

## Come Together, Right Now, Over Me: Conceptual and Tangible Design of Pleasurable Dupliances for Children

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### Abstract

This paper adds to the small amount of existing research on the design of children's technology. We present the concept of dupliances, which are defined as devices that encompass both physical and virtual activity, as an alternative to information appliances that are only intended to support specific information related or virtual purposes. A key design incentive is to put the uninteresting physical bodies of current information appliances to use. This has been accomplished here by combining the physical theme of play with the virtual theme of communication. The results of this mating are presented through two design concepts: the YoyoPager, which combines a yoyo with pager functionality, and the SkipRope++, which merges a skip rope with a cell phone. The overall design goals were simplicity and pleurability, and the dupliances designed came out physical, multisensory and allowing social interaction and sharing while still being personal. We believe they may work as instances of the intangible with which children can interact and experience.

*Keywords* Dupliance, Children's Technology, Multisensory, Interaction Design

### 1. Introduction

In today's western society, computers are literary everywhere; at schools, at work, at home, in your car, in your television set, on television, in your refrigerator and in many other places. In some of these places, it is as if you never knew they were there. The computer in your refrigerator, for instance, usually keeps quiet and maintains the temperature without interfering or obstructing. However, most computers you are likely to run into on a day-to-day basis are much less invisible. The desktop computer for instance, as common an *objet d'art* as anything on today's desktop, is anything but invisible. Rather, it is intrusive and overbearing, complex and imperious. It leaves us with no time for ourselves and with an uncanny sense of lost control (Norman, 1998).

Still, the problems and the complexity we encounter when using a desktop computer are small compared with those of a 5-year-old, e.g. when trying to use the physical mouse to control a virtual button on a window that is inside a computer screen which diminishes and abstract any lifelike interaction. And even if these obstacles could somehow be defeated, the 5-year-old would still not be able to read the button's label.

When it comes to research on the design of information technology, children seem to a large extent have been left out. There is only a modest amount of research published in the field (Druin & Solomon, 1996), especially if we regard it as separate from publications that deal with the impact technology has on children, which is more common. A part of the answer to why this may be is that it is only recently that technology for children has become commercially successful in industry. Also, as new technologies are becoming vital ingredients in schools and homes, developing creative and exciting technologies for children becomes attractive (Druin, 2001).

In this paper, we intend to add to the small body of research on design of technology for children. It will be demonstrated how the concept of dupliances (Andersson et al, 2001) may prove useful for children's technology when its instances focus on simplicity and pleurability, which we believe to be important elements of children's technology that to a large extent is nonexistent, regarded as suspicious or even unwanted in technology aimed for adults. The paper begins with an analysis of information appliances, and how some recognized drawbacks of this concept inform the design of dupliances conceptually. We then move on to present our design methodology and process for designing children's dupliances, and give an account for the prototype dupliances that have been developed. Then follows an assessment of the prototype designs, and analysis and a discussion of these prototypes in the context of the perceived user group, after which the paper end with a conclusion.

## 2. The Information Appliance

The term *Information Appliance* was originally coined by Jef Raskin in 1978, but were only recently renewed and made widely popular by Donald A. Norman's *The Invisible Computer* (1998). Here, Norman sees the information appliance as the vehicle away from the intrusive, imperious and intrinsically complex desktop computer, toward a more humane, unobtrusive and invisible model of computer use.

Traditionally the term appliance has been used to name devices designed to perform specific functions—especially electrical household devices such as toasters, coffee machines, mixers, refrigerators and corkscrews—and which do so efficiently and with little conscious effort from the user (Mohageg & Wagner, 2000). Information appliances are also defined as being designed to support specific activities, but specialize in information (Norman, 1998). Mohageg & Wagner (2000) broaden the definition to include information technology artifacts dedicated to a small group of tasks, which most often come as small, easy to use and low cost consumer devices. Examples of information appliances are: calculators, fax machines, telephones, electric musical instruments and digital cameras (Norman, 1998). Recently, the notion of information appliances has also given name to a host of small devices, such as hand-held computers, mobile phones and PDAs (Mohageg & Wagner, 2000). Whether or not these devices are in fact appliances in the traditional sense is highly debatable, but the term has been widely accepted and now appears frequently, e.g. in advertising, even if the concept is not always understood or pursued (Norman, 1998).

The main characteristic of an appliance as well as of an information appliance is its simplicity to learn and use, and an element of elegance from the simplicity of its limited purpose and scope. Information appliances also benefit from the specialization of function in that it allows customization in terms of operation, look, shape and feel. In addition, Norman (1998) suggests three axioms for designing information appliances. The first design axiom proposed is simplicity, where the appliance should strive for invisibility to the task in a Heideggerian spirit, where the tool should be so designed that it becomes a part of the task itself. Second, it should be versatile, allowing novel combinations and creative interconnections with other appliances, and third, it should be pleasurable in that the user takes pride and has fun in owning and using the information appliance.

### 2.1 Drawbacks of Information Appliances

Some of the presumed benefits of information appliances proposed in the previous section introduce a number of tradeoffs. While designed to be simple and specialized, these characteristics seem to come at the cost of lost flexibility and power. Both Odlyzko (1999) and Norman (1998) note that there is no distinct tradeoff between flexibility and ease of use that is optimal for everyone, and for that reason there is no universally optimal configuration of an appliance as people have different needs. For instance, a child would probably not value the same configuration of a digital camera that would an adult. Moreover, a balanced configuration may not even be possible to achieve for a limited user group such as a household, or even a single individual user, as people's skills and expectations grow through learning.

Another drawback that information appliances suffer from is that while the concept of simplicity and devotion to a specific instance of functionality may be elegant in several ways, in practice it also infers that many users will have to carry a whole range of appliances. As for the ordinary office workers for instance, the accumulation of the multitude of appliances they would be humping seems likely not to be as elegant as the single appliance may appear by itself.

Furthermore, while all these devices each support one specific instance of virtual activity their physical bodies are merely lifeless containers. Mohageg & Wagner (2000) avow that a refrigerator is bought solely for the purpose of keeping groceries cool, and that it does little else than blends with the rest of the kitchen aesthetically. From our experience in working with consumer products, we feel it is safe to say that the refrigerator is in fact used for a host of other purposes as well; such as a notice board for shopping lists and photos, and—in extreme cases—even refrigerator poetry. Information appliances, however, seem seldom to give rise such additional physical functionalities. The physical body of a cell phone is primary nothing but a jug of the electrical circuits needed to support the virtual activity of allowing people to talk over distance. The physical shape of the cell phone is traditionally only used to communicate a language of design chosen by the manufacturer. Recently, some manufacturers have begun shipping cell phones replaceable covers in different colors. A potential interpretation of this recent advance is that cell phone manufacturers have found that users do not only find the virtual functionality of information appliances to be important, e.g. how good the sound of the cell phone is or how well the antenna does, they also value and appreciate their physical appearances.

It has also been argued that when one device is asked to do more than one thing, it must compromise on how well it handles each distinct task. The specialization, in terms of physical shape, features and structure, that makes an information appliance ideal for one task will interfere with any other activities (Norman, 1998). However, this view presumes that the scope of the device is limited only to support virtual tasks. It is not as

apparent if we consider simple analog appliances, e.g. such as a napkin. It is not unusual for people to put a knot on the corner of a napkin as a reminder of something, where the knotted corner may in fact be considered an instance of virtual functionality being added to a physical item, the napkin. According to Norman's view of appliances, this added second task would limit the napkin's suitability to its physical task of drying one's hands. However, we believe that the napkin in this example retains its physical functionality while it is able, at the same time, to hold an additional meaning or function. The key incitement of this line of reasoning is that it is our view that an appliance may in fact have two functionalities that will not interfere with one another, as long as one of these functionalities is intended to support virtual activity while the other supports physical activity.

### 3. The Concept of Dupliances

As described in Andersson et al (2001), a dupliance is a device that should be as simple to learn and use as any well designed information appliance, but instead of encompassing one function supports two functions or tasks, one of which being virtual while the other be physical. Subsequently, a dupliance is hence one traditional appliance and one information appliance that come together in one body, hence forming a dupliance (prefix *du-* from e.g. *duplicity* and *due*, Ital.). Additional motivation for designing dupliances draws on two recognitions made in the previous section: First, the physical body of an information appliance is often only a container—an unresponsive body—for an instance of virtual functionality. Hence, a dupliance could be seen to enrich the user experience either by adding a physical dimension to an information appliance, or by adding a virtual dimension to a traditional physical appliance. Second, we believe that a dupliance would not by default suffer from the drawbacks of devices that incorporate more than one functionality suggested by Norman (1998), as a dupliance would support two functionalities where one is virtual while the other is physical.

It is the responsibility of the designer to find physical and virtual tasks that are orthogonal and that may be combined in the same physical body, which we do not perceive as an obvious and easy task. In addition, we do not consider it possible to give specific guidelines or checklists on which to found the design of every dupliance, and that there is no method of design or recipe available that will always results in useful and creative dupliances. As argued by Stolterman & Löwgren (1999), the result of a design process will never be better than the people who participate in that process, regardless of what method or process that are being used. But we believe that it is possible to design many dupliances other than those presented here, many of which are probably better in some sense than those we portray.

Currently, there are not many dupliances available, but some examples of existing instances of dupliances include of course toilet paper holders equipped with virtual functionalities like LCD clocks or AM/FM radios. However, there are a number of devices that should not be mistaken for dupliances, according to our definition, such as microwave ovens and coffee makers. Their virtual functionality is only intended to support the main physical activity, and hence they are in fact appliances. Arguable, they are dupliances in that they encompass and maintain a virtual and a physical dimension, but are appliances in that both these dimensions work together towards a single goal. However, devices like *Interactive Barney*, discussed in e.g. Strommen (2000), could actually be seen as a surreptitious dupliance if we consider its physical function to be play and its support of virtual activity to be not only support of the play itself, but also to secretly influence the upbringing of children.

Early hypothetical benefits of this notion—besides putting the uninteresting physical bodies of information appliances to use—included fewer devices to carry, novel synergy effects arising from creative embodiment of both a virtual and a physical functionality, and an expectantly higher degree of acceptance from some user groups.

### 4. Design Methodology and Process

Design methods traditionally involve designers in three stages: analysis, synthesis and evaluation (Cross, 1984; Roozenburg & Eekels, 1995;). During analysis, available knowledge on existing solutions and properties of the environment form the basic input to the process that determines the structure of the problem space in which the solution is sought (Goel & Pirolli, 1992). The dilemma is that we by generating knowledge from the current situation limit the boundaries of the problem space, hence the space in which we search for design solutions, and it is implausible that novel or radically different design solutions will be generated. To overcome this, we were influenced in part by the approach to productive design argued by Hekkert (1997).

The approach used in this project consisted of four phases, some of which were executed concurrently and iteratively by a group of three designers. First, we searched to break down the structure of the old problem space by trying to question and bring up for discussion all our knowledge and assumptions about information appliances. During this phase we made observations about problems and benefits of information appliances, but because of the second part—the construction of a new frame of reference around the concept of dupliances—we were not limited to design solutions determined by the structure of the problem space of information appliances.

As described in section 3, the novel concept of dupliances became the overall product vision, and we found ourselves no longer in danger of sub-optimizing the notion of information appliances.

Third, we established what we entitle a *Context Picture* for the dupliances to be designed. A proper understanding of the needs of any product as well as any user can best be obtained when the product's context-in-use or the user's environment is known and explored. Once obtained, the context picture acts as frame of reference for a straightforward assessment of new design solutions, especially in terms of general validity and verification issues. In practice, the context picture is a physical folder containing written information about the target user group and the environment in which they will be using the product, and some quick paper-based sketches of typical user group members are also created. In addition, it is encouraged that all members of the design team gather pictures, clips and photocopies from newspapers, magazines and books to be put in the folder to further represent the user. Given time, this folder provides us with a simple but useful representation of the user against which to review design ideas. Depending on the size of the project, the written information found in the context picture folder can be either assumptions made by the designers, or better: information gathered through literature studies or empirically through questionnaires, interviews or observations. Obviously, the context picture is in a way a "low-fidelity user", which is most useful in certain stages of the design process, but we do not consider it as a satisfactory alternative to talk to, test and evaluate real users. Rather, the context picture is seen more as a straightforward complement.

Fourth, when the concept of dupliances as well as the context picture began to sharpen, we came up with a number of design concepts through a three-staged brainstorm session (see e.g. Jones, 1992). Here, physical appliances were listed on the left part of a large whiteboard, and virtual appliances-like activities on the right, after which each physical item were combined with each virtual item. To curb the number of possible combinations in order to focus the session, *play* had been chosen as a theme for the list of physical appliances, and *communication* as a theme for the virtual task list. We went through the list to find pairs that made sense subjectively and no ideas were criticized at this stage. These pairs were listed as dupliance candidates on the center of the whiteboard. Quick paper-based sketches and short use scenarios were then constructed of each candidate and structured, analyzed and discussed in terms of the framework of dupliances and the context picture. The outcome of this effort was the two design prototypes presented in section 5. For these we then developed several paper-based sketches, some expanded use scenarios and eventually tangible prototypes.

#### *4.1 Designing Dupliances for Children*

The notion of dupliances is like that of appliances in that it is a concept of possible products rather than a product in itself. To be able to design dupliances with any prospect of being accepted and successful the audience must be known, and information must be gathered about the users and both the social and physical environment in which they roam. This is done through the concept of context pictures introduced in the previous section. We began by looking at a range of possible user groups denominated by a number of different aspects, such as age, occupation, recreational pursuits, personalities, geographical location etc, all of which could be supported by dupliances. As we have a special interest in the design of children's technology, and we feel that there is much yet to be done in that area, we choose children age 5-10, which was later adjusted to 4-7, as the target user group for this particular set of prototypes. The age span was lowered partly as a result of user feedback, and partly because we soon found it intrinsically difficult to come up with ideas of dupliance designs and scenarios of use that seemed proper and made sense for children age five to ten. It was difficult to uncover both appropriate activities to support as well as interaction techniques that would be useful for a 5-year-old while still being accepted by a child of 10. In the same way, it was difficult to find activities and interaction styles that 10-year-olds consider fun, hip or cool that are comprehensible to someone that is five years of age. We believe that the 4-7 age span to some extent is more coherent than children age five to ten. One important factor we took into consideration is that children in Sweden generally go to school when they seven years of age. Hence, designing for pre-school children allows us to make generalizations about e.g. illiteracy and daytime activities. However, it must be recognized that there are large differences between children of any age, and consistent user groups are in effect unattainable. But since it is from a commercial point of view impractical to tailor products to diminutive groups of users, these are the kind of generalizations to which designers are forced.

Designing technology for children is also enticing in that it may be considered less constraining than developing products for adults, as it may be easier to escape the obvious goals of effectiveness, efficiency and productiveness that often tend to permeate the goals of technology for adults (Druin, 2001). In addition, children also bring many interesting limitations, which makes projects interesting on a more concrete interface level as well. Input, for instance, is generally limited by undeveloped fine motor skills, illiteracy, limited vocabulary and often poorly articulated speech. Illiteracy and poor understanding of letters, numbers and shapes also influence the output, where we also will struggle with a short attention span (Strommen, 2000).

#### 4.2 Overall Design Goals: Simplicity and Pleasurability

Given the dupliance candidates we have chosen that embody the physical theme of play and pre-school children as the user group, we began to consider Norman's (1998) first and third design axiom of information appliances—that of simplicity and pleasurability—as the overall design goals of our prototypes. The designs should hence, according to Norman (1998), show simplicity both in terms of functionality as well as in “ease of use”, which we interpret as possessing a high level of usability, which is a vital determinant of engagement and thus an important part of the design of any successful children's product (Druin, 2001). The designs should also be pleasurable, in that the user should take pride in owning, caring and using them (Norman, 1998). As children tend to be very upfront and honest about their toys (Druin, 1996)—if they do not like a toy they will not play with it—the second axiom becomes more than a goal; it becomes a means of design survival.

### 5. Prototype Designs

This section introduces the two design prototypes as they have evolved during the project.

#### 5.1 SkipRope++

As cell phone technology is becoming widespread, miniaturized and cheap, we might consider connecting the services provided with certain activities rather than with a dedicated device we must always carry. To some extent, equipping e.g. your car, bike, desk and sweater with cell phone technology would make the technology more ubiquitous and invisible. We believe the need for omnipresence in this respect to be especially true for children, which may be too young and have too much on their minds to take on the responsibility of carrying and taking care of a dedicated cell phone. Because the cell phone is connected to a certain activity, it may also be designed to encompass what might be expected of the specific physical activity that the dupliance supports, which in this case may be, as we will see, to support rough treatment, damp environments, shocks etc.

The *SkipRope++* design concept draws on this idea of omnipresence by combining a children's jump rope with cell phone functionality. Using the *SkipRope++*, children would have the possibility of establishing a “hot line”, either to parents or to friends. The cell phone, the virtual activity, is operated by the child by pulling and pushing back the top of the handle in which she wants to talk. The other handle is then used for sound output, as is visible in the tangible design prototype showed in Figure 3. Hence, the physical shape of the jump rope provides a natural, though somewhat historical, user interface for making telephone calls.



Figure 1.



Figure 2.



Figure 3.

Figure 1 shows one of the early paper-based design sketches. Note that the user interface still does not use both handles, and idea developed later in the design process. Figure 2 presents the evolution of the tangible design of this prototype, with some additional inspirational material to the right. Figure 3 is a photograph of the *SkipRope++* prototype in simulated use by a member of the target user group.

#### 5.2 YoyoPager

A yo-yo provides a small physical body that may encompass many instances of virtual functionality, as the physical activity of yo-yoing seems very wide-ranging, e.g. in that it can take place both indoors and outdoors, during all seasons, and the physical appearance of the yo-yo is all but bulky and of no particular hinder in most situations. Here, we choose to introduce pager functionality aimed at children 4–7 to the yo-yo.

If a parent or a friend wants to give the child a buzz, the *YoyoPager* is contacted and a pre-stored picture of the communicator or a concept becomes visible on the yo-yo while it will simultaneously blink, make sounds and vibrates. A picture of the child's mother or a friend would indicate they seek contact; a picture of food implies that dinner is being served; an umbrella could indicate that the weather is soon to worsen etc. The figurative means of communication allows the *YoyoPager* to be used by very young and illiterate children.

This dupliance also shows how a lifeless physical body of an information appliance may come to life without interfering with its functionality, and it is also to some extent an example of how the concept of dupliances might lead to fewer things to carry. We also believe that adding the physical dimension of play, which we consider to be a factor of pleasurability, to a pager might lead to better acceptance from this particular user group than would a traditional pager. This hypothesis will however need further investigation.

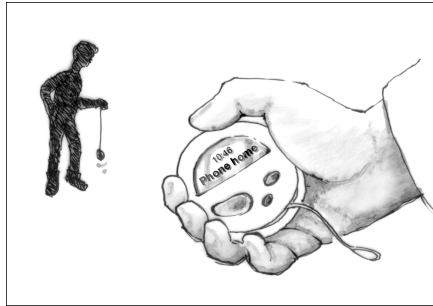


Figure 4.

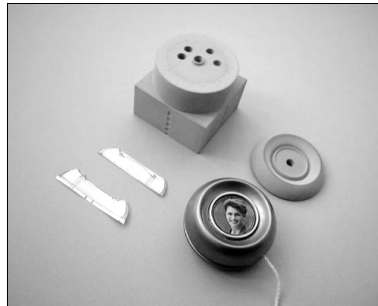


Figure 5.



Figure 6.

Figure 4 provides an early sketch of the concept of the YoyoPager. What is noticeable about this sketch is that the means of communication between the pager and the user is written language. This error of design was later changed as a result of continuous heuristic evaluation to the kind of symbolic communication discussed above. Figure 5 shows the evolution of the tangible design, while Figure 6 is a picture of the YoyoPager in the hand of a member of the user group. Note the metallic circle around the picture which is pushed to confirm the contact.

## 6. Assessing the Design Prototypes

During the design of the prototypes, two evaluation methods have been used to ensure that the designs do not contain obvious flaws and that the overall design goals of simplicity and pleasurability were being pursued.

### 6.1 Preliminary Qualitative User Feedback

First, we have gathered a small amount of very preliminary user feedback in a way that resembles that of Contextual Inquiry (Beyer & Holtzblatt, 1998), in which we observed, chatted with and took notes of three children as they were playing with the prototypes. Each session lasted for about 15–20 minutes. At times we interrupted the play with sounds to simulate the virtual functionalities, and we also asked them, after briefly introducing the concept, to try to “place a call” with the SkipRope++. The feedback we sought was qualitative, such as their perceived acceptance of the product, their opinions of the combination of functions, their attitude towards the aesthetics of the prototypes (such as the colors being used and the size of things) and the way they were supposed to interact with the devices. We also asked them if they thought “it would be any fun to use this prototype every now and then”, e.g. having it with them to kindergarten or when out playing. All three subjects said they liked the appearance of both the prototypes, and one child was even slightly annoyed when we asked him, as he was busy yo-yoing. Two of the subjects seemed to have problems using the SkipRope++ prototype’s interface. All three said that they thought the prototypes would be “fun to have”, but only one seemed so interested that he asked if he could keep the YoyoPager (which he of course couldn’t).

Other than giving us some promising yet very preliminary feedback—and inform us about a few minor design flaws such as the size and placement of the YoyoPager’s confirmation button, some additional aesthetical design ideas and minor changes in the color schemes—we are fully aware that these inconclusive results are far from general, sufficient and rigorous. Hence, we are currently in the process of carrying out a larger study of children within the user group based on Contextual Inquiry and consider this not primarily as research results but rather as some preliminary feedback useful for informing the design during the development process.

### 6.2 Heuristic Evaluation

Second, the prototypes have consistently been tested for usability towards the set of basic heuristics provided by Nielsen (1994), in what could be labeled as expert reviews or heuristic evaluation. When used continuously in an iterative style, the value of heuristic evaluation lies in informing the redesign rather than assessing the outcome. We believe that Nielsen’s (1994) heuristics are appropriate and perhaps even more important to consider when designing technology for children, and particular significance has been given to the following set of heuristics:

- *Visibility of dupliance status* and *Recognition rather than recall*: It is our view that it is of great importance that the status of a children’s dupliance be visible at all times, and that potential actions and

options are comprehensible and detectable. This is encompassed in the SkipRope++ by making the on/off switch to the virtual functionality legible in a physical sense. The user switches the phone on and off by physically pulling out and pushing back the tip of the jump rope's handle, and hence the status of the virtual functionality is physically visible at all times.

- *Match between dupliance and the real world:* It is of course important that the dupliance is consistently speaking the language of the user, but it is especially so in design situations where there is a considerable and to some extent insurmountable difference between us as designers (and adults) and the users (children). One example of a design error corrected by heuristic evaluation is in the interface of the YoyoPager. In early sketches, the design used written language to communicate between the dupliance and the user, as is typically the case of pagers. During heuristic evaluation, it was discovered that this means of communication is not suitable for users that are 4—7 years of age, as these are generally illiterate. The YoyoPager was then redesigned in order to encompass this finding.
- *Error prevention:* We believe that preventing errors are fundamental to the design of children's technology, as the whole concept of understanding errors includes some conception of the intra- or infrastructure that constitute the device or makes it realizable. This added abstraction is sometimes difficult for adults to understand, and may be even more incomprehensible to children.

## 7. Analysis and Discussion

It has been argued that designers of technology for pre-school aged children are faced with a dilemma. While computers seem to involve and stimulate, there are concerns about whether such interaction is appropriate for young children. Computers seem to have a seductive power that may draw children away from experiences that are essential to their development. There is fear that early involvement with computers may, in the extreme, result in a generation of physically, cognitively and socially underdeveloped youngsters (Fulton Suri, 1997).

In contrast, physical play, according to Fulton Suri (1997), embodies many of the characteristics that we should strive for in designing computer interactions for children, but has not been sufficiently pursued by current computer technology developers. Physical play may be both solitary, through which a child develops fine motor skills, as well as social, where simple rituals, taking turns, being a leader and being a follower is learned. Computer interaction however, tends to be solitary, where on a computer only one child is generally in control (Fulton Suri, 1997). The dupliance prototypes in this paper do not suffer from this as they support both physical play, and especially in the case of the SkipRope++, also supports social play in groups. Two jump ropes could also be configured to allow children to talk to each other, further supporting social development.

Play at the preschool age is also essentially physical, and involves multisensory experience in the exploration and formation of concepts, in terms of look and feel, smell, sound, kinesthetic and tactility. Thinking and problem solving develop through these interactions and through the child's own constructions and creations (Fulton Suri, 1997). The dupliance prototypes presented meet these requirements as they are exceptionally tangible, as they are designed to be quite small to meet the understanding and experience of scale of children at that age, and they communicate in a multisensory fashion. The YoyoPager communicates with the user through vision, sound and vibration, while it at the same time allows the child to carry it around, play with it, to place it in different pockets and to show it to friends etc.

Traditionally, computer interaction is sequential in that a child can only switch from one application to another, while traditional toys are more flexible in that they can all be brought together and creatively combined (Fulton Suri, 1997). The dupliance prototypes presented here resemble traditional toys in this manner, as they work independently of one another, since they do not share either hardware or software. This makes collective use of them, as well as switching between using them, easier than the traditional desktop computer as the dupliances each have representations that persist in the physical world. Hence, there is no abstract divider between the user and the interaction (Strommen, 2000), which makes interaction in some sense more natural.

Finally, Fulton Suri (1997) argues that it is a problem that computer activities are often not accessible by children independently. That is, the computer has usually its own special place, which is almost by definition separate from the child's space of play. This separation often leads to a need for permission and, given the intricacy at which today's desktop computers are operated, adult interference. The dupliances prototypes do not suffer from this, as they are mobile technology, which infers that they are not by necessity kept in a certain place, and belong to the child in the same sense as the child's other toys belong to him or her, and the child should not have to ask for permission to use them. As noted earlier, dupliances are also designed to be used by a child without parental interference.

We believe that dupliances may play an important role as they are open both towards the information-related, virtual world as well as towards the physical world, which in the prototypes developed for this paper has been represented by play. Furthermore, they are consistent with the terms of the three perceived opportunities to

enhance child-computer interaction suggested by Fulton Suri (1997). First, as have been noticed, they support social play, and second, they provide opportunities for rich sensory and motor interactions and in that make the virtual world more tangible. Third, they bring the notion of computing further away from the computer as a tool being used to accomplish specific work-related tasks. They are also portable and self-contained devices with appealing aesthetics that remain far from the efficiency-first basis of many of today's computer products.

Hence, it is our wish that use of these dupliances may contribute to a massification of the virtual world for the children; an instance of the intangible and incomprehensible which they can play with, feel and listen to, and since these dupliances are mobile it is also possible to share these experiences with for instance friends, siblings and parents. We believe this to be an important step towards the child's conceptualization and understanding of what is being presented to them. It is our view that children do not only reflect what is being presented to them, but search actively for meaning and understanding. These dupliances are intended to help children grasp and appreciate the virtual in a way that is careful and appropriate, fun and enticing, i.e. pleasurable.

## 7. Conclusions

In this paper, we have added to the small body of research on design of technology for children. More specifically, our target group has been children 4–7 years of age. We have presented the concept of dupliances, as being devices that encompass both physical and virtual tasks in one physical body, which separates them from information appliances that has only one specific virtual purpose. Here, a key design incentive has been to put the uninteresting physical bodies of current information appliances to use, which we for this particular project has accomplished by combining a physical theme of play with a virtual theme of communication, which were meant to result in products that come together in one physical body. The results were presented through the design concepts *the YoyoPager*, which combines a yoyo with pager functionality, and *the SkipRope++*, which merges a skip rope with a cell phone. We believe that the overall design goals of simplicity and pleurability have been met, which is also partly supported by preliminary user feedback. The dupliances we developed are mobile, physical, multisensory, allows social interaction and sharing while still being personal and are designed to work as instances of the intangible and incomprehensible with which children can interact and experience.

## References

- Andersson, N., Fallman, D. & Johansson, L. (2001). Dupliances: Physical and Virtual Activity Encompassed. *Proceedings of ACM CHI 2001, Extended Abstracts* (pp. 153–154), ACM Press.
- Beyer, H. & Holtzblatt, K. (1998). *Contextual Design*. San Francisco, CA: Morgan Kaufmann.
- Cross, N. (1984). *Developments in Design Methodology*, New York, NY: Wiley.
- Druin, A. (1999). *The Design of Children's Technology*. San Francisco, CA: Morgan Kaufmann
- Druin, A. (1996). A Place Called Childhood. *interactions* 3(1), 17–22
- Druin, A. & Solomon, C. (1996). *Designing Multimedia Environments for Children*. New York, NY: Wiley.
- Fulton Suri, J. (1997). Challenges and Opportunities in Designing for Preschool-Aged Children, *interactions*, 4(2), 36–46
- Goel, V. & Pirolli, P. (1992). The Structure of Design Problem Spaces. *Cognitive Science*, 16, 395–429.
- Hekkert, P. (1997). Productive Designing: A Path to Creative Design Solutions. *Proceedings of the Second Conference of the European Academy of Design*. Stockholm, Sweden, unpag.
- Jones, J. C. (1992). *Design Methods*. New York, NY: Van Nostrand Reinhold.
- Löwgren, J. & Stolterman, E. (1999). Design Methodology and Design Practice. *interactions* vi (1), 13–20.
- Mohageg, M. F. & Wagner, A. (2000). Design Considerations for Information Appliances. In E. Bergman (Ed.) *Information Appliances and Beyond* (pp. 27–52). San Francisco, CA: Morgan Kaufmann.
- Nielsen, J. (1994). Heuristic Evaluation, in J. Nielsen & R.L. Mack (Eds.) *Usability Inspection Methods* (pp. 25–62). New York, NY: Wiley.
- Norman, D. A. (1998). *The Invisible Computer*. Cambridge, MA: MIT Press.
- Odlyzko, A. M. (1999). The Visible Problems of the Invisible Computer: A Skeptical Look at Information Appliances. *First Monday* 4 (9), unpag.
- Roozenburg, N. & Eekels, J. (1995). *Product Design: Fundamentals and Methods*. Chichester, England: Wiley.
- Strommen, E. (2000). Interactive Toy Characters as Interfaces for Children. In E. Bergman (Ed.) *Information Appliances and Beyond* (pp. 257–298). San Francisco, AC: Morgan Kaufmann.