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"Worker, build your own machinery!" A workshop to practice the Technological Disobedience.

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Abstract: This paper presents an account of the experience of a workshop with title "Worker, build your own machinery!", held at Politecnico di Milano. The title of the workshop refers to a Ernesto Che Guevara's quote in a 1961 speech: as the Republic of Cuba's Minister of Industry, his aim was encouraging Cuban workers and technicians to face the scarcity of resources due to the country's economical and political crisis. The general approach he suggested to address this issue was self-production of the spare parts required for productive activities: this would involve a number of strategies, such as repair, reuse and repurpose. Self-production included a drive towards the re-appropriation of technologies, suitably combining mass-production and handicraft tools. Over time, these practices became common not only in the field of industrial production, but also in everyday life. This workshop was directly inspired by the research work of Ernesto Oroza, designer and Cuban artist, who studied the changes that 50 years of isolation produced on the island's materiality. The first part of the paper introduces and explains the theoretical concepts on which the workshop was based, whereas the second part exposes and discusses the obtained outcomes. This will include a reflection over the role of design and designers facing the deep social, economic and technological changes we are presently experimenting. These considerations will be aimed at encouraging future designers, emphasising the importance of their educational role and providing inspiration regarding issues, such as repair, reuse and repurpose, which are all essential for a sustainable approach.

Introduction

The aim of the paper is to describe the workshop experience that was held at the School of Design of Politecnico di Milano and focused on the topics of repair, reuse and repurpose in the context of product design.
In present society, discussion about repair, reuse and repurpose activities and DIY practices is very vibrant not only because these are key strategies to improve design sustainability but also in that they enable people to express themselves and find personal satisfaction (Salvia, 2013). We need to be aware that we are living through a new industrial revolution (Marsh, 2013; Anderson, 2011), this is based upon the merging of craft and industrial methods, hence reversing the trend that led in the past century to shift from local to globalised production and therefore permitting the return to *individualised practices* (Tanenbaum et al., 2013). This revolution is possible thanks to the *democratisation* of technological practices and product design (Tanenbaum et al., 2013; Von Hippel & Paradiso, 2008) that is enabling people to come back to the pleasure of craft and DIY activities (Salvia, 2013). Some scholars called this pleasure also *haptic satisfaction* (Rosner & Bean, 2009). Nowadays, personal fabrication of the largest part of objects is accessible to everybody as the result of modes of production, which were in the past only available to large organisations (Mota, 2011). The user is no longer just a passive consumer, lost in the loop of compulsive consumption, but is allowed becoming a creative appropriator, a hacker, a tinker and even a co-designer (Tanenbaum et al., 2013). In literature, a considerable amount of research focuses on the users' modification of mass-produced goods, declined e.g., as *Design by Use* (Brandes et al., 2008), *Non intentional Design* (Brandes & Erlhoff, 2006), *Objects in Flux* (Mitchell, 2011), only to name a few of these strategies. The practices of objects modification, appropriation, misuse and re-use present a long and diverse history. We can state that such actions

are an integral part of our engagement in the world and are therefore not at all extraordinary. However, when faced with the normalised and highly scripted products of mass-production, these actions take on an unusual and often disruptive quality (Mitchell, 2011). Other research works go beyond the above, rather emphasising the dimension of the interaction in the practice of appropriation and transformation of daily objects. These practices are grouped in the expression of *Everyday Design* (Wakkary & Maestri, 2007; Wakkary & Tanenbaum, 2009; Wakkary & Maestri, 2011; Desjardins & Wakkary, 2013) and are based on the fact that people creatively and constantly appropriate and transform objects around them. Non-expert designers are able to customise, reuse, repair, appropriate artefacts with a DIY approach and today supported by these technologies of tinker-maker revolution. Connected to Everyday design in fact, there is the concept of *Everyday Making* (Shewbridge, 2014) that describes the process of creating physical representations of ideas using fabrication tools. The scholars analysed the 3D printer as a tool for *Everyday Making*. This research proves that nowadays people are motivated to use a 3D printer at home for different purposes: replacing objects that were broken or missing, duplicating objects or making small alterations to existing objects.

3D Printing and DIY

In our developed society, we are looking for a new ways for producing goods. We are witnessing the diffusion of additive manufacturing technologies, including FDM (Fused Deposition Modelling), one of the most widespread techniques used for 3D printing models, prototypes or products. Thanks to 3D printing it is possible to open up and explore the convergence of virtual and physical words and offer to people powerful new tools of design and production (Lipson & Kurman, 2013).
In fact, like it was the case with the advent of desktop publishing, today's emerging digital manufacturing technologies are opening up a potentially world-changing approach to entrepreneurship: the World Wide Web allows sharing, modifying, personalizing, hacking, etc., almost anything. Fox (2014) called this phenomenon as *Third Wave DIY* to identify a "*DIY that draws upon the read/write functionality of the Internet, and digitally-driven design manufacture, to enable ordinary people to invent, design, make, and/or sell goods that they think of themselves*".

As a result, everyone can be a designer, hence capable and motivated to modify, appropriate, personalize, repair, reuse and repurpose design objects and systems: however, the reasons behind these activities can be various and different (Maestri & Wakkary, 2011; www.designforrepurposing.com). As a matter of fact, such practices can often be found in situations where social, economic, or material constraints limit the availability of goods and services, so that people are almost obliged to redesign their life and the objects giving shape and sense to it. The lack of availability for products is perceived like a marketplace evaluation that can motivate DIY behaviour, thus encouraging people to perform DIY activities for goods, repairs, and maintenance (Wolf & McQuitty, 2011).
In this paper, we present the workshop on the repair, reuse and repurpose in product design. This workshop was directly inspired by the research work of Ernesto Oroza (www.ernestooroza.com), Cuban designer and artist, who studied the changes on materiality of the island caused by 50 years of isolation, focusing especially on the last 25 years (Cuba's DIY Inventions from 30 Years of Isolation, available: www.youtube.com/watch?v=v-XS4aueDUg; Oroza & de Bozzi, 2002).
The paper presents the first part of the explanation of the theoretical concepts on which was built the workshop, that it will be explained and illustrated in the second part.

The first part of the paper introduces and explains the theoretical concepts on which the workshop was based, whereas the second part exposes and discusses the obtained outcomes. This will include a reflection over the role of design and designers facing the deep social, economic and technological changes we are presently experimenting. These considerations will be aimed at encouraging future designers, emphasising the importance of their educational role and providing inspiration regarding issues, such as repair, reuse and repurpose, which are all essential for a sustainable approach.

Cuba: DIY society

The history of Cuba is not very different from that of other Caribbean islands, where a succession of conquerors has made for centuries the economic and political situation very unstable, influencing the development of the island itself. What makes this history very different are the facts, which took place, starting

around the mid XX century, when Cuba became an outpost of resistance against the North American domination. Thanks to the help of the Soviet Union and the choice to direct the young revolutionary government towards communism, Fidel Castro influenced the destiny of the island and Cuban people.
After the U.S. left Cuba back in the 60's, when the embargo was declared, they brought with them most of the engineers too, so Ernesto Che Guevara (Cuban Minister of Industries at that time, 1961-1966) told the citizens to learn how to make stuff themselves. *Obrero construye tu maquinaria!*, "*Worker, build your own machinery!"* It was the exhortation that Guevara launched to the participants of the First National Reunion of Production. This event was the first ideological impetus to the National Cubans Movement of Innovators and Inventors. They were called the National Association of Innovators and Rationalisers (ANIR), and innovating and rationalising was exactly what they did. This was the beginning of Cuba's backyard innovation.

Figure 1. Dr Ernesto Guevara speech, Industry Minister in the Production National Meeting in 1961. © Ernesto Oroza.

Ernesto Che Guevara's exhortation was chosen as the title of our workshop in a provocative way and to encourage students to take action in innovating design, starting from fabricating their own tools. We think that this exhortation is very up-to-date in the context of design we described before.
At that time, Cubans had no choice but to create and repair, over and over again, both the state factory machines and the smaller machines in their homes: fabricating goods not officially available on the island became an essential skill.

Figure 2. In 1992, The Cuban military issued a book called "Con Nuestros Propios Esfuerzos" (With Our Own Efforts) that detailed crowd-sourced ideas on manipulating, repairing or re-using everyday objects. © Ernesto Oroza.

This first wave of makers left a trail of invention that changed the course of interacting with technology in Cuba (Oroza, 2009).
The second wave that definitively converts the Cuban society in a DIY society, started when the Soviet Union collapsed (1991) implying the end of the URSS's aids to the small island. In 1991 the Cuban government proclaimed a "Special Period" of extreme rationing and shortages. In 1993, a desperate new law finally permitted, despite some restrictions, to start businesses dedicated in making and tinkering. A new era of creative enterprise was forced open (Oroza, 2009). The lack of goods, rather then money, shaped Cuban attitudes toward objects (Oroza, 2012; Hill, 2011).

During the Special Period, started on 1991 and whose end was never declared, Cuban people realised that in retrospect goods in the prior decades had been plentiful, and they began working on and with these objects. For a long period nothing new came to the island, and used objects provided the only material for creating new objects (Oroza, 2012). The components of broken and unusable objects became vital and necessary components for other objects. Nothing was thrown away: in contrast, everything was kept, since it could become precious and valuable in the near future.
Cubans began to bring this repair-mindset home, turning their own households into laboratories. The Cuban home became a laboratory of invention and survival (Oroza, 2009) and at the same time it effectively eliminated litter as a problem.

The Technological Disobedience

The Cuban artist and designer Ernesto Oroza coined the expression "technological disobedience" for defining everyday creative practices raised in Cuba in the '90. Oroza defines "technological disobedience" the Cuban's systematic disrespect towards complexity, closeness and exclusionary characteristics of industrial objects logics.

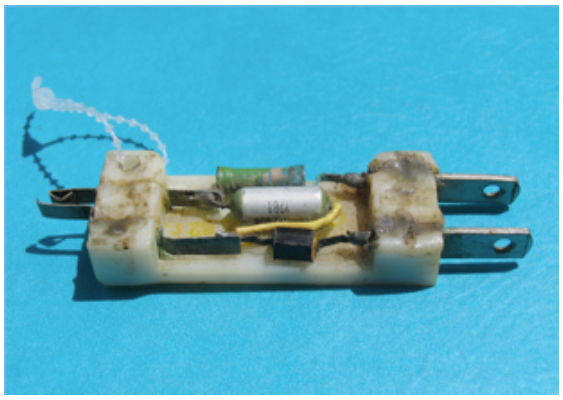

Figure 3. Battery Charger for battery non-rechargeable (two capacitor, one diode), 2007. © Ernesto Oroza

The greatest majority of industrial objects are closed, complete and nearly airtight, while their design may explicitly exclude the possibility of the user repairing or intervening upon them. From his studies and collections (Oroza, 2002; Oroza, 2009), we can realise that Cuban people weren't discouraged by complexity or scale: moreover, they learned to disrespect the "authority" of any kind of objects. They weren't afraid rethinking the objects' original purpose and life cycle, as the most expert professional designer.
The watchwords were "resolver" (to solve in English) and "inventar" (to invent but also to dream up) and with these aims the Cuban industrial culture dissected, opened all possible bodies, repaired and altered all kinds of objects, undeterred by their technical complexity and scale, such as automobiles.
As a surgeon becomes desensitised to wounds, Cubans became desensitised to designed objects. They stopped seeing the original purpose of the object, instead thinking to it as a collection of parts. This is the first Cuban expression of disobedience in their relationship with objects, a growing disrespect for an object's identity and for the truth and authority it embodies.
People of Cuba also invented, designed and produced the tools and machines to create and modify objects coming from the domestic industrial production, because the Cuban houses became archives, storage places, warehouses, workshops, design studios, production places and shops. They created a completely new market with reinvented industrial products transformed thanks to a craft approach, in a communist country where the concept of market was forbidden.

Figure 4. Recycled plastic objects. © Ernesto Oroza.

It is remarkable that the questioning of objects and of industrial logic came from a craft perspective. They were logical and industrial products reviewed from traditional processes and manual operations. Industrial products started to be tinkered with and examined by hand. The accumulation of products led workers to radically question industrial processes and mechanisms. They started looking at objects with the eyes of an artisan. Every object could potentially be repaired or reused, even in a different context from its original design.

The technological disobedience became the most reliable resource for Cubans to navigate the inefficiencies of the state political system.

The workshop: *"Worker, build your own machinery!"*

After the explanation about the context and the introduction of the principal concepts and aims, the second part of the paper is focused on the description of the workshop experience.

Aims

The workshop was developed to introduce product design students to the issues of repair, reuse and repurpose of objects. Instead of directing them immediately to the important subject of sustainability, we chose to emphasise the DIY approach and the use of additive manufacturing technologies such as 3D printing with FDM desktop 3D printers for their easy access. Furthermore, we used the Oroza's concept of Technological Disobedience because we considered it as innovative, exciting and promising. We can say that it is an extreme case of Everyday Design and Making approach that allows students looking at the design process as something that has never actually an end, but they can always consider it as always in-progress. In addition, this concept permits students to look at objects according to another logic, starting from a different point of view and disobeying to their predetermined authority.

Characteristics

The workshop was organised in the Master of Product Design at the School of Design, Politecnico di Milano on May 2014. Forty students of the second year were involved, including 8 foreign students from Colombia, Brazil, Spain and England. The period of the workshop was 5 days to spend together in the classroom: during that period four lectures were delivered and the students researched, worked and designed. The classroom was equipped with large tables for working on different materials with simple handle tools brought directly from the students, while they also had access to the well equipped workshop of the School and to a provisional 3D printing corner organised by +Lab (www.piulab.it) with 4 3D printers desktop FDM.

Tasks

In general, the workshop tried to build a suitable environment for carrying out exercises in repair, reuse and repurpose for motivating an analytical look at the potential and the limits of the artifacts we consume, as we knew from other cultures, needs and approaches. It contributes to research on repair and DIY approach through the design activity. In particular, the tasks of the workshop are undertaken both individually and in groups. The two exercises of the workshop were:

1) *One glass per day*: daily exercise aimed to train each student in the practices of reuse, repurpose and improvisation. Mode of participation: Individual. On each day, the students ware asked to develop a drinking vessel in one hour using simple and provisional materials and processes (Figure 5). The task is aimed to drive the participant towards facing a continuous need. This will allow exploring and encouraging ideas of improvisation, re-use, reproduction, appropriation, adaptation and so on. The idea here is to look at the object as something that was never realized before and with the goal to solve ("resolver") a basic need: to drink. The participants considered the raw materials available in their own home and they have to work with simple tools (scissor, cutter, glue…).

2) *Re – exercise*: a group project to be carried out throughout one week. The aim was to repair, reuse or repurpose objects to design others objects or machines. We asked to the students to brought to the classroom broken or obsolete objects and we collected them on a big table (Figure 6) in the center of the classroom.

Figure 5. Students while designing the drinking vessels

This table was the metaphor of the accumulation process that we described above. We asked to the groups (10 groups in total) to find a basic need (eat, drink, wash, and so on…) and design an artefact or a machine accord-

ingly, using the objects or parts of the objects they brought and shared with the classmates.
They work in their projects using simple and basic tools to transform, change and convert the components from old to new objects, trying to apply the Technological Disobedience approach. Furthermore, in this exercise, the participants were invited to consider the possibility to use the 3D print technology (FDM) to design special components for including them in the final solution (Figure 7).
The use of 3D printing in repair and reuse as well as in product design research has grown in recent years. For example, Martino Gamper's project called "In a State of Repair" (http://martinogamper.com/in-a-state-of-repair/) is a collaboration between the designer and the renowned Italian department store La Rinascente and London's Serpentine Galleries. This project celebrates the craftsmen, craftswomen, artisans and technicians who repair the objects that break down, stop working or go wrong.

Figure 6. Broken or obsolete objects brought by students.

'In a State of Repair' was also launched at the Salone Internazionale del Mobile 2014, to explore the expectations of customer service and the story of consumption; a story that does not necessarily end when a person purchases an object and leaves the store. A small 3D printing lab was used during the faire to create spare parts useful to fix other stuff.
Another recent research involving 3D printing in repair process is the interdisciplinary project 'Making Stories' of the Faculty of Computer Science and the Faculty of Design and Arts, Free University of Bolzano (http://vimeo.com/118686468?from=facebook). 'Making Stories' wanted to extend the lifespan of daily objects, technologies and materials long after their warranty has expired. It is a participatory collaboration between young designers and computer scientists who challenge the short lifespan of daily objects, technologies and materials. They work with broken, apparently useless, things, repairing them or creating new objects, which present alternatives to the current economic model characterized by mass-production and consumption (http://adhocracy-athens-sgt.tumblr.com/post/108492024552/making-stories-faculty-of-design-and-art-and).

Figure 7. The +Lab corner with 3D Printing facilities.

Results and discussion

In this section we illustrate and discuss the results obtained from both exercises of our workshop.
The first exercise "*One glass per day"* was useful to train the research of design solutions for a repetitive need. This resulted in the creation of a collection of about 1000 solutions for designing a drinking vessel.

Figure 8. 1000 improvised and provisional drinking vessels

The exercise was very interesting because in a small time the students saw a big number of solutions and projects and they could deal and compare about them. Furthermore, they ex-

perimented the ease of building a physical model, a sensation to which they are not very accustomed.
To exemplify findings from the second exercise we selected two case studies among all the projects: SHOW-er and Termoformastira. We decided to illustrate these two projects because they are good examples of the process that students carried out during the workshop. In addition, the first one led to an object and the second to machinery to produce objects.

SHOW-er
From all objects brought, they were given randomly one object to address one basic need: entertainment.

Figure 9. Objects selected by the students of the Group 9 to carry on their task.

The principal object assigned to them was the old-fashioned stereo, which is obsolete in terms of technology and also in terms of its aspect. However, this stereo was still working. The students themselves firstly selected the other objects randomly and then, after deciding the design solution, they changed some objects with others accordingly to their final idea of the project.
The students thought to work on the concept of obsolescence of the object and decided to upgrade its functions transforming it in a karaoke system able to support mp3. To translate their idea in a concrete product they applied the technological disobedience approach, so that they weren't scared to open the body of the stereo and others objects and operate on them. They didn't use the 3D printer, since this was not compulsory.
The students worked in a group, sharing and comparing ideas, doubts, skills and success.

We suggested watching a video produced as part of our findings to understand properly the design process and the repair, reuse and re-purpose exercise carried out by the students.

Figure 10. Students hacking the circuit to include a microphone (the shower components) and to connect a mp3 player.

Figure 11. The SHOW-er, a karaoke system. (https://vimeo.com/95500867)

Termoformastira
In the same way as described in the previous project, students were given a random object and picked up other objects. The need they addressed was related to a basic human need: drinking. Taking into account the first object we assigned to them, the flat iron, they decided to design a machine to produce glasses using a kind of primitive thermoforming process.
Firstly they fixed the iron and then looked for other objects in the table, coherent with their idea. They decided to use a pneumatic piston removed from a broken seat.
They used the 3D printer to produce connection parts in PLA exploiting the fundamental characteristics of this flexible technology that is useful to produce customised components in a small number.

The design process, repair, reuse and repurpose exercises were also captured in video.

Figure 12. Objects selected by the students of the Group 2 to carry on their task.

Dissemination of results

As we can experience, personal initiatives and new uses for tools and materials from around the world are shared through online and offline communities and events (Tanenbaum et al., 2013). To communicate and explain the design process of each group, we asked them to produce a video with step by-step descriptions to facilitate distributed craft knowledge. Sharing would firstly take place inside the workshop, and then also in the worldwide community of people interested in discover these creative solutions and ideas to extend the life of products.

At this moment we created a Facebook page and we published all the videos on Youtube, Vimeo and on Ernesto Oroza's web site.

Conclusions

In this paper we gave an account of our workshop experience focused on repair, reuse and repurpose practices and about the possible contribute that the product design competencies can give to these design activities. Our suggestion to today's product designer is to read the Guevara's exhortation as an invitation to look at the production and at the objects in a different manner.

This exhortation sounds a little bit revolutionary still today because we are in a historical moment in which the well-established discipline of product design is faced with issues such as: DIY, maker, digital manufacturing, open source and so on.

Also the repair theme, included its facets of reuse and repurpose, begins today to be taken into account in the field of product design. Not only designing durable and repairable artifacts, the design community strives also and challenges to fix, reuse and repurpose artifacts not designed to be adjusted.

Figure 13. The pneumatic piston as a useful component of this new machinery.

Figure 14. Termoformastira, a domestic thermoforming machine.
(https://vimeo.com/95498670)

The repair process thus becomes a transformation, which encourages us to consider the longevity and the preserving of objects rather than discarding them, which enables us to value the intrinsic creativity that is part of the act of buying.

The workshop that we designed is like a pilot study. It was developed trying to put together all these concepts and present them to students of Masters in Product Design with a double purpose. The first was a didactic one, focusing on raising students' awareness about these current and important issues. The second purpose was focused on practical research, trying to understand from the performance of the exercises and their results which contribution the designer can give to these processes of extensive creativity, Everyday Design, which even ordinary people seem able to master without a specific background in product design disciplines.

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Group 2. *Termoformastira* https://vimeo.com/95498670
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Group 5. *+BBQ* www.youtube.com/watch?v=WB7s5ZvsOKw
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Group 7. *The toast-balino* https://vimeo.com/95500879
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