

BRAZILIAN ERGONOMICS

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versão final para

APPLIED ERGONOMICS

## **IN PRAISE OF BRAZILIAN ERGONOMICS**

(Opening speech at the 7th Aberggo Congress)

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### **Abstract**

After a brief indication of the statistical data relative to Brazil's society and economy, a description is given of the start of Brazilian Ergonomics in 1974. The main themes of this national ergonomics - health, productivity, design and cognition - are singled out. The way these orientations have developed in the main regions - North-East, South, Centre-East and South-East - is shown, along with the activity of consultant-ergonomists and industrial physicians.

### **Relevance to industry**

Thanks to this text, a consultant in a company installed in Brazil, or a manager in such a company, can find out the relationships which Brazilian ergonomics research centres and ergonomics experts have with the various aspects of the country's society and its economy. It also indicates the assistance necessary for the installation or development of an industrial activity in the various parts of the country.

*Key words:* Ergonomics; Brazil; Economy; Society

As I have been involved in the development of Brazilian ergonomics since 1974, I would like to take advantage of this Congress - which is held at a date close to that of the end of my professional career - to express what I believe to have understood and what I have admired in the development of Brazilian ergonomics. The gist of my speech is intended to show that Brazilian ergonomics is remarkably adapted to

the country's requirements and, as such, clearly satisfies what could be expected, despite the difficult conditions of its development.

The organizer of this Congress, Professor Ana Maria de Moraes, wanted it to have a strong international participation. I therefore thought it would be a good thing to present, first of all, certain aspects of the economic and social life of Brazil which will appear ordinary, mutilated and incorrect to many listeners, but will perhaps surprise others, since, despite its importance, Brazil is not well known. I have used statistical comparisons with other countries. Sometimes this is very artificial, but often enlightening. The countries concerned outside Brazil are Portugal, former metropolis of Brazil and an economically expanding member of the European Union, the USA, the world's leading power and very active in Brazil, and India, another great "New Industrialized Country."

#### **BRIEF DESCRIPTION OF BRAZIL'S SOCIETY AND ECONOMY**

Brazil is a huge country: 8,500,000 square kilometres, barely smaller than the USA (including Alaska). Its population is 160,000,000, just over 60% of that of the USA, 18% of the population of India and 16 times the population of its former metropolis, Portugal (Table I).

Less well known is that Brazil's GDP (Gross Domestic Product) was more than \$400 billion in 1993, ranking it as the world's 10th economic power, just after Spain (\$540 billion) and well ahead of Mexico (about \$300 billion). This corresponds to 3/4 of the GDP of India and more than 5 times the GDP of Portugal.

Although Brazil ranks number two in the world in terms of the surplus of its agricultural trade balance and is a major exporter of minerals, it is industrial production that accounts for 37% of GDP and 62 % of exports. As such, Brazil has

clearly thrown off the colonial pact which characterizes industrially developing countries. It is a "New Industrial Country", to use McNamara's expression. The high rate of tertiary production (52% of GDP and 46% of employees) underlines this fact even more (Table II). Note that, from 1970 to 1993, Brazilian exports increased 14-fold while those of the USA and India were around 10-fold. The growth of exports of manufactured products was extraordinary between 1970 and 1993 (66-fold) while that of India, for the same period, was 15 and that of the United States 12. In 1993, manufactured products accounted for 62 % of total exports (Table III). Brazilian industry is highly diversified; it covers 94% of the national demand for manufactured products but, as written by Cambassides (Atlas Eco, 1991-1992), it suffers from a lack of competitiveness despite very low wages (minimum wage: \$100 per month). As we see it, this background constitutes a real invitation to Ergonomics and neighbouring disciplines.

It is actually at the social level (Table IV) that Brazil is in a difficult situation. The infant mortality rate is still at 63 per thousand, i.e. 6 times higher than the United States and 5 times higher than Portugal; only India is worse off. And yet the number of doctors is relatively high (1,5 per thousand) compared to the USA (2.3) and Portugal (2.9). But are these doctors properly located in terms of requirements?

Education spending represents 4.6% of GDP, i.e. slightly less than in Portugal (5.1) and especially the USA (5.5%), but is higher than that of India (3.1%). This corresponds to an illiteracy rate of 18 % while, in India, 50% of the population is illiterate.

Where resources are lacking in Brazil is at the level of further education. The schooling rate at this level is only 12 %, half the Portuguese rate, twice the Indian rate and one seventh of the American rate. These facts should probably be compared with the difficult situation of the credits which Brazil sets aside for

research and development (0.4% of GDP). This corresponds to 2/3 of the Portuguese rate, less than 1/2 the Indian rate and one seventh of the American rate. The relatively moderate financial effort made in terms of higher education and research could explain Brazil's relative technological dependency to a certain extent. Certainly, things are changing fast, but this is the context in which the Brazilian economy has developed over the last 20 years.

#### EMERGENCE AND DEVELOPMENT OF BRAZILIAN ERGONOMICS

I have to thank Professor Franco Lo Presti Seminerio for three successive invitations, in 1974, 1978 and 1980 to work in Brazil towards the development of Brazilian ergonomics.

The first Brazilian ergonomics seminar was held from September 9th to 13th, 1974, at the ISOP, a major institution of the Getulio Vargas Foundation, an institution which has since disappeared. Among the organizers and the main speakers, the names of those who were ergonomists in Brazil before Ergonomics was created there included: Pr. Seminerio (Chairman) his colleague José Augusto Della Colleta, (who has since become specialized in Work Security) Pr. Alberto Mibielli (already an experienced work physiologist), Ana Albertina Graça Branco (who later became a CNAM ergonomist) Fany Tchaicovsky, a design ergonomist, Ued M.M. Maluf (a brilliant specialist in the modelling of cerebral and artificial intelligence phenomena) Paul Stephaneck (Professor of Psychology at the Ribeiro Preto University (S.P.) (former co-workers of Professor Faverge, one of the founders of French-speaking ergonomics and Professor at Brussels University), Itiro Ida (Professor at the COPPE, post graduation studies centre of the UFRJ (Federal University of Rio-de-Janeiro), Renier J.A. Rozestraten (also professor of psychology at the Ribeirao Preto University) Joao Bezerra de Menezes, (specialist in design ergonomics). Bryan Shackel (Professor at the University of Loughborough (U.K.)) and F.L.

Van Nes (researcher at the ergonomics laboratory of the Philipps Industries Research Centre (Holland)) along with myself, were the foreign representation. Note that the contribution, from the outset, was already mainly Brazilian.

Before that 1974 meeting, and to an even greater extent afterwards, a lot of Brazilians went to different countries throughout the world to study ergonomics and earn qualifications. At the CNAM Ergonomics Laboratory, we had the pleasure of welcoming 30 young researchers for periods of at least one year. Some 20 of them obtained their M. Sc and 10 of them their Ph.D. The most important point was that Brazilian ergonomics was developing considerably in Brazil.

When the ABERGO was officially created under the chairmanship of Professor Itiro Ida on November 30, 1983, ABERGO was quickly elected member of the International Association of Ergonomics. Professor Ida was succeeded by Professor Rozestraten, Doctor Leda Ferreira and Professor Joao Bezerra, thus proving the dynamics of the first core of 1974.

#### ERGONOMICS AT THE SERVICE OF BRAZIL'S SOCIETY AND ECONOMY

As we saw in the introduction relative to the economic and social characteristics of Brazil, although this country is a major economic power, its creative activity is still not enough to reduce its dependence on international science and technology. Certainly, no country, even those which are very industrialized, is totally independent in this sense and a lot is done through exchanges, on the condition of being admitted to the exchanges table; but one can only borrow ideas and techniques if one makes a sufficient contribution. The great anthropologist Leroi-Gourhan sees little difference between borrowing and creation in his book "Milieu et Technique" which dates from 1945.

“Pure borrowing can only be done by a group whose technical environment is already able to receive. This does not mean to say that the borrower is at exactly the same level as the lender; on the contrary, a slight gap is normal. As regards invention, the same condition applies: a group only invents if it has the pre-existing elements necessary to start innovation. Consequently, a certain identity is revealed between innovation and borrowing. We shall come back to this condition in which the group borrows and invents indifferently. In many cases, there is a merger between borrowing and invention. It is almost normal for the group with the pre-existing elements - which have not yet found a suitable association effect - to obtain from the outside an object or an idea which will lead it to new applications.”

At this Congress, we shall see that many aspects of Brazilian ergonomics have produced inventions which are related, first of all, to international exchanges, but mainly to the pertinence with which Brazilian ergonomists chose their development themes in terms of their country's requirements. The main concerns of Brazilian ergonomists can be grouped in four themes.

1) Brazilian ergonomists rightly are concerned about the health of workers. The bad health of many poor people in Brazil and the unfavourable working conditions lead to a considerable pathology. This has been underlined for some time by excellent Brazilian epidemiologists and industrial physicians. A substantial trade union movement is acting along these lines.

2) It was seen previously that one of the major problems of the Brazilian economy was its poor productivity, despite low wages and limited social advantages. Thus Brazilian ergonomists have chosen to work closely with work and company

organizers. Many ergonomics groups contribute to industrial engineering units or constitute the main part thereof.

3) The place of ergonomics linked to design was considerable 20 years ago. It has remained essential, as shown by the programme of this Congress. This is explained by Brazilian artistic creativity but is most often accompanied by prior analyses which benefit from Ergonomic Work Analysis.

4) The place of cognitive ergonomics is still insufficient in Brazil due to the difficulties this country has encountered in creating an independent hardware and software industry. But the situation is changing fast.

In each of these fields, it is encouraging to see that original Brazilian books have been published or are in the course of preparation.

These activities are encouraged by the voluntary policy of Brazilian Universities, the CAPES and the C.N.P.Q., national institutions in charge of research.

#### MAIN BRAZILIAN ERGONOMICS CENTRES

Naturally, the main ergonomics centres for both research and higher education are found in the three cities of the industrial centre of the country (Rio-de-Janeiro, Sao Paulo and Belo Horizonte) but also the other three main centres of growth: Brasilia, the capital, Florianopolis, the ergonomics centre of the industrial south, and Joao Pessoa, the old and clearly determined centre of the northeast, which is still underprivileged.

It was at **Joao Pessoa** or **Campina Grande** that Itiro Ida, Mario Vidal and Ana Albertina Graça Branco succeeded each other as professors and managers.



**Florianopolis**, capital of the State of Santa Catarina, has a Federal University (U.F.S.C.) with a remarkably open policy in regard to students from not only the whole of Brazil but also the whole of Latin America. The ergonomics section quickly developed on the basis of industrial engineering under the drive of Professor Neri Dos Santos, this led to the formation of a good pedagogical team including Professor Leila Gontijo (former president of ABERGO) and Professor Ingrid Borg. This section is a good example of the combination of concerns relative to work organization, health and design.

The **University of Brasilia** (UNB) is very large, like the city itself (25 years old and one million inhabitants). The UNB also has a policy of openness to students from all over Brazil. It has an excellent Ergonomics Psychology section run by Professor Julia Issy Abrahao, the author of a thesis which constitutes one of the bases of worldwide anthropotechnological study. This section should become the school that produces the many professors of cognitive psychology, whose presence is lacking in most of the countries teaching staffs.

At **Belo Horizonte**, in the Industrial Engineering department of the Federal University (U.F.M.G.) an ergonomics section is taking shape with Professor Francisco Antunes Lima, whose work concerns ethics in work activity contributes an original, in-depth study which should constitute a significant contribution in the field of ergonomic epistemology at international level. Among the important members of this unit which is being formed, is Professor Ada Assunção, whose major concerns are in the field of health at work.

Obviously, most of the Brazilian ergonomics activity is located in two main areas: Sao Paulo, one of the world's major industrial cities, and Rio-de-Janeiro, the former federal capital.

The **State of Sao-Paulo** is a great producer of industrial and agricultural wealth. It has its own research policy which makes special resources available to its researchers. We have seen that the University of Ribeirao Preto gave Brazilian ergonomics two of its main founders, R. Rozestraten and P. Stephanek. I don't know if this effort has continued. The University of Campinas has Professor Aparecida Iguti, as an ergonomist, and Tom Dwyer, a work sociologist, who has published several international level books on work security. But it obviously in the city of Sao Paulo itself that the most important sections are concentrated. A national organization, the Fundacentro, institute in charge of the prevention of work accidents and industrial hygiene, set up an ergonomics section a few years ago, the main strength of which is Leda Leal Ferreira, Her books show, on the basis of Ergonomic Work Analysis, what groups of workers (like civil aviation pilots) think of their work and the difficulties they encounter, and what ergonomics can eradicate or attenuate. Once more, this is a significant contribution to World Ergonomics. Several Brazilian ergonomists have worked with her, like Professor Regina Heloisa Maciel, presently Professor of Psychology at the University of Sao Paulo (U.S.P.), Professor Laerte Sznelwar, presently professor of ergonomics in the Industrial Engineering department of the U.S.P. and Marçal Jackson Filho, who was in charge of the Fundacentro unit in Florianopolis.

The Pontifical Catholic University of Sao Paulo has an interesting work sociolinguistics group, led by Pr. Maria Cecilia Perez de Souza e Silva who, in 1995, jointly organized a linguistics and ergonomics symposium in cooperation with Professor Mario Vidal and Pr. Vera Feitosa from COPPE (UFRJ).

It is obvious that the very large University of Sao Paulo (U.S.P.) should be the ergonomics teaching centre in Sao Paulo. It was Professor Afonso Fleury, Director of the Industrial Engineering Department who, for the last 10 years, fought for the

introduction of ergonomics teaching, which took place this year, along with Dr. Leda Ferreira, Pr. Laerte Sznelwar, the founder of Brazilian ergotoxicology, Dr. Egberto de Medeiros, ergonomist in the Brazilian branch of the world's largest software producer, and Fausto Leopoldo Mascia, industrial engineering lecturer.

Mention should also be made of the presence, in the Social Sciences Faculty of the USP, of an international level work sociologist, H el ene Hirata.

**Rio-de-Janeiro**, the former capital of Brazil, has long been one of the world's great intellectual centres. As we have seen, it was at the ISOP that Professor Seminerio set up an ergonomics research centre which started ergonomics specialization courses in 1978. But the ISOP was scrapped. There was also a design ergonomics centre in the Industrial Technology Centre of the Ministry of Industry. It was run by Maria Diva Pires, along with the cooperation of Venetia Santos, at present a very active consultant ergonomist, and Argemiro Garcia who, alas, is no longer with us. Diva Pires worked in anthropometry, which had been insufficiently developed in Brazil till that time.

The Congress showed the old, and still very lively, activity of Brazilian design ergonomics concentrated around Ana Maria de Moraes at the Rio-de-Janeiro State University (UERJ)..

For some considerable time, the Federal University of Rio-de-Janeiro (U.F.R.J.) has had a higher education centre, the COPPE, whose industrial engineering department has a large research unit run by Mario Vidal, distant heir of Itiro Iida. The ergonomics unit of the COPPE has produced many MAs in ergonomics who teach our discipline in various units of the country. It has now produced three Doctors of Ergonomics, including Francisco Duarte, who highlighted the fact that, in certain cases, through Ergonomic Work Analysis it was possible to determine the

minimum number of staff necessary for the safe operation of complex continuous-process production systems, Another important researcher in the group, Dr Vera Feitosa, also accomplished work of international significance on the linguistics and ergonomics of administrative documents. She was the joint organizer of the recent symposium on "Linguistics and ergonomics". In fact, the unit run by Mario Vidal is difficult to describe in a simple way since Mario Vidal himself insists on a double-entry classification of the twenty-odd types of research in progress: a classification according to social requirements (prevention of accidents, mental health, productivity) and according to the theories and methodologies used. It was also this unit of the COPPE which formalized the exchange between university ergonomics and trade unions, an exchange which is also present in several of the units already mentioned .

Despite the length of this text, I am aware of the fact that I have not described the activity of company ergonomists and the many consultant ergonomists who help social and economic life in various ways. I refer, in particular, to Dr Ana Isabel Paraguay, Beatriz Lira, Elisabete Rodriguez, Paulo Pereira Dos Santos and many others. Mention also will be made of the active and long-standing role of industrial physicians, in particular Leda Ferreira, Carlos Deniz Silva and Milton Carlos Martins.

Brilliant Brazilian ergonomics has already rendered great services to its country and is starting to make a significant contribution to international ergonomics.

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- CORDELIER S., DIDOT B. pub. (1994) L'état du Monde. Annuaire économique et géopolitique mondial. La Découverte ed., Paris
- LERIO-GOURHAN A. (1945) Milieu et technique. Albin Michel ed., Paris

**TABLE 1 : SURFACE, POPULATION AND GROSS NATIONAL PRODUCT OF BRAZIL, PORTUGAL, INDIA, AND THE U.S.A IN 1993  
(DATA FROM CORDELIER S., DIDOT S.PUB. (1995))**

	BRAZIL	PORTUGAL	INDIA	U.S.A.
<b>SURFACE KM2</b>	8,511,965	92,080	3,287,590	9,363,123
<b>POPULATION</b>	159,000,000	9,880,000	913,700,000	260,500,000
<b>GNP (BILLIONS US \$)</b>	416	78	272	6.380
<b>GNP/h US \$ / HEAD</b>	2,600	7800	300	24.700
<b><u>GNP AGRICULTURE</u> BILLIONS US \$</b>	45	?	87	153
<b>% TOTAL GNP</b>	11.0	?	32.0	2.4
<b><u>GNP INDUSTRY</u> BILLIONS US. \$</b>	155	?	76	1,914
<b>% TOTAL GNP</b>	37	?	27.9	30.0
<b><u>GNP TERTIARY</u> BILLIONS US \$</b>	216	?	109	4,312
<b>% TOTAL GNP</b>	52	?	40	68

**TABLE II : POPULATION (1993) WORKERS DISTRIBUTION (1992) URBANIZATION (1993) IN BRAZIL, PORTUGAL, INDIA AND THE U.S.A.**

	<b>BRAZIL</b>	<b>PORTUGAL</b>	<b>INDIA</b>	<b>U.S.A.</b>
<b>TOTAL POPULATION</b>	<b>159,000,000</b>	<b>9,880,000</b>	<b>913,700,000</b>	<b>260,500,000</b>
<b>AGRICULTURAL WORKERS % TOTAL WORKERS POPULATION</b>	<b>29</b>	<b>?</b>	<b>66</b>	<b>3</b>
<b>INDUSTRIAL WORKERS % TOTAL WORKERS POPULATION</b>	<b>25</b>	<b>?</b>	<b>15</b>	<b>24</b>
<b>TERTIARY WORKERS % TOTAL WORKERS POPULATION</b>	<b>46</b>	<b>?</b>	<b>19</b>	<b>73</b>
<b>URBAN POPULATION % TOTAL POPULATION</b>	<b>75</b>	<b>34</b>	<b>26</b>	<b>75</b>

**TABLE III : ENERGY (1991), EXPORTS (1992), RESEARCH AND DEVELOPMENT EXPENDITURE (1985) OF BRASIL,  
PORTUGAL, INDIA AND THE UNITED STATES (BASIS, 1993)**

**\* C.T.E. COAL TON EQUIVALENT**

	<b>BRAZIL</b>	<b>PORTUGAL</b>	<b>INDIA</b>	<b>U.S.A.</b>
<b>G.N.P. BILLIONS US DOLLARS</b>	<b>416</b>	<b>78</b>	<b>272</b>	<b>6.400</b>
<b>ENERGY PRODUCTION MILLIONS C.T.E. *</b>	<b>83.0</b>	<b>1.3</b>	<b>250</b>	<b>2.400</b>
<b>ENERGY CONSUMPTION MILLIONS C.T.E. *</b>	<b>121.2</b>	<b>19.3</b>	<b>273</b>	<b>2,758</b>
<b>PART OF MANUFACTURED PRODUCTS EXPORTS IN TOTAL EXPORTS %</b>	<b>61</b>	<b>?</b>	<b>72</b>	<b>77</b>
<b>EXPORTS GROWTH 1970-1993</b>	<b>1.400</b>	<b>?</b>	<b>1.100</b>	<b>1.100</b>
<b>MANUFACTURED EXPORTS GROWTH 1970-1993</b>	<b>6.600</b>	<b>?</b>	<b>1.500</b>	<b>1.200</b>
<b>RESEARCH AND DEVELOPMENT % GNP</b>	<b>0.4</b>	<b>0.6</b>	<b>0.9</b>	<b>2.7</b>

**TABLE IV : HEALTH, EDUCATION AND BOOKS PRINTING IN BRAZIL, PORTUGAL AND THE U.S.A. (1990-1995)**

	<b>BRAZIL</b>	<b>PORTUGAL</b>	<b>INDIA</b>	<b>U.S.A.</b>
<b>G.N.P./CAPITA (US \$)</b>	<b>2,600</b>	<b>7,800</b>	<b>310</b>	<b>25,000</b>
<b>INFANT MORTALITY</b> ‰	<b>63</b>	<b>12</b>	<b>96</b>	<b>10</b>
<b>NUMBER OF PHYSICIANS</b> ‰	<b>1.5</b>	<b>2.9</b>	<b>0.4</b>	<b>2.3</b>
<b>EDUCATION EXPENSES /G.N.P.</b>	<b>4.6</b>	<b>5.1</b>	<b>3.1</b>	<b>5.5</b>
<b>ILLITERACY RATE</b> %	<b>18</b>	<b>14</b>	<b>50</b>	<b>?</b>
<b>UNIVERSITY STUDENTS</b> %	<b>12</b>	<b>23</b>	<b>7</b>	<b>76</b>
<b>BOOKS PUBLISHED PER YEAR</b>	<b>17,600</b>	<b>6,400</b>	<b>13,900</b>	<b>&gt; 200,000</b>