Designed in Brazil

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REVIEW

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Abstract

Background
Health design in Brazil has been characterized historically by replacing imported products with others that are locally manufactured on a small scale. In January 2007, the Health Design Group was created at the National Council for Scientific and Technological Development, a partnership between professors and scholars from the University of Sao Paulo. Aiming at documenting some important experiences on the Brazilian scene to provide historical and methodological subsidies for research, 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.

Method
Interviews and surveys in newspapers and journals were conducted with selection of some Brazilian experiences in design for health from the end of the 1950s till the early 2000s, along with its researchers.

Results
Several examples of design for health and historical documentation in Brazil are shown concerning 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, the Laboratory of Design and Materials Selection (LdSM) of the Federal University of Rio Grande do Sul (UFRGS) in the field of craniofacial Orthopedics and some experiences of design are shown in the field of Ophthalmology.

Conclusion
We emphasize the cross-disciplinary integration of subjects such as medicine, bioengineering and design in all the previously cited experiences. Based on these experiences and looking forward to implementing new research methods, some members of the Health Design Group are involved in the development of solutions for low vision people: first a high-power-high-optical-quality magnifying glass and secondly an innovative reading stand associated with a magnifying glass that has already been successfully tested in accordance with ethical standards by low vision patients. This experience in design of medical equipment has occurred in an interdisciplinary work with the implementation of bioethics in research.

Key Words
Design, Brazil, Health.

Background

In January 2007 the Health Design Group of the National Council for Scientific and Technological Development of Brazil (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.

With the purpose of documenting some important experiences on the Brazilian scene to subsidize the research of this group historically and methodologically, a survey was conducted on some important pioneer experiences, considering the technology available at the time they were developed, which paved the way for the current research. These examples were pioneers ones we found in the medical area, an area in which very scarce investments are made in the design field in Brazil.

Method

Interviews and surveys were conducted in journals with selection of some experiences from the end of the 1950s till the early 2000s, along with its researchers:
- Brazilian Foundation for the Development of Science Teaching (FUNBEC) and Prof. Dr. Isaias Raw

- 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
- Some experiences in the field of Ophthalmology, related to some of the authors
- Bio-design of craniofacial implants at the Federal University of Rio Grande do Sul and Dr. Wilson Kindlein Júnior´s team.

Results

The results of the surveys and interviews are presented below:

1-FUNBEC

FUNBEC was 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. Later Dr. Raw and Antonio Teixeira de Souza created the Medical Division, aiming at the innovative development of equipment for 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 [1].

The mechanical engineer and designer Jose Colucci Jr. worked there between 1981 and 1988 and was general manager of the Division of Medical Engineering. 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, a country with expensive dollar and high taxes to import parts for this kind of equipments, at that time.

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 and problems with the local Metalworkers' Union.

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.

2-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 in the world.

The first Brazilian electrocardiograph was produced in 1959 by Coretron, a private company founded by Prof. Adolfo Leirner, the late Dr. Joseph Feher, and Prof. Isaias Raw. 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 and 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 aesthetically pleasant.

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

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

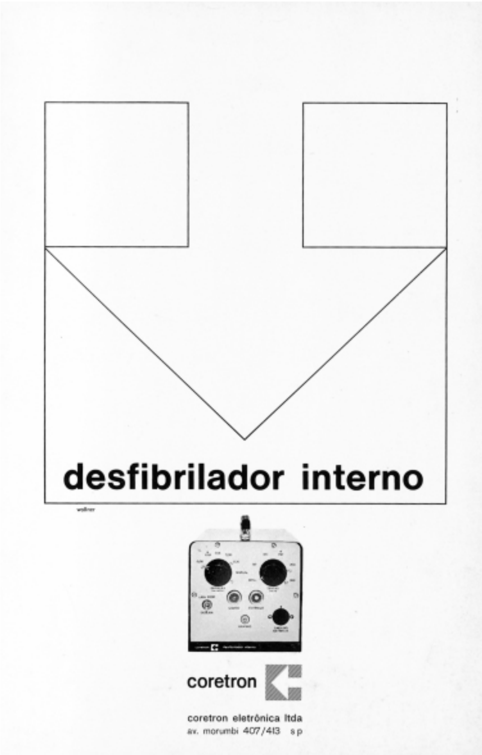

Fig. 3. Coretron company folders showing photos of equipment.

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.

Prof. Leirner also says that the great pioneer of bioengineering at InCor was Prof. Dr. Euryclides de Jesus Zerbini, who established the artificial heart-lung laboratory, which preceded InCor in manufacturing extracorporeal circulation machines in Brazil in 1956-58. Prof. Zerbini performed around 1000 surgeries in this period. Because of this Brazil became a cutting-edge country in cardio-vascular surgery.

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

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 still scarce in this area.

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. 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 advocates "low tech" technology for Brazil: a simple, cheap and competitive technology [1]. 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.

According to Dr. Leirner, marketing spends more than research. When he surveyed data in a pace-maker factory, he found that marketing spends 70% of the value.

Considering these conditions, Prof. Leirner concludes that it is worthwhile to manufacture medical products in Brazil

3-Rede Sarah

As an important 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[1].

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.

The design of hospitals included techniques that aimed at a better quality of services, such as better thermal comfort, natural lighting and the creation of green spaces; so some equipment was 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.

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 of the problem at hand and there may not even be an imported similar product.

4-Laboratory of Design and Materials Selection (LdSM) of the Federal University of Rio Grande do Sul (UFRGS)

A Brazilian technology in biodesign was developed in this laboratory, led by Prof. Wilson Kindlein Jr. and consists of customized craniofacial implants with the use of titanium mesh and hydroxyapatite cement [3, 4, and 5].

The process has three phases:

Phase1: the site of the skull where the defect occurs is selected after a computerized tridimensional tomography imaging is obtained and connected to a rapid prototyping system to perform a physical printing of the 3D model of the selected area.

Fig. 5: Physical 3D model of the patient’s skull

Phase 2: It is possible to fabricate an exact ‘negative’ of the defect by using a 3D physical model with epoxy resin and silicon rubber mold. Then a reproduction of the defect site is created in order to fabricate the prosthesis in an adequate size and convexity. A titanium plate is then developed according to the defect format.

Phase 3: The silicon mold cavity is filled with calcium phosphate cement. A titanium mesh is positioned inside of it, taking special care not to expose it excessively to allow the fixation of screws in appropriate holes. The implant adaptation to the patient’s anatomy is analyzed by using manufactured models. The procedure sequence is shown in Figure 6.

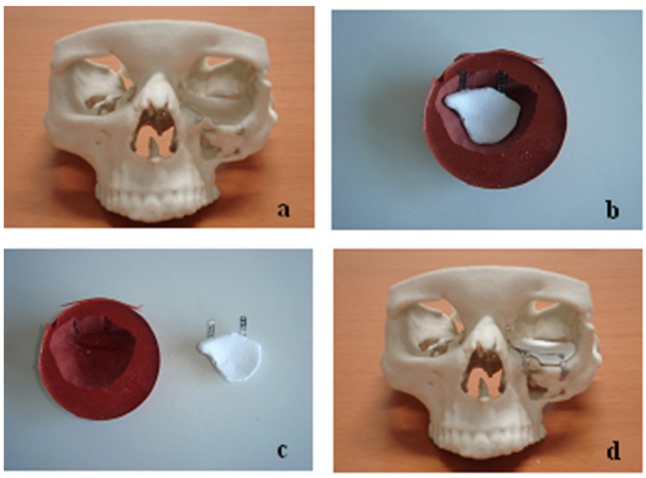

Fig. 6: Manufacture of the implant. a) Manually prepared implant prototype following the defect contour. b) Implant of CFC and titanium mesh into the silicon rubber mold. c) Implant removed from the mold. d) Verification of the implant adaptation to the patient's anatomy.

The prostheses developed for craniofacial surgeries as well as facial osseous reconstruction exactly fit the patients' anatomy. The cement calcium phosphate implants strengthened with titanium adapt easily in terms of size, shape, convexity and mechanical resistance. The prosthesis is fixed with titanium screws.

Through this**,** Brazil stands on the front line of countries which dominate this type of technology. This kind of technology is considered as sophisticated and of great social value.

5-Ophthalmology

In Brazilian design for health the discipline of Ophthalmology at the USP School of Medicine had the participation of the following pioneers in the development of ophthalmological equipment [2]:

- Prof.Dr. Newton Kara-Jose: corneal aestesiometer
- 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
- Dr. 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 videokeratoscope.

In the Low Vision area, Sampaio and Haddad have developed a low cost telescopic system using black plastic tubing from photographic film packaging. Also in Brazil Fernandes and Jacobovitz have used adapted PVC tubes to make telescopic low vision systems.

The results from 1 to 5 show past experiences of doing the best in design for health with the technology that was available at the time ("low tech") that inspired some of the authors to continue in a more standardized way to research in the low vision area.

Discussion

These experiences show us that medical product designers with different abilities were reported however there was no standardization of interdisciplinary groups in order to perform scientific studies, particularly within the universities. These studies would present practical results for the community, and the empowerment of people through product design [6].

The recently-created Health Design Group of the National Council for Scientific and Technological Development (CNPq-Brazil), interdisciplinary group with members from the Department of Design of FAUUSP and from the USP Department of Ophthalmology seeks to produce the results that will become clear during the next paragraphs, 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 cross-discipline work done by this group.

Participatory observations of patients resulted in the design of innovative equipment for people with low vision: "reading-stand coupled to magnifier" [2, 7].

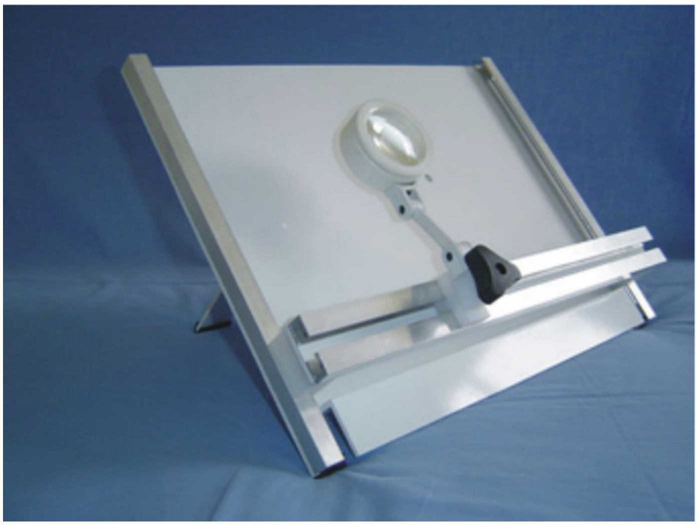

Fig. 7. Reading stand coupled to magnifier

After submitting the project to the Ethics Committee of the Hospital, some Health Design Group members and Hospital das Clinicas of USP Ophthalmic Clinic staff members performed a preliminary evaluation of this innovative equipment "reading stand with sliding magnifier" for low vision developed at the USP [8].

Nine low vision patients used this equipment comparing it with a hand magnifier of similar power. This preliminary study has shown the preference of the majority of the patients for the reading stand with sliding magnifier that maintains at a stable position the reading line and focus showing that this innovative product makes reading easier.

Another solution developed by some members of the Health Design Group was a high power hand magnifier [9, 10]. It has a simple design, but with concerns about ergonomics and usability.

Fig. 9. Hand magnifier with ergonomic ring

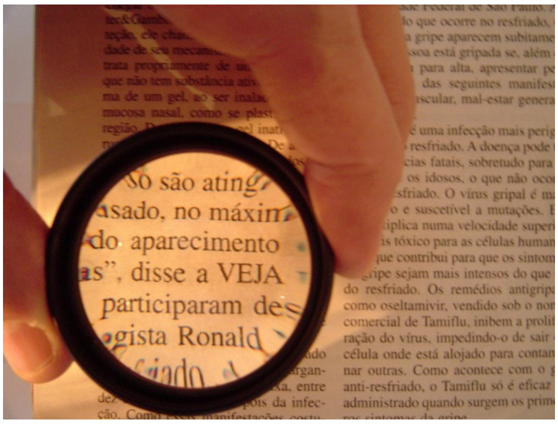

Fig. 10. Hand magnifier showing magnification of entire words at more than one text line.

The Health Design Group is achieving favorable results, in terms of developing products for visually impaired people at the University of Sao Paulo and will continue the research in this area [11, 12].

Conclusion

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.

This paper shows several examples of cross-disciplinary interaction along decades in Brazil. In the 60's, Coretron united design and the medical area within a business approach. In the 70's, Rede Sarah represented an interaction between the medical area and design research. In the 90's, there was an intersection, at the University of Sao Paulo, between medicine and physics in order to produce ophthalmic products.

Nowadays, only after the creation of the Health Design Group, was it possible for interaction between the medical ophthalmic area and design within the University of Sao Paulo, resulting in products for low vision people.

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.

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PEER REVIEW

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests