EXPECT THE UNEXPECTED
THE CO-CONSTRUCTION OF ASSISTIVE ARTIFACTS

Lieven De Couvreur[a] , Jan Detand[a] , Walter Dejonghe[a] and Richard Goossens[b],
a Industrial Design Center, HOWEST - University College of West Flanders, Ghent University, Belgium
b Applied Ergonomics and Design, Faculty of Industrial Design Engineering, Delft University of
Technology Delft, The Netherlands;
lieven.de.couvreur@howest.be

ABSTRACT

This paper aims to explain emerging design activities within community-based rehabilitation contexts through the science of self-organization and adaptivity. It applies an evolutionary systematic worldview (Heylighen, 2011) to frame spontaneous collaboration between different local agents which produce self-made assistive artifacts. Through a process of distinction creation and distinction destruction occupational therapist, professional non-designers, caregivers and disabled people co-evolve simultaneously towards novel possibilities which embody a contemporary state of fitness. The conversation language is build on the principles of emotional seeding through stigmergic prototyping and have been practically applied as a form of design hacking which blends design time and use time. Within this process of co-construction the thought experiment of Maxwell's Demon is used to map perceived behavior and steer the selecting process of following user-product adaptation strategies. This practice-based approach is illustrated through a case study and tries to integrate both rationality and intuition within emerging participatory design activities.

Keywords: self-organization, stigmergic prototyping, co-construction, situated action, surprise, , community based-rehabilitation

INTRODUCTION

According to several studies in the latest world report on disability the world health community acknowledges that all over the globe : "*assistive products, when appropriate to the user and the user's environment, have been shown to be powerful enablers to increase independence and improve participation. (WHO 2011 p.101)*". The word appropriate is a key term and contains a lot of ill-defined complex aspects which (1) differ for each specific local context and its dwelling disabled or nondisabled individuals. Furthermore many of these aspects are (2) emergent, not predictable and change continuously in time. This vision is explicitly reflected in the International classification of functioning and disability (ICF, 2001) which provides a multi perspective view on disability and frames the phenomenon as an interactive and evolutionary process. By including contextual factors the World Health Organization mainstreams the experience of disability but also acknowledge its highly idiosyncratic and dynamic character. Experiencing a degree of disability embraces a temporarily negative state of interaction between the features of a person's body, the activities he or she wants to achieve and features of the society in whom the person participates (Figure1).
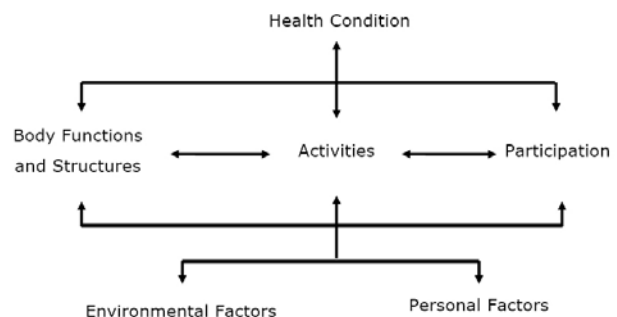

Figure 1 International classification of functioning, disability and health (WHO,2001)

Although many occupational therapist are applying this holistic worldview in their practices, they often get confronted with the reductionist approach of rehabilitation engineering which provides the market with professional assistive devices. Many of these devices are designed properly from an objective point of view, but once clients and environments start to evolve or change their goals, friction is caused through their static and close-ended characteristics.

These characteristics are both inherited out of classic medical and engineering principles. (1) The traditional healthcare frame perceives disabled people as medically not normal, and "being normal" – not better or worse – is the desired objective (Correia et Al, 2011). Too often the assistive technology industry looks at assistive devices as a kind of medication treatment which is prescribed by an expert and tries to cures people from an acute disease. Based on unidirectional and standard interventions it aims to integrate disabled people back into society. (2) This view is reinforced by the design engineering perspective which is driven on a culture of technology-push and market-pull. Assistive technology manufactures are part of the mainstream industrialized world in which goods and services are delivered to and for people. To include as many users they put the emphasis on providing cost-efficient aids and are forced to find a certain stage of consensus on various factors.

Apparently the language of acute medical conditions and universal design are ill suited to maintain well-being over a life-time. Both approaches have been very successful in solving well-defined problems with static structures shaped by clear objective symptoms. In these frameworks disabled people and their caregivers are forced to adapt one way as they are literally the terminal stop in top-down processes. When this adaptation process demands too much cognitive, physical or social effort new actions emerge on a local scale. At this moment the authors recognize 2 main scenarios. (1) The most frequent scenario is that of non-use. In many cases these expensive devices get rejected and end up in the back of closets. The disabled client resigns with the fact that (s)he will have to find another variation of the device or ceases his quest and relies on an allied health professional to perform his activity.(2) The second scenario recognizes a more bottom-up and bidirectional phenomena. In certain conditions spontaneous coordination emerges between local agents which lead to the production of self-made assistive artifacts. Existing devices are getting hacked or even constructed from scratch to create new possibilities and motivate people's behavior. In these contexts disabled people and their caregivers become conscious actors, rather than being objects of pity and in need of care. Through a process of reciprocal exchange new activities are designed which honor specific abilities and new states of functioning emerge. The aim of this paper is to explain these spontaneous design activities through the mechanisms of self-organization and complex adaptive systems.

COMMUNITY-BASED REHABILITATION : COMPLEX ADAPTIVE SYSTEM.

Reality show us that a substantial portion of all assistive technology is abandoned after initial purchase or use due to changing skills and environments. Over the past decades several research illustrates the variety and complexity of factors which influence the acceptance and usage of assistive products. Most of them can be roughly categorized by their social or technical (Hocking, 1999) background and have an influence on different levels (Wessels et al,2003) within the local product ecology of the assistive device: (1) Aspects related to the assistive device,(2) Aspects which are personal user related (client), (3) Related aspects to the user's environment and (4) Intervention related aspects. Some practical examples are : acceptance of disability, stigma, quality of the device, physical barriers, progression of disability and lack of instruction. All of these phenomena are constructed from a complex mix of subjective experiences which are provoked by user-product-environment (inter)actions.

Predicting or coping with these underlying phenomena requires a set of new methods other than those applied in classical reductionist science. Research in the field of persuasion and decision-making has pointed out that it is impossible to build up knowledge on the basis of average effects to make predictions on

individual level behavior (Kaptein,2011). These methods should not exclude wicked aspects but incorporate the experiential knowledge of disabled users and caregivers into design processes and frame ill-defined, idiosyncratic and unexpected behavior as opportunities for more adequate solutions. Every single contextual disability is connected with individual conflicts of values, goals, skills and specific interests. Therefore, if one wants to design meaningful assistive devices, one should take into account the whole product ecology (Forlizzi, 2008) of an individual context (Figure 2).
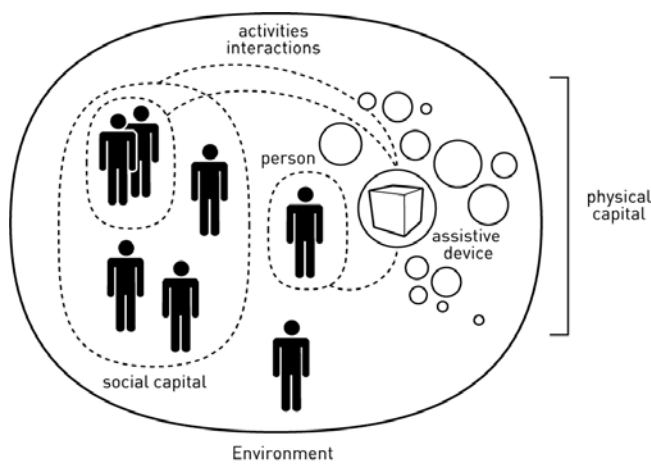

Figure 2. Product ecology adopted from Forlizzi (2008)

As previously noted, in some environments amateurs manage to deal with the complexity of dynamical aspects through a type of collective design hacking or community-based rehabilitation. Platforms like instructables.com, open prosthetics and "papas bricoleurs" from handicap international lively illustrate the revival of self-made assistive artifacts .In most cases, disabled people cannot act as designers but have certain caregivers in their environment for the daily support with whom they have a strong emotional tie. These relatives or friends are also longing for new assistive devices that give them new possibilities to interact with their disabled kids, parents or friends. Another attractor is the human willingness to voluntary contributed with one's skills & talents to help other. (Lyubomirsky, 2007). Each design activity clusters different meaningful ingredients (Desmet, 2001) from the perspective of all stakeholders. Goal-directed and productive engagement with a local context seems to be a good recipe for raising happiness. The image of the caregiver working in his garage and developing a unique solution so that a disabled friend can perform a

job more efficiently has a personalized appeal in this complex age of technology; but it is an everyday occurrence. All these humble artifacts represent "universe of one" solutions which articulates trade-offs between intrinsic values on social-technical factors regarding qualitative occupational experiences. This approach is highly iterative and is constructed on local implicit knowledge of all direct stakeholders. The focus is no longer maintaining life in a neutral state (medical model), but creating an overall sustainable form of wellbeing with underlying interactions that evoke processes of learning, adapting and evolving.

Self-organizing community-based rehabilitation projects embody lively the opposite perspective of disability which is defined as functioning and denotes the positive aspects of the interaction between an individual (with a health condition) and the individual's contextual factors (environmental and personal factors). Many community-based rehabilitation contexts can be considered as complex adaptive systems, consisting of different stakeholders, which cooperate while interacting with a shared physical environment. In most cases the groups are rather small, up to 3 to 5 people. This implies that the complexity does not arrives from the number of agents but rather from the dynamic networks of interactions and relationships. The adaptive character is expressed in the fact that individual and collective behavior changes as a result of personal experience. (Juarrero, 2000). The key roles in these design activities are forming a trialogue around the aspects of assistive technology: activity, user(s) and appropriate technology. It is preferable to talk about archetypal roles than key players because in some situations one agent can fulfill more than one role (De Couvreur and Goossens,2010).Each agent is finding meaning though a dialogue with his own actions. The output of such a complex system is typically unpredictable, yet exhibits a form of self-organization which deals with contextual disability as an hybrid or mixed system steered by with reflective, behavioral and visceral, , aspects(Norman,2004 & Ortony, 1988). This spontaneous adaptation process driven by actions leads in certain conditions to low-fidelity assistive artifacts with a high utility acceptance and affective percentage.

HACKING DESIGN : SELF-ORGANIZATION

Many community-based rehabilitation contexts can be considered as social systems. If we dive deeper in the contextual creation process of self-made assistive artifacts we can draw clear similarities with the principles of self-organizing systems. The science of self-organization deals with complex adaptive systems which spontaneously arrange or assemble themselves. The internal organization consists of agents, individual components which interact with each other and the environment. Out of the varying interactions some kind of order will emerge which leads to preferences that create more order and stability. Within the context of disability we perceive these preferences as states of functioning or more specific, qualitative occupational experiences. They embody a positive state of equilibrium between relevant factors of a disabled person, his activity capital and the surrounding habitat, which incloses both social and physical aspects (De Couvreur, 2011).
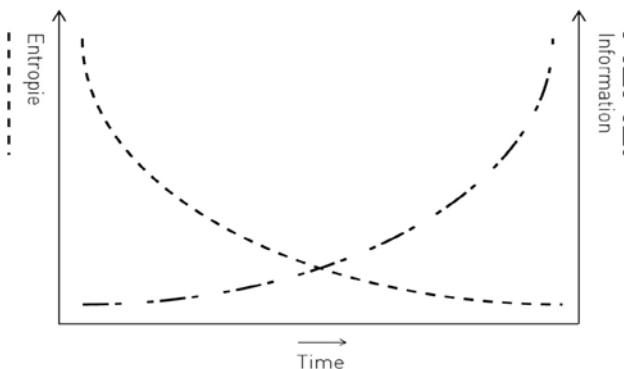

Figure 3 Entropie vs Information:

A practical way to define a self-organization system is by the its state of statistical entropy, which is a measure of variation. In general a self-organizing design process reduces variety or uncertainty, and at the same time increases information or constraint. Professional designers have always been aware of the importance of rigor and chaos in the first stages of product innovation processes, especially for complex and new projects (Buys,2008). The cybernetician Heinz Von Foerster (1961) formulated this principles as "order from noise" which emphasizes a simple rule : the larger the variety of configurations a system undergoes, the larger the probability that at least one of these configurations will be selectively retained.

The same principle occurs in design activities of successful community-based rehabilitation projects. Through a process mutual adaptation different agents produce actions and re-actions which construct meaning and fitness for all of them. Formally, the basic mechanism underlying co-construction is the (often noise-driven) variation of artifacts and activities which explores different possibilities in the social system's state space until it enters an experiential attractor. Important to note is that all this is achieved in a way that is parallel and without central authority. All contributing agents have implicit preferences (goals or values) and explicit skills (regarding activity, user(s) and appropriate technology aspects) that give direction to their further evolution and that of the social system. Each of the agents will act differently when he perceives specific conditions which arise from stigmergic behavior out of local (inter)actions or variation. The bigger the friction between a disabled individual and personally meaningful activities, the more he and his surrounding caregivers will be pressured to intervene. This explains the phenomenon of physical hacking culture in real life society. In a way, hacking is a natural response when the resources at hand fall short to achieve one's personal or social goals. If we observe different self-made artifacts it becomes clear that human agents act not only for material gain, but for various physical, mental and social well-being aspects.

Evolution is often viewed as a biologic process that is general slow. But the power of human exploration & exploitation, which are both inherently driven by creativity, can also been seen as a type of human evolutionary process. Through spontaneous appearance of novel structures or the autonomous adaptation, environments can be changed in much faster timeframes. The adaptive capacity of human agents is very high, due to the high number of specific actions they can produces and external conditions which can be sensed. However, this makes it more difficult for some agents to select the most appropriate action. On the other hand many disabled people, surrounding households and occupational therapists are doing a great job and manage the chaos and complexity through a type of stigmergic intuition. Creating enough variation is one thing but the key is

also to use all cognitive repertoires of contributed agents as a type of social "vicarious selector" (Campbell, 1974.) Each direct stakeholder consists of a repertoire build of implicit knowledge constructed through reflective, behavioral and visceral experiences. This reflection-in-action approach makes it is possible to anticipate the consequences of further actions. Still we may not fall in a cognitive trap as there are clearly big distinctions between the remembering self and then experiencing self (Kahneman,2011). Therefore we need a process of continuous learning which is built on surprises through interaction with the assistive artifact and the changing environment. Surprise is right there in the fuzzy border between two related phenomena - emotion and attention. This basic emotion elicits reality constructions for all participating stakeholders and helps them focusing on a new, possibly significant aspects.

THE REFLECTIVE PRACTITIONER : MAXELL'S DEMON

Within community based healthcare projects this mutual adaptation process is coordinated through stigmergic prototyping (Figure 4). A process is stigmergic if the work ("ergon" in Greek) done by one agent provides a stimulus ("stigma") that entices other agents to continue the job. (Heylighen, 2007). The use of a prototype in a specific context creates a type of shared understanding and stimulates interaction that is spontaneously raised in that context. The utility behavior is observed through logging affective responses of all agents.
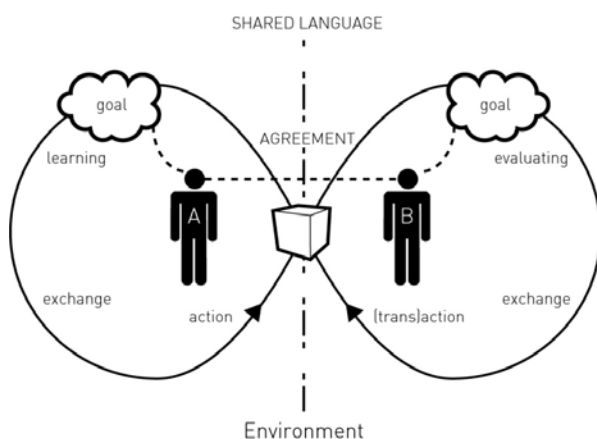

Figure 4 Stigmergic prototyping, adopted from Pangaro's (2009)) interaction—cybernetics—design

This process of active learning has an impact on all interacting agents, including the prototype. In this sense the process is a double-blind method (Dejonghe et al,2011). (1) The intended influence on the behavior of the agents (stakeholders) is not made conscious, and certainly not by the presence and influence of the designer. If the intended behavior does not happen spontaneously, the design of the prototype has failed. (2) Moreover: the agents will be able to observe not intended uses and (to the designer new) meanings by the interacting agents because traces will be left during the interaction.The aim of this paper is to illustrate this selection process more profoundly and practically explain how spontaneous design activities in community-based rehabilitation lead to higher states of fitness for all agents.

The phenomenon of self-organization is paradoxical with the second law of thermodynamics, which states that entropy ("disorder") of itself can only increase, not decrease. The tough experiment of Maxwell demon teaches us a way to create a mental model for the order-surprise and to simulate the violation of "the Second Law" within hacking design
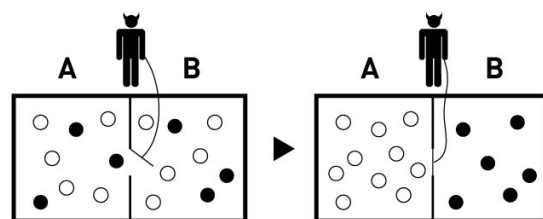
.

Figure 5 Maxwell demon

"A container is divided into two parts by an insulated wall, with a door that can be opened and closed by what came to be called "Maxwell's demon" (Figure 5). The demon opens the door to allow only the "hot" molecules of gas to flow through to a favored side of the chamber, causing that side to gradually heat up while the other side cools down, thus decreasing entropy." This example illustrates a form of asymmetrical evolution where a selection is driven by a certain preference. We applied the same principle in various co-construction cases through a simple 4-channel matrix which distinguish four frames by the combination possibilities of following binary distinctions: surprise/no surprise and desirable/undesirable (Schön,1983).

	EXPECTED ASPECT	UNEXPECTED ASPECT
POSITIVE FEEDBACK	say do make	say do make
NEGATIVE FEEDBACK	say do make	say do make

Figure 6. Reflective & affective practition - The Schön matrix. (Schön,1983).

The matrix (Figure 6) is used to map the observed behavior and build up a type of fluid intelligence which guides future strategies for the following iterations. Many of these observations are triggered by appraisals which can be considered as non intellectual, automatic evaluation of significance of a stimulus for one's personal well-being. (Roseman and Smith, 2001) towards social and technical aspects. Agents create in a sense a sort of blind variation as they work locally on a assistive artifact. They don't exactly know what the effect will be on the environment and how the disabled individual will perceive the interaction with the physical prototypes. Through interaction with tangible contextual factors (environmental and personal) friction-based actions will disappear and synergetic ones will further evolve and lead to a stable system within the ecology. The dynamics of design with self-organization are typically non-linear, because of circular or feedback relations between the components. Actions which lead to affordances(Norman, 1999) can reinforce the process, but repetitive frictions can cause a destructive negative feedback loop. Ideally each individual agent should fill his matrix from a first-person perspective and also observe the group from a third-person perspective. Hereby gained knowledge is developed through active construction of combining a variety of usefullness, pleasantness and rightfulness appraisals from different stakeholders (Desmet,2010). The combination of all matrixes with the stigmergic prototypes makes the observed behavior more comprehensive, reliable and less implicit by taking into account more diverse perceptions and points of view. It reduces the complexity which arrives from the multi perspectives from different stakeholders. This method is appropriate for handling wicked aspects as it takes into account that not only will happen what was intended by the builders of the prototype but also something different that will emerge (express itself, organize itself) in the chosen context, embodied by the spontaneous behaviour of the interacting agents.

CASES STUDY : FRED'S PRISMGLASSES

This framework has been developed through action research at the Industrial Design Center of Howest University. Over the last 4 years several co-design cases have been set up around meaningful activities of individual people with disabilities Each co-design team randomly consists of a disabled client, a caregiver, a student industrial design, a student occupational therapy and other stakeholders from the local rehabilitation context (Figure 7). The process takes approximately 12 weeks wherein the group alternates between design time and use time activities. From day one students are only allowed to communicate with tangible prototypes and report their findings on a self-reporting shared blog (Bellens, 2011). All use time observations were filmed and subsequently analyzed with the Schön-matrix from the students their perspective. Design time experiences are attach to the corresponding open-ended prototypes which all have a unique numbering.

CONTEXT

The participating client was Fred, a middle-aged man who works in a hospital as head of the sanitary nurses. With his technical staff he is responsible for keeping the hospital free of bacteria. At the age of 23 Fred was diagnosed with ankylosing spondylitis. This disease, also known as Bekhterev syndrome, mainly affects joints in the spine and causes rigidity. Because of this disability Fred cannot lift his head entirely upwards. His field of view slowly decreases each year. At the start of the co-design session he was not able to see the top of a door anymore. This state of dysfunction cause a lot of friction with some daily activities in his working environment. Some practical examples are: replacing lamps, reaching for material from high cabinets or setting up the beamers. In his quest to find a solution the participant hasn't found any professional assistive device which could help him in his familiar surroundings.

Figure 7. The co-design team.

PROCESS

To illustrate the process we discuss some concepts (emotional seeding, surprise, hacking) through key incidents in the design process of the above mentioned case. All the posts from the self-reporting blog have been coded in design-time or use-time categories (Figure 8). Design time is considered as any activity which involves the creative process of prototyping or hacking. Use time involves the observation when the client is performing his activity in situ with the constructed artifact. Our aim is to illustrate within both type of activities the concept of stigmergic prototyping which stimulates the process of decision-making by anticipating on unexpected prior actions, behavior or appraisals within the social system. Due to the limited capacity of this paper format we will only discuss the first 4 activities in the beginning of the co-design process. The starting point is a design brief (B0) formulated by the occupational therapists.
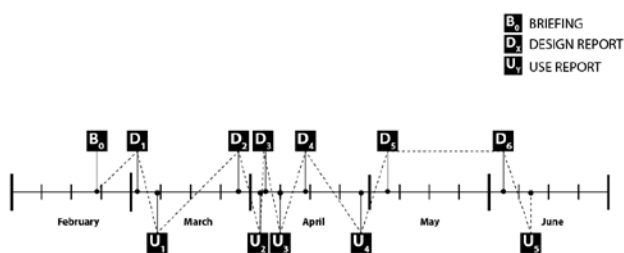

Figure 8. Oscillation between design time and use time.

Design time Report 1

Before visiting the client the students react on the design brief and externalize their premature knowledge into three low-fi prototype variations (Figure 9). All of them integrate mirrors into wearable glass concepts. To reduce the design effort in time and energy they decide to re-using old parts and waste material which are located in the workplace. By doing so they report to be surprised on the fact that the relation between the eye-mirror distance and the experience of controllability are so strongly correlated and have a strong effect on the performance. The behavioral experience stimulates them to make a fourth prototype which integrates these findings. These positive usefulness appraisals two reactions: dividing the mirror in 2-parts and moving it closer to the eyes.

Figure 9. Design time Report 1 prototypes

Use time Report 1

For the first time the group came together. Fred evaluated all the prototypes within his working environment without any proper explanation (Figure10). The test with the *periscoop 2.0* revealed that Fred used the prototype in a completely different way than anticipated. Instead of handling the two mirrors to correct his field of view, he only manipulates the farthest mirror to gain an eyeshot of the place right above his head. He perceived the prototype as an useful solution for different odd jobs related to his ceiling at home.

As mention in the Schön-matrix another latent goal emerged out of the interaction with the *pentabril 1.1.* Fred mention that he is passionate about photography. In his free-time he takes pictures of big paintings from Flemish primitives and stained glasses of old churches. This reaction was constructed out of a pleasantness appraisal and can be interpreted as stigmergic cue towards an emotional fitness which focuses on the level of an meaningful activity. Another unexpected positive reaction was evoked by the compactness shape of the artifact. The nature of this response arised from a rightfulness appraisal an focusses on Fred's self-image. As Fred is a very proud man with a high degree of self-efficacy. The non-intrusive character of the *pentabril 1.1* embodies

his attitude towards assistive devices. Of course a lot of unexpected negative aspects raised too, the size of the *pentaglass 1.0* was to small, the artifact blocked his view of the ground, and so on… But the effort to overcome them was perceived as manageable by the students and the positive appraisals triggers them to plan new actions

Figure 10. Use time report 1 (Bellens, 2012)

Design time Report 2

In this faze the students try to unriddle the negative unexpected aspects through creative prototyping and make new variations on the *pentaglass 1.1* and *Periscoop 2.0* (Figure 11). They still work on both main design strategies as they have still time, interest and resources to do so. Although the open-ended prototypes have evoke several stigmergic cues, the students want to repeat the same behavior and see if they can observe coherent patterns in the appraisals and the behavior.

The occupational therapists have noticed that Fred spontaneous corrects his vision through a flexion of his hip joint. This behavior makes him capable of self-adjusting his field of view and eliminates the technical requirement on the level of the product. As the distance and angle between both reflective mirrors is so crucial the designers decide to make their own prism glasses out of PMMA or plexi glass. Although they manage to calculate the exact angles and size, the students don't manage to reach the same optical performance. They decide to change their strategy and with the help of the occupationial therapist they manage to buy standard prism glasses for 34 Euro. This object turns out to be *pentaglass 3.0.*

The *periscope 2.1* consists of a mirror which is attach by means of a curved profile on the inside of a helmet suspension. The students expect that this hacked artifact allows Fred to carry out tasks located above

his head, which demand a certain precision, such as turning in a screw or replacing a lamp. The artifact makes it possible to keep both hands operational during the activity.

Figure 11. Design time report 2 prototypes

Use Time Report 2

While testing the *periscoop 2.1* Fred looked and behaved reasonably satisfied. He confirms the advantage of the hands-free aspects and appraised the prototype also useful in the process of climbing on a ladder. The space between the mirror and his eyes gives him the opportunity to peek at his steps. He also repeats the spontaneous tendency to move the mirror closer to his eyes and emphasizes on the compactness related requirements (Figure 12). The purchased *pentaglass 3.0.* is tested by flipping it 180° and placing it in front of Fred current glasses. He stills manage to self-adjust his vision and is able to perform both activities looking more ahead and examine the ceiling. Only the global vision is distorted because the lenses doesn't align correctly with the position of Fred's eyes. Measuring and aligning both aspects are set as subsequent actions in design time 3.

After this co-design session it is clear that *pentaglass 3.0* has the strongest cues on both levels, usability and an affective user experience. The recovered prism lenses must be integrated in a compact frame that is compatible with Fred's collection of eyeglasses. While taking part in this focusing conversation, Fred was very enthusiastically to test out al prototype. He constantly suggested new solutions on different aspects to improve the artifacts. The students are aware that they have to meet Fred's standards and expectations on the level of finishing aspects and workability. Later on in the design time this aspect nudged the decision to use 3D printing as a production process.

Figure 12. Use time report 2 (Bellens, 2012)

END RESULT

This codesign process has led to an open design product called the reversed prism glasses which includes : CAD files for an adjustable 3D printed frame, recovered prism lenses, compatible onto any standard read glasses through magnets and small heatshrink tubes, a low-fi calibrating eye-tool and the possibility to personalize with you initials.

Figure 13. Reversed prismglasses

CONCLUSION

In many more cases disabled actors cannot act physically as designers but somehow trigger surrounded caregivers from their direct environment to take action and give birth to the spontaneous creation of local community-based rehabilitation groups. Design for self-organization is an optimistic and sustainable way of turning disabilities into new possibilities. An acknowledgement that there is more design opportunity in the world than will ever be addressed directly by professional designers alone. The challenge for designers (Fischer and Giaccardi, 2006) is to conceive and realize structures that not so much tell the agents what they should do, but that helps them to find out for themselves what is the most effective way to act in a coordinated and synergetic manner. Meaning is developed in situ (Boes, 2008) through active construction of functional and social experiences derived from different stakeholders. Mismatches will lead to new understanding and become challenging opportunities for new solutions.

These design-driven mobilization systems reaches consensus about goals and fundamental values, motivates/stimulates people with the right stigmergic challenges. More practice based methods can be implement around the components of human self-organization: creativity, stigmergic prototyping, the capacity of surprise and the search for synergetic emotional connections. The basic rule is simple: just (re-)act and see what happens.

REFERENCES

Buijs, J. (2008). Action planning for new product development projects. Creativity and Innovation Management. 17(4), 319–33.

Bellens, J. & Stubbe, J. (2011). Design for (every)one, Prismabril . Available from: http://prismabril2011.blogspot.com/ [Accessed 22-05-2012].

Boes, S. Kanis, H. (2008). Meaning in product use: a design perpsective. In H. N. J. Schifferstein & P. Hekkert (Eds.), Product experience (pp. 305-332). Amsterdam, The Netherlands: Elsevier.

Correia de Barros, A., Duarte, C., Cruz, J. B. (2011). Complexity in inclusive design: needs or opportunities?", In: Proceedings of the Senses & Sensibility in Lisbon Conference (2011). UNIDCOM/IADE, 6– 8 October 2011, Lisbon.

Campbell, D.T., 1974. Evolutionary epistemology. In The Philosophy of Karl Popper. pp. 413–463.

De Couvreur,L. , Goossens, R. (2011): Design for (every)one: cocreation as a bridge between universal design and rehabilitation engineering, CoDesign, 7:2, 107-121

De Couvreur, L., Detand, J., and Goossens, R., (2011). The role of flow experience in codesigning open-design assistive devices. In: Proceedings of the include 2011 conference, 18–20 April 2011, London.

Dejonghe, W., Detand, J. & De Couvreur, L., (2011).ECCO Seminar on Stigmergic prototyping. Available at: http://ecco.vub.ac.be/?q=node/145/ [Accessed 22-05-2012]

Desmet, P.M.A., (2011). Design for happiness: four ingredients for designing meaningful activities. Submitted for publication.

Desmet, P. M. A. (2010). Three levels of product emotion. In C. Bouchard, A. Aussat, P. Levy, & T. Yamanaka (Eds.), Proceedings of the International Conference on Kansei Engineering and Emotion Research (pp.236-246). Paris, France: Arts et Métiers ParisTech .

Fischer, G., Giaccardi, E. (2006) "Meta-Design: A Framework for the Future of End User Development." In H. Lieberman, F. Paternò, & V. Wulf (Eds.), End User Development — Empowering people to flexibly employ advanced information and communication technology, Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 427-457.

Forlizzi, J. (2008). The Product Ecology: Understanding Social Product Use and Supporting Design Culture. International Journal of Design Vol 2, nr 1, 11-20.

Heylighen F. (2011) Self-organization of complex, intelligent systems: an action ontology for transdisciplinary integration, Integral Review (in press)

Hocking, C. (1999). Function or feelings: Factors in abandonment of assistive devices. Technology and Disability, 11, 3-11.

Juarrero,A (2000). Dynamics in Action: Intentional behaviour as a complex system. MIT Press

Kahneman, D. (2011), Thinking fast and slow,New York, Farrar, Straus and Giroux.

Kaptein, M. C., & Robertson, J. (2012). Rethinking Statistical Methods for HCI. In: Proceedings of the 2011 annual conference on Human factors in computing systems, CHI 212. IN PRESS.

Lyubomirsky, S., (2007). The How of Happiness. New York: The Penguin Press

Norman, D.A. (1999). Affordances, Conventions and Design. *Interactions* 6(3):38-43, May 1999, ACM Press.

Norman, D. A. (2004). Emotional design: Why we love (or hate) everyday things. New York, NY: Basic Books.

Ortony, A., Clore, G. L., & Collins, A. (1988). The cognitive structure of emotions. Cambridge, UK: Cambridge University Press.

Pangaro (2009) interaction—cybernetics—design, École Nationale Supérieure des Mines de Paris, October 2009 Available at: http://www.pangaro.com/ecoledesmines/index.html / [Accessed 22-05-2012]

Roseman, I.J & Smith, G.A. (2001). 'Appraisal theory: assumptions, varieties, controversies.' In K. Scherer, A. Schorr and T. Johnstone (Eds.), Appraisal processes in emotion (3-19). Oxford: Oxford University Press.

Schön, DA: (1983), The Reflective Practitioner: How Professionals Think in Action, Harper Collins, New York

Von Forster, H.(1961). "A Predictive Model for Self-Organizing Systems," Part I: Cybernetica 3, pp. 258–300; Part II: Cybernetica 4, pp. 20–55, with Gordon Pask, 1961.

Wessels,R. (2003), "Non-use of provided assistive technology devices," a literature overview, Technology and Disability 15, pp. 231-238

World Health Organization. (2001). International classification of functioning, disability and health (ICF). Geneve, Switzerland.

World Health Organization. (2011). World report on disability 2011. Geneve, Switzerland.