Design Thinking and ICT to Create Sustainable Development Actions
Design Thinking, ICT and Sustainable Development

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Abstract: Environmental problems are complex, open and poorly defined. University students can be trained to solve environmental problems and to create actions to repair, preserve, manage or improve the environment. Some organizations have begun using design thinking with ICT to help students and the public solve complex problems. Design thinking is a creative and collaborative form of work during which intuition is important, solutions are numerous, experimentation arrives quickly, failure is perceived as learning and, mostly, consumers' needs are taken into consideration. In the framework of a rigorous process and specific tools, design thinking calls in creative and analytical modes of reasoning for the development of products, services and healthy places adapted to the targeted public. Also, if we want to use ICT to facilitate the design thinking stages, various applications are available: *Blendspace* (to store all the information found about a problem), *Lino* (to share pictures of the problem), *ICardSort* (to link and sort ideas), *Loomio* (to choose a solution), *Padlet* (to draw prototypes in teams) and *Wrike* (to plan in a team).

1 INTRODUCTION

Sustainable development is a difficult concept to grasp. Its nature, meaning, stakeholders and the actions ensuring its fulfillment are starting to emerge (Norberg and Cumming, 2008). Its definition has also evolved considerably. Initially, it was conceived as the use of resources and the environment to meet current needs without compromising the needs of future generations (World Commission on Environment and Development, 1987). Later, it was defined as a cultural adaptation made by society as it becomes aware of the emerging necessity of non-growth (Daly, 1993). Next, it was perceived as a process for planning flexible, wise, long-term development to avoid destroying the very resources that keep us alive (Meadows and Randers, 2004). Recently, the issue was to promote human well-being taking into account the built, social and natural resources (Costanza et al. 2013). Through all of these definitions we see that sustainability is not an end in itself, but a dynamic process that requires resilience and an ability to manage resources wisely in order to adapt to changes (Berkes, Colding, and Folke, 2003).

Since sustainable development cannot be implemented in a single day, we hear more and more of a transition toward sustainability (Mochizuki and Fadeeva, 2010). During this transition, many environmental actions emerge throughout the world. Environmental action is a voluntary action implying decisions, planning, implementation and reflection, undertaken by individuals or by a group with the intention of reaching a specific goal (Emmons, 1997). Among today's sustainable development initiatives, there are the Slow Food Movement (Petrini, 2006), Conservation Design (Arendt, 1996), Transition Towns (Hopkins, 2008), Smart Growth (Duany et al., 2010), Ecological Cities (Register, 2006), ban of harmful products (Maniates, 2010), biodiversity restoration measures (wildlife crossings, green walls, green roofs; Fuller et al. 2010), sustainable happiness (O'Brien, 2012), assisted migrations (McLelland et al., 2007), etc. Slow Food practitioners take time to share « clean » local food with people from their community. In Conservation Design, while developing new neighborhoods, urban planners first identify natural and cultural treasures onsite then focus the buildings away from these treasured areas. In Transition Towns, citizens become aware of the urgency to prepare to the oil peek's impacts and are encouraged to develop their resiliency by relocating what can be relocated and by tightening social connections. Smart Growth and Ecological Cities' followers use various techniques

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to absorb or reuse rain water, to slow down automobile traffic, to increase density in inhabited areas or to improve universal access to parks. The ban on harmful products consists in prohibiting the sale of products harmful to the health or of objects made with threatened species. As for biodiversity restoration measures, they are varied: wildlife crossings, green walls, green roofs, biodiversity hedges, animal shelters for specific species (insects, amphibian, small mammals)… Sustainable happiness as conceived by O'Brien (2012) is characterised by the reflected and critical choice of pleasure favourable to the health and quality of life of humans and ecosystems. Finally, during assisted migration, species threatened by climate change are intelligently displaced or habitats are converted to help these species migrate to more favourable locations. Throughout these sustainability initiatives, systems, structures, practices, the future, values and the physical environment are modified and creativity is omnipresent (Pruneau, Langis and Chamberland, 2014; Montuori, 2012).

2 LEADERS IN SUSTAINABLE DEVELOPMENT AND DESIGN THINKING

Kerry et al. (2012) studied the competences demonstrated by sustainable development leaders working in forestry, urbanism and sustainable agriculture. They found that these leaders demonstrated creativity and more particularly design thinking, a form of creative problem solving. Design thinking (created by IDEO) is a creative and collaborative form of work during which intuition is important, solutions are numerous, experimentation arrives quickly, failure is perceived as learning and, mostly, consumers' needs are taken into consideration (Brown, 2009; Martin, 2009; Kelley and Littman, 2005; Liedtka and Ogilvie, 2011; Lockwood, 2010). Given the societal changes needed in sustainable development, design thinking is starting to be promoted in environment (Plattner et al., 2011). To take risks; to open up to innovation; to enlist in the unknown, the uncertain, the complex; to understand with empathy what others go through and how different events affect them; to foresee how things could be different and to face current and future challenges, one must have a good dose of imagination and creativity. To create, experiment and evaluate community environmental actions, design thinking could prove to be promising.

Design thinking puts into practice the sensitivity and the designer's method in complex problem solving. In the framework of a rigorous process and using defined tools, it calls on creative and analytical modes of reasoning (Lietdka, 2014). In recent years, design thinking gained popularity and is now used to solve problems and create products in business, services, medecine and environment (Dorst, 2011; Kimbell and Julier, 2012). The design thinking process unfolds according to the following steps: 1. *Inspiration*: conduct an ethnographic study to understand the people concerned by the problem (the consumers) and the situation; 2. *Synthesis :* define the problem many times, gather information and different perspectives on the problem; 3. *Ideation:* formulate many ideas; 4. *Prototyping:* prepare, experiment rapidly, evaluate and refine prototypes from the best ideas proposed; 5. *Communication:* design and implement communication strategies. The design thinking process steps are not linear since the designers' attention regularly moves between the problem space and the solution space while the empathy for the consumers' needs increases and the winning solution is refined. In design thinking, three elements are combined: empathy, creativity in solutions and the rational in the analysis of solutions (which must correspond to the needs) (Stewart, 2011). In this way, there exist two types of design or process by which objects are modeled to solve problems. The design can be traditional and call on inductive and deductive thinking. Using traditional design, simple and closed problems can be solved, such as the identification of the position of a star at a certain time of year. However, to solve complex problems such as finding climate change adaptation measures, the addition of another type of thinking is needed: abductive thinking consisting in considering one element that could exist. Design thinking calls on inductive, deductive and abductive thinking.

3 DESIGN THINKING AND ICT

Some universities have begun using design thinking in combination with ICT to train their students to solve complex problems. This type of design is called social design (whose goal is social innovation; Kimbell and Julier, 2012) and collaborative design (Paulini, 2012; Seidel and Fixson, 2013). For example, at Stanford University (San Francisco), at Toronto University and at Temple University (Philadelphia), the design thinking process is used with students to help them find innovative solutions

in business, urbanism, environment... In the same way, at Cambridge University (Boston), a technological environment called *CSCL-environment* (Computer-Supported Collaborative Learning) is used to help students represent, define and solve complex problems. So, in universities and organizations such as *ClimateCoLab* (MIT, USA), *MindLab* (Denmark) and *Creativity Institute* (Australia), with the help of tested problem solving pedagogical approaches and technological applications, students and citizens are empowered in solving contemporary problems. Useful solutions come out of these processes. There are also online platforms (ex: *Innocentive.co*m; *Quirky.com; OpenIdeo.com; MyooCreate.com*) where challenges are presented and the public or a given community is invited to submit solutions. Here, the concept of *collective intelligence* appears according to which participation by many people promotes the contribution of various perspectives for the definition of a problem and the formulation of new ideas.

At the various design thinking steps, numerous applications can also be used: blogs and interactive white boards, to define the problem; *Wikis and Popplet,* to share solvers' views and graphically represent the problem; *Skype*, to share images of the problem; *Blendspace,* to store all the problem's information; *Lino*, to share pictures of the problem; *PiratePad,* to write in a team; *ICardSort*, to link and sort ideas, *Loomio* to vote in order to choose a solution; *Padlet*, to draw prototypes in teams and *Wrike*, to plan in a team (Darrow, 2013; Langis, 2015).

4 DESIGN THINKING, ICT AND SUSTAINABLE DEVELOPMENT

Given the important need to innovate in sustainable development, the design thinking process could prove to be useful to invent structures or products allowing to repair or to improve the quality of the environment (Brown, 2009). For example, using the design thinking process, university students could be invited to restore biodiversity in an urban setting by inventing then testing an insect hotel. In order to do this, they should take their consumers' (the insects) shelter and food needs into consideration then install and test hotel prototypes built to answer these needs. In the same way, students could create a bird nest material dispenser taking into consideration the nests that are normally built by the local birds. Finally, they could apply the design thinking process to organize a community refrigerator project to collect and distribute leftover food to supply meals for homeless people. Here, homeless people's needs, the needs of the families supplying the leftovers and those of the volunteers transporting the food as well as operation and maintenance costs should be taken into consideration during the design thinking process.

During the design steps carried out in the classroom or remotely, various technological applications can be used. At the design thinking *Inspiration* stage, students must investigate the problem-situation collaboratively as well as the consumers' needs. As we know, environmental problems are complex, comprised of causes, actors, impacts, places and circumstances. *Stormboard,* a collaboration tool, could enable a group of students to study a complex problem in all its aspects. Indeed, *Stormboard* allows users to draw columns titled *What? When? Who? Where? Why?*, where solvers can add information on various aspects of the problem, with the help of words, images and even videos. *Realtimeboard* and blogs (such as Wordpress and Overblog) could also serve as shared online platforms to gather the documentation found about the problem: pictures, documents, films and *Skype* conversation recordings with experts or consumers.

At the *Inspiration* stage, the *Narrative Clip*, a small wearable camera that is attached to consumers' clothing could also be used to document their experience of a given area while they are moving in this area.

At the design thinking *Synthesis* step, students must pose the problem, that is summarize, simplify and organise the information found about the problem (Schacter et al., 1997). They must represent the problem in a way that is favourable to solving it and make connections between its elements (causes, places, impacts…). Visual representations (drawings, graphs, concept maps…) allows to study the problem in depth visually, verbally, numerically, sequentially and emotionally (by expressing the feelings and opinions linked to the situation) (Green, 1993). Visual representations help relieve the brain and facilitate the exchange of information between solvers. At the *Synthesis* step, *Popplet* and *Mind42* could facilitate the community of solvers task by providing the interface to produce rich conceptual maps with boxes, links between the boxes, drawings and even Youtube videos inserted at relevant locations on the map. At this stage, programs such as *Moovly*, *iMovie* and *Stupeflix* could also be useful to

summarize the study realised on the problem. These programs would allow students to easily produce videos where we would see them discussing the problem.

At the *Ideation* step of the design thinking process, *Padlet*, which offers a white wall that can be used as an online brainstorming tool, could be helpful. In the same way, specialised sites or sites with sites focusing on environmental subjects such as *Pinterest*, *La Bioguia* and *ClimateCoLab* could be used to represent ideas to inspire new solutions paths. Finally, *Loomio* and *Mural.ly,* collaborative decision making tools allowing the evaluation of different ideas and to grant them a value, would facilitate the choice of solutions that would be tried out as prototypes. *Loomio* consists of a discussion and a voting tool. Mural.ly has a flexible canvas to gather information and make a decision with a voting tool.

At the *Prototyping* stage of the design thinking process, drawing tools such as *iDroo*, *kleki.com* and *Sketches* would help to prepare prototypes of the best ideas at the *Ideation* step, in order to collect consumers' opinions on those prototypes. As for *Avocado*, it would help to represent prototypes with the help of successive images while *Second Life*, a 3D virtual universe, would materialize the prototypes. As for the prototypes that need to be built and not only drawn or virtually animated, *Wrike*, a project management tool (that allows to list, describe and assign tasks) ensures effective planning of the construction and prototype trials.

Finally, the *Communication* stage of the design thinking process would be facilitated and enlivened by the use of a tool to produce posters (*Glogster*), magazines (*Madmagz*) or presentations (*emaze*).

5 CONCLUSIONS

Environmental problems are complex, open and poorly defined. They include many characteristics, functions and variables. Many links exist between their elements and solving them requires interdisciplinary collaboration. Design thinking has already produced original and relevant solutions to these types of problems. By way of example, IDEO company engineers used design thinking in developing countries to build an *Aquaduct Concept Vehicle*, a bicycle that transports, filters and stores water while the cyclist pedals. Thus, design thinking would be relevant to create conservation, management or environmental improvement actions with university students or the public. Combined with ICT, design thinking would be even more promising to facilitate the collaborative design of healthy and environmentally conscious places, practices or products. In fact, ICT could facilitate the collaborative work at the *Inspiration*, *Synthesis* and *Ideation* steps of design thinking by offering platforms to share perspectives and information on the problem, discussion platforms and platforms to visually represent problems. As well, as we know, many university courses are partially or completely offered online nowadays. Online communication tools (Skype, Facetime) open endless possibilities to work with a remote group and to contact experts and people outside the classroom to better describe the problem. At the *Prototyping* step, ICT allow a less costly and quick production of drawings and models demonstrating the best solutions. They strengthen students' capacity to plan and manage prototype trials. Finally, at the *Communication* step, the possibilities of graphic design and publication of images and videos using ICT are endless.

The design thinking process should be the subject of environmental education research in the coming years. Trials using design thinking to invent healthier ways of life and land use planning could be made with university students, first without using ICT and afterwards adding ICT to the process.

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