooms to cater to activities of the different age groups. However, they all mingle together, and hence the peer culture in Fritids differs from classroom atmosphere of the school where all the children are of the same age.
3. Theoretical Background

In this section, I bring to attention the views from the cognoscenti of Interaction Design in the light of sustainability. The length and breadth of these thoughts is an important backdrop for my motivations and design methodologies.

Theory of Affordances has been central to my research and I dwell upon it at length to understand the various aspects that can be utilized in context to eco-ethical interactions with the artefacts. I discuss the use of affordances by other designers to further my claim of designing for transparency. Thereafter I discuss the work done in context to these theories.

I also discuss the pedagogical considerations of the children in the chosen age group. I draw parallels from these insights into my methodologies and hence try to connect the child psychology (res cognitans) to my design methodology (res extensa) (Dourish, 2001).

There are a variety of viewpoints regarding technology usage for children of this age group. I also address the importance of the haptic needs that these children should not be robbed off as increasingly electronic gadgets begin to replace the conventional learning apparatus. There are views regarding the use of child-tangible interactions, which may be the essential bridge between the conventional tactile qualities and the modern technological advances. I also address the importance of symbols and graphics that play an important role in the growing up years of a child’s learning. Lastly, I discuss some examples of the language of storytelling that is integral to how children 6 years and above express their perceptions.
3.1 HCI and Sustainability:

I would like to bring into focus the various thoughts on the subject of HCI and sustainability. These thoughts are relevant and are especially addressed to the interaction design community hence they are germane to this thesis.

Blevis (2007), in his paper on Sustainable Interaction Design (SID) takes a stalwart stand on a designer's role towards the goal of sustainability. According to him, concern for sustainability in the arena of interaction design is in an apparent infancy. His view is that sustainability should be a central focus of interaction design. He discusses the link between interactive technologies and the use of resources, both from the point of view of how interactive technologies can be used to promote more sustainable behaviours and from the point of view of how sustainability can be applied as a vital lens to the design of interactive systems.

Blevis (2007), critically analyses the term Human-Computer-Interaction which he thinks in itself is anthropocentric and he feels that human-centeredness is often construed as a notion of engineering needs and requirements that follow the cognitive models of users rather than a concern for human conditions.

Dourish’s (2006, pp.541-550) insight on the importance of ethnography in HCI is that, “it is not enough to simply consider the implications of ethnography for design needs and requirements but also the kinds of intellectual, moral and political commitments they embody.”

Fry (2005, p.1) passionately refers to the role of a designer in the wicked landscape of policy makers, communities and clients. He says that, “the design community is deaf to the voices of the complexity of un-sustainability.” He feels that, “there is a poverty of responses towards the misplaced faith in technological solutions, the myopia of political and corporate leadership and the extent of changes that are required if a psychology, culture and economy of sustainment are ever to arrive.” He urges “the designer community not to timidly subordinate to the will of clients who trade in unsustainable practices.” Rather he recommends that “they constitute dialogues of transformation with clients and communities and develop economic workable path finding and service practices.”

Makelberge (2003, p.4) writes about a sense of languor surrounding the failure of technology-centred thought within HCI to explain the role of interaction design in an ontological sense of designing and being designed in the world. He refers to how billions of people on this planet consume junk with no apparent clue on how it affects someone else’s surroundings.

DiSalvo et al. (2009, pp.385-394) maps the overall scenario and suggest that, “HCI should borrow eco arts from disciplines that have a longer history of engagement with environment.” He feels that, “dialogic art and activism from fields such as architecture and planning (e.g.7000 Oaks) may provide useful lenses for rethinking how sustainable HCI should be constituted.”
As a follow up to Blevis’s (2007) call on SID, Hanks-Blevis et al (2008) surveyed 435 undergraduate students concerning the attitudes of American population towards sustainability and the material effects of information technologies. According to the United States government Environmental Protection Agency (2006), “Americans discard approximately 2 million tons of used electronics, including computers and televisions each year. In addition, an estimated 128 million cell phones are retired from use annually.” The toxicity of such a massive amount of electronic waste has dangerous environmental consequences. The acts of interaction designers are implicated in this situation, not only apropos of the design of hardware devices, but also as pertains to the design of software, which may often be the cause of premature obsolescence of hardware.

3.2 The Theory of Affordances:

The original theory of affordances by the psychologist Gibson (1986) highlights the reciprocal relationship between man and his environment. According to Gibson, “since man and environment evolved together they are inseparable.” His direct perception theory explains perception in terms of information. The theory states that, “humans perceive environment in terms of what they can do with it.” In other words, it is a clue to what the environment affords to him.

According to the theory, “these affordances are a combined property of the relationship between the environment and human. Affordances are the perceived action possibilities for man in his environment. Hence, affordances cannot be seen separate from the environment, but they also cannot be seen separate from man. Man can only perceive what his individual cognitive perceptual system is capable of perceiving.” In addition, “man perceives what he can do with his environment in terms of his individual bodily capabilities. Man’s intentions also play a role in perceiving the action-possibilities of his environment” (Gibson, 1986). In this way the human cognition, perception and intention influence this relationship between the man and his environment.

Frens (2006, pp. 49-52) in his book ‘Designing for Rich Interactions’, gives examples to explain this theory, he paints a scenario, where if one feels tired and needs to rest. “If you are in a forest environment, you can rest by sitting on a tree trunk, and if you are in a city environment, you can rest by sitting on a bench. The tree trunk and the bench are both perceived as sit-able because there is a horizontal plane that is at the right height for a human body to sit on. One perceives them as affordances for sitting only if you are tired. However, for an elderly person, the world affords different things. A low chair that is nice and comfortable for a thirty-year-old man maybe a dangerous contraption for a ninety-year-old man, since he may find it difficult to rise again from that chair.”

Gibson (1986) notes that action and perception are inseparable, because we need action to perceive and we need to perceive to act. Michaels and Carello (1981) explain this concept as, ‘affordances write a perception in the language of actions’. Hence, “for perception to be valuable, it must be manifested in appropriate and effective actions on the environment. On the other hand, for actions to be appropriate and effective they must be constrained by accurate perception of the environment.”
Smets and Norman (1994, pp.79-84) have further extended the theory of affordances to the realm of design paradigm. They have proposed the possibilities of creating rich interactions in the practice of product design and HCI through this theory. Interestingly, designers tend to interpret this theory in a variety of different ways.

From the eco-ethical point of view, the affordance theory can manifest itself into interesting schemata through clever design intervention. The concept of ‘visual perception’ in affordances refers to how man gets clues or “information-for-use” (Frens, 2006, pp. 49-52) from his environment. It has been implied in this theory that one not only perceives possibilities to act in the world, but that one also perceives what will happen when one acts. In context to the world of artefacts, one perceives not only the action-possibility but also the function linked to that action-possibility. The “information-for-use” after the action in an interaction is termed as “feedback”. Wensveen et al. (2004, pp. 177-184) argues “for a unity of action and reaction, which may lead to a natural information-for-use.” He proposes that “interactive products should be designed to manipulate and behave so that it can express information for user action.”

Darby (2000) has effectively put to use “feedback” toward raising awareness in electricity consumption and has noticed a significant behavioural change with a reduced consumption of approximately ten percent.

The project Static by The Institute of Design in Eskilstuna has also developed various products for everyday use by exploring the concept of feedback in homes and offices. [Fig.4]

The Oxford dictionary (2000) defines the term feedback as the modification, adjustment or control of a process or system by a result/effect of the process, especially by a difference between a desired and an actual result; information about the result of a process, experiment etc; a response.

Darby (2000) in her paper, ‘Making it obvious: designing feedback into energy consumption’ discusses how ‘invisibility’ hampers our ability to learn about the use of electrical energy more intelligently and less wastefully. She notes that while some aspects of energy usage may be highly visible, a large part of domestic energy consumption remains hidden from view.

My thesis is an exploration based on the similar aspect of “making things visible” (Norman, 1998, pp. 99) with a special focus on showing the use of natural resources and hence, “designing for transparency” of processes, so that the user is empowered with better knowledge to be able to act intelligently and behave sustainably.
3.3 Related Work

Tidy Street project:
A good example of implementing a demonstration with the intention of making things visible, was mobilized by, “The Tidy Street project” (Tidy Street, 2011). In March, April 2011, the households of Tidy Street, Brighton, UK were given electricity meters to track the electricity usage of different devices, they recorded their electricity consumption using the Tidy Street website. The daily average of the street was then marked on a large street display, with chalk on the road to show how Tidy Street compared to the average Brighton household’s electricity usage. The result was the residents, in collaboration with a local graffiti artist, produced an engaging artwork. This also stimulated the street and passers by to reflect on their electricity use. [Fig. 3 a]

Figure 3 a) Tidy street project, b) Lambent shopping trolley

The Lambent Shopping Trolley Handle:

The Lambent shopping trolley handle (Change Projects, 2011) was designed to attach onto any supermarket trolley. It has a display of multi-color LED’s and a scanner. As consumers pick up the products from the supermarket isles, they can scan them on the trolley handle to make a healthy or an ethical choice. The items were also determined by low, medium or high food miles based on their place of manufacture. This way the consumer can make a choice based on his preferences.

This trolley was surveyed in a real life scenario and it was observed that consumers often selected items with lower food miles in cases when they did not have a preference for a specific brand. However, they did not make the lower food miles choice when they had brand preferences. The ethical choice with lower food miles was made almost seventy percent of the time. By making this comparison available to them, they had an opportunity to reflect and hence they could make a conscious ethical choice.[Fig.3 b]
The Power Aware Cord:

This cord was designed to visualize the glowing pulses and the flow of electricity. Electrical energy is often not noticed and yet all of us are surrounded by its silence and invisibility. The TV set, the mobile phone charger, appliances on standby or the increased consumption with the change in volume.

The Power Aware Cord (The Interactive Institute, 2012) helps you to rediscover energy as an ambient ‘display’ to see energy consumption at a glance at any given time. [Fig. 4]

Figure 4 Power aware cord

The Flower lamp:

The Flower lamp (The Interactive Institute, 2012) was designed with the new trend of remote energy metering. It tracks the energy consumption of a household and visualizes the same by blooming when low and contracted when high.

To make the flower lamp beautiful it is important for the residents of the house to collectively use less energy.

A separate study conducted by Darby (2000) in her paper, ‘Making it obvious’ suggests that energy savings up to ten percent have been recorded by the method of providing such a feedback to the consumers.
3.4 Pedagogical Considerations

3.4.1 How much technology?

During my empirical studies in the school I found that, the teachers use computers in all classes with digital boards. Students have access to laptops from time to time, depending on the discretion of the teachers based on the curriculum and the relevance of using digital media to the subject of inquiry.

I floated some technological solutions that may address some of the paper usage issues, especially, to be able to address the IB course structure. My proposal was of a digital doodle that can balance the individual needs and make it easier for the teachers to organise their time and energy. The prototype I proposed was similar to an old fashioned slate that can be controlled and operated digitally by the teachers through their computers. The obvious parallel that they drew to it was a tablet. This led to the discussions on the subjects such as, development of motor skills, haptic needs and technology.

![Figure 5 An old fashioned slate = An iPad?](image)

3.4.2 Haptic needs:

I was watching my six-year-old daughter manipulating the doodle application on the iPad. She could draw with her fingers on the screen, use different colours, textures and erase what she did not like. The interactions are simple and haptic. She tends to be creative with what is available to her, uses the available bank of objects, combines it with her own drawings and even creates a story out of nowhere.

On the other hand, I notice her working with a pencil and a paper. She draws, erases, it gets a bit dirty and smudgy, she is a little frustrated sometimes but then she picks it up and starts folding the paper, cutting the drawing and starting to create a three dimensional object, a pop up book, a standing sculpture or a stuffed animal.
3.4.3 Technology or no technology:

During my empirical studies and during the interviews with the teachers and the principal of the Bladins International, it was observed that although the school had the facility to use advanced digital materials the teachers were careful to use the technology so that it compliments the education purpose without compromising the haptic qualities of some of the traditional tools and materials.

I take a look at some of the views in this direction to be able to decide the level of technology that I should introduce in this project.

Antle (2009) conducted a comparative study of children’s performance and behaviors. The study was conducted using three different methods of puzzle making: traditional hands-on, mouse-based and tangible input methods. The study provided evidence to support the claims that hands-on direct physical manipulation of objects in a spatial problem-solving task is faster and easier. Hands-on direct physical manipulation supports more exploration than a mouse driven approach.

A cross-section of disciplinarians such as cognitive scientists, educational theorists and gesture researchers have supported the significance of haptic needs in the learning process and in the development of thinking. Piaget (1952) has been involved into developing a long tradition of cognitive structuring that suggests that direct physical interaction with the world is a key component in a child’s cognitive development.

Froebel (1837) and Montessori (1966) have the history of developing manipulative educational material that represents abstract concepts in mathematics. The tablet is perhaps an example of such manipulation extended on a computational domain. Child-tangible digital materials may be an answer to replacing traditional materials without compromising the tactile needs. Proponents of this approach claim (Resnik, 2006) that there is benefit to supporting physical actions on computational objects, which can make difficult mental tasks easier to perform. However, Kirsh (1995) suggests that the value of actions that can simplify mental tasks, which do not involve abstract concepts or symbolic representations, may not be suitable for computational objects.

The above views are interesting and opens up possibilities of using ubiquitous computing and tangible interaction methods to approach this age group. However, what it does not factor in is the ecological rucksack that each of these replacements may carry. In case if we proposed to replace paper with digital doodles or tablet PC’s. Would it be possible to determine the ecological effect of making so many new tablets as opposed to the amount of paper that may or may not be saved? Are we being short sighted with our problem solving though technology?
3.4.4 Symbols and children:

Gestures and symbols are the initial tools to build a child’s vocabulary. From the time, a child is a year old, he understands people around him as intentional agents and he learns through imitation (Piaget, 1962)(Rakoczy, Tomasello and Striano, 2004).

The cultural learning process is initiated in children as they are introduced to different forms of actions through artefacts. For example, if a child sees an adult twist open a jar, he knows through imitation that anything that looks like a jar needs to be twisted to be opened, or anything that looks like a button needs to be pushed and one that looks like a knob has to be turned. Through intention reading and imitation, they learn the functions, the “intentional affordances” of tools, objects that are used for instrumental purposes (Rakoczy, Tomasello and Striano, 2005).

Similarly, they also learn to perform symbolic actions, first without objects through gestures and language, and then with artifacts using drawings, replicas, and other objects. Much before they learn how to read and write they identify graphically represented symbols such as STOP signs, do not walk on the grass, etc. Children interpret graphic symbols and signs as behavioral representations.

My daughter, when she was 5 years old could not yet read so many words, when at school she was introduced to the concept of recycle of materials and the recycle symbol. Once, when I was asking her to clean her room after her play, I said to her that all the toys that are lying on the floor may end up in the dustbin, if she does not pick them up. She picked up a toy brought it to me and showed me the graphic of ‘do not throw in the trash’ sign.

3.4.5 Storytelling through pictures:

Åsa Harvard (2012, pp. 10) in her research on narratives quotes Reggio’s (2006) preschool pedagogy of the many different languages such as drawing, dancing, singing, collecting things and other such creative expressions that children express themselves with.

The various stages of a child’s development can be understood through the stories they tell. As per this chart, children from the age of six are able to follow a schema and hence would be able to tell a story pictorially in the order of the events (Donely, 1987)(Wilson and Wilson, 2010). [Fig. 6a,b]

Birt (2009) has made an attempt to make sustainability visible through illustrating processes. She has designed product wrappers and objects such as plates and water glasses by visually illustrating the stories of the product lifecycle or a water cycle to educate consumers and especially children. [Fig. 7]

I have tried to explore this aspect of a child’s expression during my research and have
encouraged their storytelling skills to understand their cognitive schema. [Section 6.6.3]  

[Fig. 28,29]

<table>
<thead>
<tr>
<th>Perspective</th>
<th>Development in Children</th>
<th>2 years</th>
<th>3 years</th>
<th>4 years</th>
<th>5 years</th>
<th>6 years</th>
<th>7 years</th>
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| Scribing stage | The pre-schematic stage | First spontaneous make-believe the child think and plays with his imagination. The child who is in this stage is usually ready for the second stage. In it, the child will begin to use his imagination in playing. 
| The schematic stage | The child becomes more mature at this stage. The child will start to use his imagination in thinking. The child will start to use his imagination in thinking. 
| The going stage | The child becomes more mature at this stage. The child will start to use his imagination in thinking. The child will start to use his imagination in thinking. |

| Betty Edwards | Creative and Mental Growth | The stage of symbols | After weeks of work, the symbols begin to emerge in a variety of forms. The symbols become a natural extension of the child's imagination. 
| The stage of nonsense | The symbols begin to emerge in a variety of forms. The symbols become a natural extension of the child's imagination. 
| The stage of symbols | The symbols begin to emerge in a variety of forms. The symbols become a natural extension of the child's imagination. |

Figure 6 a) Drawing development in children 14 b) Illustration of a Jellybean factory by a 7 yr old.

Figure 7 Visualizing process cycles
4. Methodology

I give you a brief outline on some of the important aspects of my working methodology and an overview regarding the design considerations in the view of sustainability.

The mood, the milieu and my role in the environment of the specified section of the school in context for the design (i.e. Fritids) were also an important aspect of consideration for a meaningful design.

My empirical observations during the preliminary studies led me to address the sustainable use of paper as the focus for this thesis. Moreover, this understanding also led to further study the culture in terms of paper use that was prevalent not just in the Fritids section but the entire school.

I conclude this section by explaining my structure of working, wherein I open up possible leads of design placements that may be of interest to other designers, while I concentrate on my area of focus.
4.1 The Design Process:

A design germinates and grows in a live environment under favorable conditions that provide adequate food for thought, brightness of ideas and flow of imagination.

The process that I can reflect upon resembles a blown glass vase. The empirical findings and the knowledge base fires one up to be malleable to be able to shape up and adapt and mould into the situations. As the thoughts and ideas blow into this situation, a form emerges. To be able to give this form a meaning, one steps back to look at it in a holistic scenario. Hence, the process that emerges is a broad and narrow structure that one passes through.

The framing of the research question was to analyze the various different ways in which the task of behavioral change in sustainability context can be addressed. This was a starting point to understand what is favorable under a given situation. The specific choice of place (school) and the target group (children 5–9 years) was narrowed down based on previous research with the consideration of a long-term effectiveness.

A detailed empirical intervention served as a foundation to develop an overall understanding of the culture in the place of design context. Many situations affected a single issue of paper use. Each of the specific situations such as the course structure, the position of printers or the recycling was analyzed further with the scope of possible design solutions. The intention was to develop live leads for other designers to pursue.

However, at this point it was imperative to take a step back and gain an overall perspective to these specific problems in terms of pedagogy, ecology and awareness.

Based on the broad and narrow perspectives a design was developed which suited the ambiance and temperament of the chosen area of focus.

The design was once again analyzed and scrutinized under the considerations of issues such as, the ecological rucksack, a product lifecycle and the broader backdrop of maintaining nature's harmony.
4.2 Design Considerations:

“The tension between design freedom and responsibility is a central issue for sustainability”
- Ann Thorpe, 2007

To make human designs so that they may be able to harmonize with the nature’s design, the responsibility lies on the shoulders of a designer.

A designer typically responds to needs. The design activity includes a spectrum from knowing to doing. That is the philosophy of understanding and the situation in context is the knowing part. The doing part is mostly the process of developing ideas through research and consequently mapping and modeling them through experimenting and prototype testing. The final stage of doing is the physical production of this design idea.

In the above process of designing, the challenge for the designer to design sustainably requires many layers of thinking.

From the conception of an idea, the designer starts to think of the possible form his design would take and simultaneously he starts to think of the possibility of materials used. The origins of materials under consideration and perhaps their history also play a vital role to make an eco-friendly design.

Scrutinizing the overall functionality of the design, what will it take to make the artifact and how the artifact will function are both important considerations to estimate the environmental contaminants and waste, the use of energy, water and other natural resources.

The lifecycle of the artifact from conception to ending up in a landfill, the places it may travel to, its packaging and transport, consumer purchase and use till its estimated duration of life.

Maybe the designer can even extend his imagination of how parts of the artifact have the possibility for reuse and recycle on its demise (Thorpe, 2007).
4.3 Changing the tune without changing the song:

User-centred design is primarily about understanding the end user, his habits, his mannerisms, his psychology and his mindset. In a way, it is about designing with the user patterns, designing without disturbing the flow. Keeping this at the heart of my empirical studies, an effort was made to be sensitive to grasp the overall mood of the place and the general mental make-up of the children in that environment. Hence, the prototypes and experiments were also conducted so as not to disturb the on-going rhythm. In other words, the empirical consideration was to change the tune without changing the song.

[Fig.9]
4.4 Me, an artifact:

Children are very sensitive to their surroundings, even the slightest change is noticed and often every change is deeply scrutinized, heavily questioned and intensely argued. My presence too had an effect on them. I was a living artifact, someone who determined activities. However, it was not necessary for me to direct any activity, they found an activity around me. I was often asked, what activity did I plan for the day but if I said that I was just there to do some of my own work, they still sat around me and found some use of me. For example, I should play a game with them or help them with their homework. If I sat at a table, they gathered around me and started to make kites, stuffed teddy bears or origami lanterns. It seemed like my presence was justified by their activity.

4.5 Structure of working:

During my preliminary studies and my time spent in Fritids, I noticed that although the Fritids is equipped with toys, games, music and outdoor activities, the most popular hobby amongst the children was to draw, paint, colour or cut paper. Moreover, there were notices, forms, leaflets all over the walls and paper seemed to flow in abundance. Various factors determined the abundant use of paper. To be able to understand the culture of paper use it was important to look at school in its entirety.

Hence, an empirical intervention was necessary to understand the use of paper both in the school environment and in the Fritids environment. I conducted interviews with the teachers, the relevant personnel and experiments along the way to understand these insights further. Based on my area of focus I chose to pursue some of the leads into further probing, iteration and reflection while others were left as live ends that maybe of interest to other designers. [Fig.10]
5. Research & Experiments

5.1 The Paper Trail

In this section, I observe that an institution such as a school is an all time paper-consuming monster, “A Papiervore”.

I hence set out a research mission to follow the paper trail through the school. I try to understand the various factors that may be responsible for the excessive use of paper. I conduct interviews along the way that lead me to follow the trail further.

The intention of carrying out this research was to get an overall understanding of how paper is used and who are the actors in the school scenario that influence the culture of paper usage.

The diversity of factors along the trail also brought into focus the understandings regarding pedagogical issues related to the course structure, technology based issues such as the double sided printing machines and practical issues such as the inconvenience of paper recycling.

The statistics I received from the school office reiterates my observation regarding the heavy use of paper.
Figure 11 The Paper trail
5.1.1 School as a Papiervore:

‘Papyrus scrolls’ was once a luxury of the royals; paper now has become a commodity.

According to the World Resources Institute (1998-99), in Western Europe the per capita paper consumption is 190 kilos per year as against 15 kilos per capita in the developing nations. PCs account for 115 billion sheets of paper per year worldwide, paper use in communications is approximately 50 percent of the total consumption however; a bigger share is taken up by the use of paper in packaging industry especially in the developed nations. The Minus One Project (2011) states that, in the last 40 years, the world consumption of paper has grown by 400 percent. This accounts for nearly 35 percent of the total trees cut, approximately 4 billion trees worldwide are used in making paper.

The Conservatree statistics (1988-2012) suggests that, one ton of uncoated virgin (non-recycled) printing and office paper uses 24 trees, by this calculation, if a single person in Europe is using 190 kilos of paper per year that means each person is responsible for the cutting of nearly 4.5 trees per year.

In school environment, paper flows everywhere. Paper is needed for books, bills, notices, letters, homework, art, craft, toilets, cafeterias, printers, and photocopiers. Paper flows uncontrollably especially in loose sheets. An institution such as a school can be compared to an all time paper-consuming creature “A Papiervore”. There were an ongoing schemata and a constant flow of paper consumption. It became enticing to follow this paper trail.

[Fig.11]

5.1.2 Course Structure:

Teachers in charge of children under the age group of 5-9 years were interviewed to understand the use of paper. One observation was that, the course structure of an International (IB) school is not based on text books. They modify the curriculum constantly based on trends and needs. Teachers continue to amend the exercises, and hence a new set of print outs is required constantly. Homework is also customised as per the child’s abilities; this too requires a personalised effort of printing different pages for different students.

Figure 12 The IB Course Structure
5.1.3 The Parent Portal:

Veracross, the school’s online portal is available for parents and teachers to monitor a child’s progress and to keep a track on what is going on in the classroom and school. A digital portal hence should ideally eliminate the need to print out information leaflets, notices and even the child’s report card at the end of every term. The teachers also put pictures of children working in the classroom, which gives the parents an idea of the activities in the class. [Fig.13]

The Parents are usually invited by the school’s technical staff in the beginning of the academic year to familiarize them with the portal. However, since not all parents are on board with the portal, teachers need to send out a printed sheet every week to update the parents regarding important happenings in the class and the school.

Moreover, in case of an international school, there is a heavy flux of new students any time of the year and since the parents are new to the country, they may not have immediate access to the Internet.

Figure 13 Monitoring child’s progress online

5.1.4 Printers:

Each classroom has an adjacent printing room with heavy-duty printers to enable ease of access to these demanding printing needs. However, these printers are not equipped with the auto front and back printing facility. Printing on both sides require special understanding of how the paper should be placed in a tray, most often they waste a few papers before getting it right. Moreover, it requires waiting in front of the printer until all the pages are printed. It is not possible for the teachers to leave a class full of children alone for so long.

There is a Minolta Bizhub double-sided printer available on the ground floor, but it requires advanced planning to print the pages. Hence, teachers due to lack of time, print single sided sheets. Consider an average class of 20 children and hence the number multiplies. [Fig.14]

Figure 14 Minolta Bizhub - prints double-sided pages
5.1.5 Paper recycling:

The international section of the school moved into new premises three years ago. There has been no paper recycling system in school since then. The state charges for recycling paper collection are very steep for organizations.

There are some recycling bins for residents outside the school; however, these bins are too small to accommodate the paper waste generated by the school. Moreover, the cleaners do not take responsibility of recycling and hence it is up to the teachers and the students or the parents sometimes volunteer to take the paper out to these bins or to the recycling plant.

I learnt from the teachers that they like to involve the children in this chore of taking the recycling paper out. However, it was not always convenient for them to do so due to weather conditions and due to lack of time or when they were short staffed.

![Figure 15. Paper for recycling](image)

5.1.6 Statistics:

I wanted to confirm my notion regarding what I thought as ‘incredible’ paper use. I received the figures from the school Office Manager, Anneli Elisson (2011-12) of the total use of paper in the International and the Swedish sections of the school. For 834 students 960,000 sheets of paper are used per year. That means 1151 sheets are used per student per year. According to Conservatree (1988-2012) statistics, one standard size tree makes 8333 sheets of paper. Hence, for every 7.24 students in Bladins a tree is cut every year. Which means, 115 trees are cut every year for the entire school. The above calculations are made to determine the optimum possibility, however it should be noted that some of the office paper also uses a small percentage of recycled paper.
5.2 Experiments & Workshops

In this section, I continue pursuing the paper trail. However, in the process of researching the paper trail I also intervene through some experiments along the way by placing appropriate affordances and other such interaction design techniques.

These experiments may be considered as seeds of possible design placements. These leads can be used as starting points for future design interventions.

To conclude this section I map the scenario of the factors and actors that play a role in the context of paper use.
5.2.1 Workbooks:

The course structure does not involve using bound notebooks. Maybe, it is easier to monitor optimum usage of paper sheets in a bound workbook considering that each page is used over on both the sides and there is a possibility to ensure that maximum space is utilized. However, due to the unique IB course schedule, workbooks are used for handwriting assignments only. This could be one of the reasons for the increased use of loose paper sheets. [Fig.16]

Figure 16 Handwriting workbooks

Experiment:

Creating reusable workbooks: (Cultural affordance, Creating longevity)

Workbooks used for handwriting practice are mostly about repetition. Every day, children write a set of sentences within a grid to be able to improve their writing skills.

Once the practice is over, there is not need to preserve the pages. A digital doodle would be an easy replacement for this purpose, however while we debate over the technology and ecological rucksack of creating digital materials. An easy applicable experiment was conducted. Each workbook was separated into loose sheets and all the sheets were laminated on both the sides. These sheets were then bound together back again by filing them. It is easy to write on a plastic sheet and clean the surface after the practice. The workbook was hence ready for multiple uses and not just a one time use and throw. It could even be used year after year.
5.2.2 Toilets:

Children seem to be always in a hurry to get in and out of the toilets. They do not like to waste their precious playtime worrying about toilet chores. A lot of toilet paper was normally lying on the floor. On closer observation, I realized that the hand towels and the toilet roll seem to release the paper too easily. When you try to pull the paper, the toilet roll spins more than how much paper was needed and hence while one may require just two or three sheets to wipe, you have ten sheets that have come loose. Since, it is too much trouble to wind it back on, it is easier to pluck it off anyway and leave the rest on the floor.

![Figure 17 The Wasp – A marker](image)

**Figure 17 The Wasp – A marker**

**Figure 18 Tightening the holder**

Toilet Paper experiment:

I made two iterations (eco-ethical affordances). Firstly, I made the toilet paper holder tighter by adding a layer of foam in between the holder and the tissue roll. [Fig.18] This created a tension and hence it required a slight extra effort to pull the paper (constrained affordance). Secondly, I sketched a little black wasp after every third sheet of the toilet paper. [Fig.17] The third sheet was chosen based on the consideration of the overall hygiene, and thinking practically how many sheets does one require at a time (Making things visible).

The main observation of this experiment was that the wasp became a marker and often the paper was torn before the sketch of the wasp. A comparative observation before and after the experiment showed that in a single day the toilet paper roll was used \( \frac{1}{4} \) less.
5.2.3 Fritids and crafts:

A large portion of paper use in the Fritids section is for crafts and arts. The tactile qualities of traditional materials such as paper, colours, crayons, pencils, clay, glue and such, the understanding of textures and how different materials behave differently are important for a child's growth and creativity. There is no replacement perhaps to these tactile needs.

However, there was an iteration that I considered, the size of the paper; the standard size for everyday use has been the A4 size of paper. What if this size was reconsidered? From my observations, children used the paper sheets to draw and cut. What they made in an A4 sheet was also possible to make in half that size (A5). Pedagogical observation suggests that children adapt their drawings based on knowledge of spatio-geometrical relationships. I tried to observe the reactions of children by replacing the paper racks with A5 sheets of paper. [Experiment p.39]

In addition to this, with reference to the discussion in the section on pedagogical considerations regarding the importance of symbols and graphics in children's growing up years, I tried to persuade them to use both sides of the paper by the following experiment of creating a tree graphic.

Figure 19. Does size matter?
Experiment: (Making things visible)

In the later section of pedagogical understanding, I address the importance of symbols and graphics in the formative years of child psychology. [Section 3.4.4] To use this psychology of graphic representation, I created a little graphic of a smiley tree; I stuck this over approximately twenty-five A4 paper sheets. I also cut approximately twenty-five of the sheets into half to see if size makes any difference to the children. I sat near the paper rack to notice their reactions without intervening.

Observations:

Something stuck on a plain sheet of paper was noticed immediately; first, they asked if they could use the paper. Then looked at the icon closely, the smiley face was easy to identify and the wood texture was apparent. However, the message on the smile was too small to read, so some bothered to read it and some ignored it. Three out of four children made the sense of it all and came up with the conclusion that we must not waste paper, we must use both sides and we must recycle it.

The size of the paper, was noticed at the end of the analysis. The other side of the paper, still remained unused.

Figure 20 Experimenting with paper size and symbols
6. Empirical work

I summarize in this section the learning from the overall empirical observations. These learning leads to building two different strategies to address the issue of paper usage for the school as an institution and specifically for the Fritids section which is the initial focus for my design context.

To relate to these different strategies I then propose two separate design ideas. I take these design ideas to the user group, which in turn lead to the idea and generation of a concept prototype.

I built a metaphorical concept prototype to test the feedback from the user group to verify the key insights.
6.1 Mapping the issue:

The paper trail [Fig.22] led to the overall understanding of the different actors in the scenario. There were important revelations with reference to the paper use such as, the position of the classrooms, the design of the printers, which do not allow easy double-sided printing, besides larger issues such as the IB course structure and the slow turn around of the Internet service providers. A sum of all these diverse aspects resulted to the incredible use of paper.

The challenge was now to be able to address such diverse aspects and the variety of actors with a strategy that was both relevant and effective.
6.2 Conclusions from Empirical Work:

In spite of my focus area being the Fritids area of the school, the influence of the school culture in paper use could not be ignored. Hence, it was important to analyse the issue at two levels,

A. To create awareness at the school level
B. To sustain this awareness that aligns with the Fritids area.

At the school level, it was crucial that the issue of paper use was brought to the attention of the staff, the teachers, the students and the parents. The behaviour of children was only reflective of how they saw others around them behave. Hence, it was vital to bring everyone on the same ground to be able to see the incredible use of paper.

The Fritids area on the other hand is synonymous with leisure activities where a restrictive use of paper may mean cutting resources and killing creativity. The challenge in this case was to make the use of paper fun, yet enhance its life cycle in a creative way. An appropriate design for this section was to remind the children that paper is a valuable commodity that must not be wasted, and that it was possible to reuse paper creatively.
In the process of mapping the overall issue of paper usage in context of the chosen school scenario, a number of factors have come into focus. The goal was to be able to get the attention of all the different actors regarding the excessive use of paper. To address to all these actors I hence, propose an awareness based design strategy. [Fig.21]

In this section, I analyze the empirical observations. I outline four major goals for the design for awareness and thereafter I devise a four-pronged strategy to achieve these goals. Moreover, I take inspiration from work done in this area with similar interaction design techniques and I use the theory of affordances as a backdrop to devise my strategy.

Based on the above considerations, I propose to formulate a ‘demonstration’ of the paper usage in the school. To suit the culture and disposition of the institution such as a school I contrive a competition to publicize the awareness about the event and thereafter create an artwork with piles of paper to display the same. I conclude thereafter by reflecting on the event and its effects.
6.3.1 Empirical Observations:

Following through the paper trail brought into focus a range of issues. However, the four broad observations were,

1. Although the overall goal of the school is to be eco-friendly, there was no visual feedback for the staff, the students or the parents to be able to acknowledge the way paper was used.

2. The main reason for this was that the school as an entity was a Papiervore but the individuals were detached from that entity.

3. The ecological rucksack related to this use was not evident. The corresponding damage to the environment was unknown.

4. The solutions to control the use of paper is finally up to the user himself. If the user is made conscious of the problem, they may be able to solve some of the issues at a personal level or come up with ideas that can be implemented for others.

6.3.2 The Staging Strategy:

In devising strategy to address, the above-mentioned empirical observations, I take inspiration from the Change Project in UK (2011). The Tidy Street Project (2011) was designed with an objective to stimulate the residents and the passers by to reflect on their electricity consumption. [Fig. 3 a]

My objective was similar as that of ‘The Tidy Street Project,’ however, the institution such as a school required special understanding on the type of strategy that would generate interest and attention from the audience. Hence, I proposed a week-long competition to make a chronicle of the paper use for eight classes. This competition served as the base to the staging of the paper piles. The intention was to create hype for the demonstration event by getting the attention from all the actors.

Consequently, corresponding to the observations from section 6.3.1, the staging strategy for the paper piles demonstration was four pronged,

1. To create a visual feedback, the strategy was to “**make things visible**”
2. To be able to improve personal accountability towards this goal, the strategy was to bring forward “**individual statistics**” (class-wise and per student paper use)
3. To be able to create awareness and make children understand the ecological damage, the strategy was to create a **graphical representation** of this information.
4. To be able to involve the users in the problem solving, the strategy was to facilitate their **participation**.
6.3.3 The Demonstration:

According to the strategy, as formulated in the previous section 6.3.2 we created a format for the competition, which was displayed on the school monitor in the main lobby. The four main goals were addressed in the following way.

The first goal was to make a display of all the paper that was being used and wasted. We wanted to create a paper pile in the front lobby for everyone to see. During a period of one week, the paper used from each of the participating classes was logged and weighed. The second goal was to make everyone personally accountable. Hence, a class wise scoreboard was maintained next to the piles to see who is wasting more. A Green award was to be presented to the class with minimum usage.

The third goal was to make the children understand the corresponding ecological damage caused, hence the corresponding number of the trees cut to make equivalent amount of paper was displayed. [Fig.23]

Reactions of different actors was monitored during the demonstration and after the demonstration the students and the teacher of the winning class were interviewed to find out how and what strategies were used to reduce the consumption. This would achieve the final goal of participation.

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<td>180</td>
<td>20</td>
<td>no data</td>
<td>234</td>
<td>221</td>
<td>844</td>
</tr>
<tr>
<td>15-Mar</td>
<td>126</td>
<td>135</td>
<td>200</td>
<td>No Data</td>
<td>36</td>
<td>113</td>
<td>68</td>
<td>85</td>
<td>763</td>
</tr>
</tbody>
</table>

| Total in class: | 448 | 495 | 555 | 745 | 108 | 188 | 502 | 392 | 3833 |
| Use per student: | 21.3333 | 24.75 | 47.75 | 36.21053 | 6.75 | 12.53333 | 27.88889 | 23.05882 | 26.233425 |
| Mass of papers (g): | 2016 | 2227.5 | 4297.5 | 3352.5 | 496 | 846 | 2239 | 1764 | 17248.5 |
| Number of trees used: | 0.005963 | 0.006149 | 0.001863 | 0.009255 | 0.003347 | 0.009355 | 0.000236 | 0.00487 | 0.0076149 |

| Trees per month | 0.023043 | 0.027671 | 0.053385 | 0.041646 | 0.008037 | 0.010509 | 0.028062 | 0.021913 | 0.2142871 |
| Trees per year | 0.330522 | 0.53305 | 0.649062 | 0.495752 | 0.672447 | 0.126112 | 0.336745 | 0.762957 | 2.571206 |

| Recycled paper in class: | 0 | 0 | 80 | 0 | 0 |

Figure 23 Paper Piles Display Board & Data
6.3.4 Snippets from the Demonstration:

The teacher, Goran Nilsson in charge of the environment group made an announcement in the school assembly about the staging of the paper piles and the “Go Green week”. Eight classes participated in the competition. The environment group student representatives of each class were given a log to keep tabs of the overall paper use in their class. A comparative chart and graphic [Fig.23] was displayed on the monitor located in the main lobby of the school. The original plan was to create the paper piles in the lobby for the entire week of the competition. However, on the first day of the competition after creating a pile of shredded paper when I moved away, the teachers saw that paper lay scattered all over the lobby like snow. Apparently, a pile of paper is very tempting for children to play with. Hence, we decided to have the display of piles only on the final day.

Reactions of parents, teachers, students and other staff members were recorded during the staging of this display.

The display was a point of attention for all the passers by. Some were aware of the competition and others were not. The ones that were aware of the competition looked at the scoreboard to check the results. Others stood there curious staring at the changing slides of the monitor to give them a clue of what were the piles all about. The most prominent word that emerged was “paper recycle?”

The piles triggered a series of reflections from the onlookers, some commented on their own their personal habits and others turned philosophical. The younger ones said, “Wow, that’s a lot of paper” whereas the older students gave suggestions of what can be done to reduce paper use.

A parent who has three sons in the participating classes spoke of how she uses electronic medium as opposed to print for most of her correspondence.

A French teacher spoke about how handwriting will soon become an art like calligraphy.

A Chinese woman spoke about her African friend who uses every single part of the animal they hunt.
6.3.5 Follow up:

I interviewed the students from the environment group to note their reactions during the “Go Green week”. The representatives from each class said that they did not ask their fellow classmates to use less paper but simply took notes of paper used in the class. It was rumoured that the classes that logged less use of paper were not fair with the figures as opposed to the ones that showed the real figures. The teachers agreed with these rumours.

The classes that showed the extra use of paper explained the additional use because of the science test that was scheduled during that week. The figure of 2.5 trees being cut per person per year was a revelation to both the teachers and the students. This figure made the desired impact.

The students recommended to their teachers to show them instructions on the smart board instead of handing out notes to each student. They also asked their teachers to give them one sheet of paper per table in the art class instead of giving it to every student.

Some of the students used recycled paper in the class and others suggested that not coming to school was the best solution for the environment.

6.3.6 Conclusion:

Overall, the demonstration of the piles succeeded in its objective of making the issue visible to the many actors influencing the paper usage. The interpretations of the onlookers travelled in a variety of directions. The piles of paper, books and boxes of recycling were perceived more as an artwork. The core theme of this artwork was unmistakably perceived as “save trees” and “recycle paper”. However, it led to many subjective elucidations such as the possibility of handwriting becoming an art; thinking of electronic correspondence as an alternative to saving paper and hence making obsolete the possibility of writing with hand.

The hype created through the competition in the classes that participated resulted in the empowerment to the children as they took initiative in finding ways to save the paper and influenced the adults with their ideas. One may debate the practicality of these ideas, however it accomplished the main goal of staging the demonstration.
6.4 The Paper-making Workshop

“We don’t need anymore heroes, we just need someone to take out the recycling”

Graffiti by Banksy

As described earlier in this thesis, Fritids is about recreation, hobbies and learning through play. Fritids is a relaxed environment where the children enjoy an unperturbed personal space. There are a number of activities that the children are allowed to take up. The choice of activity is left to individual students as they can pursue whatever interests them. To suit the mental model of the Fritids area I mobilized a paper-making workshop.

The intention of this workshop was to involve the children into the process of making paper. The intention was also to gauge their understandings regarding paper as a natural resource. The observations from the workshop proclaimed the importance of direct involvement in this age group. These learning in turn gave birth to the idea of a child friendly paper-making machine. The concept of this machine was to recycle the leftovers paper bits from their craft activities and to produce a unique quality of hand made paper that helps them further create additional things out of it.

In this section, I also bring into focus the environmental issues related to paper-making, the benefits of improving the paper cycle and hence the significance of designing a machine that enables paper recycling.
6.4.1 The Workshop: (Addressing the “why” of eco-ethics)

To match the mood of the Fritids section, a workshop was organised to make paper. It is possible to make interesting handmade paper by recycling bits and pieces of useless paper. The objective of this workshop was to get the children involved into the process of making paper. The workshop was divided into three parts.

Approximately 20 children participated in the paper-making workshop.

Before the workshop, a little survey was conducted through a questionnaire to gauge what they already knew about paper. Most of them were aware that paper is made out of trees. They had interesting answers for various uses of paper such as, paper mache’, origami, writing, cutting and making things. I also asked them to make a note of things that they would use if there were no paper. The answers I received were, sand, ice, animal and human skin, stones, board, computer, walls and floor.

Thereafter, they were shown a short video of how paper is made out of trees in a paper-making factory. The film was shown to give them an idea of the actual process. They were surprisingly interested in a very technical narration of how trees are cut and transported to the factory in a truck, how the machines make paper pulp and then how the pulp gets converted into paper sheets which are eventually cut into smaller size and packed to reach the consumers. I had to repeat the film three times by a popular demand. My intention was to keep the film short considering their short attention span but perhaps the narration in the film was too fast and children tend to repetitively watch something to be able to grasp it properly.

The recycled paper making workshop was conducted by dividing the children in small groups of four, they made bits of paper by selecting different colours of their choice, and thereafter under adult supervision, they blended paper with water in a mixer. The paper bits changed colour as it was being mixed with water, the bright red turned into pink. The children referred to this as a strawberry smoothie.

The “aha” moment was when they saw the small irrelevant bits of paper turning into a whole new colourful sheet of paper with their own decorations of glitter and dried flowers. However, they had to wait for the paper to dry to be able to hold it in their hands. This, if not done with an iron, takes about 5-6 hours. They went out to play during this period but kept coming back every now and then to check if it was ready.

Figure 24. Making paper out of paper
The paper-making experiment was enjoyable but hectic; the cutting, the mixing, the waiting for it to dry, this was a process they could not forget easily. My presence became synonymous with the paper making experience. I took this opportunity to find out what did they remember from the workshop. Hence, I asked them to narrate through words and pictures, a story of making paper.

The tree to paper life cycle was clear in most of the stories. Another interesting observation they made was that the paper bits transformed its form into an altered texture, and a distinct colour. The function and use of this paper also changed along with its form.

Some of the children had already found ways of utilizing this handmade paper, they showed me the different shapes and cards that they had made. As a reminder of their efforts, we made a collage of a tree to put up next to the paper rack.
6.4.2 Important facts about Paper-making:

Ts’ai Lun, a Chinese court official from the Han Dynasty in 105 AD invented the paper-making process, which used textile waste such as rags to make paper. Many other substitute raw materials were tried to make paper such as straw, silk, animal fiber, however the quality was not suitable for comfortable writing. In 1843 a wood grinding machine was invented that created pulp suitable for making paper (Paper Online, 2012).

Paper is a natural, biodegradable and recyclable invention that if produced sustainable and used responsibly is in complete harmony with the nature’s cycle. Trees capture and store billions of tonnes of carbon from the environment. This sequestered carbon from the forests is subsequently stored in the products that are made out of wood such as paper. When paper is recycled, this carbon storage is also prolonged.

According to Paper Online (2012), recycling plays a vital role in the sustainability of the paper cycle. The reuse of processed raw materials cuts down on energy, wood fibers and wastewater treatment.

However, the detrimental factor to the environment is the increase in its consumption. With the industrial revolution and the technological advances, it has become very easy to produce paper. With the increase in the speed of its production, its demand has also increased and made a way into our everyday lives as an important commodity. To meet the demands of the world only some countries in the northern hemisphere cultivate timber however, it has resulted into a major deforestation in the southern hemisphere (Paper Online, 2012).

Paper production has increased considerably in the last 40 years. Paper-making is energy intensive. Around 500 kWh of energy is required in Europe to make 200 kg of paper. This is approximately the average annual per capita paper consumption in the countries of the European Union. A 500 kWh of energy is equivalent to powering one computer continuously for five months (Paper Online, 2012).
Observations: (paper-making workshop)

The original aim for the paper-making workshop was to involve the children into the process. Besides, noticing the impact of the workshop on their psyche and their enthusiasm of handling the materials inspired me to develop a child-friendly artefact that enables them to experience the process at their own will.

The paper-making workshop was exciting because they were creating something. There was an element of curiosity and imagination built into this process. The changing forms of the paper as they tore it, mixed it with water, churned it to feel the pulp and then struggled to flatten it on the mould and the deckle and waiting for it to dry. All this had a lasting memory and in the end, the overall experience was very rewarding for them.

The produce from their toil had a very special meaning to the children that were involved in the process. They carried a special pride of making the paper themselves.

This paper was especially unique mainly because the children made it themselves, but also because it was unique in its form. It was different from the normal drawing and writing paper. It had a different texture, the colour had transformed naturally and unpredictably and the paper carried the embellishments of their personal choice such as the glitter, the colour bits and the dried flowers.

Moreover, when the paper was ready, that was just the beginning of unleashing their creativity. They had started to discuss amongst themselves about how they would use their paper. They began to create cards, artworks, boxes and other such crafts by cutting the handmade paper into various shapes. [Fig.25]

The children also seemed to have grasped the process accurately as their pictorial narrations suggested. [Fig.25] This observation was especially important towards the goal of empowerment and knowledge building on the subject of eco-ethics.

These observations served as the basis for my motivations into developing the idea of recycling paper and making an artefact that makes creative craft paper from waste paper.
6.4.4 The Machine:

The above observations encouraged me to recreate this one-time experience into something that children can make on their own. The workshop triggered the possibility of in-house recycling of paper. There were all sorts of paper in the school and the Fritids, some were reusable and some were unusable. If there were a system to recycle paper in school than it would be possible to create your own paper with artistic possibilities.

I visualized a child friendly paper-recycling machine. If we revisit the workshop process, the basic mechanism would require the following functionalities. Paper Shredder + mixer with water source + a mould and deckle with a water drain and absorbing facility + a mechanical press. [Fig.26]

![Figure 26 Basic functionality of a paper-making machine](image)

The only motorized equipment in the above system is a mixer. However, since paper is a porous material it is possible to churn the paper mache mechanically as well. For example, some of us may have witnessed our grandmothers churn tomatoes to make fine tomato puree with a mechanical blender.
6.4.5 The Design Strategy:

The interaction qualities that I seek to achieve in the design of the proposed artefact has relevance towards developing eco-ethical culture on three fronts:

A. Exploring the advantages of mechanical interaction qualities (Developing Skills)
B. Tactile qualities involved in the art of creation (Direct Involvement)
C. Transparency of the process (Knowledge Building)

With the advancement of technology and ubiquitous computing, the children of today have an overwhelming exposure to instant gratification. These easy accomplishments help them with rapid intellectual growth. However, the physical endeavor attached with creative skillfulness is diminishing. I elaborate on this aspect in the next section under the rubric of 'The History of HAI'.

My insistence of mechanical design model is based on two rationales. Firstly, the aim is to design for sustainability. Hence, the idea is to minimize resources. The mechanical functions of the artifact uses the energy of the user in the process of creation instead of any external resource, this is a subtle learning in itself.

Secondly, when the controls and results are not automated and hence not always predictable the user begins to explore the art of “getting it right”. This (mal) functionality helps in developing skills and improves the level of involvement as observed during the paper-making workshop. [Section 6.4.3]

Additionally, children feel comfortable using something that is relative to their own scale and that can be used intuitively without any help. Mechanical controls refer to movements that are on human scale. Hence, they offer direct information-for-use. This helps the age group that this design is aimed at (Frens, 2006)[Section 6.5.1]

Making things may be articulated as a production or a creation. Nevertheless, the difference between ‘production’ and ‘creation’ has a fundamental difference in perception. ‘Production’ is monotonous, predictable and quantitative. On the other hand, ‘creation’ can be described as a phenomenon that is related to skill, art, exclusivity and a distinct experience. The making of fine wine and cheese is a creation, as it requires special knowledge, skill and understanding. The creator is closely associated to what he intends to create. The involvement with the process of creation is very intimate. The interaction with the object of creation is not only physically involving but also intellectually involving. This makes the experience unique and memorable.

With the proposed design, I wish to achieve this sense of creation. My intention is to make their experience memorable through direct involvement.

I have previously discussed the significance of feedback or transparency as an important ethical affordance. [Section 3.2] To empower the user with the comprehensive knowledge of the process of recycling plus creation of paper and the resources used in this process is a vital factor in creating eco-ethical culture. Cultivating a complete understanding of the recycling process in the creation of new paper by making the process transparent is perhaps the most important factor in designing the proposed artifact.
6.5 The Concept Prototype:

I start out by discussing the history and aspects of human artefact interactions by especially highlighting the qualities of mechanical interactions. I discuss the information-of-use provided by the artefacts, which offer a direct and transparent feedback of action. With this endeavour of designing for transparency, I propose a concept prototype, which represents a heritage piece that can signify heirloom status for creating artistic paper.

The prototype of such a machine, was created and tested amongst the audience as a metaphorical representation of the interactions that I envision the final design to have. I give two anti examples of similar concepts that I would like to refrain from in the conceptualizing of the final design.
6.5.1 The History of Human Artefact Interaction (HAI):

I take a look at how human artefact interactions have evolved over time. I do this especially to understand how to shape the design of the proposed paper-recycling machine. Although these observations are not specific to children, it provides us insights into the evolution of interaction qualities of a human body in relation to the affordances presented by artefacts.

Frens (2006) in his thesis, “Designing for rich Interaction”, analyses the various stages of the human-artefact interaction ever since man started to make artefacts. He further explains the concept of affordance as the information-of-use. He suggests that, people can use products because products offer information-for-use. Information-of-use in his view can be afforded in many ways and differs in level of abstraction of how it relates to our bodily skills.

For example, a spoon, offers information-for-use that relates directly to our body. Just the appearance of a spoon makes it apparent that the handle of the spoon is inviting you to hold it and the scooping end of it determines filling and lifting food that fits the size of your mouth. The information-for-use is very directly available in the expression of the form of the spoon. The information relates directly to our bodily skills.

On the other hand, a typewriter offers a series of labelled buttons that give information-for-use. The form of the buttons shows that they can be pressed, but what will happen then is only decipherable by reading the labels on the buttons. The information-for-use in case of a typewriter is much more abstract in how it relates to our bodily skills.

The handcrafted tools and artefacts before the industrial revolution such as hammers and knives were in a way, mechanical extension of the human body. The clue (affordance) for using the product was largely apparent from its form. The perceptual-motor skills of the person operating the products determined single or multiple functionalities of these products.

In the era of mechanical products, artefacts and tools offered new functionality and further extended and amplified the physical reach of man. However, these products and tools were not as versatile as the handcrafted products. The functionality of mechanical products was mainly determined by their mechanisms and less by the skills of the user. The operation of controls made themselves visible such as the handles, knobs and the levers. Since these mechanisms and controls referred to movements that were on human scale, they offered direct information-for-use.

Thereafter, electrical components replaced the mechanical handles and levers as functional parts of products such as telephones, cabinet radios and kitchen appliances. They were smaller than the earlier mechanisms; hence, designers gained more freedom in shaping artefacts. They also offered new functionality and different styles of controls compared to the mechanical products. Switches and dials replaced the cogs and levers. Hence, the information-for-use became more abstract in the electrical appliances. This abstraction has continued in the digital era as the miniaturization continued.
The traditional industrial design process is concerned with the design of the physical form. Whereas, the design process of digital interactive products is an eclectic mix of the physical aspects from the traditional industrial design and interaction design techniques borrowed from the Human-Computer Interaction community (Frens, 2006).

Over time information-for-use has become increasingly abstracted from human skills. Ulmer (2002) states that man’s lifetime of experience with the physical world and according to Buur et al (2004), a body that is capable of doing very refined things has become obsolete. Frens (2006) argues that for rich interaction, it is important to provide information-for-use through form, thereby making functionality immediately accessible for human skills.

As Gibson (1986) points out, an affordance is neither a property of the environment nor a property of man, but that affordances can only exist as a combined relation of the environment and man. Frens (2006) brings this theory further by stating that it is inspirational for designers to design so that humans can meaningfully interact with the environment based on his perception and not based on his memory. He suggests that artefacts with rich interaction may be designed so that they are intuitive, and have an expressive, meaningful form. In other words, it might be possible to design products that can be gradually explored and that need skills beyond memory.

Through my elucidation of this concept of interactions; designing through form so that the artefact also meaningfully refines human skills, I would like to take us into the mechanical era of artefact design. This I do especially with a view on eco-ethical design and designing for sustainability.

To address this concept of refining human skills specific to my target group of children, I would like to also quote Montessori (1949) on the importance of developing life skills in children from her book, “The Absorbent mind”.

“"We may put it like this: the child's intelligence can develop to a certain level without the help of the hand. But if it develops with his hand, then the level it reaches is higher, and the child's character is stronger. So even here, in what we tend to think of a purely psychological matters, the facts are that a child's character remains rudimentary unless he finds opportunities for applying his powers of movement to his surroundings."

6.5.2 Creating creativity:

With reference to the design strategy as stated in the earlier section [6.4.5], keeping attributes and visions of the final artifact at heart, I decided to create a metaphorical concept prototype which,

a. Contained some mechanisms for the children to operate  
b. Gave the impression of creating paper  
c. Showed the process of making the paper

My intention was to take inspiration from a heritage piece that was both interesting and fun for the children. Hence, I created a bioscope box. A bioscope is a classical travelling cinema that is integral to a children’s fair. It has two spools on two sides of a box and a couple of viewing holes for the children to view a little animation movie. There are mechanical anglers on top of the box to reel in the animation from one end to the other end.

I replicated this simple mechanism in a cardboard box. In addition, I also created two slits on the two other two sides of the box. On one end, the children were asked to put bits of paper and on the other end, there were hidden previously made paper sheets, which I slid out after every cycle of the animation was completed. The animation was a series of images in the form of a paper collage, which showed bits of paper mixing up with water and transforming into a sheet of paper.

Step one: put bits of paper in the slit of the box  
Step two: look into the viewing window and see the process  
Step three: slide out the handmade paper sheet

My objective was to test the children’s interactions with a classical piece such as a bioscope, which is not the type of artifact that they interact on a day-to-day basis. Moreover, I was interested in noting their reactions when they discover a real sheet of handmade paper at the end of the viewing cycle. I also wanted to see if they could narrate the series of events through pictures or through words. [Section 3.4.5] This was mainly to gauge the effect of the prototype and their understanding through it.

I have attempted to use recycled box, used paper and recycled magazine paper to make the paper collage of the narrative strip in the bioscope to ensure minimum wastage of paper in the making of this prototype and throughout the project. Moreover, the making of the prototype was done in collaboration with the children of Fritids.
6.5.3 Observations from the prototype:

I chose to call the prototype, a paper-making machine. I got a mix of children; some had been a part of the paper-making workshop and others who were entirely new to the subject of paper-making. The children were between the ages of 6 to 8 years.

The box raised a lot of curiosity; the situation would have got unmanageable for me. Hence, I had to allow just 3-4 children at a time for the testing. Approximately 15 children interacted with the machine. The time they spent with the prototype was approximately 2 hours. Most of the children wanted to repeat the process more than once.

Here is the description of the scenario when they experienced the prototype for the first time. [Fig. 27]

A basket of paper that needed recycling was put at the side of the box where the children could shred the paper into tiny bits, thereafter they moved to the viewing window to see that these bits are flying into the box and are being churned with water and the water was changing the color as the churning continued. The churned liquid then settled into the mould and deckle, which then got pressed by a sponge and the sheet of paper is ready. At this point, the animation is over and the children look up from the viewing window. I then open the slit of the box on the other end and hand them a real handmade sheet of paper.

The majority reaction was ‘AAH’ or ‘WOW’. Most of them quickly ran to get more friends to show them what they had just witnessed. They believed it, now they wanted to try once again.
The second time experience was just as magical for them, but there were many questions:

1. Did the paper really get mixed with water?
2. How does it work? How did you do it?
3. Does it work on electricity or battery?

The third time they wanted to control the machine, so I let some children turn the mechanical knobs while the others looked into the viewing piece. The one’s on the controls felt in charge and then I let go for them to discover my bluff. However, the box continued to mystify them.

Some narrated the story of what they saw in the box, others used the paper and made things out of it to stick on the box. An interesting piece of observation was that a child made the connection of this box with the smiley icon I had created on the sheets of paper during the size and symbol experiment. [Section 5.2.3] [Fig. 28 and 29]
6.5.4 Related Examples:

The Homestead fair in Texas encourages children to interact with hand tools and involves them into making things through workshops and demonstrations. It is a fun and educational festival with an exposition of fine crafts and heirloom skills. They especially focus on making unique heritage products. This fair has a similar vision to what I propose through my prototype.

On the other hand, I would like to give a few examples that have similar functionality to what I have proposed. However, these are the antithesis towards my goals of design and hence I propose to refrain from such blunders.

Nakabayashi is a Japanese paper-recycling machine that converts office paper into toilet paper rolls. Approximately 1800 A4 size paper sheets would make two large toilet paper rolls every 2 hours. [Fig. 30]

The machine has been criticized over its extremely high cost price of 95,000 US dollars and its bulkiness as each machine weighs about 600 kilograms not to mention the energy usage in processing the paper (Inventor Spot, 2011)

Figure 30 Nakabayashi toilet paper maker and Tara paper-recycling machine

Tara paper recycling machine is made for schools in India especially to recycle paper into handmade paper and cardboards that can be utilized for crafts and gift materials. The machine is unwieldy, inconvenient and awkward looking (DA Sustainable Livelihoods)

Moreover, it is also very bulky and not suitable for children to operate.

I would like to keep these examples especially handy so that what I propose cannot be confused with anything like this.
7. Results and Analysis

I revisit the research question in this section and analyze it in relation to the learning in the journey of empirical observations and understanding.

I restructure the research question with an added insight from the user group by adding a layer of ‘direct involvement’. ‘Knowledge’ continues to remain a key factor and ‘designing for transparency’ continues to be a key strategy in the overall goal of embedding an eco-ethical culture.

I also brood upon the practical issues regarding desired goals versus challenging scenarios. I then put the proposed design through a critical lens of sustainability issues and project the opportunities and threats that it may present.
7.1 Revisiting the Research Question:

I began the research by addressing the ambiguity of information in relation to eco-ethics. I then discuss the design of various affordances that may constrain or inform the user to behave eco-ethically. To understand how design of affordances can shape human behaviour I set out to make interventions in the empirical setting of the school through experiments and workshops.

With the goal of empowering the user with the knowledge of eco-ethics, I have proposed an argument for designers to adopt the transparency strategy. By proposing to design for transparency, I suggest that artifacts should provide a complete knowledge of the use of resources. This knowledge with the help of appropriate affordances should also help the user to behave responsibly.

Within the framework of eco-ethics in terms of “paper use” and using the context of Fritids environment as a base, I have tried to explore my strategy of “designing for transparency.”
In the course of this journey, I have learnt that especially, if your user group is children it is important to add a layer of direct involvement toward the goal of empowerment. With the understanding of the child psychology of “learning by doing”, direct involvement in the processes has a lasting impact with this age group.

Moreover, with the chosen user group it is essential that both the education and responsibility have to be presented in a way so that it does not become a chore. Hence, if they are encouraged to engage in the process, the method becomes interesting and the learning is hands-on and in relation to their daily lives. Consequently, through direct involvement we establish the crucial link between the general sense of environment and specific daily actions (Holt, 1970).

Weaving my hypothesis through the proposed design strategy of transparency and through the methodology of direct involvement, I endeavor to accomplish the goal of embedding an eco-ethical culture. [Fig. 31]

Children and eco-ethical affordances:

The observations in the course of testing the metaphorical concept prototype with the user group have confirmed my hypothesis of “designing for transparency” to some extent. However, there is no conclusive evidence that such an effort will accomplish the goal in a long run. A high level of artifact-fatigue is often observed with this age group. There is a very good chance that after the initial excitement and curiosity has passed they may find the process boring and tedious.

The attempt was hence made to build the artifact as a curious looking heritage piece, a piece that signifies longevity and heirloom status. Children may not be able to grasp the heritage qualities of the piece, however the unusual characteristics of the artifact helps to generate added curiosity and also helps to convey the sustainable meaning. At the level of the metaphorical concept prototype, the viewing windows implicated this curiosity. Furthermore, since the children in the Fritids are between the ages of 6- 9 years hence, each child would typically stay in this section of school for three years. Additionally, there will be a fresh set of children coming in every year. If the artifact finds its place in Fritids, the older children can pass their knowledge of using the machine to the younger children.

The mechanical controls of winding the spool by turning the knobs were performed with ease and enthusiasm. This was especially interesting as there were many children to look through the viewing window but only one child was at the controls. This made the act special and conveyed a sense of power.

The ease, with which I could convince the children that the process was real and that they really made paper, shows that it is difficult for them to separate reality from play. This literal understanding presents many possibilities that can be manipulated.
The primary function of the artefact proposes the eco-ethics of paper recycling, however, it also proposes a solution, and a creative alternative to “how” this recycling is possible on a everyday basis. This brings out the possibility towards developing culture.

During the “go green week” competition [Section 6.3.5 p. 47], it was observed that the children manipulated the paper-use log to show low figures and to win the competition. This gives us an insight into the psychology of “pretending to look good” in the context of sustainability. Eco-ethics in this age group show similar insights such as in the adults.

I would also like to point out at this juncture that my intention in this research is not to change behaviour but to embed a culture. The selection of my user group determines this strategy. As explained earlier in this thesis, the motivations for choosing the age group of 6-9 years is so that the eco-ethical culture that builds within this age group may have a lasting influence through their lives. [Section 2.1]

Likewise, we can also hope that this empowerment through knowledge of eco-ethics may resonate from children to their parents. However, there is an equal possibility that the culture from Fritids may not carry to home environment and that the culture may develop only in relation to the artefact and the environment of Fritids and in relation to the peer group. As observed by child psychologist Corsaro (1985), children in peer groups must be seen as a distinct entity from a single child. He also observes that, the status and power within the peer groups is a very important factor in determining the trends and culture of the group. An entity of a peer group of children also tends to have added influence on adults.
7.2 Sustainable Design for sustainability:

My effort for conceptualizing the child friendly paper-recycling machine was to make the paper lifecycle visible to the children and involve them into improving the life of a paper by changing its form and through creative use. However, the big concern is that the final design of the artifact itself should reflect the sustainability aspect of the design. Various considerations that must be weighed and scrutinized, such as,

1. The water use must be limited
2. Energy use should be avoided or must be minimal if inevitable.
3. The materials used to make the artifact should harmonize with the nature’s design rather than overwhelm it
4. The waste in the process should not clog or contaminate the drains

7.3 Place Specific:

At the inception stages of such a machine, we are not yet able to determine the possibilities beyond its functionality of use in the arts and crafts and hence for the time being we can presume that it will be used specifically in schools. Hence, most likely the recycling machine may become place specific. It makes the children creative within the Fritids environment of the school but it may not correct their habits at home.

7.4 A part solution:

The machine is only a part solution to the recycling problems; not all the paper in the school maybe suitable to put through this machine. However, it does give the children a first hand experience of the process of recycling. Their involvement in making paper from paper would engrain into them the importance of reuse and recycle. This may also lead them into finding ways of recycling other materials. For example old sock puppets or rag dolls.

7.5 Bi-products:

The extra paper pulp that is made in the process can be also used to make paper mache toys and more such strategies can be developed to maximize the recycling.
8. Reflections

I open the discussion to understand what the term ‘sustainability’ means to the people. I note the contradictions and limitations of information that is available to the public. I further note the perils of inventions that have resulted in the deterioration of natural resources. I bring into focus the terms such as ecological rucksack and the ecological footprint. I reflect upon issues that are germane to a designer such as the product lifecycle, the materials and the resources that are integral to design generation. I consider some radical ways of design methodology that may be worthy of considerations in the interest of sustainability.

I then summarize my journey through the research. Discuss its contributions to the field of Interaction Design and the future opportunities that it may present for the designers.
8.1 The Ecological rucksack:

I took a little vox populi (Survey Notes) to define sustainability – I received a variety of answers.

What is sustainability? Is it the ethical use of natural resources? What is the ethical use of earth’s resources? Is it the minimal emissions of CO2 and fossil fuels; is it restoration of the endangered species, forests and mangroves? Is it about self-sufficiency within a locality, a city, a state or a country? Is it about reducing the consumerism and hence productions? Is sustainability the opposite of development and growth?

The answer is clearly not in black and white, right and wrong. However, what is apparent is that the responsibility rests on people. If you would like to reduce the consumption by reuse and recycle it will be the public at large. On the other end of the cycle, if one is to monitor production or trigger innovative products and services to facilitate the saving of natural resources, it will have to be the policy makers (governments, organizations, etc). In any case, it is about developing the right understanding of ethics in terms of sustainable behaviour. Awareness is a general term used. Awareness is wide, it can be through education, demonstrations, a news item or through the manufacturer’s claim with an advertising campaign.

However, the information received through this awareness is ambiguous. An ecologically designed car has perhaps gone through the most environmentally unfriendly process of production (Toyota Prius). Somehow, when innovations trigger, their effects are manifold and may often be out of control from the sustainability perspective. As Thackara (2005) points out ‘In the bubble’, that during the times of the Industrial revolution and inventions of electricity, television or aviation, when they delivered a spectacular package of promises, the unforeseen consequences of their innovations can perhaps be excused as naïveté. However, that alibi is not available to the Silicon Valley developers. It is imperative for designers to look ahead in time and predict the consequences of their design. Map the perils and design responsibly.

Information networks which promised paperless offices, on the contrary began to talk to printers with the help of Ethernets and increased the use of paper eight fold (Gilder, 2000).

Gilder (2000) predicts in his book Telecosm that Internet computing will soon consume as much power as the entire U.S. economy did in 2001. According to Konrad (2001), a single server farm consumes the same amount of energy as a city the size of Honolulu.

Every product that enters our lives has what they call a “hidden history”- an undocumented inventory of wasted or lost materials used in its production, transport, use, and disposal. They call all this waste the “ecological rucksack” of a product or lifestyle.

The ecological rucksack differs from the ecological footprint of a product, a rucksack determines the true origin of the raw materials and the overall waste management during the process of production of the item both upstream and downstream. Ecological
footprint on the other hand gives you the idea of the associated use of natural capital in contrast to the planets non-renewable resources. The rucksack portrays the load each produced item puts on the environment. Here is an example to illustrate a difference between the two notions: one may be conscious of the ecological footprint aspect when a material such as the naturally degradable timber is used, but one would scarcely think of its impact on the environment even before buying it! Thus, if one decides to buy flooring and in spite of making sure the timber originates from Europe, one may not be aware that it has been transformed in Chinese sawmills! Not only does this imply transport pollution but thousands of poor Chinese people that may have been lured into leaving the country side and end up as helpless low-cost workforce.

8.2 The product lifecycle:

Ann Thorpe brings forward a very interesting argument in her book ‘The Designer’s Atlas of Sustainability’. She points out that it is not possible to understand a living thing or an artifact without understanding the networked system of which it is a part. The holistic approach of understanding the whole by seeing parts in relationship is familiar to designers. It is important to use iterative techniques that require them to go back and forth between the big picture and the details of individual parts. The big picture, though it may include only the artifact and the immediate user, often includes broader aspects of the context for the artifact (Thorpe, 2007).

In designing for sustainability, Ann suggests that it is important to see artifacts as part of the nature’s holism. The key to an eco-design is the challenge to develop the ability to see materials and their use in designing the artifact in such a way that they can be balanced elegantly in the big picture of ecology to harmonize with the natures design rather than overwhelm it (Thorpe, 2007).

Usually, designers focus on the construction and use of an artifact. However, the true challenge is to be able to look beyond these factors. The first step maybe to see the material trails that will constitute the making of the artifact. To think of all the raw materials, the waste materials, the logistics and energy required for the production of the artifact. Moreover, it is important to understand the entire life cycle of the artifact. She point out that the general outline of a product life cycle of building a small electronic device or a brochure is almost the same. [Fig. 32]
This may seem like a daunting task at first. However, if you consider any food package, you will see listed on it all the ingredients, a nutrition chart, it will inform you of any allergic ingredients, preservatives and sometimes even the manufacturing conditions. It also informs you of the place and date of manufacture, recommendations of storage and the date of expiry. The package informs you even before purchase, a significant history of the product. It is then up to the choice of the user what his priorities are. The reason of making this information mandatory is so that what we eat should comply with how our body functions.

If the design and production of each artifact is monitored to comply with nature’s ecological balance, this may evade the detrimental effects of eco-poisoning.

8.3 Woodless Paper:

Mc Donough (2002) an architect and Braungart (2002) a chemist have printed their book ‘Cradle to Cradle’ on synthetic paper. The synthetic paper does not use any wood pulp or cotton fibre but is made from plastic resins and inorganic fillers. This Durabook format is based on a revolutionary technology patented by Melcher Media Inc. They claim that this paper is waterproof, durable, child tested and recyclable. The book according to them is a prototype of a product that can be broken down and circulated infinitely in industrial cycles as paper or other product.

In their opinion, a tree is one of the finest of nature’s creations and it plays a crucial and multifaceted role in the interdependent ecosystem. They feel that, a tree is not a fitting resource to use in producing a humble and transient substance such as paper.

A radical approach to design by visualizing entirely different materials through scientific innovation is also a promising factor in the interest of environmental sustainability.
8.4 Retrospections and the Road Ahead:

My goal in this thesis was to research what are the possible ways of embedding an eco-ethical culture. I have chosen paper use as a tool to demonstrate my hypothesis. I would imagine that my hypothesis of ‘designing for transparency’ through direct involvement holds good for developing eco-ethics in relation to a responsible use of any other natural resource.

I see an emergent need for people to be empowered with the overall knowledge of eco-ethics. Eloquent interventions through interaction designing techniques can make this possible. I have demonstrated this possibility through developing leads of a variety of design placements in the context of the chosen school. Interaction Designers with relevant talents and inclinations may be able to pursue these leads to develop design ideas. [Section 4.5 and 5.2]

The concept of recycle is often associated with responsibility. Through the design of the proposed artefact, the intention is to redefine ‘recycling’ as a pleasurable and a creative activity. One may argue that the function of the artefact is no different from making an old sock puppet. Then again, even in its inactivity, the artefact is more than just doing craft; it is a reminder that paper must be used responsibly and a riposte of the dilemma about ‘how’ paper can be used responsibly.

Perhaps, this is a crucial aspect of consideration when designers address the issue of sustainability. An effort must be made to embed the culture of eco-ethics into the day-to-day life styles of the user in a subliminal way so that the user does not have to make any extra effort in adapting to this culture.

Working with children:

The chosen age group of children and the observations regarding their behavioral psychology may be useful for other interaction designers to draw upon when addressing similar target groups.

Overall, the experiences, insights and understandings through the journey of developing my hypothesis have been rewarding. I have tried to keep my mind open throughout this journey and have tried not to overwhelm any of my decisions by preconceived notions.

My design decisions have been mainly guided by the users, that is by remaining attentive to their behavioural psychology. I have adapted my Interaction Design working methods, to suit the environment of the specified school and its Fritids environment. Grasping the temperament and disposition of the milieu in which the design is placed is vital to a user sensitive design [Section 4.3]. Fun and creativity hence became vital to my working method.

I can easily succumb to admit that both the methodology of direct involvement and the design idea of the paper-recycling machine, were actuated by noticing the enthusiasm and interest shown by children. The design and the prototype have been user generated and collaboratively created. On another level, this also confirms Corsaro’s (1985) observation
as mentioned earlier [Section 7.1] that an entity of a peer group of children has added influence on adults. This is a crucial learning especially while working with the given age group.

I believed that I have had little success with some of my experiments such as, when experimenting with the symbols. [Section 5.2.3] [Fig.20] However, the narration of the very same symbol on the final prototype told me a different story. [Section 6.5.3] [Fig.29] This gives you an idea of how sensitive this age group can be and the potential there is toward making lasting impressions on them. Moreover, this also confirmed the psychology of a child’s expression through images as mentioned earlier [Sections 3.4.4 and 3.4.5].

I have enjoyed the freedom of gathering empirical understandings and during the design process without any institutional restrictions. There are practical issues concerning privacy and security which become vital while working with children and these had to be especially dealt with during documentation of the project. For example, taking pictures is usually prohibited in schools, hence special permissions need to be taken. However, I have strived to work within the school’s system, policies and its ongoing schemata. For this it was important to adapt to the culture of the place and understand the vision of the school. For example, the IB course structure encourages ‘Learning by doing’. Opportunely, the visions of the school happened to match the goals of my design [Section 7.1].
References & Notes:


Eliasson, A. (annelli.eliasson@bladins.se) (9 March 2012)

Paper use in Bladins – Statistics

Approximately 940,000 sheets of A4 paper per year is used by the administration for the whole school and all the teachers and students.

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Nilsson, G. (goran.nilsson@bladins.se) (15 March 2012)


Notes: 7000 Oaks and Counting (2007), Tiffany Holmes situates a screen-based visualization of energy expenditure in the lobby of the National Supercomputing Center. The visualization depicts the number of trees needed to offset the building’s carbon footprint (referencing Beuys’ 7000 Oaks). Specifically, data is expressed through circular
and swirl-like patterns, images of nature (often trees), and screens of textual information discriminated by color and typographic hierarchy.


Suvery notes – A cross section of people were asked on the spur of the moment to define sustainability. The sample size was approximately 20 numbers. These comprised mostly
(17) of adults and some (3) students. The answers ranged from a personal point of view, such as, save trees, save the planet, use bicycles, save wildlife, use local produce, control CO2 emissions. The most common answer was the dictionary meaning of the word, something that lasts.


# Project Plan – Phase 1

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Week 21st (21st May to 27th May) – Exhibition Setup