

Horizonte) and they are stocked on the carpentry, replacing the space reserved for reusable materials. The manufacture of dustbins requires a repetitive (and no creative) process and is done by specialized and divided tasks that require very low training. Progressively, this predictable manufacture cycle is being chosen instead of the production of furniture from reusable materials, considered a more complex and specialized task.

This emphasis in the use of reused material aims (1) to improve the economic profit to workers, adding value to products and (2) to induce a skill development of the scavengers, as a way of professional and social progress. In this case, it was used a singular approach on the problem, inducing the product design by workers who were associated with voluntary designers. It was necessary an specific methodological procedure for product design when dealing with different life conditions related to social risk, in order to find a way to valorize the human being and his (or her) work.

The traditional design procedure, which is based on standard and industrial production, is not adequate in this case. The specific contextual condition in the carpentry (huge variability of raw material, low capacity to economic investment, low education level of works etc.) requires a strategy based on participatory methodology to problem investigation and the participation of workers in the product development.

LITERATURE REVIEW

An essential thinking is understood the garbage like a resource (Dogan and Walker, 2003; Dijkema *et al.*, 2000). Global consumption is considered very high (Karlsson and Luttrupp, 2006) and it is widely reported that 20% of world population consumes about 80% of resources (Manzini, 2007; Tukker *et al.*, 2008). Become evident connections between social inequality, justice, democracy and its influence on the exploitation of resources and consequent environmental impacts (CMMD, 1991, CSD, 1992; WSSD, 2002). We understand that the work value is a fundamental factor to social sustainability and that is little discussed in literature, some authors tell us about it (Petrina, 2000; Walker & Dorsa, 2001; Jeswiet & Hauschild, 2005).

The traditional mass production and the companies'

conventional priorities (as profit improvement by a continuous sales growing process) seem incompatible with sustainability. The term "sustainability" refers to the thought that human activities should take into consideration environmental and ethic issues in addition to economic ones, and the question in the design area is "how functional objects can be designed and created in a consistent manner with sustainability principles" (Walker, 2002). It is perceived that the conventional concept of ecodesign is tied to the issue of competitiveness of the product on the marketplace. However, we observe that reduce environmental impacts is like dealing with a way to "hand double" that involves changes not only in the production chain, but in consumer behavior and changing lifestyle of Western societies (Manzini, Vezzoli, 2005; Manzini, 2007; Karlsson and Luttrupp, 2006; Petrina, 2000; Tukker *et al.*, 2008; Zafarmand *et al.*, 2003). About 70% to 80% of environmental impacts on society are caused by mobility (air and ground transportation), food (meat followed by other types of food), energy use in and around the home (heating, cooling and energy spent with products), home construction and demolition (Tukker *et al.*, 2008). Ecodesign in the sense traditionally adopted, related to reduction of environmental impacts, does not lead to sustainability, we need ecocentric approaches to product development that involves a drastic reduction in the levels of production and consumption (Manzini, 2007) trying to understand the sociological nature of this problem through which culture is produced and consumed and breaking the cycle of wastefulness of Western cultures untenable: production - consumption - garbage (Petrina, 2000). The result of consumption or disposal of post-consumer products is only a small part of the problem, because the product itself contains on average only 5% of the raw materials involved in manufacturing and delivering it (McDonough and Braungart, 2002 *apud* Dogan and Walker, 2003). Thus, we must rethink the design and production in order to erase the concept of garbage (Dogan and Walker, 2003; Dijkema *et al.*, 2000) which is consonant with the industrial ecology proposal in which the waste of one company is a resource in another one, constituting a "closed loop". It is also consistent with an environmental approach - which

aims at adding value to waste, initially valueless, through recycling, reuse or other actions, as opposed to hygienist - with the principle of collection and waste treatment, an *end-of-pipe* approach.

We observe the need to overcome the level of technical design, considering socio-cultural problems (related to education, social inequalities and lifestyle). Advances in ecodesign and environmental approaches are significant, whereas, with regard to sustainability, they seem little (Walker and Dorsa, 2001). In that sense, "not every proposal for environmental improvement is sustainable" (Borchardt et al., 2008).

Countries at different stages of economic development need sustainable policies of consumption and production suited to their specific contexts, i.e. different policies. Crul and Diehl (2006) presented some sustainable principles for developing economies. For example, countries of the "base of the pyramid" (according to Prahalad, 2005, the term "base of the pyramid" refers to the base of the economic pyramid, where people who live on incomes below \$ 2.00 per day are) have an initial goal of establishing a foundation for a sustainable and equitable growth and poverty eradication (Tukker *et al.*, 2008).

RESEARCH METODOLOGY

The methodology for characterization and analysis of the work involved the use of technical elements of AET - Ergonomic Work Analysis (GUÉRIN *et al.*, 1991) and suggestions for field research in the area of action research (Thiollent, 1983, 1985, 2007). Thus the social and economic aspects (relating to work) are also addressed in a sustainable perspective. We propose a design procedure that emphasizes the integration of the work group and the development of concept skills. Such procedure would consolidate and spread the skills that workers develop manufacturing products from reusable materials. A sustainable approach has to question the work's value because it is a fundamental matter to social and economic sustainability, in this case consonant with environmental one.

Designers learn conventionally which is convenient to industrial situations, while dealing in other contexts requires a specific approach to understand the universe of the other (e.g. the work of artisans and

people in social risk - Freitas and Romeiro, 2005), the human being who works locally, in a specific way, based on his life experience and subjected to conditions both local and organizational, the region's own living on the aspects geographical, social, cultural, political etc. In seeking to understand the other, the designer can go "beyond the product," overlooking the "logic" of the "design thinking" (Brown, 2008) of this social group, contributing not only in the product, but participating in "methodological" and educational improvement, especially when there is still no defined path and there are problems preventing an advance of living conditions of the population. No longer just about creating a product, but to help them to do so in a timely manner, enabling social inclusion through learning at work, adding value to the product and, consequently, to the work.

CASE STUDY: THE ASMARE'S CARPENTRY FACTORY

The carpentry is an inherent sector of ASMARE, is one of its craft workshops and reuse, which exists formally since 1994 and is located next to a warehouse for collection and separation (sorting) of recycling material. The initial goal of creating the space for the carpentry was to contribute to the learning of young people and provide maintenance to scavengers' wood carts. Over time, the area also began to operate with the recovery of parts of the association (furniture, tables, whatever it takes to repair).

Among carpentry's activities are the production of dustbins (Figure 2) for garbage collect, the production and maintenance of scavengers' carts, the furniture and materials reuse (Figure 3), the manufacture of tailored products associated with the use of ecoplaca and participating in social projects involving local universities. Carpentry also has the support of partners and collaborators for the development of products in the stage of product design.

Other forms of action include collaboration with the Belo Horizonte City Hall through participation in the realization of socio-educational measures for young people who committed some infraction and the learning from the scavengers group through the apprentices and associates who participate in the

activities of the carpentry.

One of the particular aspects of the carpentry products in the furniture sector is the constant quest to do what is (categorized by actors involved in the work) as “ecoproduct”, which in this case means making products made up of recycled (such as ecoplaca) or reused material according to customer demand and the nature of activities in AMARE. In many cases the customers already knew the ASMARE or acknowledged the work carried out there with the collect and sorting of materials, some of which cooperate in other ways as with donation of recyclable materials.



Figure 2. Dustbin manufactured in the carpentry factory.

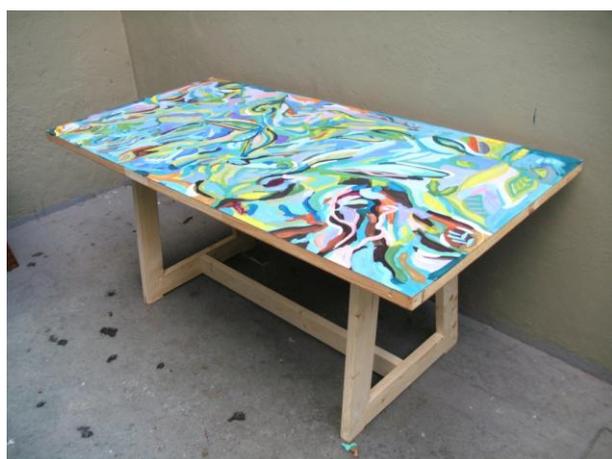


Figure 3: Table made up of reused material (wooden pallets and door) manufactured in the ASMARE's carpentry

The workers present in “day by day” carpentry during the research period are the Instructor, Carpenter, Associates and Apprentices. Decisions in the carpentry are focused on Instructor and

Carpenter. Above the internal organization of the carpentry is the ASMARE administration, which evaluates and approves (or disapproves) the internal decisions. Associates do not receive salaries in ASMARE. The profit is shared by all partners, which also applies to those who participate in activities in the carpentry. The workers themselves organize their schedules according to what they consider appropriate for the conduction of collecting and sorting waste activities.

Many of the workers of this system are excluded from the formal labour market in search of alternatives for their income. They live in situations of social risk, characterized by exposure to violence, addictions, poor housing, diseases, low income to support the family and other factors. Some are able to insert themselves back into society, but there are many difficulties for the social reintegration. The level of formal education among the carpentry workers is low, ranging between four and eleven years.

The activities in the carpentry are linked to the manual skills that employees develop throughout their experience at work, which is defined by both the Instructor and the Carpenter as “handmade work” for not being framed in the patterns of serial production in the case of reuse of materials. The multiple functions performed by the workers are noticeable.

PRODUCTION PROCESS, EQUIPMENTS AND MATERIALS

Varied activities can be observed in the carpentry production, from the production of single pieces to serial production (Figure 4), with greater intensity in the task division and a larger number of parts produced, with less intervention from the “shop floor” in product development, except by the Carpenter and Instructor, participating in the activities of design and manufacturing.

The main recycled material used in the production of products is known as “ecoplaca”: it is a composite material composed of “75% plastic (polyethylene), 23% aluminum, 2% cellulose fiber” come from post-consumption long-life packaging. The ecoplaca has variations such as “tube ecoplaca” consisting of 75% aluminium, 25% of polyethylene and is different from finishing of those that has cellulosic fiber, moreover “tube ecoplaca” is made from industrial waste that

comes from the toothpaste tube's production (<http://www.idhea.com.br/ecoplacas.asp>).

The resources employed in the reused materials line are from donated furniture (that would be discarded by previous owners), wood from pallets and crates, steel (and others metals leagues), PVC and acrylic. In a complex process that involves the creative and decision-making competences, the Instructor and the Carpenter (sometimes together with other professionals as designers, architects, decorators, painters or sculptors) transform the demands of products from reused materials in products sketches, drafts with basic dimensions and prototypes (Figure 5).

It serves as the basis for production, which unfolds, through instruction and instructor supervision, in various operations carried out by Carpenter and by others members and apprentices, who are concentrated in manufacturing (the Instructor also carries out manufacturing activities when necessary). In the case of reuse, identification and selection of most appropriate materials in storage are required.

ELEMENTS OF PRODUCT DESIGN, SERIAL PRODUCTION AND REUSE

The elements of product design in the carpentry work vary with production model. When it comes to manufacturing a product from reused material, the creative effort is greater and can be observed diverse elements of a design process. A single drawing works for a smaller amount of parts according to the availability of material and flexibility of the design adopted.

The same design lasts for a longer time and may be reproduced in hundreds products' units with the use of recycled material, such as ecoplaca. We can identify phases or topics of design methodology applied in the carpentry. In pursuit of product design are made sketches of the product, are established and listed the dimensions of it, small models are built in alternative materials and manufacturing planning are made to check the feasibility of product performing. Finally, it made a prototype before the stages of production process.

The serial production (in the case of dustbin) can



Figure 4. Some stages of dustbins' production process.

provide an increasing production, which may contribute to the carpentry economic viability; on the other hand, value-added products made from reused materials can compensate for the more complex design and production processes.



Figure 5. Some stages of production process from one reuse experience.

The design process in the employment of reuse materials available involves a creative effort to

develop new parts from a variety of with materials with heterogeneous, nonstandard characteristics. In this sense, there are contradictions between the use of recycled material, the “ecoplaca” (as a means of producing serial mode, because there are patterns of material, though not very hard ones, but they contribute to adopt this type of production) and the use of materials available for reuse (which implies another kind of production, more artisanal characteristic and variable one, resulting in more creative engagement related to product design). That is, the choice of material is not just a choice that aims to lower environmental impacts at this point.

ECONOMIC, SOCIAL AND ENVIRONMENTAL SUSTAINABILITY IN THE CARPENTRY FACTORY

The production of dustbins made of “ecoplaca” allows the economic sustainability of the ASMARE’s carpentry factory, because it provides a working capital for production, which is essential to meet the demands and pay those involved in the carpentry work. The dustbins’ manufacture is more profitable than the production based on reuse of materials due to its marked variability and qualifications required for the frequent creative exercise to recreate objects from materials with predetermined and different shapes. Furthermore, the demand of reuse materials tends to be more unpredictable, according to the Instructor.

However, the economic value of a product made of reused materials can offer higher profit margins than an ecoplaca dustbin because its value is more likely to overcome the value of dustbin. For example, if the table (see Figure 3) spent the equivalent of \$34.00 for the cleaning of the woods (which were donated) and the cost of materials used for finishing, plus about \$8.50 relative to paint and tools for painting art of the worktop. The price of the piece to an end consumer, considering the worktop art square meters, more product design, plus the equivalent of cleaning the wood used plus the cost of other materials and tools for production would be about \$1,875.00. That is, the profit of the table would be \$1,832.40 (equivalent to 4,300% of the cost of material), whereas the profit in the current system is shared by all ASMARE associates and corresponds to the cost of labour. In the dustbins case, based on the

production discussed in this article, the average profit was 92.25% of the cost for the production (including materials and tools).

Thus, the great potential to add value to the work with most rewarding activities through the value that can be added to the product in the reuse of materials is evident. This possibility requires, from people involved, greater diversity of human skills. Post-consumer materials available for reuse are a resource that could be also a source for working capital in the carpentry factory. Another aspect is the need for knowledge of the actors themselves about the post-consumer furniture pieces available in the carpentry factory, among which are design classics, objects that are part of design history. As to the social aspect, reuse allows the acquisition of a greater diversity of skills in the workplace (although it requires greater oversight and monitoring by the Instructor), enabling the group integration in various stages of product design with greater possibilities for a more rewarding, creative work, properly human, distancing itself from the machines monotony and repetition. In contrast, in the production of dustbins, learning happens in smaller variety, given the repetition of activities based on a model series, which is considered easier for the manufacture and activities learning. Socially the formation of associates and trainees is a key aspect to be considered in the organization. Moments of satisfaction were identified among learners in an activity involving the product design and construction of reduced scale models. Some workers have expressed greater interest in production from the reuse of materials than of the dustbins, those who prefer working in the dustbins production say they are easy, they know how to do it.

Also as a sustainable aspect, we can take into account the consideration of the use of environmental criteria, which do not appear as priorities in working practices due to economic urgencies in the social context. It is noticed that, according to interviews respondents, there is not a perceived distinction between the product that uses ecoplaca and what is made from reused materials; both are seen as beneficial in a social-environmental perspective. There are still several points of ecoplaca production chain of which there are not

available information, as on the reverse logistics of the carton and which cities are specifically from such post-consumer packaging, whereas eco plaque factories and collection sites are concentrated in Sao Paulo. The environmental benefit is greater through the reuse of materials in a qualitative analysis, because it is housed in a local context that contributes to the diversion of large volumes in landfills that receive waste from Belo Horizonte, inserting them into new cycles of value, contributing to an environmental approach.

Thus, the activity of reuse can bring major benefits related to work improvement in the carpentry factory, providing more learning activities, and exploring the creative abilities of those involved, seeking the construction of free subjects, able to express, reflect and argue their choices in a social dialogue. Thus, we propose a "guiding" design procedure (Figure 6), which encourages the strengthening of the subjects to be experienced by the workers, serving as a basis for future adjustments.

DISCUSSION

There are some interesting aspects related to organization and production process in the ASMARE carpentry factory: for one side, the production of standardized dustbins using "ecoplaca" is a way of economic sustainability, especially in the short term. On the other side, the reused materials can improve the workers profit, adding value and creating more valuable products. In fact, ASMARE is considered an example of good experience in terms of scavengers' life improvement, and social projects linked to ASMARE have support by the Catholic Church, Brazilian Government and people from Belo Horizonte.

It was observed that ASMARE products have very good acceptance by the consumers, specially the medium and high class, who are interested in the "sustainable" and "recyclable" products. In this case, the production of furniture made from reused material can be an alternative to improve the profit and develop the creativity and skill in the workers group.

However, the research demonstrates the necessity of a specific design method in this case.

Generally, existing procedures are directed to

industrial contexts where there are people with better educational level and life conditions which have great influence in the way that is possible to create, project and produce things. Furthermore, the framework is very different specially related to machinery, maintenance, and management. Nevertheless, we need to test the practical steps stated in the methodological procedure proposed for product design to validate this one. A next step will be trying to put it in practice in line with the organization management and support.

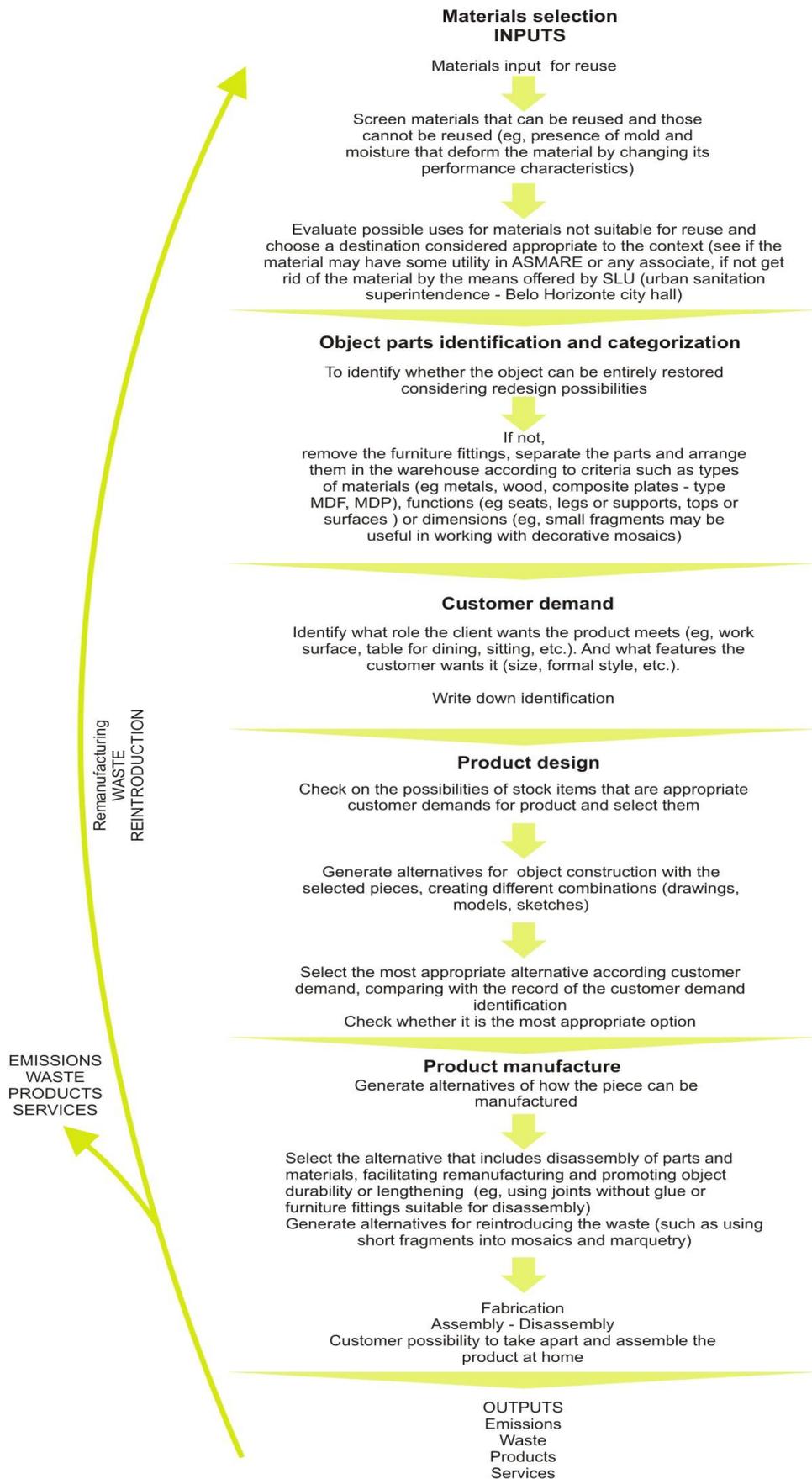


Figure 6. Methodological procedure proposed for product design. Source: Braga, 2010

CONCLUSIONS

The value of human work is a critical key to more sustainable approaches. The design education needs the support of the social sciences and humanities in this regard as complementary in understanding the construction process of the human being.

The poorly qualified and low-value job, common to the majority of developing countries, reduces the worker to the object, especially when there is not an improvement of living conditions, when the urgency for obtaining money is still to feed day, the next meal. Get to know better those situations in which there is product design exercise and, work to provide some improvement for those exposed to social risk - socially marginalized - for designer is still a huge creative and pedagogical challenge.

In this regard, an incipient field of design, the subject construction is essential, without it there is only a copy, repetition, obedience, non-reflexivity, not realizing his own life and work.

Restore the human condition is beyond the design proposal, it is in local and organizational politics, it is in the will of him who has the human condition to aid the release of the other. In this sense, there are other important disciplines, but the local and organizational culture can contribute greatly to the achievement of improvement of living conditions. This article is limited in regard to learning through methodological procedure proposed for product design, which encourages the construction of reflective and creative subjects in the organization addressed in the case study. It is hoped that, through such studies, design can expand its focus beyond "user centered" to "human-centered", an "anthropodesign" with social issues experienced at each region, mainly those where the huge social inequalities prevail, considering its particularities.

REFERENCES

- Borchardt, M.; Poltosi, L. A. C.; Sellitto, M. A.; Pereira, G. M. (2008) "Considerações sobre ecodesign: um estudo de caso na indústria eletrônica automotiva", *Ambiente & Sociedade*, Campinas, v. XI, n. 2, jul. - dez., p. 341-353.
- Braga, M. F. (2010) *O ecodesign na marcenaria da ASMARE - BH: um estudo de caso*, Dissertação (Mestrado em Engenharia de Produção) - Escola de Engenharia, Universidade Federal de Minas Gerais, Belo Horizonte.
- Brown, T. (2008) *Design Thinking*, Harvard Business Review.
- CMMD (Comissão Mundial Sobre Meio Ambiente e Desenvolvimento). (1991) *Nosso Futuro Comum*, 2 ed. Rio de Janeiro: Editora da Fundação Getúlio Vargas.
- CSD (Commission on Sustainable Development). (1992) *Agenda 21: The United Nations Programme of Action from Rio*, December, <<http://www.un.org/esa/dsd/agenda21/>>, accessed jun. 2009.
- CEMPRE (Compromisso Empresarial Para Reciclagem). (2009) *Um por todos e todos por um: Cooperativas ampliam esforços conjuntos para se fortalecer em meio à crise*, Cempre Informa, n. 105, maio/jun., <http://cempre.tecnologia.ws/cempre_informa.php?lnk=ci_2009-0506_capa.php>, acesso em: out. 2009.
- Crul, M. R. M., Diehl, J. C. (2006) *Design for Sustainability: A Practical Approach for Developing Economies*, United Nations Environment Programme, Delft University of Technology, November, <<http://www.unep.fr/scp/publications/details.asp?id=DTI/0826/PA>>, accessed October 2009.
- Dijkema, G. P. J.; Reuter, M. A.; Verhoef E. V. (2000) "A new paradigm for waste management", *Waste management*, n. 20, Mar., pp. 633-638.
- Dogan, C.; Walker, S. (2003) "The best of both: A study of the feasibility of integrating scales of design and production for sustainable products", *The Journal of Sustainable Product Design*, n. 3, pp. 135-147.
- Freitas, A. L. C., Romeiro Filho, E. (2005) Ademically Supported Social Work for the Development of Handicraft Skills - Case Study: the Pitangaporã Project. In: *Product: Management & Development*. , v.3, p.87 - 91.
- Guérin, F. et al. (1991) *Comprende le Travail pour le Transformer*, Paris: Éditions de l'ANACT.
- IDHEA - INSTITUTO PARA O DESENVOLVIMENTO DA HABITAÇÃO ECOLÓGICA. (2009) *Ecoplaca*. Disponível em: <<http://www.idhea.com.br/ecoplacas.asp>>. Acesso em: 13 fev. 2009 a.
- IDHEA - INSTITUTO PARA O DESENVOLVIMENTO DA HABITAÇÃO ECOLÓGICA. (2009) *Ecoprodutos, materiais sustentáveis: Ecoplaca tubo*. Disponível em: <<http://www.idhea.com.br/pdf/ECOPLACA%20TUBO.pdf>>. Acesso em: 15 jun. 2009 b.
- Karlsson, R.; Luttrupp, C. (2006) "EcoDesign: what's happening? An overview of the subject area of EcoDesign and of the papers in this special issue", *Journal of Cleaner Production*, n. 14, pp. 1291-1298.
- Manzini, Ezio. (2007) *Design, social innovation and sustainable ways of living: Creative communities and diffused social enterprise in the transition towards a sustainable network society*, DIS- Indaco, Politecnico di Milano, <<http://www.producao.ufrj.br/design.isds/material.htm>>, accessed 29 August 2007.
- Manzini, E.; Vezzoli, C. (2005) *O Desenvolvimento de Produtos Sustentáveis: Os requisitos Ambientais dos Produtos Industriais*, São Paulo: Editora da Universidade de São Paulo.
- Mintzberg, Henry. (2003) *Criando Organizações Eficazes: Estruturas em cinco configurações*, 2. ed., São Paulo: Atlas.
- Petrina, S. (2000) "The Political Ecology of Design and Technology Education: An Inquiry into Methods", *International Journal of Technology and Design Education*, n. 10, pp. 207-237.
- Prahalad, C.K. (2005) *A Riqueza na Base da Pirâmide: Como erradicar a pobreza com o lucro*, São Paulo: Artmed.
- Thiollent, Michel. (2007) *Metodologia da pesquisa-ação*, 15. ed., São Paulo: Cortez.
- Thiollent, Michel. (1985) "O Processo de Entrevista", In: THIOLLENT, Michel, *Critica metodológica, investigação social e enquete operária*, 2. ed. São Paulo: Editora Polis. pp. 79-99.
- Thiollent, Michel. (1983) "Problemas de metodologia", In: FLEURY, Afonso Carlos Corrêa; VARGAS, Nilton (Orgs.).

Organização do Trabalho: Uma Abordagem Interdisciplinar, Sete Casos Brasileiros para Estudo, São Paulo: Atlas, pp. 54-83.

Tukker, A.; Emmert, S.; Charter, M.; Vezzoli, C.; Sto, E.; Andersen, M. M.; Geerken, T.; Lahlou, S. (2008) "Fostering change to sustainable consumption and production: an evidence based view", *Journal of Cleaner Production*, n. 16, pp. 1218-1225.

Walker, S. (2002) "A journey in design an exploration of perspectives for sustainability", *The Journal of Sustainable Product Design*, n. 2, pp. 3-10.

Walker, S. And Dorsa, E. (2001) "Making design work: Sustainability, Product Design and Social Equity", *The Journal of*

Sustainable Product Design, n. 1, pp. 41-48,.

WSSD (World Summit on Sustainable Development). (2002) *Global change global opportunity: trends in sustainable development*, United Nations Department of Economic and Social Affairs, Johannesburg, August, <http://www.un.org/esa/sustdev/publications/critical_trends_report_2002.pdf>, accessed jun. 2009.

Zafarmand, S. J.; Sugiyama, K.; Watanabe, M. (2003) "Aesthetic and sustainability: The aesthetic attributes promoting product sustainability", *The Journal of Sustainable Product Design*, n. 3, pp. 173-186.