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Design for sustainable coffee (post)consumption

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International Symposium on Sustainable Design (ISSD)

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Realização:



Caros leitores

O **Simpósio Brasileiro de Design Sustentável (SBDS)** e o **International Symposium on Sustainable Design (ISSD)** são realizados conjuntamente a cada dois anos. A primeira edição ocorreu em 2007 na cidade de Curitiba. As demais, nas cidades de São Paulo e Recife, respectivamente. Em 2013, coube a Porto Alegre no Rio Grande do Sul, sediar esse evento científico que já é considerado uma referência para os estudos sobre o design e a sustentabilidade na América do Sul. Para sua realização, estabeleceu-se uma parceria entre os Programas de Pós-Graduação em Design da Universidade Federal do Rio Grande do Sul (UFRGS), do Centro Universitário Ritter dos Reis (UNIRITTER) e da Universidade do Vale do Rio dos Sinos (UNISINOS).

A insustentável leveza do ter é o título desta edição, que teve como foco as questões ligadas ao consumo, desde o importante papel do design para a competitividade das organizações nos desafios da globalização dos mercados até o igualmente relevante papel do design para a produção e a crítica da cultura material nas sociedades contemporâneas. Nesse sentido, a presente edição prestou uma atenção especial à contribuição do design para a sustentabilidade econômico-social das organizações – empresas, ONG's e instituições, sem claramente desconsiderar a dimensão ambiental, pilar fundamental do tripé da sustentabilidade. Dessa forma, foi possível valorizar o grande trabalho dos pesquisadores brasileiros e da América do Sul que procuram situar o design como uma alavanca para a inovação na sociedade.

Nesse âmbito, quatro subtemas foram propostos para este evento:

- Cultura de design para a sustentabilidade – explorando as contribuições teórico-metodológicas do design para o desenvolvimento sustentável
- Design e cultura para sustentabilidade – abordando os desafios que o desenvolvimento sustentável aporta para o design;
- Design e consumo sustentável – focando nas propostas de designers para um consumo mais sustentável;
- Sustentabilidade e consumo de design – propondo uma reflexão com relação ao consumo de objetos de design diante dos desafios da sustentabilidade.

Destacamos que o Simpósio foi pensado com a intenção fomentar o diálogo sobre o design sustentável entre seus participantes. Para tanto, os trabalhos apresentados foram distribuídos em sessões temáticas que transcorreram à tarde. Na manhã do dia seguinte, foram realizadas sessões plenárias para o compartilhamento e debate das ideias explanadas. Como resultado, identificaram-se novas perspectivas e oportunidades de investigação no campo do Design Sustentável, além da criação de novos vínculos entre os participantes. Os trabalhos aqui publicados, todos apresentados durante o evento, compõem um mosaico extenso e valioso do conteúdo debatido e das discussões procedentes.

Para encerrar, gostaríamos de fazer um agradecimento especialmente a Maria Beatriz Galan (Faculdade de Arquitetura, Design e Urbanismo da Universidade de Buenos Aires -FADU-UBA) e a Rita Almendra (Faculdade de Arquitetura da Universidade Técnica de Lisboa - FA-UTL) que nos brindaram



com uma palestra de abertura e outra de encerramento respectivamente. A energia e entusiasmo emanado por elas engrandeceram o evento. Gostaríamos também de agradecer a todos os participantes do Simpósio, cujo engajamento foi fundamental para o sucesso alcançado. Por fim, cabe um agradecimento a CAPES pelo apoio fornecido ao evento para sua realização.

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Design for a sustainable coffee (post)consumption

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Keywords: Ecodesign, reuse, sustainable consumption

Coffee is the second largest traded commodity in the world after oil. The worldwide annual generation of Spent Coffee Grounds (SCG) is about 6 million tons, but up till now they are practically unutilized, being discharged to the environment or burned. Nowadays, many universities have worked to find new solutions for coffee grounds. There are many projects and scientific articles on the properties of SCG that describe how to extract lipids and many other precious elements. This project is carried out by Politecnico di Torino (DAD) in collaboration with the biggest Italian coffee roasted company, and has the goal to evaluate the feasibility of SCG valorisation at home and at restaurants and cafés. The first result is a communication about how to reuse SCG from moka at home (remove odors, keep pests out or whip up a coffee dye) and increase the consumer awareness. The second outcome deals with SCG from cafés. This includes both logistic and productive phases, that can give many different products such as paper, cosmetics or mushrooms. This project has also a strong educative aspect because it allows not only to be aware of the environmental problem, but also to be part of the solution. .

Introduction

Coffee is the second largest traded commodity in the world after petroleum, and therefore, the coffee industry is responsible for the generation of large amount of residues (J.V. Nabais, P. Carrot, M.M.L. Ribeiro Carrot, V. Luz, A.L. Ortiz, 2008). With 5.77 kg per year consumed by Italians, Italy is seventh in the ranking of countries that consume the greatest amount of coffee. Each year, only in Italy, 3.4 billion of espressos are consumed, served in over 200,000 cafés, throughout the peninsula (source: Reteurs). Spent coffee grounds (SCG) are the solid residues obtained during the treatment of raw coffee powder with hot water or steam to prepare instant coffee. A worldwide annual generation is estimated for SCG in the order of 6 million tons (T. Tokimoto, N. Kawasaki, T. Nakamura, J. Akutagawa, S. Tanada, 2005). However, most of these residues remain unutilized, being discharged to the environment or burned for elimination, which are not environmentally friendly techniques. Discharges to the environment cause severe contamination and environmental pollution problems and burning results in the production of carbon dioxide, the green house gas (T. Tokimoto, N. Kawasaki, T. Nakamura, J. Akutagawa, S. Tanada, 2005).

This way in which farming goes to transformation, distribution, consumption and elimination, is straightly linear (cradle to grave) with increased pollution for the environment and lost of properties still present in SCG. This linear approach means an increasing cost for local community both economic (collection, transport and treatment) and environmental falling directly on the territory.

Some studies about the composition of SCG (S.I. Mussatto, E.M.S. Machado, S. Martins, J.A. Teixeira, 2011) reveal that this residue is rich in phenolic compounds that present important biological functions and antioxidant potential, with interest for the food and pharmaceutical industries (K. Ramalakshmi, L.J.M. Rao, Y. Takano-Ishikawa, M. Goto, 2009).

SCG contain many other elements such as caffeine, minerals, polyphenols, nitrogen, lipids and waxes, carbohydrates. Besides the pH of SCG is between 5.0 and 6.9, this means that is very useful for the growth of plants, mushrooms and worms. SCG's properties depend on the chemical elements inside it: the minerals, such as phosphorus and potassium, and the presence of nitrogen make SCG a very good nutrient for plants and roots. Polyphenols are antioxidants and antibacterial and lipids are important for protection against dehydration of plants.



The objectives of the work carried out in collaboration with the biggest Italian coffee company are not only the creation of a system that gives new life to the SCG but also the educational and social aspects related to the project.

Background

One of the most important Italian coffee company wants to design a system that could valorized the SCG which is now considered simply as a normal waste. This leader company was founded in 1895 and it is wholly owned by a single family. It is recognized worldwide as the symbol of Italian espresso and of Italians. In fact, 790 billion cups of coffee are consumed worldwide each year, 14 are produced by this company, with 3,500 employees and a turnover in 2007 of more than one billion Euros, is the first single-product company coffee in the world, with a strong commercial presence in over 80 countries, and leader of the Italian landscape (for consumption at home and outside the home), with more than 48% (by value Nielsen) market share (source: IRI). The company has supported the research group funding the study design, providing the coffee grounds used for experimental and providing technical advice on the properties of its raw material with chemical and physical analysis.

In this research we considered the SCG coming out from the preparations of espresso coffee in espresso machines at home and professional ones at cafés. From each cup of coffee, which uses average of 7 g of coffee, we obtain 13 g of SCG because of the quantity of water, which results to be about 50% of its weight. Low caffeine remains in the beverage, the most part remain in the coffee powder. The amount of lipids remains unchanged and it can be extracted for pharmaceutical uses of great economic return. This research takes advantage of all the data and experience gathered in 2008 obtained thanks to the first collaboration with this company (Barbero, Toso, 2010).

Methodology

The aim of this collaborative research is the study of coffee (post)consumption to obtain a sustainable system. In this research we can identify four steps:

- 1- research and analysis phase dedicated to coffee grounds properties;
- 2- study of projects, researches and existing products using the SCG;
- 3- design the systemic processes related to the valorization on SCG;
- 4- communication design of the project directly affects the customers to raise awareness to a more conscious use of SCG.

This last step is characterized by two different projects: one dedicated to the coffee preparation **at home**. Coffee is usually prepared with the moka pot, a stove-top coffee maker which produces coffee by passing hot water pressurized by steam through ground coffee. And the other one designed for the coffee preparation **at cafés**. A shot of espresso is made by forcing hot water through tightly packed, finely ground espresso coffee. What comes out is a dark brown, slightly thick liquid with a small amount of *crema* (a foam) on top. There are many variables in the process of making a shot of espresso. The temperature of the water, the pressure of the water, the fineness of the ground coffee and how tightly the coffee is packed are just a few. The skilled espresso maker, or *barista*, controls all of these variables to produce a quality shot of espresso.

SCG coming out from this two different kind of preparations has basically the same characteristics and properties. This is the reason why it can be treated in the same way. But the aim of this research is actually to valorize SCG and to reuse this rich material in two different contexts: home and cafés, with an high component of education and sensibilization.

Analyzing SCG properties and characteristic, we decided to split and examine in depth three topics related to different themes and questions:

- 1- What to do with SCG obtained **at home** from coffee preparation?
- 2- What people actually do around the world to reuse and valorize SCG (**products, services and researches**)?



3- **Scientific articles** written by researcher from universities and research centres.

These topics allow us to define two different projects for the two different contexts: "**home**" and "**cafeteria**". The first project has a more educational purpose; the second one has a social objective which involves the local community.

Traditional use of SCG

The use of coffee grounds after the consumption is not a practice used only in recent years. There are many recipes tied to tradition that allows to take advantages of all the properties of SCG. Thanks to their nutritional properties coffee grounds are good fertilizer. Moreover, belonging to the so-called "green" category due to the high quantity of nitrogen, it can be used for the preparation of **compost**.

The coffee grounds are a valid alternative to the use of products with high toxic content to ward off ants and other unwanted **insects**.

SCG stimulates **drainage**, removes stagnant fluids and reactivates the circulation and, mixed with yogurt and cocoa, have a moisturizing and firming effect.

Some external factors such as smog, smoke or radiation and a deficiency of antioxidant elements are the basis of degenerative diseases and premature aging. Polyphenols contained in coffee grounds, are among the most well-known antioxidants. The local application of antioxidants limits the damage to the **skin** cells, preventing the loss of young skin characteristics.

Thanks to its granularity the coffee grounds can be used for its **abrasive** property. It is sufficient to mix coffee grounds and boiling water for cooking pasta or rice, containing starch, to get a good abrasive detergent for washing dishes. Actually this property is useful also as a home-made scrub.

Actual activities with SCG around the world

It was important for us to include in the research, a section of the study and analysis of what is done currently with the SCG. This allows to understand specifically what is achievable and what is not, what is the timing of implementation and how does it translate into practice the specific properties of SCG.

In this part we have included all products and services currently on the market. We have started with grow-at-home **Mushroom Kit** that lets people grow their own oyster mushrooms right out of a little brow box. The substrates are made of SCG and other organic waste (it depends on the brand). There exist many kind of kits that can be found on-line. All these kits work essentially in the same way. The substrate, made of SCG and other organic waste, is already part grown to the point where they are well established and ready to produce mushrooms. In just 14-20 days the kit will produce the first harvest of two or even three crops over an 8 weeks period.

Probably the most famous is the Californian kit "Back to the Roots", founded by Alejandro Velez & Nikhil Arora during their last semester at UC Berkeley in 2009. They came across the idea during a class lecture of being able to potentially grow gourmet mushrooms entirely on recycled coffee grounds. Inspired by the idea of turning waste into wages and fresh, local food, they experimented in Alex's fraternity kitchen, ultimately growing one test bucket of tasty oyster mushrooms on recycled coffee grounds.

There are other mushrooms kits such as Fungi Futures, Chido's Mushrooms, Espresso Mushroom Company.

Another project that processes SCG in mushrooms is The **UpCycle** company, that has installed in Paris an urban mushroom container. The objective of this initiative, called U-Farm, is to produce a food of quality to the worthless print carbon, thanks to the waste transformed into resources.

Daniele Gioia and Annarita Marchionna, graduated in food technology, confirm the studies made so far. Their work's goal is the production of high quality mushroom using coffee grounds. The opportunity to test the idea came through the announcement **NIDI** (Nuove Idee di Impresa Innovativa) launched by the Camera di Commercio di Potenza. The two young Italians have shown that mushrooms' taste and



aroma have a perfect identity, with features even better - than mushrooms that usually arrive on our tables - from the point of view of texture and visual appearance.

Another interesting experience to be mentioned among university research cases is the project, started in autumn 2008, that uses student and community volunteer foot and pedal power to collect and compost spent coffee grounds from community and campus coffee sellers in Moscow, Idaho. Over three tons of grounds have been composted at local community gardens and student farms in only 9 weeks of operation. **MoCoPro** slowly set in motion in 2008 by the University of Idaho. In spring 2009, it incorporated over 15 volunteers weekly on over a dozen foot and bike routes to collect grounds from 12 campus and community coffee sellers. The project would not exist without the cooperation of many coffee sellers and community members (www.moscowcoffeecompostproject.blogspot.it).

Furthermore there are many products completely or partially made from SCG. You can find materials such as **C2C**, a cup produced by adding to coffee grounds, waste paper and polylactide resin presented in 2003 at the Re-design exhibition by a group of Canadian designer.

Curface is a composite material made from SCG and recycled plastic. The nonprofit industrial design firm, Re-Worked, has been combining their creation with reclaimed wood to build some truly unique and sustainable furniture. Curface first debuted at the 2010 Ecobuild Conference in London, but have recently replaced their website with a vague message about halting all production. The firm's most recent project was the Google Coffee Lab that included large custom tables made from Curface and exterior panels for a Sanremo espresso machine, designed by Alessandro Milanese. The material's finish resembles a matte carbon, is waterproof and needs no sanding or finishing.

The Dutchman Matthijs Vogels, with Sprout Design, from coffee grounds draws the line of cups and saucers **Cup 'a coffee**. He collects large amounts of SCG, and once clean, he presses it in the molds. The process is natural, does not need any additives, all products in the line are biodegradable.

Furthermore, the **S-café fabric**, produced by Singtex by 2010, is a performer fiber which uses the coffee grounds and exploits the natural ability to absorb odors, protect against UV rays reflecting sunlight and dry very quickly.

Other interesting products are **Crush** paper, produced by Favini by 2012, Italy, made with residues of agro-industrial processing of citrus, coffee, coffee grounds, corn, olives, nuts, kiwi which replace up to 15% of cellulose, and **Earth Blocks**, Colors Tokyo, Japan, 2012, it's the lego-like blocks composed of organic waste, mainly bark, wood chips, dust, coffee grounds and tea leaves, mixed with recycled polypropylene. Each brick is currently available in size and color only. Each set contains 50 pieces and can be purchased at \$ 30 at the Guggenheim Museum.

Literatures on the topic

The great value of the SCG is evidenced by the large amount of **scientific papers** written by academics and research institutions regarding the reuse and properties of coffee grounds. The numerous articles investigate different aspects of this topic.

In many articles, related to the extraction of **lipids** and **waxes**, SCG is investigated as a potential source of **phenolic compounds** and **energy**. Due to their high organic material content (Silva, M. A.; Nebra, S. A.; Machado Silva, M. J.; Sanchez, C. G., 1998) and the presence of compounds (Fan, L.; Pandey, A.; Soccol, C. R., 2000) such as caffeine, tannins, and polyphenols, which can have negative effects on the environment, the disposal of SCG needs to be properly managed. Similarly, burning of SCG can result in the release of greenhouse gases into the atmosphere. This has stimulated efforts to find ways of reducing their environmental impact and/or transforming them into value-added products.

The production of **biofuels** such as ethanol and biodiesel, the use as a **substrate** for the cultivation of mushrooms (L. Fan, A. Pandey, R. Mohan, C. R. Soccol, 2004,) and use as an **adsorbent** for the removal of basic dyes (Franca, S. F.; Oliveira, L. S.; Ferreira, M. E. 2009) or heavy metals from wastewater are some of the applications under consideration. At Chemical and Materials Engineering, University of Nevada, Kondamudi, Mohapatra and Mano Misra analysed and wrote about how to extract oil from spent coffee grounds and to further transesterify the processed oil to convert it into biodiesel. This process yields 10-15% oil depending on the coffee species (*Arabica* or *Robusta*). The



biodiesel derived from the coffee grounds (100% conversion of oil to biodiesel) was found to be stable for more than 1 month under ambient conditions. It is projected that 340 million gallons of biodiesel can be produced from the waste coffee grounds around the world. The coffee grounds after oil extraction are ideal materials for garden fertilizer, feedstock for ethanol, and as fuel pellets (Narasimharao Kondamudi, Susanta K. Mohapatra, Mano Misra, 2008).

Another promising but still relatively unexplored approach is the use of SCG as a raw material for the recovery of functional **compounds** of potential interest to the **food and pharmaceutical industries**. Antonio Zuorro and Roberto Lavecchia of Department of Ingegneria Chimica, Materiali e Ambiente, Sapienza Università di Roma, wrote about extraction with an environmentally friendly procedure and analyzed SCG to evaluate the recovery of relevant natural antioxidants for use as nutritional supplements, foods, or cosmetic additives (A. Panusa, A. Zuorro, R. Lavecchia, G. Marrosu, R. Petrucci, 2013). The cosmetic products might be a suitable application for SCG because the barrier properties of the stratum corneum are largely dependent on the intactness of the lipid lamellae that surrounds the corneocytes. The purpose of the article *From coffee industry waste materials to skin-friendly products with improved skin fat levels* was to assess the feasibility of using the lipid fraction of SCG extracted with supercritical carbon dioxide in the development of new cosmetic formulations with improved skin lipids (sebum) and hydration. The use of spent coffee lipid extract in cosmetic industry seems to be a suitable approach to recycle the wastes from coffee industry. Emulsion containing 10% of the lipid fraction of SCG presented promising characteristics in the improvement of sebum skin levels with a good acceptance by consumers when compared to an emulsion containing 10% w/w of green coffee oil and a placebo without coffee oil.

But the SCG, thanks to the chemical elements which it contains, is an excellent raw material for many other uses such as a substrate for the **vermicompost or absorbent for odors or colors removal** (Ivo Safarik, Katerina Horska, Barbora Svobodova, Mirka Safarikova, 2011).

In any case, this specific project derives from the previous research done by Silvia Barbero and Dario Toso in 2008 and published in articles (2010) and books (2008), furthermore it was presented during the international exhibition Salone del Gusto and Terra Madre in 2008. This systemic project aimed to use the same system with which the coffee company extracts caffeine to obtain decaffeinated products, to extract lipids and waxes from coffee grounds intended for the pharmaceutical chain. What you obtain is a compact paste devoid of lipids used in the production of a soil used to grow mushroom (*Pleurotus ostreatus*). The same substrate provides three harvests in about one month. The exhausted soil is used for the production of vermicompost, an excellent fertilizer for vegetable cultivation.

Sustainable design for post-consumption at home

After the research phase focuses on defining a clear picture of the current situation we dealt with the project itself. We followed two strands with different objectives and targets. First of all we worked on the "home world" to raise awareness of the consumer and make him/her more aware of the value of SCG.

We must consider that people at home have available small quantity of SCG every day: the challenge that we have accepted is to convey to the consumer the principle that considers waste not like something useless that must be thrown away, but as a valuable resource. It's a paradigm shift, a small step that can lead to obtain great results and the generation of many other products.

For this purpose, we suggested the consumer what are the possible uses that he can make with SCG, always having in mind, obviously, all of the issues identified through the initial analysis. Considering, therefore, that the amount of SCG at home is quite small but daily repeated we can suggest to create compost, fertilizer, dyes, creams, soaps and much more. This must be related to some detailed information on the various recipes to follow for the realization of all these things.

This first project, dedicated to those who prepare coffee at home, is characterized by a strong component of **education** and awareness. The purpose is just to make the final consumer conscious of the value that SCG has, now treated as a simple waste.



Sustainable design for post-consumption at cafes

The other strand of the project concerns the SCG resulting from the transformation of the coffee at cafés. In this context, among the various options studied in the research, we opted for the re-use of SCG in the production of oyster mushrooms. The practical experiments it's been fundamental and it demonstrated the effectiveness of the SCG as an activator and accelerator of mushrooms growth. The project illustrates how the production of mushrooms is possible thanks to the SCG management from the cafés and the organization of the SCG collection and transport. We speak about a sustainable collection and transport of course that use clean, renewable energy and short transportation. The study of the collection and logistics is an important part of the project. Since today the SCG is treated as household waste, undifferentiated and thrown into the dustbin is necessary to think of a particular system for the collection and the transporting. The bartender obviously has to worry about separating ground coffee from other waste. But this is not hard to get and does not involve additional work for the bartender who currently already storing SCG in a separate container. He/she must not fill the container with other waste that may contaminate SCG.

For this second project dedicated to the communication of the re-use of SCG by the cafés, it is essential the social and sharing aspect.

The production of mushrooms is not only interesting because it transforms what until now has always been considered as a waste as a valuable resource, but also because it is closely connected to the territory and linked to seasonality. In fact, the substrate can depend on the organic materials that are available in the territory or in the season. The important thing is that coffee grounds are always about 30% of the substrate. The remaining percentage can be made up of green cuttings or from untreated wood waste or pruning residues. The oyster mushrooms obtained in this way can be useful for the same coffee company's Foodservice, offering products, accessories, advice and services designed to respond to the market needs. The production of mushrooms for the company means being able to convert what is the biggest waste of coffee chain to produce high quality food linked to the territory. This leads both to reduce the cost of disposal both to have an increase in revenues from the sale of mushrooms.

The Italian coffee company endorses the new social business involving also its employees and their families.

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