The Brazilian experience in design for health: Interdisciplinary and Bioethics

BONATTI, Fernanda Alves da Silva, BONATTI, José Américo and DOS SANTOS, Maria Cecilia Loschiavo

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The Brazilian experience in design for health:

Interdisciplinary and Bioethics

Fernanda Alves da Silva Bonatti, University of Sao Paulo, Brazil

José Américo Bonatti, University of Sao Paulo, Brazil

Maria Cecilia Loschiavo dos Santos, University of Sao Paulo, Brazil

Abstract

Health design in Brazil has been characterized historically by replacing imported products with others that are locally manufactured on a small scale. The formation of interdisciplinary groups has never been submitted to specific norms, particularly at universities.

In January 2007 the Health Design Group was created at the National Council for Scientific and Technological Development, a partnership between people from the design group at the authors' Institutions: Architecture and Urbanism School and School of Medicine.

Aiming at documenting some important experiences on the Brazilian scene to provide historical and methodological subsidies for research done by this group, a survey was conducted to find the pioneer experiences that, using the technology available at the time they were developed, paved the way for the current research.

We selected some experiments that began at the end of the 1950s lasting until the 90s, along with their researchers; among them are the Brazilian Foundation for the Development of Science Teaching (FUNBEC), the department of bioengineering of the Heart Institute (InCor) of the University of Sao Paulo (USP) Medical School, the medical equipment at Rede Sarah, and some experiences in the field of Ophthalmology.

Besides the historical documentation, the results of the Health Design Group specifically include the development of two products, a high-optical-quality magnifying glass and the innovative reading stand associated with a magnifying glass that has already been successfully tested in accordance with ethical standards by low vision patients at authors' Institution.

Thus, the creation of the Health Design Group fosters cross-disciplinary integration of subjects such as medicine and design. Based on the previously cited experiences and looking forward to implementing new research methods at authors' Institutions, this group is getting the first results, such as the inclusion of interdisciplinary work and the implementation of bioethics in research on the design of medical equipment.

Keywords

health design; ethics; cross-disciplinary integration; bioengineering; ophthalmology; low vision; medical equipment.

In January 2007 the Health Design Group of the National Council for Scientific and Technological Development (CNPq-Brazil) was established, under the leadership of Prof. Dr. Maria Cecilia Loschiavo dos Santos associate professor at the University of Sao Paulo Architecture and Urbanism School (FAUUSP). This group includes design professionals from FAUUSP and ophthalmologists from the Department of Ophthalmology of the USP School of Medicine.

In order to document some important experiences on the Brazilian scene to subsidize the research of this group historically and methodologically, a survey was conducted on the pioneer experiences, considering the technology available at the time they were developed, which paved the way for the current research.

Interviews and surveys were conducted in newspapers and journals. We selected some experiments that began at the end of the 1950s and went until the 90s, along with its researchers; among them are Brazilian Foundation for the Development of Science Teaching (FUNBEC) and Prof. Dr. Isaias Raw, the Department of Bioengineering of the Heart Institute (InCor) of the USP School of Medicine and Prof. Dr. Adolfo Leirner, medical equipment at Rede Sarah and architect Joao Filgueiras Lima and some experiences in the field of Ophthalmology, related to the authors´ field of research.

FUNBEC

The first case selected for health care products in Brazil involves FUNBEC, a company which initially produced kits and mini-kits for chemistry, biology and electricity in the garage of the USP Medical School building. Later FUNBEC occupied an appropriate building on the USP campus, donated by the then Dean (1960-1963), Dr. Ulhoa Cintra. Dr. Isaias Raw created and led the production of these kits. FUNBEC initially received grants from the Rockefeller Foundation and the Ford Foundation.

Through the cooperation and work of renowned technicians and professors, such as its founder Isaias Raw and Antonio Teixeira de Souza, the Medical Division was created. Its innovative thinking was aimed at the development of equipment for use in Cardiology. FUNBEC then transformed the cardiac monitor, the electrocardiograph and the defibrillator, only available at highly sophisticated hospitals, into standard equipment for general hospitals in Brazil.

FUNBEC was a private foundation whose sole source of income was the sale of products. The company earned money from the sale of medical-electronic equipment and spent it on the teaching of science. USP ceded the space for an administrative and educational area, but FUNBEC had also a 15,000 square meter factory in Alphaville, near Sao Paulo, with 650 employees.

The mechanical engineer and designer Jose Colucci Jr. worked there between 1981 and 1988 and was general manager of the Division of Medical Engineering. He remembers that the Medical Division, including the plant, was sold to pay debts incurred according to Labor law. Without its own sources of revenue, FUNBEC became dependent on government funding to sustain the science teaching programs and died a painful death. The company went bankrupt in 1988.

Colucci, who had an M Sc in Industrial Design from USP, took a second M Sc and Ph D program in Bioengineering at USP and at the University of Illinois. He taught at FAUUSP for 15 years in the field of project methodology. He currently lives in Boston, USA, working in the design of medical equipment at IDEO, an institution whose offices located in Palo Alto, San Francisco, Chicago, Boston, London, Munich and Shanghai "help organizations innovate through design."

In an internet interview done by the authors with Colucci on March 19, 2007, some important points could be highlighted. According to Colucci, FUNBEC was the most innovative Brazilian company of its time. Several items of electronic equipment for cardiology were pioneers in Brazil: the electrocardiographs (from ECG-3 to the ECG-50), cardiac monitors, M-mode and bi-dimensional ultrasound equipment. But this equipment was neither high-tech nor sophisticated, compared to those from companies in the USA, Japan and Europe, despite being well adapted to the Brazilian conditions. The ideas for new products came from the sales and marketing department. By talking with doctors, participating in congresses and conferences, etc., this department found out the demand for a given kind of equipment and studied the feasibility of developing it in Brazil. When asked about production difficulties in Brazil, Colucci said there were many. Among them, the lack of a qualified workforce, the difficulty of obtaining electronic and computerized parts (The Computer Equipment Law at that time closed the Brazilian market to foreign computer products. This law is no longer in force, and anything can be imported), and problems with the local Metalworkers' Union, who never understood that FUNBEC was not a private company.

InCor

The second case of Brazilian experience in health design involves research in bioengineering at the Heart Institute (InCor) of the USP Medical School, under the supervision of the MD and Engineer Adolfo Leirner, with his significant collection of state of the art products. As Director of the Center for Biomedical Technology, he built the first Brazilian pace-maker in 1961 in cooperation with the cardiologist Prof. Dr. Adib Jatene. Leirner designed and built the first dual-chamber pace-maker of the world.

The Center of Biomedical Technology at InCor is formed by 15 researchers and 25 other staff, and is in partnership with the Unversity of Campinas-Brazil, USP Polytechnic Engineering School, PUCRJ (Pontifical Catholic University of Rio de Janeiro) and the University of Berlin.

On February 27, 2007 and on March 15, 2007 the authors of this paper interviewed Prof.Dr. Adolfo Leirner at InCor, São Paulo. The first Brazilian electrocardiograph was produced in 1959 by Coretron, a private company founded by Prof. Dr. Adolfo Leirner, the late Dr. Joseph Feher, and Prof.Dr. Isaias Raw.

Fig, 1. The first electrocardiograph produced by Coretron, in 1959.

Alexandre Wollner, a designer who was the partner of Heinz Bergmüller at the time, was called to help design the equipment. They did the design and graphic planning. They designed other equipment too. Without advanced technology or even adequate tools, such as injected parts, they lathed the parts in an attempt to make them less ugly.

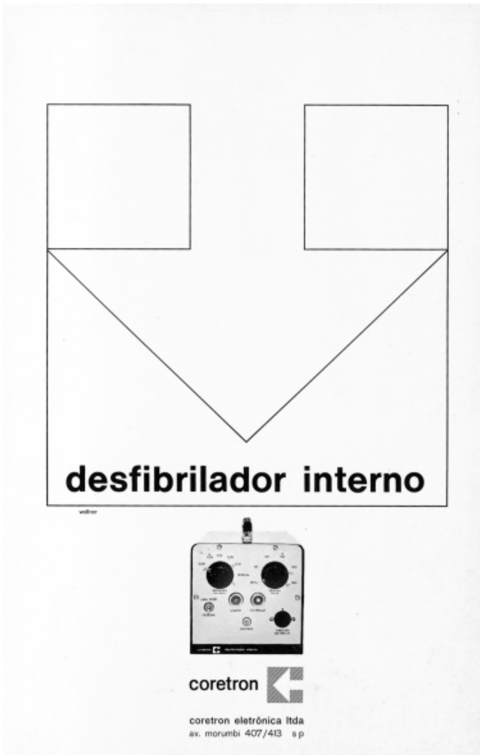

Fig. 2 and 3. Coretron company folders showing photos of equipment.

The defibrillator, the first produced in Brazil, was made with riveted steel plate because at that time there was no aluminum welding technology in Brazil. It was developed with the help of Prof. Dr. Adib Jatene, a cardiologist, also at the beginning of the 1960s. At that time, only one unit was sold in a year, while today there is law that requires even the soccer stadiums to have cardiac defibrillators. According to Prof. Leirner, Coretron did not close, in fact, it was transferred to FUNBEC. All the assets of Coretron were also transferred to FUNBEC.

Prof. Leirner's first degree was engineering . After graduating from medical school, he began to use engineering as a tool, because he realized the need for equipment and to know where it was used. He believes that today, with ready components supplied by the market, engineers should bear a greater responsibility in coordinating projects. He also says that the great pioneer of bioengineering at InCor was Prof. Dr. Euryclides de Jesus Zerbini, when, at Hospital de Clínicas, USP School of Medicine, he established the artificial heart-lung laboratory, which preceded InCor in manufacturing extracorporeal circulation machines in Brazil, in 1956-58 . With 3 aspirator pumps and 1 arterial pump Prof. Zerbini began operating with this machine in 1958 and in 1964 he had already performed 1000 surgeries. These were valve exchange procedures, since coronary surgery did not yet exist. He packed this machine and transported it by plane to operate all over Brazil.

Fig. 4. The first extra-corporeal circulation machine, in 1958.

Because of this Brazil became a cutting-edge country in cardio-vascular surgery. A man like Prof. Zerbini changed the situation in Brazil. He trained doctors who went to Curitiba, Santa Catarina, etc. In the Brazilian Northeast the first line cardiologists were trained by him at InCor.

As to producing medical equipment in Brazil instead of importing, Prof. Leirner says that there is a problem in establishing product prices in the medical world. They are characterized by a phenomenon called "inelastic demand". Overall demand is elastic, because if the price goes up the demand falls. The inelasticity occurs when prices rise and the demand does not change. This is the case, for instance, of petroleum and cooking salt. Even at higher prices people continue to consume them. This also happens with medical products, because they are necessary for survival.

He gave the example of Albert Einstein Hospital here in Sao Paulo, which will establish a program to implant a German artificial ventricle; it will cost US$150,000.00 in Brazil. This equipment, which costs US$ 100,000.00 abroad, costs US $ 30,000.00 or 20,000 to develop in Brazil. The disposable part, which is the very heart, costs US$ 30,000.00 in Germany and US $ 5,000.00 in Brazil. In his view prices are expensive outside because they charge what they can charge; in general it is the government that pays. In Germany it is the government that pays, and in the US which uses few units it is the private patient or the private insurance companies who pay. Another example given by Dr. Leirner was the bovine pericardial valve, which costs US$50 to produce and the Brazilian public Unified Health System (SUS) pays US$350 for it; in the USA it costs from US$1000 to US$1500.

When doing a survey of prices, Dr. Leirner found that the pace-maker produced by him cost US$ 2500 and the one produced in New York US$10000. The Americans used the argument that they needed to have these huge profits to reinvest in research, but Prof. Leirner does not believe this is completely true. Marketing spends more than research. When he surveyed data in a pace-maker factory, he found that marketing spends 70% of the value. The conclusion is, therefore, that it is worthwhile to manufacture medical products in Brazil.

Regarding material resources, Prof. Leirner emphasizes the use of the rapid prototyping systems in his laboratory, especially those that use laser-hardened polymers. Formerly, to replace part of the skull it was necessary to make a sculpted silver prosthesis. Today a 3D tomography measures the skull and a computer guides the laser to make the missing part, using a computer aided design/computer aided machine (CAD-CAM) system.

Prof. Leirner believes that today, here in Brazil, it is unlikely that there will be problems in obtaining materials. We have compounds of carbon, pyrolytic carbon, nanotechnology; these conditions are very different from the time when production of these devices began, in the late 50s. Aluminum and magnesium were not used. However, in relation to the human capital, the situation is very different, it is scarce, completely disproportionate.

He also cited the great number of patents that are generated abroad, as in the USA and Germany. In Brazil, we have a small number of patents and he believes that only a fraction of these are negotiated. Here in Brazil, things can be made using simple technology. Cardiac surgery, for instance, still uses the same old machines. The valves are similar to those made in the 70s, thus, in this process we are doing well because it has not changed, despite the antediluvian technology. But when the equipment requires more advanced technology, such as cochlear implants, for instance, we cannot produce it.

In addition, there are problems characteristic of an emerging country. He cites the example of the pace-makers. He made a pace-maker here in Brazil in 1965, that, although it was not state-of-the-art, would, in his opinion, save the lives of tens of thousands of Chagas disease carriers who do not have access to any pace-maker today. He believes it is better that 10 people die because a not-so-perfect pace-maker fails, than 10 thousand people because of the lack of any pace-maker at all. He advocates "low tech" technology for Brazil: a simple, cheap and competitive technology.

Rede Sarah

As the third contribution to understanding the Brazilian experience in health design we have the case of EquipHos, the Center of Hospital Technology and Rehabilitation Engineering of Sarah (National Institute of Medicine of the Locomotor System), a multidisciplinary project, but unconnected to formal systems of education, which has the participation of doctors Aloysio Campos da Paz Jr., surgeon-in-chief and architect Joao Filgueiras Lima, who was involved both in designing equipment such as the "stretcher-bed" and planning the hospitals he developed.

The Hospital Sarah Kubitschek Brasilia for diseases of the locomotor system, for which planning began in 1976, was inaugurated in 1980, in Brasilia, DF/Brazil as a referral hospital for a subsystem of specialized medicine. Actually, the idea of Rede Sarah in this city began 1974, originating from the work of the Social Pioneers Foundation, an organization originally founded in the state of Minas Gerais by Sarah Kubitschek, wife of Juscelino Kubitschek de Oliveira, the President of Brazil from 1956 to 1961, and founder of the city of Brasilia.

The design of hospitals included techniques that aimed a better quality of services, such as better thermal comfort, natural lighting and the creation of green spaces; so some equipment were included in the project to be used both by doctors and patients of the hospital . For instance, to create infirmaries open to the balconies, it was necessary to develop a bed that could be used both in internal and external areas. Therefore the "stretcher-bed" was developed, a bed on wheels, but lighter than the traditional hospital beds, to be easily transported to the hospital balcony.

Cama-maca; primeiro modelo.
Bed-litter; first model.

Fig. 5. The first model of the "stretcher-bed" (1980).

Jardim das enfermarias.
Infirmaries garden.

Fig. 6. The "stretcher-beds" in the Sarah gardens in Brasília-DF.

On May 14 and 15, 2007 a visit was made by members of the Health Design Group to Salvador-Bahia, to the Center of Technology of Rede Sarah (CTRS), where we had the opportunity of interviewing the architect Joao Filgueiras Lima , and recording a video to record his experience in the field of medical equipment. This project was supported by the Fund for Culture and University Extension of the Institution.

Currently the demand for medical equipment comes from clinical requirements. The stretcher-bed itself underwent changes over time and, currently, the project is being improved in response to the request that the stretcher-bed be able to move vertically. This modification seeks to reach wheelchair height, since most of the Rede Sarah patients have spinal cord injuries and thus they will be able to move more easily from the wheelchair to the stretcher bed and vice-versa.

The national production was highlighted by presenting several advantages. First there is an advantage regarding cost. The cost of domestic production is much lower when compared to the price that is paid for similar imported equipment. Secondly, when the equipment is manufactured in Brazil, in addition to the lower cost, technology is acquired. At CTRS, besides the experience gained in human capital, an additional value to be highlighted was the construction of specific machinery to facilitate the construction of some equipment, representing an extension of the technical capacity of this service.

Another advantage of domestic production occurs over time, when one looks at equipment maintenance, which is lower for the domestic products, allowing greater flexibility in assistance.

Finally, when domestic production is feasible, it opens up the possibility of doing a project more in line with the required features, and there may not even be an imported similar product.

One of the difficulties CTRS faces in production is regarding the supply of parts, when necessary, from certain companies; they refuse to provide these parts to complete the products, claiming that it is not financially worthwhile, due to the small production of equipment by Rede Sarah when compared to the large companies in this sector. Therefore sometimes they are forced to manufacture parts that could be acquired from other companies.

Ophthalmology

In Brazilian design for the discipline of Ophthalmology at the at the USP School of Medicine, the participation of the following pioneers in the development of ophthalmological equipment and products must be mentioned: Prof.Dr. Newton Kara-Jose: corneal stesiometer; Prof. Dr. Hisashi Suzuki: cryo-extractor of cataracts with plastic syringe and copper wire spiral, vitreophage, bipolar diatermo-coagulator and an iris hook for mechanical dilation of the pupil; Prof. Dr. Remo Susanna Jr.: valve implant for surgical treatment of glaucoma; Jose Americo Bonatti: cryo-extractor for cataract surgery with improved polypropylene pen and copper internal block and tip (patented), equipment for generation and registration of intraocular pressure, binocular indirect ophthalmoscope and video-keratoscope.

The first Brazilian indirect ophthalmoscope was developed in 1991 in a partnership at USP between the University Hospital the Institute of Physics of Sao Carlos, under the coordination of Jose Americo Bonatti.

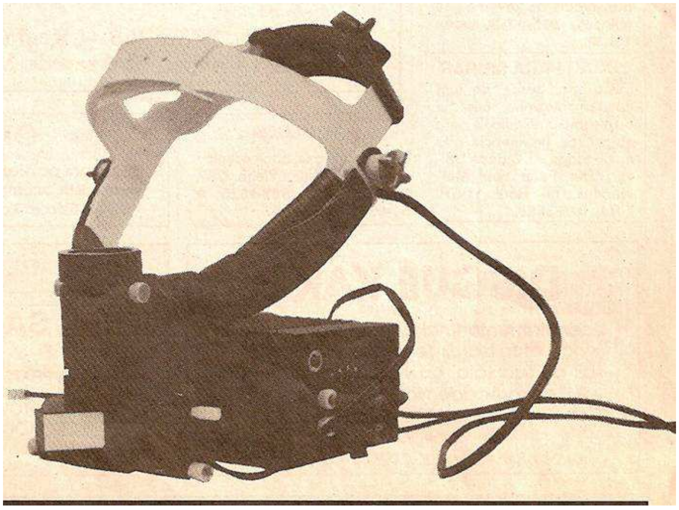

Fig. 7. The first Brazilian indirect ophthalmoscope, 1991.

In the Low Vision area, it is important to cite the development of low cost telescopic systems presented at the International Conference on Low Vision in New York, USA, 1999, a project by Prof. Dr. Marcos W. Sampaio and Dr. Maria Aparecida Onuki Haddad, using black plastic tube of photographic film packaging. Another project that must be mentioned in Brazil is that of Dr. Luciene Chaves Fernandes and Dr. Sérgio Jacobovitz who used adapted PVC tubes to make telescopic systems.

On May 3, 2007, Prof. Hisashi Suzuki, reported the difficulties he faced in the development of the vitreophage at the end of the 1980s. He built the first Brazilian vitreophage, with which he performed more than 1000 surgeries at the Hospital of the Clinics of the USP School of Medicine, but the American equipment entered the Brazilian market at reasonable prices, conquering the Brazilian surgical centers. Prof. Suzuki concluded that the isolated construction of a medical equipment does not have a long life. It is necessary to have a multidisciplinary group (engineers, chemists, biologists, designers, etc.) as part of the medical team. In order to create new designs and new developments in instrumentation, there must be, according to Prof. Suzuki: a qualified workforce, interest in developing new technologies and interdisciplinary integration.

Discussion

These experiences show us that although people with different abilities were reported, there was no standardization of interdisciplinary groups, particularly within the universities, aiming at scientific studies to present practical results for service to the community, and the empowerment of people through product design. The formation of the Health Design Group of the National Council for Scientific and Technological Development (CNPq-Brazil), interdisciplinary group consisting of a partnership between the Department of Design of FAUUSP and the USP Department of Ophthalmology seeks to produce these results, involving participatory observations with Low Vision patients from the Hospital das Clínicas of the USP School of Medicine, following the protocols of the Ethics Committee of the same hospital.

In Brazil, it was only in 1996 that the Law Nr. 196/1996 was enacted, by the National Health Council, establishing the normative principles for the forms of "free and informed consent" of people involved in scientific research, in addition to determining the role of the Committee of Ethics in Research and the National Commission on Ethics in Research, of the Ministry of Health. Nevertheless, in design research there is no Ethics Committee establishing principles to be followed by researchers dealing with users. It should be emphasized that in the case of such work, the implementation of appropriate standards was only possible due to the interdisciplinarity of the group, which allowed the submission of the work project to the Ethics Committee of the Hospital.

Participatory observations of patients resulted in the design of innovative equipment for people with low vision; it was seen that the patients found it very difficult to maintain quality in reading: they lost the focus of the hand magnifier and could not maintain the horizontality of the reading line. Moreover, holding a magnifier is a tiring activity for the elderly or other people with motor problems, because after a while the limb that holds the magnifier may tire. From these observations a prototype has been developed and tested with low vision patients from the USP Hospital of the Clinics, with good results.

Fig. 8. Reading stand coupled to magnifier developed by the authors in 2005.

Fig. 9. USP Hospital of the Clinics patient testing the figure 8 equipment.

The equipment "reading stand coupled to magnifier" presents favorable characteristics such as tracking a line of reading by sliding the magnifier attached to the horizontal rail. The position in which the patient reads, with the best eye normally next to the magnifier, is ergonomically favorable in this equipment because it is inclined 45º permitting more comfortable reading, avoiding spinal pain (lumbar, thoracic and cervical). The inclined reading stand brings the text nearer the patient.

The ergonomics and usability were also considered when thinking about coupling the magnifier to the reading stand, particularly in the case of the elderly or those with associated motor problems. The fixation of the magnifier to the rail prevents the patient from having to search for the focus all the time because the focus is maintained by the equipment even when the patient stops reading temporarily, allowing them to return to reading from the same point afterwards. Thus, it is possible to increase the time and quality of reading.

Health Design Group and Hospital das Clinicas of USP Ophthalmic Clinic staff members performed a preliminary evaluation of this innovative equipment "reading stand coupled to magnifier" for low vision developed at the USP. Nine low vision patients were evaluated using this equipment comparing it with a hand magnifier of similar power taking into account the following evaluation parameters: etiology of low vision, best corrected visual acuity for distance, patient´s opinion comparing both low vision aid resources, authors` opinion observing the patient using both low vision aids. The results showed that the preference for the low vision aids was: five patients preferred the reading stand coupled to magnifier, two patients preferred the hand magnifier; one patient was indifferent for any of the resources; one patient informed badly at the evaluation of the low vision aids. This preliminary study shows the preference of the majority of the patients for the reading stand and a magnifier that maintains at a stable position the reading line and focus showing that this innovative product makes reading easier; the evaluator doctor translates the patient´s opinion as an expert and contributes for the improvement of the product so as it can be evaluated again in the future.

Another product which was developed by the Health Design Group was a high power magnifier. It has a simple design, but with concerns about ergonomics and usability, the product is different from other similar products because of the possibility of being offered to users at a lower price than some imported products that could perform the same function.

Fig. 10. Hand magnifier with ergonomic ring developed by the authors in 2007.

Fig. 11. Hand magnifier showing magnification of entire words in more than one text line.

Conclusion

The Health Design Group, which includes professionals in design and ophthalmology linked to the University of Sao Paulo, is achieving favorable results, in terms of a pluralistic dialogue among the diversity of knowledge areas.

Experiences of Brazilian development of medical products have been recorded, and they are essential to the formation of a historical identity for the Brazilian people.
Two products have been developed by the Health Design Group: a hand magnifier of high optical quality and an innovative product "reading stand coupled to magnifier" which pleased the patients when tested.

The implementation of ethical standards in research in the fields of design in Brazil is an innovative methodology, and we hope that this initiative continues, paving a way for this practice to be consolidated in the future. In order to go further, the old lessons of the Greek philosophers should be considered: they subordinated Ethics to the idea of current happiness in life.

References

Bonatti, F.A.S. (2006). Desenvolvimento de equipamento de auxílio à visão subnormal. (Development of a low vision aid device) *Arquivos Brasileiros de Oftalmologia,* 69(2), 221-226.

Bonatti F. A. S., Bonatti J. A., Sampaio M. W., Haddad M. A. O., Souza P. R. M., Kara-José N. Avaliação de pacientes utilizando equipamento inovador de auxílio à visão subnormal. (Evaluation of patients using an innovative low vision aid). *Arquivos Brasileiros de Oftalmologia* (accepted for publication).

Bonatti J.A., Suzuki H., José, N.K., Matheus, L.C.A.. (1997). Desenvolvimento de equipamento de geração e registro de pressão intra-ocular suportada por perfuração corneana colada com fibrina. (Development o equipment for generating and recording intra-ocular pressure supported by fibrin-glued corneal perforation) *Arquivos Brasileiros de Oftalmologia*, 60(5), 514-515.

Bonatti J. A., Bonatti F. A. S., Santos M. C. L., Carricondo P. C., Kara-José N. (2008) . Development of an aspheric 22-diopter 50-mm diameter magnifier. *Arquivos Brasileiros de Oftalmologia*, 71(2), 234-237.

Cavalcante, I. (1991). Ataque à miopia com raio laser. (Attacking myopia with laser beam) *Jornal da USP.*, 5(171), 12.

Clarkson, J., Coleman, R., Keates, S., Lebbon, C., (2003). *Inclusive design: design for the whole population.* London: Springer.

DAV- Incor. (n.d.) Retrieved February 6, 2007, from http://www.inventabrasilnet.t5.com.br/davincor.htm

Haddad, M. A. O. (2000). Low Cost Telescopic System: Its Effectiveness in Cases of Macular Retinochoroiditis Due to Congenital Toxoplasmosis. In Stuen, C.(Ed.), *Vision Rehabilitation:assessment, intervention, and outcomes* **.** Lisse: Swets&Zeitlinger Publishers.

Latorraca, G. (1999) *João Filgueiras Lima / Lele.* Lisboa: Editorial Blau.

Kit "Os cientistas". ("The Scientists" kit) Retrieved February 6, 2007, from http://www.inventabrasilnet.t5.com.br/kitciencia.htm

Lima, J. F. (1999) *CTRS – Centro de Tecnologia da Rede Sarah* (CTRS – Rede Sarah´s Technology Center) Brasília: SarahLetras.

Manzini, E. (1998). Products in a Period of Transition. In Balcioglu, T. *The role of product design in post-industrial society*. Kent: Kent Institute of Art and Design.

Margolin, V. (2003) Design at the crossroads. In Margolin, V.(Ed.), *The politics of the artificial.* (pp. 28-37) Chicago: The University of Chicago Press.

Moura, E. (2003). Entrevista com Joao Filgueiras Lima (Interview with Joao Filgueiras Lima). *Revista Projeto Design*, 280(6), 4-6.

Oliveira A.C., Yasuoka F.M.M., Tonissi- Jr. S..A.., Cansian, A..M., Ramos, J.E.B., Romão, A.C. (1992). Construção de um vídeokeratoscópio para análise topográfica da córnea (construction of a video-keratoscope for topographical analysis of the cornea). In *Program and abstracts. XV Encontro Nacional de Física da Matéria Condensada.* (p.157). Sao Paulo: Sociedade Brasileira de Fisica.

Papanek, V.(1977). *Diseñar para el mundo real: ecología humana y cambio social*. (Design for the real World: human ecology and social changes). Madrid: H. Blume Ediciones.

Press, M., Cooper, R. (2002) *The role of Design and Designers in the Twenty-First Century.* Great Britain: Ashgate.

Rede Sarah. Retrieved February 6, 2007, from http://.www.sarah.br.

Santos, M. C. L. (1988) Por um design para a vida (A design for the life). *Revista Design & Interiores*, 1(6), 54.

Suzuki H, Suzuki R, Suzuki CR. (1995). Diatermo coagulador bi-polar coaxial: modo de construção. (Coaxial bipolar diatermo-coagulator: instructions for making). *Arquivos Brasileiros de Oftalmologia,* 58(3),175-176.

Suzuki H, Suzuki R, Suzuki CR. (1995), Gancho de íris para dilatação mecânica da pupila: modo de construção (Íris hook for mechanical dilation of the pupil: instructions for making). *Arquivos Brasileiros de Oftalmologia,* 58(5),367-368.

Whiteley, N. (1993) . *Design For Society.* London: Reaktion Books.

Fernanda Alves da Silva Bonatti

Fernanda Alves da Silva Bonatti is graduated in Medicine in 1984 and Architecture in 2004 at University of Sao Paulo, Brazil. "Design Therapy: development of a Brazilian low vision aid device" was the theme of her Final Graduation Monograph in Architecture. Currently is doing her post-graduation PhD course in the area in Design and Architecture at University of Sao Paulo.

José Américo Bonatti

Jose Americo Bonatti is graduated in Medicine in 1982 at the University of Sao Paulo, Brazil. He is PhD in Medicine area Ophthalmology. He has developed in an interdisciplinary team of medical engineering at the University Hospital of the University of Sao Paulo in a pioneer way in Brazil some ophthalmic equipments like binocular indirect ophthalmoscope, videokeratoscope for corneal analysis and a device for generating and measuring intraocular pressure for experimental ocular studies.

Maria Cecilia Loschiavo dos Santos

Maria Cecilia Loschiavo dos Santos is a philosopher and an associate professor of Design at the School of Architecture and Urbanism, University of São Paulo. She got her MA at University of São Paulo, Philosophy, in Aesthetics, 1975 and her Ph.D. at the University of São Paulo, Philosophy, in Aesthetics, 1993. She was a visiting scholar in postdoctoral programs at: University of California, Los Angeles. School of Public Policy and Social Research, 1995-96; University of Campinas, Brazil, Institute of Philosophy and Human Sciences, 1997; Nihon University, Tokyo, College of Design and Arts, 1999; Canadian Center for Architecture, Montreal, 2001. She has published many articles in Brazilian design magazines and international academic conferences. She is the author of several books, among them Móvel Moderno no Brasil. Her current research is about Discarded Products, Design and Homelessness in Global Cities and she is deeply committed to design and social responsibility issues.