Ontological Design Ways of Sustainable Intervention: A Conceptual Framework

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Abstract

What is meant by the ontological way of sustainable intervention between technology and humans, and how can it be studied? This paper seeks to assist designers to structure their ontological reflection for sustainable intervention by discovering coherency in technological transformation. Grounded in the notion of ontological designing, this paper proposes a conceptual framework for sustainable interaction design. This framework imposes requirements on function, on behavior, and on meta-conjunction to reflect on and plan what a digital artifact is for; what the artifact performs; and what the artifact synthesizes. Four functional dimensions are highlighted: *Balancing* (B), *Prevention* (Pv), *Persuasion* (Ps), and *self-Motivation* (M). In each of the dimensions, the behaviors of digital artifacts are articulated as key design activities. Finally this paper attempts to justify the meta-conjunction process, which is established in each example of digital artifacts. Therefore, the results of these analyses show how ontological designs are shaped in a set of conceptual boundaries.

Keywords

ontological design; sustainability; conceptual framework; interaction design.

Our lives take place on the blurred boundary [18] between technology and the natural world. Today new technology systems are in need of sustainable intervention to address environmental problems. Designers' critical reflection can make the boundaries determinate and embody concepts of digital artifacts conscious and meaningful (e.g. a hybrid rather than a gasoline-powered car). Yet, if designers fail to carefully articulate the problem space of ongoing tensions, interventions may lead into unproductive directions. One possible approach is to envision ontological design ways in an alternative conceptual structure. This conceptual structure points out the reflective attempt to rediscover our connection with new technology systems and expose our true values.

Drawing on the questions, what is meant by ontological activity toward sustainable intervention between human and technology systems, and how can it be determined, this paper discusses the methodological approach of ontological designing [27]. This discussion lays the foundation for the role of designers in the ontological conversation with materials of sustainable interaction design [2], and how they perceive such activities. In this paper, the intervention seeks to discover possible context as the relation between the goal of human users and the behavior of a technology system. When interventions by designers are synthesized within a digital artifact, the digital artifact produces their functional behaviors, which are a useful set for leading users to reconcile their environment at micro and/or macro levels. Thus, this paper assumes the designer as a *critical agent*, whose concern is not limited to the explanation of the character of digital artifacts, but extends to the activity of producing design knowledge that transmits good design intentions.

In setting out the framework, this paper will use the term "*ontology*" in a sense that provides a systematic approach for describing the concept of a digital artifact and the synthesis, including functions and behaviors. By analyzing examples in current digital artifacts and future interaction scenarios that are vital to understand and predict complex human-technology networks, this paper highlights four functional dimensions, which are predominant purposes of sustainable interaction design: balancing, prevention, persuasion, and self-motivation. Each of the dimensions is modeled with the behavioral thread that provides key design activities of digital artifacts. These contexts and solutions imposed on the behaviors transform from the blurry boundary into critical design description.

What is Meant by Ontological Activities for Sustainability?

Willis's perspective on ontological designing [27], dealing with the nature of reflective thinking, contributes to designers' understanding of a subject matter of users. She asserts that "designing is fundamental to being human – we design, that is to say, we *deliberate, plan,* and *scheme* in ways which prefigure our actions and makings." The notion of ontological designing induces the purpose of advancing toward the intervention into interactions among humans, technology, and nature: The form of a digital artifact is an explicit formulation of ontological concept synthesized by designers. With radically different understanding of users' situations, reflection on ontological designing fits well with where/how a designer sees the focus of a particular formulation: on the role that his/her reflection plays in action, i.e. its effect on substantial intervention during the design process for solving ill-defined problems of the real world. While the designer explores the space of possible designs, ontological activity brings together interpretations of the current state of the world, effort, improvisation, and goals. The process of ontological reflection generates *coherence* for the expected world that the actions of the designer produce. This world is located within the interpreted world, as all goals and expectations can be viewed as interpreted representations of potential future designs.

For example, Oulasvirta [19] points out that people often have multiple digital artifacts and accessories tailored for specific tasks such as a mobile phone and a PDA. Although this current context of digital artifacts seems to provide such benefits as suitable display and manipulation choices, these benefits may not significantly change the user's practices of conservation: people might be asked to invest excessive attention and energy for operation as well as consumption of physical materials. Given that designers' reflective interpretations analyze where/how the advantage of a new technology system fits into and changes the existing practices, this ontological action help reach "a sufficient stage of maturity that information appliances are possible with adequate performance, high reliability, and reasonable cost." [15] If we would follow this path, then we would see the new technology aesthetic around us – wind power stations, hybrid cars, solar energy, and so on. Interaction designers consider their own intervention in the external world "not as an end in itself, nor as an artifact positioned to impact a situation" [21], but always as a challenge against accepted design knowledge. Ontological designing is re-creativity instead of mere analysis; autonomy instead of subordination; rationality instead of blind reaction; and intentionality instead of compliance.

The Conceptual Framework of Ontological Designing

An explicit formulation of how designers are intervening may help clarify expressions of ontological thinking, making possible coherency that could be effectively carried out. The so-called method of collection of *designerly* [6] activities for the formulation seems to offer a possible means for organizing discussion at the macro level, in which designers' thoughts are brought together and proceed to sub-classify the activities until, as one of the optimized decisions, the particular kind of activity emerges. The framework specifically aims to stimulate the constructive thinking by which interaction designers may modify current everyday practices with the advantages of functional systems of new digital artifacts such as smart materiality, intelligent architecture, wearable technology, persuasive technology, and ambient technology. (e.g., the shift of interface from the physical button of telephones to the intangible one in smart phones to decrease physical materiality) This framework imposes requirements on function, on behavior of digital artifacts, and on the meta-conjunction process to reflect and plan what a digital artifact is for; what the artifact performs; and what the artifact synthesizes. To categorize the most fundamental functions of the intervention, an analysis of over seventy papers in the sustainable design literature, in such academic disciplines as Eco Design, Industrial Design, and Human Computer Interaction (HCI), was conducted by the author from May to December in 2008. An investigation of ways to integrate the advantages of new technology systems into existing behaviors of digital artifacts was also conducted utilizing examples of advanced interaction scenarios and implementations as well as empirical studies.

This paper assumes that the ontological design activities represented can be viewed as describing requirements of *Function* (F), of *Behavior* (B), and of *Meta-Conjunction* (C) in developing a digital artifact. These aspects are the basic constituents of the ontological reflection that has been applied to various artifacts, including physical devices, software, and functional processes. By interchanging the variable factors of environmental issues and qualifications denoted, different compositions of functions and behaviors can be used to specialize a digital artifact interacting with the world. In this framework, the functional dimensions constituting a rectangle mainly explore these four functions as shown below. In Figure 1, each of dimensions is consistent with the behaviors of digital artifacts that enable designers to orient what they are doing in the synthesis process.

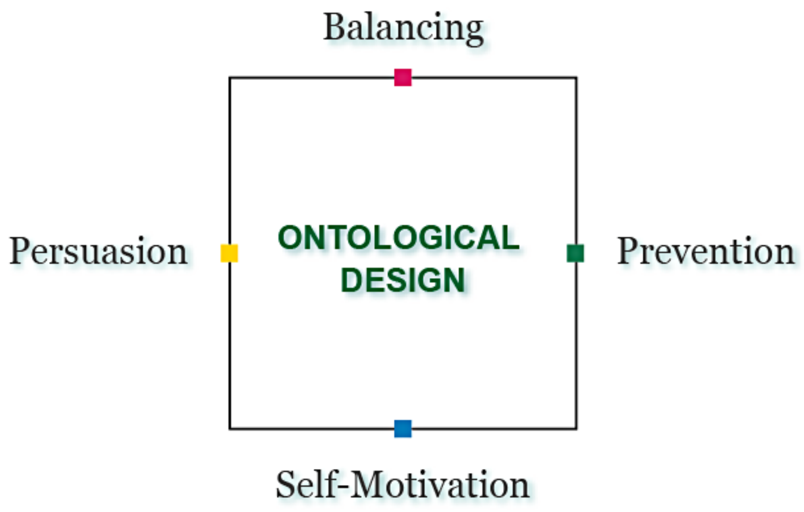

Figure 1 The conceptual framework of ontological designing

Function (F) of a digital artifact is defined as the purpose, "*what the artifact is for*". In this case of sustainable intervention, the indicated functions are "to balance between now and future", "to prevent environmental problems", "to persuade sustainable practices", and "to promote self-motivation of users".

Behavior (B) of a digital artifact is defined as the attributes, "*what the artifact performs*", that can be derived from its function. In the prevention example, behaviors include "using bio-degradable materials" and "using renewable natural materials (e.g., solar energy)".

Meta-Conjunction (C) of a digital artifact is defined as its components and their relationships, "*what the artifact synthesizes*". Components include those which are often specified by a set of variables, functions and behaviors described for a user community, time, environmental factors, constraints, technology, strategy, or materials. The notion of meta-conjunction can be applied at any level of designing. For example, depending on the class of an artifact and the perspective a designer chooses to take, he/she may imbue a radically different conjunction such as spatial conjunction, physical conjunction, information conjunction or organizational conjunction into a digital artifact: a designer's conceptual activity can be viewed as formulating a particular class of artifacts.

At the meta-conjunction level, all processes of design synthesis are unique, since individual designers' conceptual processes and perspectives crystallize the functions and behaviors of a digital artifact with the specialized mode of their understanding of users and environments. They internalize heterogeneous conceptual activities and produce design conjunctions as externalization. The design decision of each composition depends on the approach to synthesis which is used (e.g., synthesizing persuasion and prevention, or synthesizing behavior^1 and behavior^2). The resulting set of meta-composition is a way to position a key domain of design activities to see the relationships in how a digital artifact intervenes to address situational problems.

In the following section, this paper will define each notion of the four functional dimensions, and enumerate what behaviors each of the dimensions has. Each of behaviors is numbered to articulate the process of meta-conjunction.

Prevention of environmental problems (Pv)

The fundamental challenges of environmental problems involve not only improving the efficiency of products that guide consumption and human behavior, but also reducing the rate at which humans poison themselves and damage the world around them [9]. The primary concern of these immediate problems is related to avoiding toxic materials that cause environmental harm. The functional requirement in this dimension deals with the prevention of superfluous consumption of energy and materiality in the short-term. Designers may reflect on and contextualize behaviors of digital artifacts by considering what benefits of new technology can be integrated. This leads to products and services that can directly fulfill users' needs, deliver eco-efficiency, and decrease the materials and energy required to deliver the products' functions. Some of behaviors which designers can consider as the primary attribution in this function are:

Pv^1 *Non-toxic material/noise pollution*

Pv^2 *Using renewable natural materials, such as solar energy, to create new functions*

Pv^3 *Dematerialization [8] in tangible and intangible products*

Pv^4 *Reduction of the materials consumed by both users and technology functions*

Pv^5 *Reduction of the needs of the manufacturing process*

Pv^6 *Usage of substitute technologies, such as nano/biotechnology, allowing the reinvention of old materiality, flexibility for users' contexts, longevity and durability*

Pv^7 *Multi-functionality that combines existing artifact capacity with the advantage of new technology without compromising the original functionality and performance*

Pv^8 *Bio-degradable organic user interfaces (OUI) [7]*

Balancing between now and the future (B)

Ezio [13] points out that "good communication systems enable connections among people without the need for movement." As an example, effective communication system design can enable restaurants, along with other surplus food sources, to redistribute food that would otherwise have gone to waste. This averted surplus could be shared among those who need it, such as the homeless or impoverished. This is one possible way that information technology could satisfy the needs normally fulfilled through materiality. [8] Thus, design activity could not only conserve natural resources, but could also enhance balancing everyday practices of the current generation with the environmental interests of the future. In this functional dimension, obtained from eco-efficiency analyses, such factors as time, local resources, life style, production, disposal phase, life cycle [1], the network of product-information-service application, health, and socio-cultural patterns should be taken into account to mediate between the interests of current and future generations. By applying appropriate levels of technological benefits, this critical reflection will enable designers to facilitate the rebuilding of infrastructure and services in which everybody can easily participate. Some of behaviors which designers can consider as the primary attribution in this function are:

B^1 *Exploring design activity to synthesize technological effect, user practice, and local environment*

B^2 *Understanding users' practices and local environments as an ever-changing complex*

B^3 *Observing vernacular design [20] developed by local community members*

B^4 *Searching for supply-chain management that uses minimal materials and resources, focusing on local sources*

B^5 *Applying appropriate technologies and services*

B^6 *Creating products and interactions that stimulate local employment and/or the local economy*

B^7 *Redistributing resources fairly within and between generations [18]*

Technologies that persuade users to engage in sustainable practices (Ps)

Stegall [23] emphasizes “A profound role in making sustainability a reality is that a designer must persuade the general public to adopt sustainable behavior.” In doing so, designers (as persuaders), may seek to discover the message that digital artifacts deliver to users and the distinct ways through which an individual’s psychological world alters into an actionable social life. Thus, this dimension mainly stimulates designers to find ways to invite users to experience making consumption more meaningful. For example, these concepts of persuasive technology [11, 12, 13, and 26] discuss the communicative representations that use such clear metaphorical signifiers as words, images, acts, styles, narratives, sensory modes, emotions and/or music. Some of behaviors which designers can consider as the primary attribution in this function are:

Ps^{1} *Understanding a digital artifact as a communicative possibility for transmitting sustainable meanings*

Ps^{2} *Educating in regards to environmental issues, and indicating the efficiency of energy and materiality*

Ps^{3} *Discouraging unsustainable behaviors and encouraging sustainable behaviors*

Ps^{4} *Co-active persuading [22] in unobtrusive or obtrusive ways as needed*

Ps^{5} *Achieving user friendliness that makes digital artifacts easier to understand and more fun to use*

Ps^{6} *Supporting interactivity/user involvement that engages the user’s abilities and skills in the artifact*

Ps^{7} *Accommodating symbolic appeal, impact, and generative capacity that includes community agreement*

Ps^{8} *Revealing a clear identity of sustainability such as in the visual style, the functions of a service agent, and materiality*

Ps^{9} *Encouraging emotional connection to digital artifacts to support durability [4, 5] and longevity*

Ps^{10} *Improving ergonomics/health and safety*

Empowering self-motivation (M)

Ehrenfeld [9] views the flourishing of immaterial notions like dignity, autonomy, freedom, and authenticity as fundamental in changing unsustainable behaviors. This humanistic and moralistic strategy is closely related to intellectual behaviors that users and community members as secondary producers can organize their own thinking and acting for ecological satisfaction. For example, design democracy, and alternative and self-help solutions (e.g., DIY products) inspire strong motivation, allowing users to manage their work and thinking. Design activity should discover how to empower and motivate users and communities to consistently participate in examining and implementing their identities and values. This design agenda may resonate with users’ responsibility for social and environmental practices that protect natural resources. Some of behaviors which designers can consider as the primary attributes in this function are:

M^{1} *Observing possibilities for creating empowerment*

M^{2} *Creating a co-participatory opportunity as a primarily productive activity*

M^{3} *Fostering creative/ontological thinking to enhance users’ actions and thinking*

M^{4} *Allowing democratic design [17] to help create good decision-making*

M^{5} *Empowering community ownership*

M^{6} *Universal design that allows the application of widely accepted practices, materials and technologies suitable for a wide range of end users and communities*

M^7 *Improving the context-based wellbeing [10] of digital artifacts that serves their purpose better than previous designs*

M^8 *Eco-labels with improved identification of materials, energy, and production methods*

M^9 *Suggesting a social networking platform to share time, resources, and knowledge*

Meta-Conjunction Process in This Conceptual Framework

The four functional dimensions are deployed as the initial statement made in Figure 1. Once a designer's ontological reflections explore possibilities with these functional purposes key behaviors can be synthesized to intervene in situational problems, and the behaviors can be selected depending on design perspectives or priority. (i.e., this conceptual design process metaphysically leaps among the requirements of functions and behaviors or edits some of them toward discovering most promising solution.)

The analysis of examples, derived from design processes or external results, shows justification of how the functions and behaviors would be synthesized to a certain creation of digital artifacts for any particular intervention into users' situations. This shows the centrality of functional behavior for categorization, which is in line with the adaptive view of design synthesis. The intentional view of ontological thinking also underlines the role intervened by the intention of designers of the artifacts. It should be noted however that the resulting set of processes do not represent any order of execution.

Applying wearable technology to existing artefact capabilities

In Figure 2, showing the Solar JKT from Zegna Sport [14], we can observe how wearable technologies have extended the basic function of everyday clothes. This interactive jacket was developed by Interactive Wear AG, in cooperation with well-known fashion and sports apparel manufacturers, to leverage a renewable resource, solar power. The main function of this clothing is focused on the prevention of environmental problems. To avoid the superfluous consumption of energy, the component of this artifact combines existing artifact capability with the effect of a new technology system, while not compromising the garment's original functionality and performance (Pv^7). In doing so, this artifact adopts the advantage of wearable technology that allows users to recharge cell phones, iPods or other artifacts through solar energy (Pv^2). The users can use the electricity generated from solar energy that is transmitted through conducting textile leads and stored temporarily in a battery or fed directly to a connected artifact. In turn, a conjunction of functional-behaviors in this interactive clothing demonstrates how ontological design perspective and development strategy applies appropriate technology system and service to current user practice (B^5). Figure 3 indicates the conjunctive relation with the two functions and behaviors: Prevention $^{2, 7}$ and Balancing ^{5} synthesized in this example.

Figure 2. The wearable technology, Solar JKT

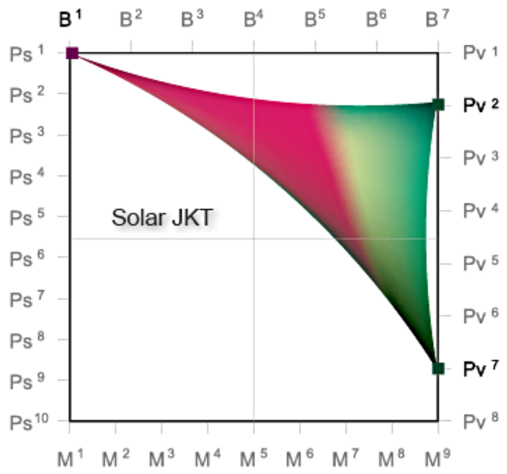

Figure 3. An ontological analysis of Solar JKT based on the framework

Reinventing a digital artifact with nanotechnology

In Figure 4, the Nokia Research Center has developed Morph [25], an elastic concept mobile phone. This concept scenario demonstrates the functional centrality for the prevention, that is, the possible usage of the substitute technology, nano-technology, which enables the reinvention of old materiality for longevity and durability (Pv^6). In this scenario, users can transform their mobile artifact into radically different forms—a keyboard, mobile phone or watch. This means that, by integrating the original purposes and performances which each of digital devices has, the components of the multi-behaviors offer users access to the technological variations in the same artifact (Pv^7). Users may then be fascinated by the interactivity for flexible accommodation of their different situations and needs (Ps^6). In doing so, to match the optimized point among spatial relations of information contexts, physical materiality and usage purposes of users, is a significant design factor here. In turn, this radical conjunction can fundamentally help reduce the consumption of physical materials used for both users' needs and technology functions with low-cost manufacturing and eco-efficiency in mind (Pv^4). Figure 5 indicates the conjunctive relation with the functions and behaviors: Prevention $^{4, 6, 7}$ and Persuasion ^{6} synthesized in this example.

Figure 4. Nokia morph concept phone

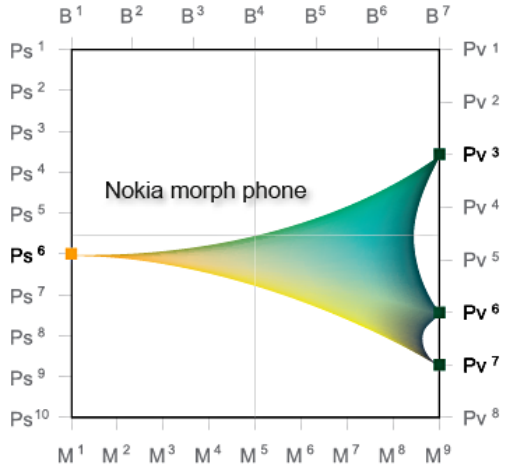

Figure 5. An ontological analysis of Nokia morph concept phone based on the framework

Understanding future sustainable habitat

In this future scenario [16], developed by the Philips's Design Probes Project (Figure 6), interaction designers can understand how new interactive architecture can be used in residential life to balance between the present and future environments. *The meta-conjunction* process of this interactive architecture is defined as the relationships that illustrate the possibility of a habitat as a dynamic eco-system, which deals with sustainable housing for an urban megalopolis in China in 2020. As seen on the right side in Figure 6, the interaction strategy enables the residents to live off the grid of the building while allowing the residents to retain their existing life styles. Regarding the behavioral performances, "the building surfaces, rather than being inert 'dumb' materials used only for construction and shielding, are sensitive skins that are 'alive' and act as membranes to harness energy.... [and create] a strong link between the exterior and interior of the habitat … collecting and channeling air, water, and light from the outside into the inside spaces." [16] In doing so, understanding users' practices in their local environments and constraints as an ever-changing complex (B^2) is fundamental. Designers should discover appropriate design activities to synthesize technological effects (the electronics and bio-chemical functionalities), user practices, and local environment in China (B^1). Searching for supply chain management of the natural resources available in the local environment is also a critical factor (B^4). In turn, this ontological design can improve the residents' current practices, ergonomics, and the welfare of future life (Ps^{10}). The conceptual activity of the design team can be viewed as formulating a particular class of organizational conjunction. Figure 7 indicates the conjunctive relation with the functions and behaviors: Balancing$^{1, 2, 4}$ and Persuasion^{10} synthesized in this example.

Figure 6. Off the grid: Sustainable habitat 2020

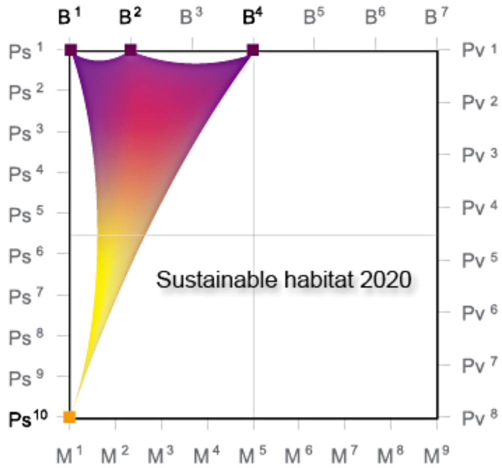

Figure 7. An ontological analysis of Sustainable habitat 2020 based on the framework

Unobtrusive persuasion of sustainable behavior

Both the symbolic and persuasive functions of the meaning of ambient technology have been discussed. In this Wattson energy monitor [28] in Figure 8, we see how the conjunction process applying symbolic expression of the digital artifact changes users' thinking and behavior by indirect persuasion. That is to say, by providing real-time feedback on total energy consumption, this digital artifact shows that the artifact can persuade users to keep monitoring consumption of energy within their home in unobtrusive ways as needed (Ps^4). A change in the intensity of color generated by the artifact gently helps users to understand the energy flow of all appliances in their home and to measure power consumption of each appliance. At this persuasive level of designing, the functional behavior enables them to try to reduce their total energy cost, sometimes by up to 20%. In doing so, designers need to understand the artifact as a communicative possibility for transmitting sustainable meanings (Ps^1). A persuasive strategy to alter users' practices of energy use should reveal a clear communicative message to save home energy in its visual style (Ps^8). Perhaps this persuasive component is also ultimately related to allowing democracy to create good decision-making by users (M^4). In turn, this design strategy can be viewed as formulating an information conjunction into a digital artifact in a certain user community. Figure 9 indicates the conjunctive relation with the functions and behaviors: Persuasion$^{1, 4, 8}$ and Self-Motivation^4 synthesized in this example.

Figure 8. The energy monitor, Wattson

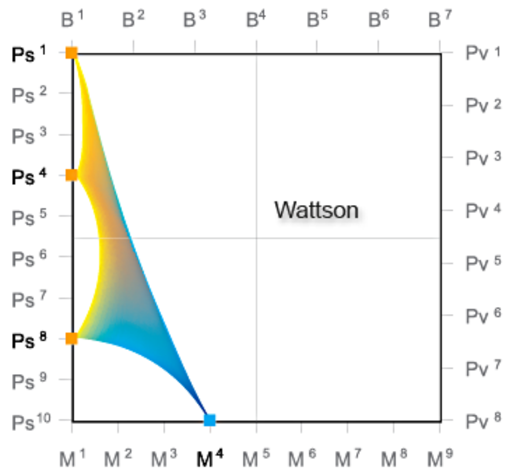

Figure 9. An ontological analysis of Wattson based on the framework

Eco-friendly approach for children

The ontological strategy of the interactive artifacts shown in Figure 10 is designed to communicate an eco-friendly message to children. The prototype toys developed by the "odo" design concept group, Sony Design Activities, [24] mainly aim to establish a sustainable function of self motivation through providing early education to children (Ps^2). To both instruct and make them engaged, the behavioral components of these artifacts tap into children's creativity as well as their curiosity about energy, introducing them to new levels of interactions (M^3). For entertainment while learning, some of these let children have fun moving parts, turning cranks, and using their bodies. This interaction between the children and the artifacts creates a co-participatory opportunity by which the children can be primarily producers to generate energy as they play (M^2). As a commitment to the environment, the behavior of the digital artifacts themselves will be made of recycled and vegetable-based plastics (Pv^8) to offer both new experiences for children and a sense of social consciousness. In pursuing such innovations, it is important that designers should consider universal accessibility that allows the widely accepted practices, materials and technologies suitable for a broad range of end users and communities (M^6). Figure 11 indicates the conjunctive relation with the functions and behaviors: Prevention^8, Persuasion^2 and Self-Motivation$^{2, 3, 6}$ synthesized in this example.

Figure 10. “odo" Design’s Products by Sony

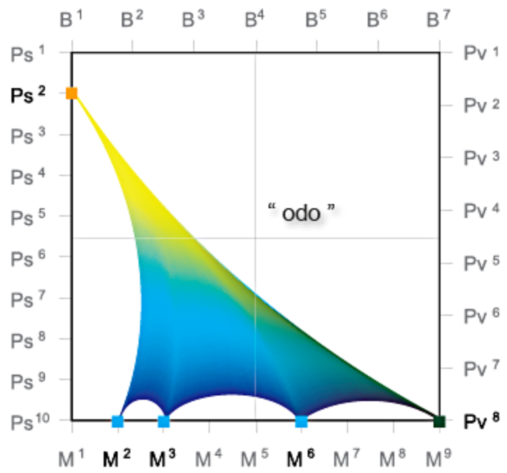

Figure 11. An ontological analysis of “odo" based on the framework

Discussion and Conclusion

This paper has discussed the design approach to guide designers to speculate on sustainable intervention between technology and human environments. This discussion established a design research foundation grounded in the philosophical idea of ontological designing. The conceptual framework proposed highlights the four functional dimensions of such intervention: balancing, prevention, persuasion, and self-motivation. Each of the functions features behaviors of digital artifacts, and these perform key design activities to stimulate designers’ ontological thinking. These meta-conjunction processes in the framework radically delineate the different shapes in each of the digital artifacts. Each analysis of ontological views suggests that the capacity to infer a creation of digital artifacts depends on experience and prior knowledge of how to apply and use this conceptual framework. These analysis results provide designers with a uniform schema that could be configured as a goal-oriented, constrained, and decision-making activity; they can explore what variables and values might be appropriate for each ontological situation. The conceptual framework, therefore, helps provide a level of meta-conjunction that captures the designer’s conception within the design situation to represent reflection in developing a particular digital artifact.

Although this paper suggests a conceptual framework to help implement ontological thinking within the four dimensions towards a more sustainable human civilization, it has only begun to construct the preliminary framework. A number of different digital artifacts and reflective interpretations of situations cannot be reviewed here. Moreover, designers might have different perspective in observing a design situation. There is still a long way to go for the framework to be improved for use in support of implicit ontological intervention, since sustainability is a loaded term in reference to ontological design. The current level should have more detailed ontological representations as a precursor to the designer’s reflective conversation. This further development should be investigated with these categories: a wide range of target user groups or community members, various environmental contexts, design strategy, differing levels of user experience [3], stakeholders, and manufacturers. Development of the topologies of new types of digital artifacts is also important, since they can indicate the functional purpose digital artifacts perform.

This paper concludes that designers’ ontological activity for sustainable intervention is an enlightened tool for re-conceptualizing the existing concept and functionality of digital artifacts, provoking meaningful reflection on new technology environments. Ultimately, the new structure of digital artifacts may not only emerge as set of additional, informal relationships, but also as a modified set of environmental components, eventually leading to new relationship with external design representation as if digital artifacts are part of organization of human technology environments. Designers may be able to structure their ontological determination by discovering coherency in technological transformation.

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Hyewon Kim’s work and interests have intersected across the following academic fields: industrial design, digital-media design, and Human Computer Interaction (HCI). She has been employed as a professional designer for several companies and a design researcher of Universal Design Research Center (UDRC) for the elderly in Korea. As a digital design theorist, she has explored design methodologies of HCI that not only include the relational processes of design, but also subjective processes that are not self-evidence. In doing so, she seeks to understand how to redistribute the communicative power between users and digital artifacts.