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SUSTAINABLE PRODUCT-SERVICE FOR CHILDREN'S SOFT MOBILITY
FLURRY, THE INDOOR-OUTDOOR BIKE

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ABSTRACT

The collaboration between Italtrike, an Italian company producing ride-on toys for children between 1 to 6 years of age, and a group of researchers from the Politecnico di Milano gave rise to the design of a new product system capable of encouraging, promoting and facilitating motricity in preschool children, through play and digital technologies. The modern day challenge is that of responding to the demands of design and innovation generated by digital transformation and not losing sight of the child's values and needs from the emotional, physical, cognitive and relational perspective. During a Design Laboratory involving a number of researchers from the Politecnico di Milano and expert designers of Design for Kids & Toys, it was possible to delve into the theme of Sustainable Product-Service for Children's Soft Mobility by developing an innovative product, both on the level of response to children's specific needs and from a technological point of view.

KEYWORDS

soft mobility, playful experience, phygital product, kid-centred design, product-service for kids

Digitisation has led to profound changes in the behaviour of adults and children. Between apprehension and opportunities we are living through a sense of confusion and uncertainty on how children of the future will engage with products and services: first and foremost, toys. Between digital fans and analogue nostalgics, there lies a schizophrenia which makes it difficult to work uniformly on the 'product system'. Everything is more complex but there are tools to successfully deal with the contemporary challenge that sees a demand for innovation and cultural quality as superior to the offer that is present on the market today. This contribution presents the results of an initial research involving collaboration between universities and businesses in developing an innovation design capable of responding to the modern world challenges of digital transformation in the toy sector. Through a path of analysis and research, the foundations were laid for the development of a product designed to encourage, promote and facilitate motricity in preschool children, accompanied by playful activities supported by digital technologies.

This work primarily gave rise to an in-depth analysis on child motricity, going on to define the state-of-the-art from the point of view of scientific research and the production sector, and the classification of the types of products present on the market which

nowadays affect child motricity. In fact, according to the genetic epistemology theory of Jean Piaget (1962), motricity is the basis for the development of the human being and as demonstrated by many studies (Bruner, 1968; Calabrese, 2001; Zoia, 2004; Boccia, 2008; Di Tore et alii, 2012; Babaglioni, 2014), physical activity affects cognitive development in childhood and increases its potential. In parallel, the role which digital transformation covers in various fields related to childhood was analysed, particularly in the moments of play and free time spent with family members. This was finally followed by an analysis of the literature concerning the use of screens and devices by children.

The results of a study[1] coordinated by Martin Paulus of the Laureate Institute for Brain Research in Tulsa, Oklahoma and the study conducted by the Canadian Pediatric Society (2017) shed light on how the digital scenario is evolving very rapidly and how 'screen time' is also increasing in preschool children. Today's children can no longer be referred to as digital natives (Prensky, 2001) but rather as 'mobile born', that is, children who learn the use of devices before learning to walk and who expect that everything can be implemented with software. The infant neuropsychiatrist Bruce D. Perry (1996) stated «different kinds of experiences lead to different brain structures» referring to the minds of the new generations, structured in a different manner with respect to the old generations, characterised by constant sharing of information from a multitasking attitude and by the continuous connection with others through social channels. The various actors that gravitate around the Kids & Toys production sector must, therefore, be aware of the fact that they have to interact, communicate and work with the children who will exploit all the connection possibilities and that the IoT will dominate the market in the coming years (a research published by Accenture in 2019 estimates that by 2022 at global level, also due to 5G technology, at least 50 million objects and devices will be connected to the network with a market value of 600 billion dollars), inevitably also influencing non-digital natives. These data suggest a tendency for children to be increasingly connected and already sedentary in the first years of life.

On the basis of this research of reference (in a psychological and market opportunity context), the objective of the applied research activity was to create a product system which, through play, enables children to regain possession of movement (attempting to respond to an increasingly widespread problem concerning the lack of opportunity to play in large spaces on a daily basis). The design of a tricycle for outdoor use stems from these assumptions, to which is added a base (to secure the tricycle to the ground) and a controller: the product system allows the child to also pedal when stationary and to connect to a video game console to use multimedia content that encourages learning. In fact, the design developed allows for playful motor activities in small indoor spaces as well as outdoors, and in different contexts of use in which children, by interacting with a screen, and therefore with the specially-designed pedagogical content, increase their cognitive abilities through their physical movement and manage to also improve the learning of educational content.

The contribution thus illustrates the methodology used in the product's develop-

ment, the results achieved and the possible implications that this type of product can have in the Kids & Toys sector. It is therefore intended to highlight the role of design in terms of tools, methods and support to companies to promote motricity in preschool children, focusing on the assessment of the main drivers which are today driving the revolution of products for children, in line with the changes that digital transformation fosters in the behaviour and in the response to the needs of children and the adult community around them.

Motricity and cognitive development: literature review on the challenges in the world of kids – Although physical movement is a natural aspect of a human being, children are inserted from a certain age into a social system in which a lot of time is spent stationary and seated, starting from school. In addition, a key concern which generally surrounds the exponential increase in the use of media by children is that this involves a displacement in time – screen-time – which could otherwise be spent on other more traditional activities considered to be more child-friendly, including physical activity, sleep, reading and practical educational activities. Many studies show that good physical activity in children improves learning (Erickson et alii, 2015), increases concentration and attention, and reduces stress, anxiety and depression. In one study (Jäger et alii, 2014) carried out by researchers from the Department of Psychology and from the Institute of Sport Science at the University of Bern, investigated the effect that good physical activity produces on the cognitive performance of primary school children aged between six and eight years. Specifically, the study had the objective of verifying whether motor activity modifies the executive functions of children, and whether and what such modifications are in relation to the variations in the level of cortisol produced from the same activity.

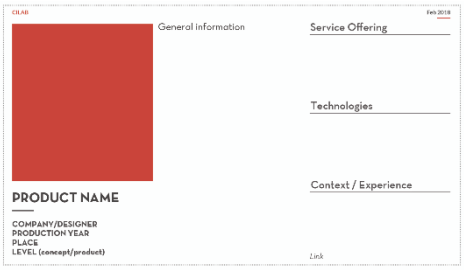
With regard to motor activity, a study by Diamond (2012) already demonstrated that executive functions in children can be implemented by practising sport. An increase in these functions results in the development of the capacity for selective attention and reasoning, responsible for an improvement in school learning. Executive functions can be defined as cognitive procedures that have the purpose of planning and organising an individual's behaviours and emotions at the moment in which new particularly difficult contextual realities are faced requiring the mobilisation of adaptive strategies (Owen, 1997). According to the model produced by Miyake (et alii, 2000), executive functions consist of three skills – inhibition, the working memory and the flexibility of cognitive response – used in problem-solving strategies. Inhibition is represented by the ability not to let impulses and non-pertinent information interfere in the task that is being performed and which could exert the role of distractors.

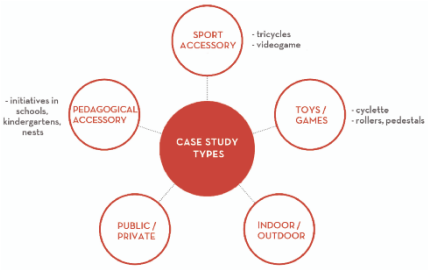
Another study conducted by two Finnish Universities (Haapala et alii, 2013) examined the relationship between cardiovascular activity and motor skill performance in children in the first year of primary school, by comparing the reading and arithmetic skills of 174 Finnish children from the first to the third year of primary school. Chil-

dren who obtained unsatisfactory results in agility, speed, manual dexterity tests and poor overall motor skill performance in the first year of school obtained lower reading and arithmetic scores in subsequent years, compared to children with better performance in motor skill tests. It was also demonstrated (Röder et alii, 2013) that physical exercise improves the neuroplasticity of certain brain structures and consequently cognitive functions, affective and behavioural responses. Specifically, in another study (Budde et alii, 2016) researchers used various methods – including brain scans, EEG recordings, and blood and saliva sampling – to study the effects of different physical exercises (dance, play and cycling) on brain activity and the consequent volume variations in different areas of the brain (the frontal and central regions, the hippocampus, the cerebellum and the motor cortex).

Case studies of products and services for motor development in kids – Based on the literature review's theoretical premises, an analysis was then conducted on the case studies of products and services available on the market which innovatively interpreted the relationship between technologies and solutions for motor development, using a specially-prepared analysis fact sheet (Fig. 1). In addition to a focus on products and services for children, effective solutions were explored for adults with a potential transfer scenario in the world of childhood. Cases were organised according to different categories and contexts of use (Fig. 2). Data collection considered three key aspects: the relationship between the product and service offered; technologies used (with particular reference to digital technologies); the types of context of use envisaged and considered for the product system.

Five case studies were analysed which made it possible to identify the framework for a subsequent design development phase. For each case, different variables were evaluated and assigned a value linked to presence and importance (Fig. 3): the dimension of the service associated with the product; the versatility of indoor and outdoor use; the presence of enabling digital technologies; the simplicity of use/interaction; the possibility of customisation; and, correspondence with target children in the age group between 2 and 6 years. An area of opportunity emerged from the evaluation of collect-





Figg. 1, 2 - Case study data sheet; Summary fact sheet of the types of case studies highlighted.

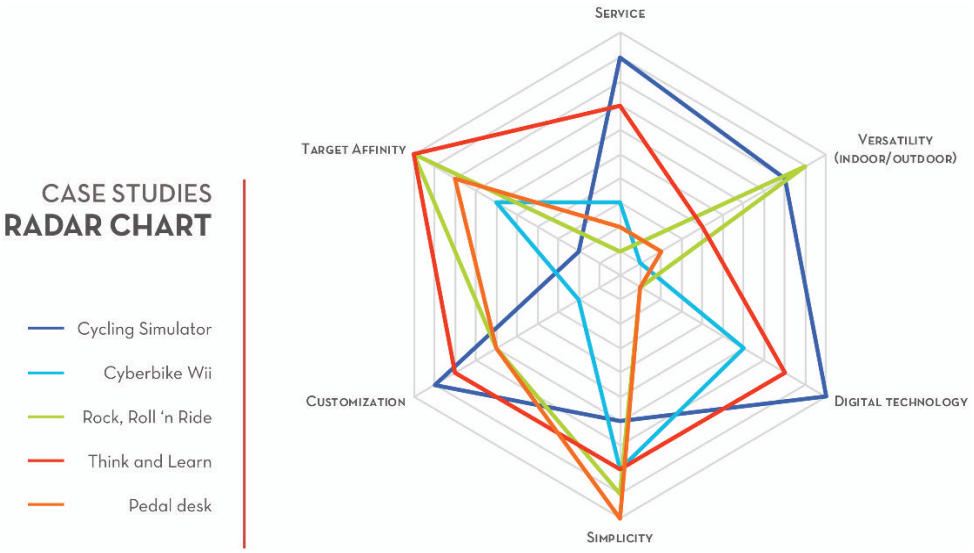


Fig. 3 - Radar chart of the variables collected through the case studies.

ed variables, which combines the dimension of service, versatility of use and use of digital technologies.

A second evaluation phase of case studies enabled the crossing of insights relating to the literature review with the areas of opportunity determined through the cases to identify five macro areas of design development for a new product system: the development of 'smart' accessories connected to sport; the development of games/toys capable of combining analogue and digital in an original and engaging manner; the development of accessories and tools of a pedagogical nature aimed at educational environments such as schools and educational centres; the development of hybrid solutions for indoor and outdoor motor skills activity; the development of product systems capable of adapting to private and public contexts.

The collection of various cases studies highlighted that there is an opportunity to develop a versatile product-service that is capable of integrating the digital component in the experience of children's physical movement. This phase of analysis underlined that: no similar products currently exist for kids; all case studies taken into consideration are inadequate from the point of view of the service's integration; versatility, which makes it possible to use the product both indoors and outdoors, is a strong point for a design that wants to be seen as innovative; the digital component is not always present in the case studies or, in any case, not well-integrated.

Enabling Technologies – Once case studies were evaluated, the project's preliminary research phase deepened the scenario technological aspects for product system in-

novation in the world of kids. Research on existing technologies focused on the following four areas.
1) Use and exploiting movement. There are some devices that convert the kinetic energy of movement (for example, through walking) into electrical energy and storing it in a battery. These devices utilize a process called Generative Braking similar to the processes of braking systems which can be found in hybrid cars – the movement of walking is very similar to the stop-and-go process of driving. Regenerative braking is a technology that is used in electric vehicles to capture the energy that it produces through its movement or, in other words, its kinetic energy which would otherwise be wasted at the moment when the vehicle decelerates or stops. This was widely developed for the car and locomotive sector (Doyle et alii, 2016). In recent years, interesting systems and products were implemented which directly capture the energy from man's movement (Starner et alii, 2004) or, for example, through the use of paving capable of creating clean and fully recyclable electric energy, simply by utilising the kinetic energy produced by walking pedestrians (Elhalwagy et alii, 2017).
2) Eco-sustainable batteries. Organic molecules derived from biological sources are an economically-viable alternative and ecologically favourable to electrodes based on metals widely used in current energy storage technologies. Research carried out by Schon (et alii, 2016) led to the discovery of a polymer-based cathode for lithium ion batteries. The redox part is flavin and is derived from riboflavin (vitamin B2). This work provides a basis for the use of sustainable and high-performance bio-based pending polymers in lithium ion batteries. The battery was tested and demonstrated optimal performance in terms of duration – a key success factor if one considers its possible applications in the Internet of Things.
3) Wearable technologies. There has been a rapid increase in the development of smart wearable systems in recent years, that is, those wearable devices modelled around the human body with the purpose of making the greatest possible use of the least invasive technology at the service of the user. A fundamental characteristic is that the human body can be used as a natural support for their functioning. Today, wearable devices are becoming increasingly comfortable, also thanks to the development of new flexible polymers and to the progressive miniaturisation of sensors and electronic circuits. The fields of application are also varied, ranging from entertainment, to the control of physical activity and biomedical monitoring. Most innovative examples include the case of e-skin, developed by a group of researchers from the University of Tokyo. This is a thick electronic skin less than two micrometres, to which transparent ITO electrodes (indium tin oxide) were attached. Starting from the latter, the Japanese researchers succeeded in creating polymeric LEDs only three micrometres thick (PLED) and organic photodetectors (OPDs) to be applied directly to the skin (Yokota et alii, 2016).
4) Products that integrate analogue to digital technology. OSMO is an innovative example from among current trends in the toys sector. This is an innovative product capable of changing the way in which children interact with digital devices transforming

them into manual games, combining creative tools, games and state-of-the-art technology to encourage creativity and problem-solving skills. The children become increasingly tech savvy; for this reason, games that can be adapted to various devices with a playful approach and with content suitable for the age and cognitive abilities represent the most promising scenario of innovation in this context (Terenzi, 2018). In this regard, the design of devices and Apps is expanding which, through the aid of the playful approach, integrate technology for the logopaedic treatment of children with learning disorders (Cianfanelli et alii, 2019).

Results have shown that the utilisation of kinetic energy can be easily transferable to the design of a new product system. Moreover, the environmental sustainability of many of these technologies is capable of creating further appeal in the products to which they are applied. Equally interesting scenarios are also opening in the applications of products that integrate analogue with digital functions (phygital) in the care design and medical sectors, in general, a potential trend for this sector.

Phygital Products – Human-computer interaction is today widely regarded as being an integral component of many educational and training systems at various levels of access to technology (Lin et alii, 2017) and many studies show that positive interaction increases motivation, attention and participatory learning in children (Parker and Lepper, 1992; Liaw, 2008). It is increasingly clear that the nature of play in the digital era is changing in terms of resources available for play and the way in which these resources are distributed in the different types of play (Bird and Edwards, 2015). A further aspect of contemporary play is the relationship between online and offline spaces. In the last few years we have seen various developments in relation to the way in which toys and other artifacts for children are mediated by digital interaction (Burke and Marsh, 2013; Vignati, 2017). This is leading to a type of communication and play that moves through physical and virtual domains and integrates tangible and intangible methods (Marsh, 2014).

It is generally possible to classify the use of technology applied to toys as follows: AI (Artificial Intelligence), that is, toys with special features such as visual perception, voice recognition, translation, etc.; Machine Learning, that is, toys that can learn, behave according to patterns, change their actions according to stimuli and adapt to the player's ability; Internet of Toys (IoToys), that is, toys connected wirelessly to the Internet, to other toys and/or to database data; Virtual Reality, that is, toys with computer-generated simulation of a three-dimensional image or of an environment with which one can interact in real-time or physically by using special electronic equipment (helmet, glasses, gloves, etc.); Augmented Reality through the use of a smartphone or tablet's camera which provides a level of information, including text and/or images, that goes beyond the real world's vision.

By play interaction, we mean an activity in which an effort is required by users who are rewarded with a pleasant improvement in their skills. The process is also characterised by the presence of emotional responses stimulated through and due to the use of

a product (physical or digital). Play activation replaces basic interactions with small challenges that are intended to increase the user's attention and interest. Finally, playful-type assistance to activities enables important learning and support because they are integrated and just-in-time, and also due to the presence of assistance and rewards for satisfactory results. The sector's trend is, in fact, driven by highly innovative companies and start-ups which are presenting products that, at various levels and with different formulas, expand the physical product with one or more of the techniques described above, with very interesting results (Mascheroni et alii, 2017).

From research to design – Starting from the results emerging from the state-of-the-art analysis phase, as a result of the collaboration between Italtrike, an Italian company producing toys for children between 1 to 6 years of age, and a group of researchers from the Politecnico di Milano, with the involvement of a group of young professionals, the new project was created that is capable of encouraging, promoting and facilitating motricity in preschool children through play and digital technologies. Italtrike is an Italian company which, since 1983, has produced tricycles, ride-on toys, balance bikes and wheel vehicles designed for children and their recreation (particularly for kindergartens and nursery schools). 'Kids on wheels' is the slogan of Italtrike, whose mission is to encourage children's mobility to promote motor skill and psycho-physical development. Products are 100% made in Italy.

During a design laboratory coordinated by researchers from the Politecnico di Milano and involving young Kids & Toys Designers, it was possible to delve into the theme of Sustainable Product-Service for Children's Soft Mobility by developing an innovative product both on the level of response to children's specific needs and from a technological point of view. In fact, the project responds to both the contemporary need of motor play and the interactive experience made possible by digital technologies. It is based on needs and specific skills and on the target's stages of cognitive development taken as a reference, that is, for children between 2 and 5 years of age. Important changes that occur in children of this age, not only with regard to the body's growth but also the personality and the relationship with others, where play is a fundamental accompanying tool, were taken into consideration in the project's development and analysis phase.

In children, imaginative play shows up at around two years of age. This involves imagination, simulation and imaginative activities in general. These stimulate divergent thinking and problem-solving abilities – two important aspects for the linguistic component. Constructive play asserts itself at around three years of age. This is expressed through the shaping, for example, of clay, salt dough, plasticine, paper, etc., as well as with the use of building blocks and graphic activities using pencils and colours. These types of activities promote the acquisition of motor skills and lateralisation (defining the body's right and left), develop fine motricity, the sensory understanding of objects and reinforce exploratory and cognitive sensations.

Socio-dramatic play emerges around four years of age. The child enjoys changing

roles or characters, pretends to be someone and identifies himself: participation in socio-dramatic play allows the child to shape his personality, express desires, dreams, talents, to control instincts and frustrations, and manipulate them to his advantage. Symbolic play also forms part of socio-dramatic play. Symbolic play has the function of representing a reality that is not present in order to reinterpret it from a subjective point of view. This includes listening and observation games, such as listening to stories, nursery rhymes, poems and decoding images, for example, when using books. Cooperative play and play linked to cognitive learning also develops in children at around five years of age. Often in these cases, the children who act as leaders are usually those that have developed more manual skills. Furthermore, between 4 and 5 years of age the development of motor skill activities is completed, that is, to run, climb, skip, throw the ball, play with sand, ride a bicycle and swings, go on slides, etc.

In summary, the development of the physical product, its recreational component and the video game took into consideration the main stages of motor skills and cognitive development in target children between 2 and 5 years of age: mastering language through conversation and asking questions; improving the ability to solve simple problems; socialising with adults and children of the same age, carrying out activities in conjunction with a recognition of the rules; first development of empathy and recognition of emotions and mental states; combination of shapes, recognition of colours and parts of the body, telling short stories or parts of a story; understanding numbers and perception of the time factor; improvement of the motor skills that make it possible to jump and stand on only one foot for a few seconds, cycling and to catch a ball in the air. The project's development was therefore divided into three different work phases.
– Phase 1) Research and scenario building. From the preliminary research results 4 key themes were identified: customisation, cooperation, new contexts of use and sharing. 4 development scenarios for new product systems emerged from each macro theme.
– Phase 2) Concept generation. In the second work phase, different concepts were developed that are capable of interpreting, in a different and broader manner, the key elements emerging from the research and scenario-building phase. Four product system concepts were drawn up, each of which emphasised one of the four macro themes identified.
– Phase 3) Product system development. The third work phase involved a convergent activity of choosing a promising concept and a subsequent phase of technical development for all the product system elements. This phase enabled the development of an innovation project capable of responding to the contemporary needs of motor play and interactive experience made possible by digital technologies.

The three phases of the design process saw the fruitful synergy of all the actors involved. The Politecnico researchers developed research tools and gathered insights useful to the project's development. In the concept generation and product system development phases, they oriented the design process thus allowing for the substantiation of choices with data and information collected in the scenario-building phase. The

company's technical team followed all the project's development phases providing important support through guidance for the balancing of strategic guidelines, on the one hand, and the organisational boundaries and skills available internally or externally to the company, on the other. The toy designers worked in close contact with researchers and technicians, translating the research results and the reflections on strategic positioning operated by the company into product design aspects.

Originality of the developed project – The product system developed in the third phase of the design process consists of an indoor and outdoor tricycle (Fig. 4). The project's innovative component is the synergy between product and service: the technological base acts as the tricycle's base to be connected to a console that allows the child to interact with an educational video game activated and guided by the movement produced with the tricycle's pedalling. The product system is therefore an original combination of physical product and educational content representing the vision of developing new services for a company, which up to that point in time, was totally oriented toward the product. Content activated through movement made with the tricycle allow for motor play activities in small indoor spaces and outdoors, in different contexts of use. By interacting with a screen, and therefore with the specially-designed pedagogical content, children increase their cognitive skills in combination with physical movement, and manage to improve learning.

Conclusions – In Design Driven innovation, there is talk of design's strategic role in defining innovation processes (Verganti, 2009; Manzini, 2015) that have an impact on new forms of organisation and innovative forms of value co-production. It is, therefore, innovation that is principally focused on the significance (process or product) wherein technologies are tools and ways to enhance the user experience and to respond to new behaviours generated by digital transformation. In this scenario, the core of the design process is an integrated system of products, services and communication, to capture new value systems and new market opportunities. Today, children are growing up in a constantly-changing environment; digital transformation is opening up new opportunities for designing new products and services that are able to support their creativity, their self-expression and play according to an ever-growing innovation potential. In this perspective, the key element of the developed project is the ability to provide the child with challenging and fun movement that is capable of stimulating fundamental skills for correct growth from a sensory-motor point of view, such as balance and stability, wherever the child is to be found and by exploiting the possibilities offered by digital innovation.

The product system, which can fall within the scope of Care Design, is useful for children to fight all those pathologies that can be connected to life habits that are too sedentary, such as childhood obesity. In addition, physical exercise stimulated by the new product system, increases children's cognitive skills through the integration of a

Fig. 4 - Flurry's setting in indoor game mode.

playful approach and specially-designed educational content. The new product thus provides children with the possibility of moving constantly through the tricycle in every context, both indoors and outdoors, and can treat motor coordination disorders. It is also a valid ally in fighting obesity and the phenomenon of child depression.

A first innovative product capable of responding to the contemporary needs of motricity and interactive play experience which, however, opens up to a broad scenario of future developments: if we, in fact, consider the needs that it intercepts and the technological potential that it includes, this first product may be followed by a broad system of solutions that explore the phygital theme to promote motor function and the ability to control and coordinate movements (also covering medical or paramedical areas). We can summarise the benefits of the new product-service by breaking them down into direct benefits (facilitates the development of physical activity for children; can be used by children with reduced mobility; can be used for physical rehabilitation; allows the indoor use of an outdoor game; adapts to different ages through adjustments and the updating of games; has a small footprint; is equipped with installation and connection to the intuitive platform) and indirect benefits (fights a sedentary lifestyle and child obesity; actively involves the child; helps with the development of coordination; is a learning support through interactive games; stimulates social interaction in multiplayer mode). In order to appreciate the product system's degree of innovation, a prototype is being built with the support of the company's know-how.

This will be tested on a panel of children. Through the compilation of data sheets, both the physical product and the video game application will be checked and assessed for certain fundamental aspects which are: the level of general usability, ease of inter-

action, the degree of adaptability and the capacity to promote physical activity.

However, the limitations of the applied research activities are also to be considered. Primarily, those linked to the team's expertise. In the product system's development phase, the project team came up against the absence of specific expertise in the development of IoT solutions and App programming. Access to external expertise required important investment for the company. Research and development activities were therefore accompanied by strategic development activities and the formulation of a business model for the project (with the assumption of partnerships with companies in the digital field and in the production of educational content on Apps and video games). The research activity's second limitation is linked to the development period (partly due to the absence of expertise): today, time to market is one of the most important variables for a novelty's success. The company's lack of internal expertise in the digital field and the need to identify and involve partners with a credible business model definitely conditioned the design development period. While considering the limitations described above, the applied research project presents itself as good practice for Design for Kids & Toys in the contemporary backdrop of changes generated by digital transformation.

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NOTE

1) The ABCD (Adolescent Brain Cognitive Development) Trial aims to recruit 11,500 children of 9 and 10 years of age, follow them for a maximum period of 10 years and collect detailed information on the use of media crossed with data of the scans carried out every two years through cerebral magnetic resonance imaging (MRI).

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