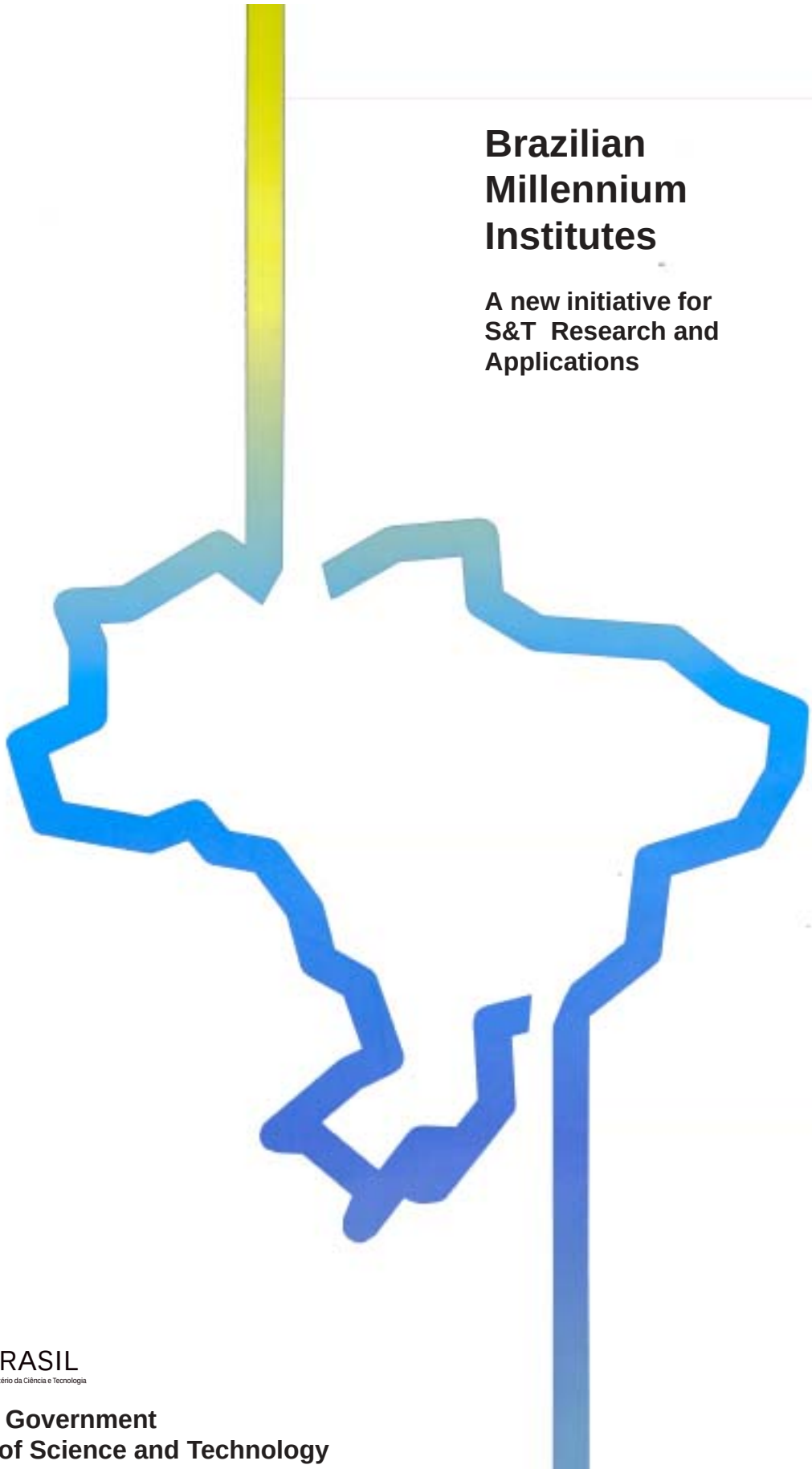
Brazilian Millennium Institutes

A new initiative for S&T Research and Applications



CT BRASIL
Ministério da Ciência e Tecnologia

Brazilian Government
Ministry of Science and Technology

The Millennium Institutes in Brazil

A global and comprehensive view of Brazilian Science shows an impressive and to some extent surprisingly robust progress. This can be easily verified by the extraordinary increase in publications in scientific journals of international reputation, clearly above the world average and in fact that of developed nations, the number of Ph.D.s produced yearly that has reached the remarkable figure of 6,000 and the strong presence of its community in the international scenario, as can be seen in the main international conferences, where Brazilian scientists are main speakers. Furthermore, our community have been playing a distinctive role in main international bodies as the Third World Academy of Sciences – TWAS, the International Council for Science – ICSU, UNESCO and World Health Organization, among others.

At the same time, the Brazilian system of science and technology recently became much more structured, both from the view points of strategic goals as well as self-sustainability, as can be seen by the establishment of the Millennium Institutes and the Sectoral Funds, respectively.

Since Brazil already dispose of a network of Centers of Excellence, with the prime objective of developing thematic topics of relevant research, the Millennium Science Initiative – MSI became the natural next step, since such Institutes aim at much more global goals, namely:

- Providing considerable increase of competence in important areas of Science and Technology through broad national, regional and international action
- Contributing to create suitable conditions for innovation by providing ways to transfer generated knowledge to the public sector, thus helping to solve national problems, or to the private sector, thus increasing Brazilian industry's competitiveness
- Promoting integration between the Institutes' main operating fields and other Science and Technology fields
- Developing more extensive research projects than those normally funded by other programs
- Contributing to Brazilian social and/or economic progress by understanding and trying to solve great global problems with significant impact on the country
- Encouraging the qualification of new researchers and the establishment of young researchers of recognized talent
- Promoting networks formed by research groups
- Innovation must be the distinguishing mark of Millennium Science Initiatives, whether in the implementation of new techniques for basic research or in the creation of mechanisms for transferring generated knowledge to society, as well as in training new Ph.D.s and young Post-Docs
- Collaboration with main scientific institutions in the world and particularly in the Latin American region must be promoted

Two groups of Millennium Institutes were established in Brazil:

- **Millennium Science Institutes – Group I**: institutes of exceptional scientific and/or technological level within their field or fields, which could have a key role in achieving new standards of national competence within those fields. There will be no more than 20 Group I Institutes, and they will receive approximately two thirds of available resources
- **Millennium Science Institutes – Group II**: institutes operating in strategic fields as defined by the Science and Technology Program of the Ministry of Science and Technology. There will no more than 5 Group II Institutes, and they will receive approximately one third of available resources

These concepts were set up by an advisory committee of high level Brazilian scientists from different areas of activities, which was created by the Minister of Science and Technology Ronaldo Sardenberg in the year 2000 and lead by Jose Galizia Tundisi. A fundamental contribution to that end was given by the Science Institute Group - SIG, lead by Phillip Griffiths, that has conceived the Millennium Science Initiative - MSI having the establishment of the Millennium Science Institutes as its main objective. The MSI had its inception with the full support of the President of the World Bank, James Wolfensohn. All such efforts in setting up the program in several countries, including Brazil, had the generous financial back up of the Packard Foundation.

The Brazilian Millennium Science Institutes are financed by the Brazilian Government and the World Bank in equal parts, as a new main chapter of PADCT, an in-going project to promote the development of science and technology.

After a rigorous selection among more than 200 projects by an outstanding committee, composed by foreign as well as Brazilian scientists, 15 Institutes were selected in Group I and two in Group II, as described in the sequel.

The present report was requested by Minister Ronaldo Sardenberg.

It has been prepared by the coordinators of the Brazilian Millennium Science Institutes and edited by Jacob Palis and José Galizia Tundisi with the support of Antonio Carlos Campos de Carvalho.

December, 2002

International Scientific Committee

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  Instituto Internacional de Ecologia
  São Carlos – SP
- Jorge Allende
  Instituto de Ciencias Biomedicas, Faculdad de Medicina Universidad de Chile
  Chile
- Henry Dumont
  Institut of Animal Ecology - Ghent University
  Belgium
- David Ruelle
  Institut des Hautes Etudes Scientifiques
  Buressur-Yvette – France
- Chintamani Nagaesa Ramachandra Rao
  Jawaharlal Nehru Centre for Advanced Scientific Research
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- Stefan Bogdan Salej
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- Maria Manuela Carneiro da Cunha
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- Cristovam Wanderley Picanço Diniz
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  Belém –PA
- Herman Chaimovich
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  São Paulo-SP
- Simon Schwartzman
  AIRBrasil – Pesquisa e Consultoria em Recursos Humanos e Políticas Públicas
  Rio de Janeiro – RJ
- Ramayana Gazzinelli
  Instituto de Física - Universidade Federal de Minas Gerais – UFMG
  Belo Horizonte– MG

Millennium Institutes in Brazil

Global and Integrated Advancement of Mathematics in Brazil and Contribution to the Region
Coordinator: Jacob Palis
Main Node: **:** Instituto Nacional de Matemática Pura e Aplicada, IMPA – 27 Centers in the Millennium Network

Institute Factory of the Millennium
Coordinator: João Fernando Gomes de Oliveira
Main Node: Universidade de São Paulo, São Carlos, USP/São Carlos – 6 Centers in the Millennium Network

Mangroves: Structure, Function, Evolutive History, Sustainable use and Relationships to Others Ecosystems
Coordinator: Horácio Schneider
Main Node: Universidade Federal do Pará, UFPA – 6 Centers in the Millennium Network

Millenium Institute on Stellar and Galaxy Evolution in the Era of Large Telescopes: Implementation of Instrumentation for SOAR and GEMINI (MEGALIT)
Coordinator: Beatriz Leonor Silveira Barbuy
Main Node: Universidade de São Paulo, USP – 19 Centers in the Millennium Network

Integration of Genetic Breeding, Functional and Comparative Genome of Citrus
Coordinator: Marcos Antônio Machado
Main Node: IAC/ Centro de Citricultura Sylvio Moreira – 6 Centers in the Millennium Network

Integrated Strategies for Research and Control of Tuberculosis in Brazil: New Drugs and Vaccines, Diagnostic Tests and Clinical-Operational Evaluation
Coordinator: Célio Lopes Silva
Main Node: Universidade de São Paulo, Ribeirão Preto, USP/R. Preto – 17 Centers in the Millennium Network

Land use Changes in Amazon: Climatic and Carbon Cycling Implications - Milênio LBA
Coordinator: Paulo Eduardo Artaxo Netto
Main Node: Universidade de São Paulo, USP, 13 Centers in the Millennium Network

Institute of Quantum Information
Coordinator: Luiz Davidovich
Main Node: Universidade Federal do Rio de Janeiro**,** UFRJ – 9 Centers in the Millennium Network

Millenium Institute of Complex Materials
Coordinator: *Fernando Galembeck*
Main Node*:* Universidade de Campinas**,** UNICAMP – 4 Centers in the Millennium Network

Institute of Nanosciences
Coordinator: Alaor Silverio Chaves
Main Node: Universidade Federal de Minas Gerais**,** UFMG – 15 Centers in the Millennium Network

Water: a Mineral Approach
Coordinator: Virginia Sampaio Teixeira Ciminelli
Main Node: Universidade Federal de Minas Gerais**,** UFMG – 10 Centers in the Millennium Network

Instituto Multidisciplinar de Materiais Poliméricos IMMP
Coordinator: Roberto Mendonça Faria
Main Node: Universidade de São Paulo. São Carlos, USP/São Carlos – 17 Centers in the Millennium Network

Institute for Immunological Investigation
Coordinator: Jorge Kalil
Main Node: Universidade de São Paulo, USP – 7 Centers in the Millennium Network

Tissue Bioengineering: Cell Therapies for Chronic Degenerative Diseases
Coordinator: Ricardo Ribeiro dos Santos
Main Node: Fundação Oswaldo Cruz**,** FIOCRUZ – 13 Centers in the Millennium Network

Research Network on System-on-Chip, Microsystems and Nanoelectronics
Coordinator: Jacobus Willibrordus Swart
Main Node: Universidade de Campinas**,** UNICAMP – 7 Centers in the Millennium Network

Millenium Institute of the Semi-Arid: Biodiversity, Bio-Prospecting e Conservation Natural Resources
Coordinator: Ana Maria Giulietti
Main Node: Universidade Estadual de Feira de Santana**,** UEFS/BA - 23 Centers in the Millennium Network

Use and Appropiation of Coastal Resources
Coordinator: Jorge Pablo Castello
Main Node*:* Fundação Universidade Federal de Rio Grande**,** FURG – 15 Centers in the Millennium Network

Millennium Institute

Global and Integrated Advancement of Mathematics in Brazil and Contribution to the Region

Network of 27 Centers in Brazil

It is well accepted nowadays that the performance of a competitive and integrated economy in the international panorama depends crucially upon its effective capacity of using its existing bases of technological and scientific knowledge, among which one finds mathematics and scientific computation.

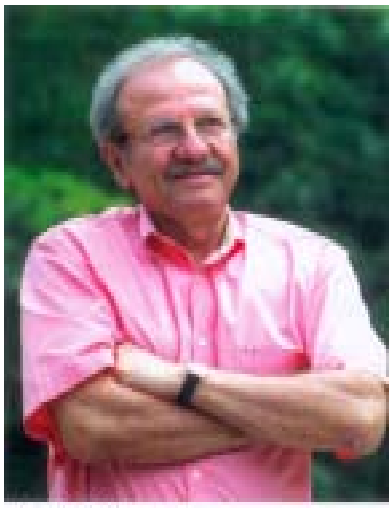
New avenues are being opened by the advancement of natural and social sciences, requiring a strong interaction with mathematics and computation. The new fields of interdisciplinary research shall certainly be the most important characteristic of the 21st century science.

Quoting from biologist Rita Colwell, presently president of the National Science Foundation in a recent speech "I cannot stress too strongly how vital mathematics is to keeping our R&D enterprise strong. Nurturing the discipline of mathematics itself is the foundation of this broader role. We see mathematics as fundamental for progress in science and engineering. ... as our world and economy change more quickly than ever, lifelong learning becomes a survival skill. mathematical literacy will become an even more vital ingredient in this scenario."

Indeed, the high demand for competent mathematicians in its different specialties has poignantly manifested itself throughout the world in several different fronts, particularly in Brazil and in Latin America.

- Therefore, it is imperative an even more expressive development of Fundamental and Computational Mathematics. It is also of prime importance to vigorously foster the integration of mathematics with other scientific disciplines opening new avenues to knowledge. This will doubtless benefit society as a whole in areas such as climate prediction, applications to medicine and biology, e.g. tomography, image reconstruction, blood flow modeling, mathematical and computational modeling of natural phenomena, e.g. population dynamics, ecological modeling. We also emphasize in this project areas of impact in mathematical physics, such as phase transitions.

- Another objective of prime importance concerns the integration of mathematicians with the productive sector. As examples we have the study of models for oil prospection and extraction, mathematical economics and finances, and electrical energy optimization.



Jacob Palis

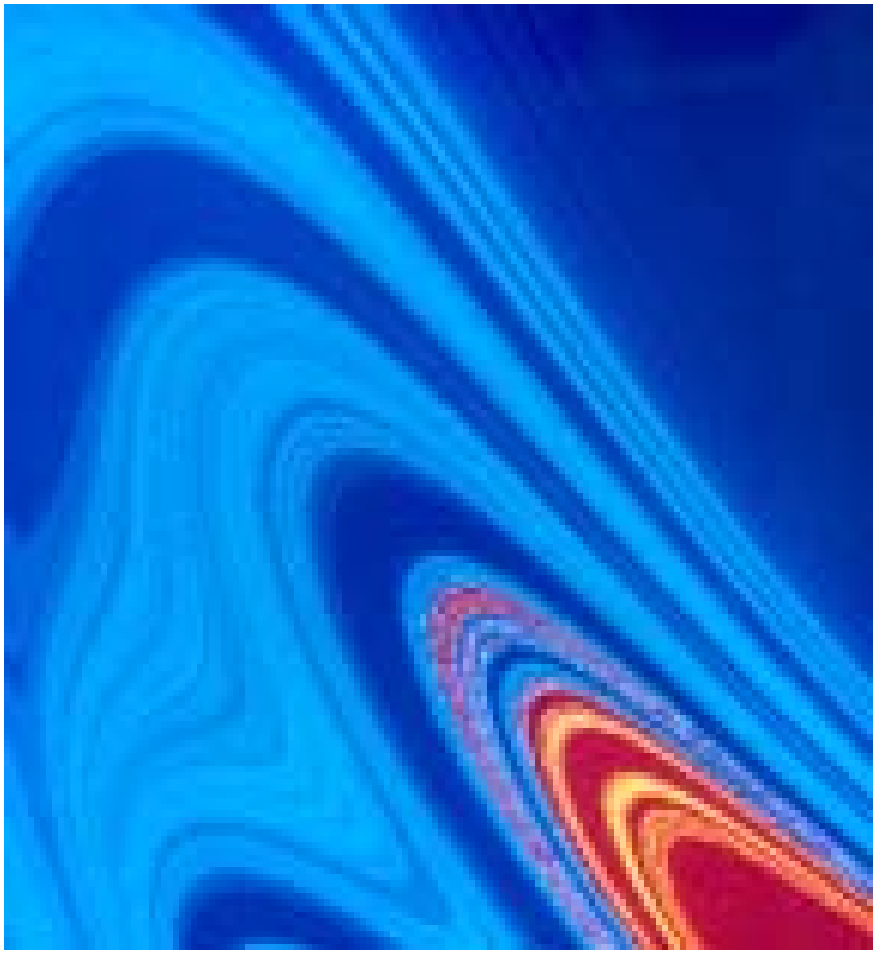
- Some of the aforementioned research areas and activities are already being developed, including some interdisciplinary ones and others leading to the integration with the productive sector. Examples of the former are, climate-weather prediction studies and applications to medicine, whereas examples of the latter are ongoing projects in oil prospection and extraction.
- The preparation of new generations of researchers is a key purpose of the Institute. This includes both the training of Ph.D.s students and especial post-docs programs. That helps to estimulate an exiting research atmosphere in the many centers that the Institute comprises, namely 27 just in Brazil.

In all the above aspects the already existing international cooperation is extraordinary, as the participation in the project of five Field Medallists, together with several other renowned scientists and research centers indicates.

- The Institute shall also give a relevant contribution to the teaching of mathematics in levels ranging from junior-high school to graduate school. The expertise in this direction already exists by members of

the present project in the level of junior-high school, high school, and college mathematical teaching. To this end we have established a paternship with the National Research Network (Rede Nacional de Pesquisas-RNP) and the proposed Institute in such a way as to give country-wide coverage of the activities. This will include video-conferencing both at the level of teaching as well as research development and exchange.

- The Institute shall also emphasize the nurturing of mathematical interest of the youth in the range of 10 through 17 years old as well as the search for new young talents. This will be done by the strengthening of the already well structure "Olimpiadas Brasileiras de Matematica" both at the regional level as well as at the national level.
- Another fundamental aspect shall be the support to eleven emerging research centers, namely Universities of Alagoas, Amazonas, Bahia, Espirito Santo, Goias, Maranhão, Pará, Paraiba Campina Grande and Paraiba João Pessoa, Parana e Piauí.
- At the same time, the exchange with other centers in Latin America, along the lines of the Millennium Institutes will certainly be very profitable. This is corroborated by the already existing intense scientific exchanges between the researchers in the proposed Institute and the most active research communities in the region, such as those in Argentina, Chile, Peru, Mexico, Venezuela, and Uruguay.

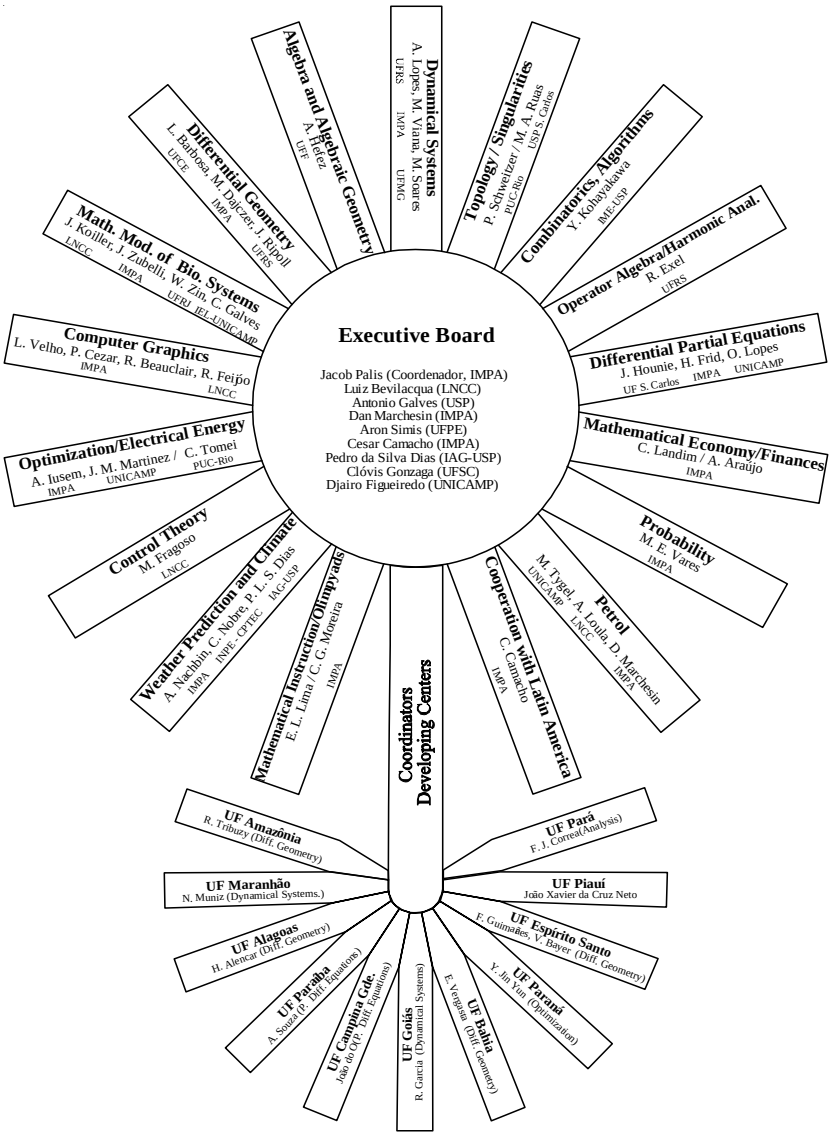


Chaotic - Strange Attractor

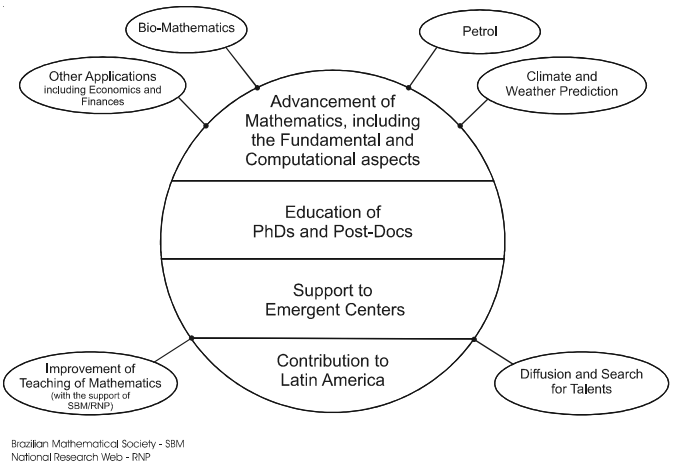
The potential for social and economic contributions of the project are significant. They involve applications to vital sectors of the country including basic research, the integration with other areas of knowledge , computational and applied mathematical modeling, teaching in different levels, and the production of highly competent human resources.

- At the regional level, the Institute will contribute to a strong presence of Brazil in fostering and performing scientific research and applications throughout Latin America, as well as in the preparation of highly skilled human resources.
- As for the potential interest that the project will bring to society, we remark that teaching and preparation of well qualified scientific personnel has a fundamental and all-encompassing importance.
- Among some of the impact areas concerning applications, we may cite climate and weather prediction, medicine, and potentially to ecology. In the latter case by using techniques from dynamical systems and partial differential equations, which are areas where Brazil has a world-wide recognition. It is relevant to point contribution that the Institute may bring to oil prospection and extraction, to mathematics and economics and finances.

The following figures are indicative of the Institute's activities and its organizational structure.



Organizational Structure of IM-AGIMB



Main Activities

Overview and Perspective

The Millennium Institute on Global and Integrated Development in Mathematics in Brazil, IM-AGIMB has initiated its comprehensive set of activities in late 2001 and at the end of 2003 it is now at almost full speed concerning its objectives. From the impressive set of results, it is clear that the Institute is and shall be of great importance to the development of Fundamental and Computational Mathematics in Brazil as a major goal. It is also contributing already in a significant way to mobilize the mathematical community into fostering integration with other sciences, like bio-mathematics, the interaction with the productive sector, like in oil and gas prospection and extraction, as well as in the training of Ph.D.s and Post-Docs. Actually, a number of Post-Docs fellowships are available to the Millennium Institute. Of great importance is the support to mathematical emerging centers, eleven of them in different regions of Brazil, to upgrade the research capability and their master's degree program. It has been very successful in its project of contributing to the improvement of teaching of mathematics in the secondary and high school levels and in the search for new talents through Olympiads. Finally, it is promoting at a higher level than before the cooperation with the world mathematical community, particularly the Latin American one. In brief, the IM-AGIMB has certainly fulfilled its objectives in its first year and reveal itself as an strategic tool to achieve a new scientific mathematical level in Brazil in a broad sense and shall be of much influence to the region in the next coming years.

Activities

Extraction of Oil

It is based on the theory of systems of conservation laws, applied to multiphase flow in porous media. In this study we have been successfully developing accurate numerical methods and software to simulate flow of petroleum reservoirs to optimize the recovery of hydrocarbons. The models for multiphase flow present non-trivial mathematical difficulties, since they are represented by systems of partial differential equations of elliptic-hyperbolic type. These and activities involve collaboration of several researchers from IMPA, LNCC and Brazilian Universities, such as UNICAMP, University of Brasília and the Federal Universities of Campo Grande, Goiás, Rio de Janeiro and University of Northern Rio de Janeiro.

Weather Prediction and Climate

Numerical methods and software are being developed for weather prediction and climate studies accurate for the climate and topography of South America. This research is conducted in collaboration with CPTEC/INPE (Brazilian Institute for Climate Research), LNCC, several Brazilian Universities and research centers (IAG/USP; IME/USP) as well as NASA/DAO (an American research center). This research also includes the study of wave propagation in hydrodynamics and meteorology, focused on dynamical aspects of free boundary problems with applications on fluid mechanics. Wave propagation in disordered media and nonlinear instability in vorticity rolls are studied too.

Probability

The probability group in Brazil focus on the study of critical phenomena in random processes and fields. This is a major sub-field of modern probability theory, which in the last decades has acted as the driving force behind many important mathematical developments, and whose applications extend to a growing number of areas of knowledge, including physics, engineering, biology, chemistry, ecology, linguistics, among others. A broad program of research is in course, involving detailed studies of a variety of systems of interest for these areas as well as the investigation of more general issues of probability theory.

Partial Differential Equations

The field is among those in mathematics with the fastest growth in Brazil, particularly with the training and incorporation of new Ph.D.s. This is very relevant since the study of PDEs is of central importance for both mathematics and its applications. The IM-AGIMB is promoting the integration of its three main lines of research in the country at large:

1. Nonlinear Evolution Equations: Hyperbolic, Parabolic, Hyperbolic-Parabolic and Dispersive Equations
2. Nonlinear Eliptic Equations and Variational Problems
3. Linear Equations – Geometric Theory of PDEs and Several Comlplex Variables

All groups are very productive. For instance, the research topics concerning the third group are: boundary behavior of homogenous solutions of vector fields, extensions of the similarity principle, Normal forms for special classes of vector fields and Global and semi-global properties of over determined systems. There is also intense interaction with foreign mathematicians, particularly from the region.

Dynamical Systems

There are two main groups in Brazil namely, *Complex Dynamics and Holomorfic Foliations* and *Dynamical Systems and Ergodic Theory*. Both groups are very active and altogether very visible in the world mathematical community.

Concerning the first field, much of the recent work has been focused on boarder problems between algebraic geometry and foliations. The perspective of research for the near future contain the following topics: classification of foliations which are transverse to curves, construction of foliations with a given invariant curve and a given group of linear holonomy, extension of Jouanolou's theorem to foliations by curves of projective varieties, classification of the so-called exceptional families of foliations , for which there is a countable , non-discrete set of parameters associated to first integrals and the study of nilpotent singularities whose desingularizations have dicritical components.

In Dynamical Systems and Ergodic Theory a far-reaching goal is to develop a mathematical theory of dynamical systems with chaotic behavior, as is the case for most interesting phenomena in Nature, describing the geometric and statistical properties of such systems, both quantitative and qualitatively. In this direction, it was recently shown that a whole class of chaotic attractors of dissipative systems are stable under external random noise. There has also been substantial progress in the study of generic systems, where one tries to reduce the global dynamics to elementary pieces. Systems with an infinite number of elementary pieces, especially, an infinite number of attractors, remain a major challenge for future research. The relations between complicated homoclinic and heteroclinic phenomena and robustness of the dynamics should be further explored, The role of fractal dimensions in this context was enhanced and further clarified by recent progress. Another very active area is low-dimensional dynamics, where we are now close to a very complete theory of systems with one degree of freedom, applying to full probability sets of initial states and of parameters.

Conservative systems, including Lagrangean and Hamiltonian systems originating from Physics, and the questions they raise in the realm of symplectic geometry, also obtained important advances. Progress has been particularly intense in the context of dynamical systems with properties of partial hyperbolicity.

Mathematical Models for Biologic Systems

The IM-AGIMB branch of bio-mathematics has been focused in the enhancement of ongoing research in some Brazilian Institutes through the promotion of cooperative links among local groups and their counterparts in Europe and the USA. Among the areas of major interest that started joint research tasks, the following can be highlighted: electron microscopy of macromolecules; kinetic models for chemotaxis and their drift-diffusion limits; dynamics of cardiovascular and respiratory systems. Other topics shall soon be focused. The training of new Ph.D.s are particularly challenging and being emphasized both in mathematical institute and in the laboratory of Respiration Physiology of the Federal University of Rio de Janeiro, which is a partner of IM-AGIMB. Several especial courses and school are being planned, an activity which is critical for the development of this field.

Topology

The main areas of topology treated in Brazil are foliation theory, locally free actions of groups, bounded cohomology, characteristic classes, bordism groups, singularity theory, fixed point theory, and other topics on the frontier between algebraic and differential topology. Such areas were present in the Brazilian Topology Meetings, the latest of which has been promoted by the IM-AGIMB. Next, one plans to support short research visits of topologists among Brazilian institutions, in order to improve even more the integration among the various centers and research groups. Even more shall also be devoted to the training of new Ph.D.s.

Optimization

The main role of the Millennium Institute related to the field of Optimization has been in bringing together the strong research groups existent in the country, such as in the IV Brazilian Workshop on Continuos Optimization, with the presence of many foreign participants, particularly from Latin America. The main areas of research are: infinite dimensional optimization, new regularity criteria, proximal methods for non-monotone problems and computational methods for non-smooth optimization; vector-valued optimization, prox-interior point methods and merit functions for semi-definite programming; spectral gradient methods, complementarity problems and proximal methods with separable distances; inexact restoration, Order Value Optimization and large optimization software, interior point methods and methods of filters for non-linear optimization; optimization in Riemannian manifolds; generalized equations and bi-level programming. Plans for the future include the addition of discrete optimization and topics numerical in analysis. Also, activities with groups dedicated to applications in energy, power systems, mechanical engineering and biomedical research.

Singularities

Singularity theory draws on ideas and techniques from algebraic and analytic geometry, algebraic and differential topology, and functional analysis. It is applied to problems in differential geometry, dynamical systems and the physical and life sciences. Current areas of research of the singularity group include the study of the geometry of finitely determined singularities in terms of their multiple point schemes, and the relationship between the invariants of these schemes and the topology of the maps and their generic deformations, as well as the study of the transition from geometrical questions to algebraic ones, based on Newton diagrams associated to the singularities. The potential applications of singularity theory in applied sciences is clear. At the present we are running joint seminars with ecologists, and supervising students projects in some areas of engineering. The group is responsible for a series of workshops on Real and Complex Singularities, which is the longest worldwide and a key international event in the area.

Algebraic Geometry - Commutative and Computational Algebra

The algebraic geometry group in Brazil has been growing significantly in the past two decades. Many high quality work has been produced in enumerative geometry, moduli of curves and especial points, linear systems on curves, holomorphic and algebraic foliations, algebraic theory of singularities and rational points of curves over finite fields. On the other hand, the commutative algebra community is yet rather small as it is in many other countries with the exception of the USA and Italy, but the perspectives for the near future are encouraging due to a growing interchange with international recognized groups and a close interaction with algebraic geometry as well as a focusing on central problems. A sample of research in the areas include work on differential simplicity of rings and Weyl algebras, D-modules and their structure, algebraic foliations and vector fields, tangent star structures and differentials, toric rings and their normality, structure of symbolic powers of ideals, cremona transformations (algebraic side), Galois theory of infinite field

extensions, Pfaff systems and Poicaré's problem, limits of ramification points of linear systems on curves, analytic classification of singularities of curves, Berstein Polynomials associated to curves, nets of quadrics, count of canonical curves in P^3, hypersurfaces with six double points, towers over finite fields, curves with many rational points over finite fields, maximal curves and rational points of Kummer covers over finite fields. Special attention is being given to the training of Ph.D.s and Post-Docs.

Operator Algebra

The questions we have been dealing with in the Operator Algebras group in Brazil are mostly related with the interplay between Dynamical Systems and Operator Algebras. While this interplay has been extensively explored by a large number of author in the area, little has been said about the case of Irreversible Dynamical Systems, the main reason being the lack of a suitable notion of covariant representation of such a system. Addressing this question we have been able to identify a different notion of covariant representation which has led to a very interesting theory which in turn has given many fruits. The advances so far achieved point to a wide area of research which we plan to develop in the coming years. Among the countless questions arising we plan to investigate more general irreversible dynamical systems, such as the Bernouli shift in two dimensions of Brownian motion.

Differential Geometry

The areas of research in which Differential Geometry in Brazil is traditionally strong, namely, geometry of submanifolds, constant mean curvature and minimal immersions, differential equations and submanifolds of constant continued their expansion through a series of high level articles published in main international journals. Additionally, Brazilian geometers started to consolidate positions in several new areas of research including some of the most important branches of differential geometry. For instance, the work on sub-Riemannian and semi-Riemannian geometry, vakonomics mechanics and general relativity, topology of manifolds and curvature, Lie transformation groups, flag manifolds, analysis and partial differential equations in Riemannian manifolds in connection with minimal/ constant mean curvature. These groups also produced a very significant number of high level articles during 2002, which were published in the best specialized journals. We can also mention expanding areas of research related to the interplay between Differential Geometry and Physics, Analysis and Partial Differential Equations on Riemannian manifolds, Topology and Lie group theory. Intensive international collaboration has been kept with outstanding foreign mathematicians. Many excellent students have obtained their doctoral degrees in Differential Geometry, either in Brazil or abroad, and are now taking up positions in our universities. One may therefore foresee significant development of the area in the following years.

Control Theory

There are two research groups in control theory in Brazil: the *uncertain dynamical systems control group* and the *geometric control group.* Both such groups has recently produced a host of new important ideas and techniques which has been published, or submitted for publication, in leading scientific journals. Besides strengthening the groups considerably this has opened up exciting prospects, such as invitation of Springer London for writing a book, plenary conferences and short period visits. For the near future, we shall plan a especial visitors program, going beyond the ones involved in ground breaking discoveries in this field. The main motivation comes from the fact that control theory has a significant role to play in almost every branch of science and engineering due, in part, to a highly interdisciplinary bent. Thus, we shall have the presence in Brazil of researchers in strategic topics such as complex network, which includes high speed communications, power network and wireless communication, manufacturing systems, speech recognition, robotics, image analysis and safety-critical and high-integrity systems. On the other hand, in order to further attract young people for the area, among them engineers, we shall consider the publication of a series of monographs.

Computer Graphics

The following are some of the current research projects. Multiresolution Models: Volume and Isosurface, Point Set Models, Surface Interpolation, Multiscale Distance Functions, Surface Parametrization, Medial Axis Tranforms, Morphological Modeling, Learning, Recognition and Synthesis, 4-K Mesh Construction. 3D Photography: Structured Light Coding, Visual and Photo Hull Methods, Façade, Match Move, Surface Triangulation, Object Movies, 3D Photography Hardware. Immersive Visualization: Stereographic Video, Motion Tracking, Storage of 2D Graphical Objects, Super-Resolution. Video and Multimedia: Presence, Talking, Structuring and Tracking, Smart Capture Station, MSRI Mirror. Applications: Medical Workstation, Assisted Interfaces. On the other hand, new infra structure are being set up in collaboration by different groups in order to enhance their research capability as well as the training of students, such as Interactive Stereoscopic Visualization Rooms and 3D Photography Labs.

Combinatorics

The work of Brazilian researchers in combinatorics is internationally recognized. The topics in which they have contributed include combinatorial optimization, graph

theory, extremal problems and Ramsey theory, probabilistic methods, and applications of combinatorics to molecular biology. Combinatorics has attained a high degree of sophistication and certainly it is very relevant the research in the area should be further estimulated. Furthermore, combinatorics provides the foundations for the design of fast algorithms, which enhances its importance. This research group continues to produce high level work that has been published in the best journals in the area. They are also very active in the organization of meetings which aim at both top level research as well as being attractive to young students. The collaboration with foreign mathematicians is strengthening considerably. The IM-AGIMB has been increasingly playing an important role in such developments.

Economy and Finances

The main research areas are the following. Incomplete markets: due to the asymmetry of the information among the economical agents, not all markets are present in a given economy; the modeling of such a phenomenon and its applications to several research areas has attracted the attention of top level researchers. The problem of characterizing the agent and the principal: one of the deepest works in economic theory is that of asymmetric information and the theory of contracts is that of asymmetric information and the theory of contracts derived from it – the mathematical characterization of optimal contracts is still an open question unless one assumes very strong hypothesis. Economic dynamics: the possibility of complex dynamics in economics has been increasingly considered, one of the possibilities being the possible explanation of randomness in the theory of finances as well as in macroeconomics. This research group has been producing a number of articles that were published in excellent journals and are being very appreciated by the international community. Interaction with foreigner scientists has been intense and the training of Ph.D. students although in small numbers has been of high quality.

Olympiads

Mathematical competitions have an enormous potential for arising the interest of young students, attracting new talent and contributing for the perception of the creative character of Mathematics. The highly successful Brazilian Mathematics Olympiads – BMO is structured in a way that school teachers participates directly in the training of the students and so they are encouraged to be more knowledgeable and interested in teaching. Thus, the BMO contributes in several ways to the improvement of the teaching of mathematics in the country and it is certainly a main instrument for the diffusion of mathematics at large and the search of young talents in the area. Indeed, many of the Olympiads best qualified student became interested in pursuing a scientific career and as a result, some of the best young research mathematicians in Brazil nowadays have been Olympiads' winners. Besides several training activities, including the Olympic Week for the winners, BMO promotes the publication and distribution at a national level of a very interesting journal called Eureka!. Presently, the Olympiads engage about a hundred thousand students from all regions of Brazil. As expected, the performance of our students in international Olympiads have been improving steadily and many of them are getting medals in such occasions, in particular at the International Mathematical Olympiads.

Education

In the scope of IM-AGIMB, the main activity concerns the training at distance of secondary school teachers aiming at improving knowledge and ability to solve mathematical questions. This is done from a focal point at IMPA in Rio de Janeiro and through video-conference it spreads to an increasing number of other centers, now totaling twelve from all regions of Brazil. It involves about one hundred school teachers in Rio and about fifty in each of the other centers. The key to its great success is the high quality of the instructors, which are also present at each of the centers, as well as its format consisting of lectures in the morning and becoming a unique lecture room involving all the twelve centers for discussions and problem solving. The project is done in paternship with the National Research Network – RNP, which is responsible for the transmission.

Latin American Cooperation

One of the main objectives of IM-AGIMB is to promote the collaboration of Brazilian mathematicians with centers and research groups in Latin America. It also promotes the visit of Brazilian mathematicians to teach courses at several levels in the neighboring countries and from that to organize the participation of the best ones in activities in Brazilian Institutions. A number of research visits by mathematicians from Uruguay, Argentina, Chile, Venezuela and Peru, where a focal point is the newly created Instituto de Matematica y Ciencias Afines – IMCA, has already taken place and other similar projects are in development. On the other hand, a Brazilian mathematician visited several cities in Bolivia for a total period of one month, which resulted after coordination with IMCA in a visit for a couple of months of twelve students from three neighboring countries to the Fluminense Federal University.

Emerging Centers

One of the key purpose of IM-AGIMB is to promote the upgrading of emerging mathematical centers in Brazil. At present they are: the Federal Universities of Amazônia, Pará,

Instituto do Milênio
Avanço Global e Integrado da Matemática Brasileira

Maranhão, Piauí, Alagoas, Paraíba – João Pessoa, Paraíba – Campina Grande, Bahia, Espírito Santo Goiás, e Paraná from several different regions in the country. Many of them have a master's degree program and the others are being encouraged to set it up. The Institute is providing such centers with some resources for visitors as well as for the participation of the researchers in mathematical meetings across the country. They are also provided with two scientific initiation fellowships per year and some resources for equipments and books. Above all, their members are becoming much more visible to the Brazilian community and thus, much more stimulated to pursue research and to upgrade their graduate programs. Their reaction to IM-AGIMB has been extraordinary positive.

In 2002, the IM-AGIMB promoted with the Institute for Pure and Applied Mathematics - IMPA many activities in all the areas that are part of the Millennium Institute such as: schools, workshops, conferences, short courses, research projects, including interdisciplinary ones. It is expected that in 2003 such activities will be enhanced and that the Institute will be at full speed in achieving its goals.

Institute Factory of The Millennium

João Fernando Gomes de Oliveira

The low performance of the production system in emerging countries, which has been highlighted by the globalization process, becomes strongly evident in manufacturing industries. They are, nowadays, classified according to their competitiveness. The industrial boom, currently happening in Brazil, affects the manufacturing industry, and also the needs coming from the agricultural equipment industries are putting the country in a critical position in respect to the industrial development. That particular segment, containing small and medium size industries, needs to be strongly competitive. The lack of scientific and technological knowledge has been frequently found, particularly in small and medium size industries. Therefore, there is a substantial need to establish an organization, with nationwide presence, which will be capable of develop research projects using an innovative and efficient management system creating the possibility of a speedy development of small and medium size Brazilian industries. Researches must address, in an integrated way, solution for technological problems at the frontier and the management optimization taylored to the regional realities in Brazil. The present project has, as a main objective, the formation of a cluster of integrated researches to support the development and competitiveness of the national industry. Bearing in mind that, its scope is related to the industry of metal manufactured goods, the researches must address the main subjects determining the competitiveness of manufacturing industries. Two important aspects of the project are: 1 - Integrate the activities in a nationwide sense, improving the quality of projects and better adjusting their goals to the needs coming from the small and medium size manufacturing industries; 2 - Enlarge the regional covering and the quantity of industries benefiting from the developed research projects.

Objectives of the Institute Factory of Millennium - IFM.

The main objective of the IFM is the formation of a cluster of integrated researches to support the development of the competitiveness of the national metal-mechanic industry. Bearing in mind that its covering is aimed at the manufacturing industry, the researches must address the subjects that determine currently the competitiveness of such enterprises. The general objectives of the IFM can be understood as a proposition, the development and the dissemination of the mechanisms to increase the competitiveness and the scientific and technological knowledge of the enterprises installed in Brazil. Such objectives may apparently look too broad and exaggerated. However, the set of institutions and projects involved creates a great possibility to develop a broad variety of researches (covering from development of basic industrial technology up to management elements), which can effectively contribute to the development of Brazilian industry, if integrated and organized. Therefore, the roles of the IFM coordination are managing the integration of all these projects and promoting the diffusion of the results. The mechanisms of diffusion range from mass diffusion, such as a

knowledge portal in manufacturing via Internet, up to the effective implementation of projects and tests in the affiliated enterprises.

In order to achieve the general objectives, others, more specifics, were defined, which point to the focus and covering of the project. They are:

1.Consolidate a network of research groups oriented to the four large areas considered primary to the development of applied technologies and basic researches, with emphasis on the consolidation of groups in regions less developed in the country, being included in an institution network. The basic areas must be covered by the groups in the project are those representing the limitation for the competitiveness of industries in Brazil, as mentioned above in the text. They are:

- Management of Cooperative networks and supply chain
- Management of Organizational transformation and Quality
- Innovation and Management of the Life Cycle of Products
- Manufacturing Processes and Industrial Automation

2. Development of research in manufacturing technology aiming at its application in small and medium size Brazilian industries, bearing in mind the needs presently recognized by the team. They include: advanced manufacturing processes such as Laser or High speed machining, Industrial metrology, reference models for product development and enterprise management, enterprise transformation methodologies and other important topics.

3. Disseminate in an efficient way the knowledge that makes possible the application of these technologies. This includes the web site www.ifm.org.br that already have the whole profile of the project and include the information link CIMM for enterprise assistance.

Importance of the Institutes of Millennium Model for the success of the IFM.

The elaboration of the IFM Project was done based on the principles of the Institutes of Millennium:

- Research in networks promoting integration in research groups.
- National coverage.
- Focus on Brazilian Problems.
- International relevance on research topics.
- Innovating managing system for the research activities.

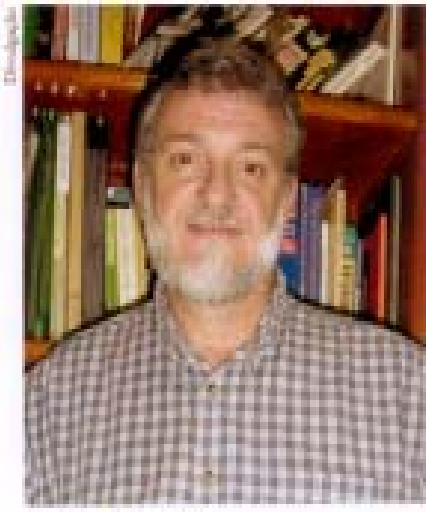
The concept of the project was highly influenced by these principles making it a powerful tool for the modernization of the national industry. After one year of work the group of IFM has now a Web based information system that receive around 150 thousands clicks per month. The impact of the IFM will be high in a country like Brazil where a consolidated research infrastructure is present but with low previous integration and small relationship with industry.

With the realization of the goals and objectives of the IFM we expect, as the main result, a consistent improvement in the relationship between Universities and Manufacturing Industries in Brazil. The increase in this relationship should result in the development of both. The Universities will start to have a more realistic view about the problems to be researched and the Enterprises will be able to receive the benefits of more applicable research and contract more qualified professionals, resulting in performance and competitiveness.

In addition to the presented aspects, the objectives of the IFM can be justified based on the need of success and competitiveness that the new manufacturing plants installed in Brazil have to perform. The research team selected for the IFM believes, after intense analysis, that the unemployment problem in Brazil can be reduced through the industrial improvement in the country. This way we expect the development and the grown of the national industry. For that, the companies installed here must have world competitiveness, since their life in the global economy will depend on the performance they can present. With the reduction of the import taxes and with the global tendency of free commerce this performance will be essential. For that a strong technological base in Manufacturing is needed.

The model proposed for the Institutes of Millennium Program was an important guide to elaborate the proposal of the IFM. Today we have a much higher integration within the 27 manufacturing research groups in Brazil and we feel that we have the power to effectively support the development of the Brazilian Industries. That happens due to the consistent and well-engineered Institute of Millennium program guidelines.

Mangroves: Structure, Function, Evolutive History, Sustainable Use and Relationships to Others Ecosystems



Horácio Schneider

This proposal will adopt a multidisciplinary approach in order to clarify important aspects of the structure, function and evolutionary history of mangroves and estuaries of the northeast coast of Brazil. Comparing to other parts of the Brazilian coast, mangroves from the north remain reasonably intact and conserved. However, since they represent an important contribution to the economy of the eastern Amazonian human populations that explore large amount of fisheries resources such as shrimp, crabs, mollusks and fish, as well as the illegal exploitation of vegetation for diverse uses, their survival is seriously threatened with the march of progress in the region. The approaches of this proposal may be summarized in three modules: (I) Population dynamics, systematic, evolution and biogeography of the fauna and flora that twill approach the basic questions to deal with population of fishes, crustaceans, mollusks and plants, using DNA sequencing and microsatellite analyses; (II) Reproductive biology and economic use, working with larviculture techniques of crustaceans (crabs and shrimps). This methodology will allow the use native species in commercial production (principally shrimp) as an alternative means of protecting natural stocks against excessive exploitation. The production of larvae and post-larvae of both species for restocking over-exploited areas or recuperating degraded areas will also be undertaken. New technologies on processing crab and shrimp meats will also be developed and transfer to the populations; (III) Biogeochemistry, botanic, historical biogeography and theoretical modeling, that will reconstruct the historical biogeography of the Amazonian mangroves during the Holocene to better understand their origin and function. Palynology, studying the associations of pollen and their changes in time, can allow the understanding of the successive modification of the vegetation cover through the effect of climate changes occurred in the region during the late Pleistocene period. The information generated by this multidisciplinary approach are relevant to the better understanding of the structural and functional processes of this ecosystem, and their application in the

use, management and conservation of natural resources will be widespread and evident.

The Millenium Institute -Coastal Studies Center, with headquarters in Bragança (state of Pará), consists of three modules:

1. Population dynamics, systematics, evolution and bio-geography of flora and fauna of mangue regions.
2. Reproductive biolgy and economic use.
3. Bio-geo-chemistry, botanics, historical bio-geography and theoretical modelling.

Since 1995, our group develops a joint project with Germany, called MADAM (Mangue Dynamics And Management). MADAM is centered in the Bragança region, in the north-east of the state of Pará. The Millenium project made it possible the immediate integration of a network of institutions and laboratories from the North of Brazil (states of Pará, Amazonas and Amapá), from the Northeast (states of Maranhão and Ceará) and from the South (Rio Grande do Sul), in an attempt to broaden multi-disciplinary studies on biodiversity of the estuarine and marine coastal areas in the North and Northeast of Brazil. The Millenium Institute was an important factor in the process of consolidation of the local research group within the Federal University of Pará. The High Council of this university is currently considering the creation of a Coast Studies Center in the Bragança campus, which would in fact mean the institutionalization of the Millenium project. On the other hand, the social dimension of the project can be easily understood by the fishermen living in mangue and estuary areas in the region, and by their families.

The Millenium Institute - Coastal Studies Center had also the remarkable effect of attracting researchers. Since it inception, four researchers were hired by the Federal University of Pará (one got his PhD in England, two in Spain and one in Japan). They are already fully integrated to the project. Also, the higher visibility attained by the group awakened the interest of several colleagues in other Latin-American countries, with the goal of extending the cooperation network. Close contacts are already in place with research groups in Venezuela, Costa Rica and Argentina. Additionally, the proposal by the Ministry of Science and Technology to hold a meeting with the Millenium project coordinators from Brazil, Chile, Venezuela and Mexico, will certainly expand the cooperation possibilities.

The strategic role of our project if self-evident, because the Northern region includes the most extended and still preserved mangue forests in the country. At the same time, since they make a significant contribution to the economy of the Eastern Amazonian region (the mange region produces a high level of fishing products: shrimp, crab, fish and other types of sea-food, besides the illegal wood extraction for different purposes), their survival is seriously threatened by the economic progress of the region.

Basic studies on the biology of flora and fauna of estuaries and

Life in the Mangrove

mangue areas will have a relevant contribution to the formulation of management models for these eco-systems, and to the implementation of proposals for the sustainable use of their resources.

For instance, larviculture of crustacea will make it possible the recovery of the natural stocks of shrimps and crabs. The understanding of the basic issues of population dynamics is extremely useful for establishing management policies and achieving the rational use of natural resources. The knowledge of the biological cycle of the native species will give rise to the planning of catching and prohibition seasons, facilitating the interactions with other productive sectors in the region. Better knowledge of systematics and taxonomy of the native species will provide support for conservation policies. Another important consequence of the consolidation of our Center in Bragança will be the strengthening of our B.S. Program in Coastal Biology and our M.Sc. program in Ecology of Coastal Eco-systems, existent since 1999, which are the only ones on these subjects in the whole Amazonian region. In only 3 years, we had 12 graduates from our M.Sc. Program, all of which wrote disssertations on subjects closely liked to the goals of MADAM and the Millenium project. The group is currently working on the creation of a PhD program on the same subjects.

Our Millenium project is focused on the Northern coast of Brazil, but its results will possibly be extended to other regions, since estuaries and mangue regions in the whole country have strong structural similarities.

Millenium Institute on Stellar and Galaxy Evolution in the Era of Large Telescopes: Implementation of Instrumentation for SOAR and GEMINI (MEGALIT)

Observational Astrophysics is a frontier science, due both to the scientific questions which extend the limits of the known Universe, and by the development of front-end instrumentation necessary to achieve the frequent discoveries. Brazil has recently joined two major enterprises, becoming partner of the Gemini Project in 1993 and of the SOAR in 1995. Dedication dates are Gemini-North: june/1999, Gemini-South: january/2002, SOAR: july/2002. The Gemini Project consists of two 8m telescopes, located in Hawaii and Chile, with a cost of US$180M. Brazil share is of 2.5%, in a consortium with USA (50%), UK (25%), Canada (15%), Australia (5%) and Argentina (2.5%). The SOAR project consists of a 4.3m telescope located in Chile. It is a consortium Brazil/ USA, with the shares of Brazil (33%), NOAO (33%), UNC (16.5%), and MSU (16.5%). The cost of the telescope is US$ 28M. The CNPq in both projects represents Brazil, but in the SOAR project there is a consortium between the CNPq and the State Foundations FAPESP, FAPERGS, FAPEMIG and FAPERJ, the major participants being the CNPq and FAPESP. The scientific team is composed 4 researchers with CNPq level 1A, 5 1B, 5 1C, 39 with 2A, 2B, 2C, and another 38, all these 91 PhDs with permanent jobs, besides 30 pos-docs and about 100 graduate students, involving 80% of the Brazilian astronomical community, and 18 institutions. The development of instrumentation which allows to reach limits of detection are needed, and new astrophysical problems arise with the new observations. The SOAR and Gemini projects offer the invaluable opportunity of interactions with partners that develop high technology instrumentation. Given the increasing complexity of instruments, the installation of competence in instrumentation has become important for the efficient use of the instruments in the quest for scientific answers.

Beatriz Leonor Silveira Barbuy

Objectives and Perspectives

The Institute includes 19 Institutions in which there are Astronomy Departments, or groups within Physics Departments. Over 80% of Brazilian astronomers are members of this Millenium Institute, which corresponds to 90 researchers, about 30 postdoctoral fellows, and a large number of graduate students.

The main objectives of the project are:

- the overall strengthening of Astronomy in the country, aiming to enhance the interaction between institutions, helping develop small groups, and reach the educational system at all levels
- the building of instrumentation for the Gemini and SOAR telescopes, of which Brazil is a partner; development of opto-mechanical projects, control and data acquisition, and software for data reduction
- improving observational and theoretical astrophysics

Regional Meetings were held involving all participants. The coordinator and sub-coordinator, together with Principal Investigators of the Instrumentation Projects were present in Official Meetings, involving local Rectors or Directors at the following Institutions (gathering participants from nearby institutions):

- Observatorio Nacional, Rio de Janeiro;
- Laboratorio Nacional de Astrofisica, and Escola de Engenharia Industrial, Itajuba, Minas Gerais;

- Universidade Federal do Rio Grande de Norte, Natal;
- Universidade Federal do Rio Grande do Sul, Porto Alegre;
- Universidade de Sao Paulo, S. Paulo.

In these meetings we were able to discuss local problems and facilities, and several young post-docs expressed their interest in being engaged in different aspects of the project. In this way we have been able to gather new talents.

Instrumentation Development:

Development of an opto-mechanical project consisting of a high-resolution spectrograph for the SOAR telescope. The optical design has been developed with the interaction of two highly experienced optical engineers: Bernard Delabre from the European Southern Observatory and Robert Tull from McDonald Observatory, University of Texas. The project has been presented to the SOAR Science Advisory Committee and the Board, with both Committees agreeing that we should pursue this project.

Development of an opto-mechanical project consisting of a high-resolution spectrograph for the Gemini South telescope. The optical design has been developed with the help of the optical engineer Damien Jones, from Australia. This project was originally designed to be inserted into the instrument already developed by University College London. However, given the difficulties with the configuration of this project by UCL, we are now proposing to build a parallel instrument, along the lines of the one for SOAR.

The infrared camera developed by Michigan State University (MSU) for the SOAR telescope. An important contribution is being provided by Brazil to this project through the participation of an optical engineer from Instituto Nacional de Pesquisas Espaciais (INPE) and interactions between our group and MSU, along with the contribution of two infrared detectors (completing the other two that MSU was able to obtain). One of these detectors is being paid for by this Millenium Institute. The other detector will be provided by Fapesp. In this way the instrument will provide images of the entire available field of view allowed by the optics of the telescope. Participation at the SPIE meeting in Hawaii. The most important event in instrumentation, the SPIE meetings had, for the first time, the participation of Brazilians involved in the Millenium Institute. The IFU spectrograph design, being developed with Fapesp funds, but also using Millenium Institute funds for the software development, was presented. Important interactions occurred between our participants and international industrial and scientific researchers.

Software A highly productive group is in charge of the development of data reduction software for the IFU spectrograph (construction of this instrument is being done with Fapesp funds). Interactions with the Gemini group in charge of similar software showed that our team is developing some of the best options for the acquisition of data from this complicated instrument. This facility will certainly be available to the Gemini staff as well. The software for the high-resolution optical spectrographs is also under study by part of this same group, in collaboration with a Ph.D. engineer from Escola Politecnica USP, who specializes in the organization of data reduction software.

Public Outreach:

One major activity to report here is from the group who has obtained funds from the Vitae Foundation in order to buy 5 robotic telescopes, which will allow virtual observations from schools.

A group at the Laboratorio Nacional de Astrofisica is in charge of contacts with the press in order to inform them of progress and scientific achievements by the Brazilian astronomical community.

For the Astronomy Olympics, held in Russia, our Millenium Institute paid the travel for two students, selected from 60.000 candidates in Brazil. One of them won the bronze medal. These were the only two participants from the Americas.

Meetings

A Science Meeting planned for June/2003 has been postponed to December/2003 (or later), due to the devaluation of our currency and the limited funds of the project - given that the expenses, in dollars, are consuming far more than projected at the beginning.

Instrumentation meetings are also planned.

A school held for graduate students at Observatorio Nacional in Rio in July/2002 was supported, in part, by contributions from the Millenium Institution for the Instrumentation courses. STRATEGIC PERSPECTIVE FOR BRAZILIAN (AND LATIN-AMERICAN) SCIENCE AND TECHNOLOGY:

This project offers 3 main strategic aspects:

Astrophysics and Technology:

Astrophysics is a frontier science, both due to its scientific questions, which extend to the limits of the known Universe, and to the development of front-end instrumentation, necessary to overcome the barriers inherent in observing the faintest and farthest objects in the Universe.

The development of instrumentation pushes the aquisition of data to the limits of detection, and new astrophysical problems appear from such new observations. In this respect, the Brazilian astronomical community has been behind the technological advances, due mainly to severe importation limits until the early nineties. The present Millenium Institute offers us the opportunity to overcome this deficiency by pursuing full collaborations in instrumentation projects within the consortia of the Gemini Observatory (two 8m telescopes operated with the USA, Canada, UK, Australia, Chile and Argentina), and SOAR (a 4.3m

telescope optimized for infrared observations, in consortia with National Astronomy Optical Observatories (NOAO-USA), Michigan State University and University of North Carolina). We are now involved in the design and construction of 2 spectrographs (one a collaboration on a Gemini spectrograph and one for SOAR), and an infrared imager for SOAR. This represents a very important step in our technological development, and involves the work of several astrophysicists and engineers.

Astrophysics and Education:

Astronomy and Astrophysics offers a natural appeal to the public of all ages, and in particular to children and adolescents. It is therefore an area of interest that allows us to project scientific techniques and knowledge to young students at all levels.

Science:

Astrophysics requires excellence, being different in this respect from areas such as the medicine, where routine work is always useful. In Astrophysics, science has to be carried out at the highest level, otherwise it is not at the world level, and has no widespread interest. One important point is that, in order to be at the highest level, both national and international interactions with colleagues have to occur. The Millenium Institute intends to make these interactions among Brazilian astronomers, in particular those in small Institutes, more intense. Also, interactions with Latin-American partners, in particular Argentina and Chile, are being conducted, as well as visits by Argentinians to Brazil (given the severe problems in that country), for short stays, are being supported by our project.

Integration of Genetic Breeding, Functional and Comparative Genome of Citrus

Marcos Antônio Machado

The citrus industry is a competing agricultural activity in Brazil with annual revenue accounting for US$ 1.5 billion. Brazil is the leading producer of citrus and the major exporter in the world. Besides its competitiveness, the Brazilian citrus industry shows low productivity, which is associated to several stress and horticultural problems, like as diseases, pests, nutritional disorders, and water stress. Citrus variegated chlorosis, citrus canker, tristeza, black spot, gummosis, and leprosis are the most prominent citrus diseases. Control of citrus diseases represents more than 60 % of the production costs. However, there is sufficient genetic variability within the citrus group that allows foreseeing solution for most challenges exclusively by taking advantage of these gene collections. Botanical and genetic difficulties associated to the citrus group determine that gains with traditional breeding programs are limited and take long time. Thus, this proposal presents the overall objective to integrate breeding and genetic mapping, and studies on the functional genome of citrus and their interactions with limiting biotic and nonbiotic factors. The project is organized with three complimentary parts, in which specific projects will be inserted: Genetic mapping to study the inheritance of biotic (diseases) and nonbiotic (nutrition and water stress) focusing on molecular markers that include ESTs and SNPs, and substantial field research. Functional and comparative genome between citrus species and stressing conditions with focus on the elaboration of ESTs data bank. Interactions between plant and pathogen studies focusing the functional genome of pathogens having full genome sequenced (Xylella and Xanthomonas), as well as the comparison of expressed genes in pathogenic and nonpathogenic fungi. The research group combines the following institutions: Centro de Citricultura Sylvio Moreira - IAC, UNESP/Jaboticabal, UNICAMP, UE de Maringá, Instituto Biológico, and scientists from the USDA and University of Florida.

Integration of functional and comparative genome of citrus and basic genetics

This is a strategic project for the citrus industry in Brazil. Citrus industry represents a very important economic activity in several regions of Brazil and this study has the objective to develop further the genetics of citrus in order to provide the industry with a solid basis for further technological development, and higher production.

Overview of the Project

This Project has several objectives to integrate genetic studies such as genetic mapping and genetic improvement with the studies on the functional genome of citrus and its interactions with abiotic factors, and diseases. It is structured in three complementary components: i) *genetic mapping* for studies of citrus diseases (citrus cancer, chlorosis, leprosis) **and** environmental stresses utilizing molecular markers and extensive field essays. ii) comparative and functional genome among species of citrus and in conditions of stress focusing on expresses sequence tags of three different species of oranges. iii) the third study is the interaction of

plants with patogens whose genomes were already sequenced (*Xylella fastidiosa* and *Xanhtomonas axonopods pv citri*). The project also will compare pathogenic and non pathogenic stages of fungi.

General objectives

Construction of genetic maps saturated of citrus with molecular markers based on DNA mutations the SNPs – single nucleotide polymorphism.

Extensive sequencing and comparison of chips of DNA (microarrays) of express genoma of citrus (ESTs) in conditions of biotic stress (limiting diseases) or abiotic (dryness and nutritional).

Evaluate the differential expressions of genes of limiting patogens of citrus.

Potential input of the project and strategic overview

A project for the improvement of the scientific and technological development applied to the productive chain of the Brazilian citrus agribusiness.

Evaluation and expansion of the availability of new varieties of citrus with impact on citrus export (orange juice or fruit production).

Generation of knowledge and simultaneous application of the genome of citrus.

Technical and scientific capacity building in areas of genomics and functional genomics

Maintenance of Brazilian leadership in areas of genomic research with a plant of world wide importance.

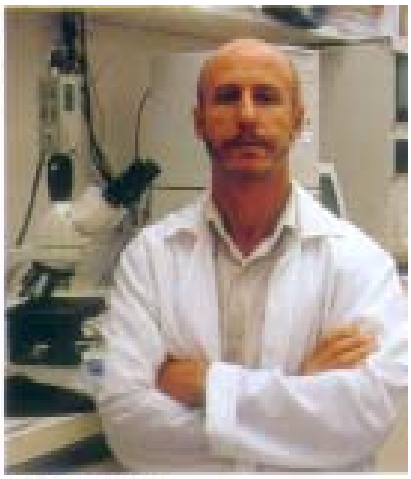
This project integrates science (classic genetic improvement, genomics, functional genomics, patogens genomics) with the needs of the Brazilian agribusiness on citrus

The project establishes a net work of experimental centers with the

real possibilities of production of new varieties of citrus resistant to diseases.

Improves the genetic basis and the knowledge of the molecular biology of citrus and its patogens.

Integrated Strategies for Research and Control of Tuberculosis in Brazil: New Drugs and Vaccines, Diagnostic Tests and Clinical-Operational Evaluation



Célio Lopes Silva

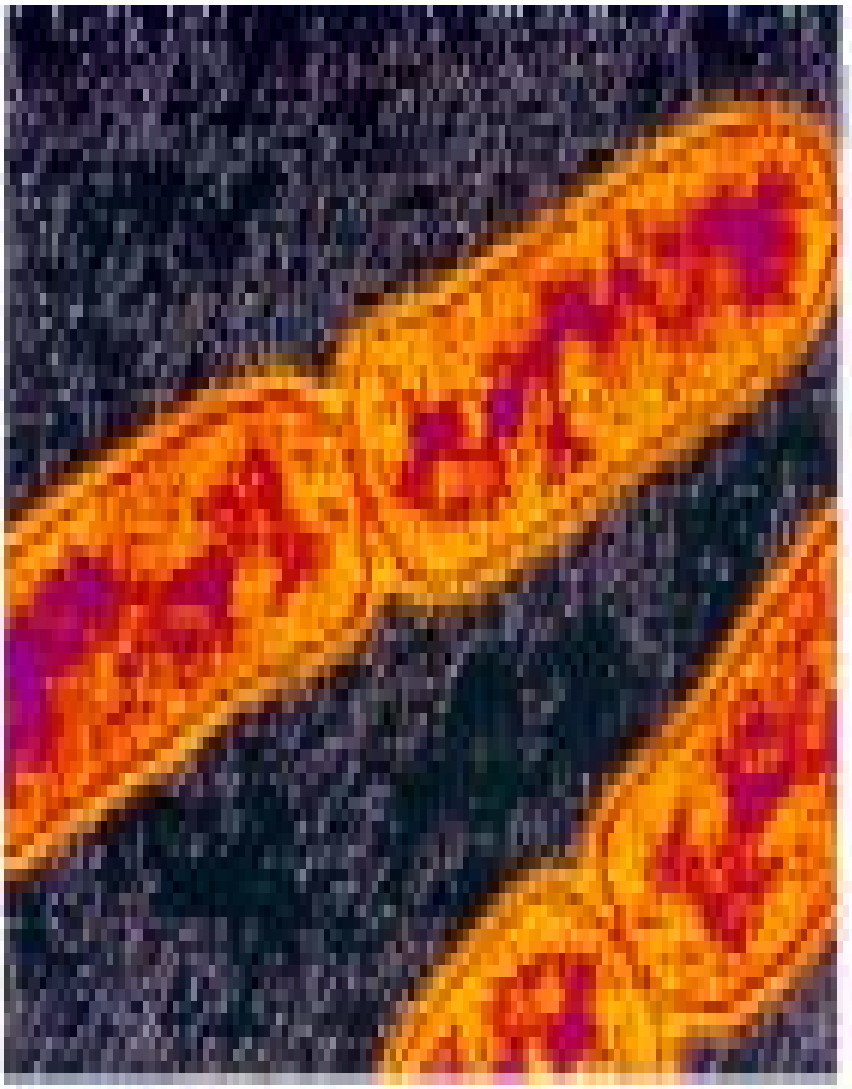
TB is a serious public health problem, demanding an innovative approach for its control. Our objective is to capacitate the country for the development of new technologies leading to the control and treatment of TB and to train high quality human resources through a multidisciplinary and multi-institutional network (REDE-TB). Our goals are: the development of new vaccines and drugs and to perform pre-clinical and clinical trials of these new products; the capacitation of sites for phase I-III clinical trials; to use of comparative and functional genomics for our proposes and in clinical-epidemiological studies; to search new therapeutic alternatives aiming the reduction of the period of treatment; to study the bioequivalence in different regions and populations with or without co-morbidities (HIV); to evaluate the biodisponibility of anti-TB drugs when used in association with medicinal herbs and anti-retroviral drugs; the development of accuracy studies for the diagnosis of paucibacillary or multi-drug resistant TB., development of epidemiologic studies based on molecular markers, to evaluate the cure/relapse and active forms of TB in monitoring sites; to perform clinical-laboratory validation and to study cost-effectiveness of new diagnostic kits; to perform clinical, epidemiological and laboratory studies, with the participation of the University in collaboration with the Family Health Program (PSF) and the community; to promote effective interaction between Public Health Network and Academy in different areas through transdisciplinarity and the capacitation of the groups in operational research, using the technique of Health Service Investigation (ISS). These activities will allow the development of new tools for TB control, the generation of new technologies and the capacitation of high quality human resources in the area of Science & Technology applied to TB and other infectious diseases.

Rede-TB

Brazilian science has greatly evolved in the past few years, thanks to the perception of the Ministry of Science and Technology (Ministério de Ciência e Tecnologia – MCT), which has made an extraordinary effort to stimulate basic research and its translation into technology, the single solution towards a new step in our nation's development. The Institutos do Milênio program - an initiative from MCT – aims to support the development of centers that represent state of the art knowledge in various fields of science and technology, acting in cooperation with government policies and raising Brazil's performance in these fields, a strategic move towards our social and economical progress. One of the projects approved by the Instituto do Milênio was the "REDE-TB", with the basic strategy of organizing a Brazilian Web of Research for the innovation and development of new products, as well as strategies for an effective control of tuberculosis in this country. The mission of REDE-TB is to establish innovations in the field of health, enabling the country to develop new strategies, technology and products for the control and treatment of infectious diseases and to organize human resources in this field, acting in collaboration, and through a multi-disciplinary and multi-institutional approach.

Several sectorial meetings were initially carried out, in order to prioritize projects and to create the website www.redetb.usp.br, allowing communication between the members of this web and the community. In September of 2002, the first RED-TB workshop took place in Rio de Janeiro, with 560 participants. In summary, the

projects of REDE-TB already underway are directed toward: a) development of new vaccines and new diagnostic tests, b) development of new antimycobacterial drugs, derived from products of the Brazilian biodiversity or combinatory chemistry, using specific molecular targets, c) establishment of a new biotechnological platform for the development of products, taking advantage of technical capability already available and research gaps, d) capacitation and implementation of pre-clinical and clinical (phase I, II, and III) studies for these products, d) utilization of comparative and functional genomics for the development of new products and for epidemiological and clinical analyses, e) optimization of the therapeutical schemes available, with a view to reduction in the toxicity and duration of treatment (rejuvenation of drugs and new formulations), f) studies on the bioequivalency of antimycobacterial drugs in different populations (including those infected with coexisting diseases, e.g. HIV), g) evaluation of the bioavailability interaction of anti-TB drugs, when administered in association with medicinal herbs and anti-retroviral drugs, h) development and analysis (accuracy, clinical and laboratorial validation, cost-effectiveness studies) of new diagnostic tests used for TB, especially in paucibacillar and multidrug resistant forms, i) identification of microbiological and immunological markers which may be used for the early evaluation of therapeutical response to anti-TB treatments, j) identification and implementation of clinical/operational research and monitoring of TB control using Investigation in Health Services (Investigação em Serviços de Saúde-ISS) techniques at Basic Units of Health (primary care centers) and in the Family Health Care Program (Programa de Saúde da Família), k) development of clinical/epidemiological studies based on molecular markers for *M. tuberculosis*, l) to foment the interaction among the Health Services web, Academic groups,



Government, and the Private Sectors, in the various areas of knowledge, and m) development of a communication and management system (administration, bioethics, regulations and intellectual property) for the REDE-TB web.

This program represents a new paradigm in research and development in the biotechnological field of Brazilian science, establishing new platforms for biotechnological development, as a sectorial component of the Brazilian innovations system, linking universities, government and private companies, working in collaboration to develop products for a better control of neglected diseases. The main goal of these platforms is to establish R&D flux for new products, defining partnerships and highlighting the necessary steps for launching a new product into the market. Within this outline, REDE-TB is able to view a temporal distribution of the activities, mainly through identification of the problems; definition of the product; steps in the R&D process; market and market share; definition of goals and partnerships; steps already taken and those underway; future projections; costs of each step or process; and research gaps which at the present moment make it difficult to reach the proposed goals. This approach has enabled integration of professionals from several areas of scientific knowledge, such as those working on the fields of basic, pre-clinical, clinical, technological, operational and business-related research.

REDE-TB has enabled partnerships with the organizations responsible for the implementation of public policies and with industries, training human resources in all specialization levels, besides stimulating the constitution of small businesses to incorporate the results from research. This web is also supported both by the Butantan Institute and by the Oswaldo Cruz Foundation, traditional organs of development, production and commercialization of vaccines. The pre-clinical studies, already underway, receive financial support from FAPESP through thematic projects. Close collaboration has been kept with the Pólo Avançado de Saúde (a regional foundation for improvement of the health services), with the Technological Park and with the Business Incubator, all under partnership with the Local Administration of Ribeirão Preto and the University of São Paulo. The Rede Brasileira de Nanobiotecnologia (Brazilian Nanotechnology Web), which was established as an initiative from the Ministry of Science and Technology, has also contributed for structuring and characterizing nanoparticle systems or drug and vaccine carriers. CAPES has recently approved a PROCADE (National Program of Academic Cooperation) project. Several projects involving international institutions have been discussed and prioritized for the conduction of the web's projects.

The financial return resulting from the consolidation of this platform will be enormous. Gaining control of new technology will automatically bring great advantages to the country, not only through expansion of knowledge in all levels covered by this project, but also in the fields of scientific production, human resources training, technological development of vaccines, and search for patents. Moreover, it will allow for the inclusion of Brazil's science and technology into a selected group of institutions capable of technological development in these fields.

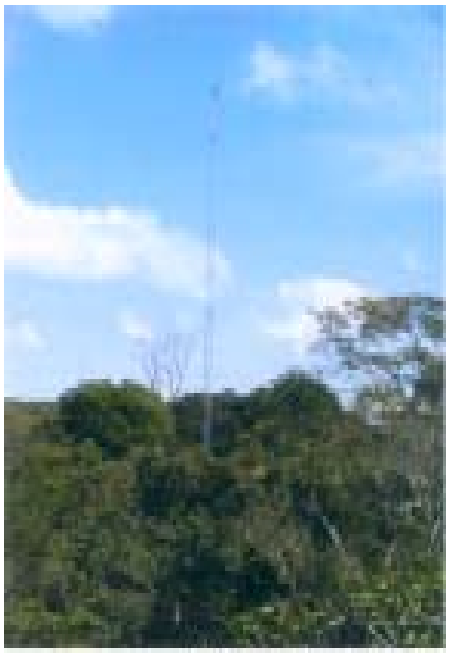
Land Use Changes in Amazon: Climatic and Carbon Cycling Implications MILLÊNNIUM LBA

Paulo Eduardo Artaxo Netto

English Abstract This proposal is part of the LBA Experiment: "The Large Scale Biosphere-Atmosphere Experiment in Amazon", that is being run since 1999 in Amazon. An extensive network of researchers is already in place at the LBA experiment, involving hundreds of scientists from the Amazon region as well as from the Southern Brazil and international collaborations. The proposal will study the climatic effects of land use and cover change in Amazonia, focusing on carbon cycling and biogeochemical cycles changes. We will work on deforested, primary forest and transition areas. Six areas were selected: 1) North of Mato Grosso state, 2) Rondonia, 3) South of Acre; 4) North of Manaus, 5) Pará state, and 6) Bananal island. On these regions we will study carbon cycling related to changes in land use and its climatic and biogeochemical forcing. The alterations in the cloud formation mechanisms and precipitation efficiency will be study in detail. We will operate carbon flux towers in flooded areas, were no information on carbon fluxes are available right now. We will also study the large-scale carbon fluxes using aircraft measurements coupled with mesoescale meteorological modeling. The strength of the research groups established in Amazonia is an essential part of this proposal. The large group of scientists from the University of Mato Grosso, Rondonia and Pará in addition to the researchers from EMBRAPA will benefit from courses, training and scientific exchange. The solid international cooperation with American European and Latin American groups in this proposal will help in innovative approaches on the project scientific thematic area, and will also help to increase human resources in Amazonia.

Millennium LBA

In some scientific fields, multi-disciplinarian teams are essential for achieving significiant scientific progress. In some cases, such teams need dozens, if not scores, of scientists working together on specific projects. The Large Scale Biosphere-Atmosphere Experiment in Amazonia is a clear example of such a situation, demanding the joint work of more than 500 physiscists, chemists, ecologists, biologists, meteorologists, climatologists, forest engineers, agricultural experts and many other researchers. Only with the coordinated multi-disciplinary effort of such a tem it ecomes possible to attain relevant



LBA Tower - Santarém, PA

progress in the understanding of the complex interactions present in the Amazonian eco-system. Interdisciplinary work increases the efficiency of scientific research, decreases the time span necessary for attaining explict and specific goals, and improves the alocation of financial resources, which is a key item in countries like Brazil.

Regarding the general impact of the Milênio LBA network, it is defintely very strong in dozens of research institutions in the Amazonian region, and elsewhere. The team work with joint goals of around 125 researchers is much more effective than 100 individual research projects. Information exchange among researchers is much more intense.

Frequently, researchers in universities are unaware that experiments similar to theirs are being implemented in the lab next door, because information exchanges between researchers involved in individual projects are usually inefficient. Such exchange takes place through publications (after 1 or 2 years) or meeting presentations. One of the most important strategical values of intedisciplinary work lies in the more efficient circulation of scientific information. Other strategical value lies in the higher easiness to solve implementation problems. The chance that one among 125 researchers do MilênioLBA might have the solution for an unexpcted particular problem of another member of the team is certainly large. The MilênioLBA has general meetings twice a year, besides frequent e-mail contact. We also share equipments in several laboratories, with the resultant increase in efficiency.

Among several significant impacts, we mention the technology transfers from more developed groups to less developed ones. Several researchers in the same area have actual exchanges, with visits, internships and joint data analysis. Another significant impact is the practical realization of interdisciplinary cooperation efforts which would hardly take place in the absence of the MilênioLBA. The complementarity of the several research areas of the project, already present in the configuration of our structure, is also important, because it makes the technology transfer easier, as well as the achievement of the project goals, and the broadening of the research horizons of all the project members.

Institute of Quantum Information

This project involves activities in the area of Quantum Information, a new subject that studies methods to characterize, transmit, store, compress and utilize, computationally, the information contained in quantum states. It is a broad and multidisciplinary theme, with an accelerated development in the last years motivated by its fundamental interest and by the exciting prospects for its application in quantum computation, telecommunications and cryptography. Despite being a recent research area, it has received relevant contributions from researchers in Brazil, who up to now have worked in an independent and non-coordinated way. Also, the country has laboratories already established or under construction which are directly related to this theme, or which could work in this area under adequate planning. The following problems will be investigated: characterization of the mathematical properties of entanglement between two or more subsystems; search for new practical applications for entanglement in physics and computation, including quantum computation and high precision metrology; investigation of physics scenarios for the generation and experimental manipulation of entanglement; proposals of new experiments in cavity quantum electrodynamics and atom and ion traps for producing non classical states; strategies for reducing the effects of decoherence, the main obstacle to the realization of quantum computers; models which enlighten the role of decoherence in the classical limit of quantum mechanics, with emphasis on classically chaotic systems; Bose-Einstein condensation; experiments involving the production of entangled states of photons and their characterization, with emphasis on transverse correlations of twin-photons and cryptographic applications; experiments with atom traps, involving the production and analysis of quantum coherence in the atoms; experiments with ion beams and traps, nuclear magnetic resonance, and quantum dots.

Objective

The Millenium Institute for Quantum Information aims to stimulate and support research activities in the area of Quantum Information. This new discipline envisages the investigation of methods to characterize, transmit, store, compress, and computationally utilize the information carried by quantum states. This is a wide and interdisciplinary area that had an accentuated development over the last few years, owing both to its fundamental nature as well as to its potential application in quantum computation, telecommunications, and cryptography. Though relatively new, this field enjoys in Brazil a wide interest among several scientists. These researchers, although working either individually or in clusters of small groups, have already presented significant contributions to the field. The major aim of our Institute is to coordinate the Brazilian effort in this important area of physics research, with special attention to updating the experimental resources of the participating laboratories, to the organization of workshops and schools, and to the training of students. The Institute has as its central part several experimental facilities scattered over several states in the Brazilian Union.

The principal investigators of this project are experienced professionals with diversified backgrounds, thus providing to this endeavor a strong multidisciplinary flavor. Because of this, the activities in this area are extremely appropriate for the scientific training of students, in view of the large number of concepts and techniques involved, ranging from fundamentals of quantum mechanics, to statistical mechanics, classical and quantum optics, condensed matter, atomic physics, dynamical systems, and computer science.

Participating Institutions

The Institute involves several institutions. Members of the Institute work at the Federal University of Rio de Janeiro (at both the Physics Institute and the Computer Science group of the Engineering Graduate School), at the Brazilian Center for Physical Research (CBPF), at the National Laboratory of Synchrotron Light, and at the Physics Departments of UNICAMP, Fluminense Federal University, São Paulo University at São Paulo and São Carlos, Federal University of Minas Gerais, Federal University of Alagoas, and Federal University of Pernambuco. Theoretical and experimental groups are involved: overall, ten laboratories in several

regions of the country participate in the project.

Strategic Perspective

In spite of the rather short time since the new upsurge of theoretical activities started (~1990), leading to the appearance of this new discipline – quantum information – several major experimental findings have already been established, demonstrating quantum cryptography, teleportation of quantum information and quantum computation.

These applications of the basic notions of quantum physics, if successful, could have a far-reaching technological and social impact. Attesting to this is the major investment in research supplied both at the government as well as the private sector levels in the USA and Europe. Major computer companies such as IBM, Microsoft and Hewlett Packard, in the US, maintain active research groups working on quantum information. In Europe, a Quantum Information Network was established in Brussels, which includes several important laboratories, such as the one at the Ecole Normale Supérieure in Paris, with which several participants in the present proposal have maintained a close collaboration over several years. These initiatives recognize the peculiarities of this field, with interests and characteristics that differentiate it markedly from research in the field of nanotechnology. Because of this, national programs in this last domain are conducted independently from those in quantum information. The very fact that this is a new field with still incipient activities in technological innovation implies that it should be considered as an important niche to be occupied by countries like Brazil.

Several researchers from other countries in Latin America participate in our list of collaborators: this is an area of research that is also attracting strong interest in Argentina, Chile, Uruguay, Peru, and Mexico. In view of its strong multidisciplinary character, it should be helpful to

aggregate efforts in several areas of science, ranging from very basic problems in quantum physics to the development of algorithms in computer science and to new challenges in nanoscience. We expect to have a strong contingent of scientists and students from other countries in Latin America in the schools and workshops to be organized by our Institute in 2003.

Budget

From its original proposed budget of about R$ 9,500,000.00, the Institute received R$ 5,600,000.00 for a period of three years. In view of the severe needs of the laboratories involved in the project, we decided to concentrate these resources in the first two years. About 75% of this amount has been used for importing equipment for the labs. The remaining resources have been spent in scientific meetings of members of the Institute, participation in Conferences, computing equipment, and also administration (less than 5%).

Main Activities in 2002

The Institute has stimulated and financed meetings between participants, in order to develop joint research. Two kinds of meetings have been held: small meetings involving a few researchers for collaboration on a research project, and a general meeting.

New collaborations have been developed among theoreticians from several institutions, and also among experimental groups. This last one is especially important, in view of the difficulties for getting advanced equipment. In particular, a network centered on the generation and properties of twin-photon beams (relevant for studies of quantum information and communication) is very active, involving physicists from the Federal University of Rio de Janeiro, the University of São Paulo, the Fluminense Federal

University, and the Federal University of Minas Gerais. This collaboration has been very important for the development of the incipient quantum optics laboratory of the Fluminense Federal University.

The general meeting of the Millennium Institute for Quantum Information was held in Belo Horizonte, Minas Gerais, from July 28 to July 30 of this year. The meeting had a total of twenty talks, from participating scientists coming from all the institutions involved in the project, and also from invited physicists who do not participate in the Institute, but collaborate with Institute members. The talks involved subjects like

decoherence, quantum chaos, quantum dots, trapped ions, cavity quantum electrodynamics, twin photon beams, and quantum computation. A poster section was organized, so that people not giving talks could display and discuss their work. The meeting was extremely productive, and should be repeated next year.

For the year 2003, the Institute will also be involved in the organization of a Pan American Advanced Studies Institute (PASI) on the Physics of Information. The PASI program was idealized by the National Science Foundation from the United States of America. Its objective is the organization of high-level schools, with the duration of at least two weeks, and attended by 25 students from USA and 25 from Latin America. The students are supposed to be advanced Ph. D. students or young pos-docs. Half of the teachers should also come from the United States of America, and the other half from Latin America. The National Science Foundation has already approved US$ 97,774 for our project. We plan to profit from the presence of leading scientists in this area to organize a workshop, parallel to the School. This workshop will be partially financed with resources from the Institute.

As for the participating laboratories, the year of 2002 was devoted not only to the continuation of the ongoing research, but also to the planning of the updating of the equipment, adapting it to the approved budget. Unfortunately, the whole process of importation in Brazil is very lengthy: it takes six months or more to import equipment.

Thus, the full benefits of this new support for research in the area of quantum information in Brazil will start to be realized only next year, when the new equipments become operative.

Difficulties and Suggestions

We expect that the Millennium Institute for Quantum Information will have a strong impact on research and student training in this area, in Brazil. Our Institute has met however some difficulties that may contribute to reduce its impact. We believe that it is possible to solve or at least minimize these problems, in the near future, with the help of officials from the World Bank and the Brazilian Government. The first problem was of course the drastic budget cut, dictated by the fact that it was impossible to contemplate, with the resources then available, the total amount demanded by the ensemble of approved Institutes of the Millennia. A supplementation of these resources would allow us to extend our activities to a third year, and better equip laboratories that may have a strong impact on international science, local technological development, and student training. Since about 75% of our budget involves imports, the budget cut was seriously exacerbated by the increase in the exchange rate of the dollar. As a matter of fact, it is difficult to understand why this exchange rate should affect the imports, since the money for them was allocated by the World Bank in the beginning of 2002, and is available in dollars in the United States of America. Therefore, it seems that this problem could be solved by having the involved officials accept that the imports will be those defined when the project was initiated, being therefore independent of the fluctuations in the exchange rate along the year.

Finally, one should mention the extenuating and time-consuming bidding process: frequently, it is impossible to get three independent proposals for small equipments, since the vendors are just not interested in spending time with this kind of process. This problem has become very serious in cases of equipment being built in the labs, and requiring a huge number of small parts. It would be important to render this process more flexible, which should be the case if our researchers were allowed to exert their judgment about the equipment better suited to their needs.

Millennium Institute of Complex Materials

The mission of the Millennium Institute of Complex Materials is the creation, improvement, study and application of functional materials formed by specially designed structures, from the molecular to the macroscopic size scale. The constituents of these structures belong to many different chemical classes, specially natural and synthetic polymers, crystalline and amorphous phosphates, iron or ruthenium and other coordination compounds, rare-earths, silica, silicate glasses and zeolites. They can be self-organized into

Fernando Galembeck

supramolecular or nanoparticle arrays, endowed with special optical, electrical, mechanical, adhesion and permeation properties, suitable for a large number of scientific or technological applications. The Institute is a research network led by eleven senior researchers (which have already authored more than 900 papers in refereed and indexed journals) from four leading Chemistry departments, associated to 35 younger Ph.D.s from various departments, 60 students and 03 researchers from industrial laboratories. The network covers 14 Brazilian cities, with a large number of international connections. Every participant will have access to large equipment through protocols for performing the experiments followed by the immediate transmission of results, or even in real time, thus allowing a strong interaction between the equipment operator and the remote user. Consequently, many researchers will be using current techniques practiced by experienced practitioners and benefiting from their support for the interpretation of the results.

A Brief History

The Millenium Institute of Complex Materials is formed by a number of research groups, directed by eleven senior researchers from four Brazilian research universities in different areas relevant to materials chemistry and materials research.

Mission, objectives, strategies.

The stated objectives of this Millennium Institute are: a) to establish the necessary conditions for inter-, and multi-disciplinary research; b) to promote the training of high level and qualified scientists; c) to achieve economically significant innovation through joint work and technology transfer to industrial or service companies; and d) to contribute to public knowledge, within the general idea of improving the understanding and application of the Complexity in Chemistry. The attainment of these objectives will enable applications related to Chemistry of Materials such as sensors, integrated chemical systems, heterogeneous catalysis, nanomaterials, nanoparticles and nanocomposites, development of modern methods of chemical analysis, chemical modeling, molecular recognition, gas-phase molecular interactions, new preparative and fabrication methods and analytical tools.

Achievements.

One year after the first funds were received, it is clear that the quantitative targets related to scientific paper and patent output are being easily met and exceeded, and the completion of graduate student theses is also meeting the proposed goal.

Most important is the impact of this new organization on the quality and significance of the scientific results of all participating groups, the emphasis in innovative activities through cooperative projects with industrial companies and the synergisms achieved, which are better described in the following examples. These will be classified in three groups: cooperation within the Institute, cooperation with companies and cooperation with other research groups.

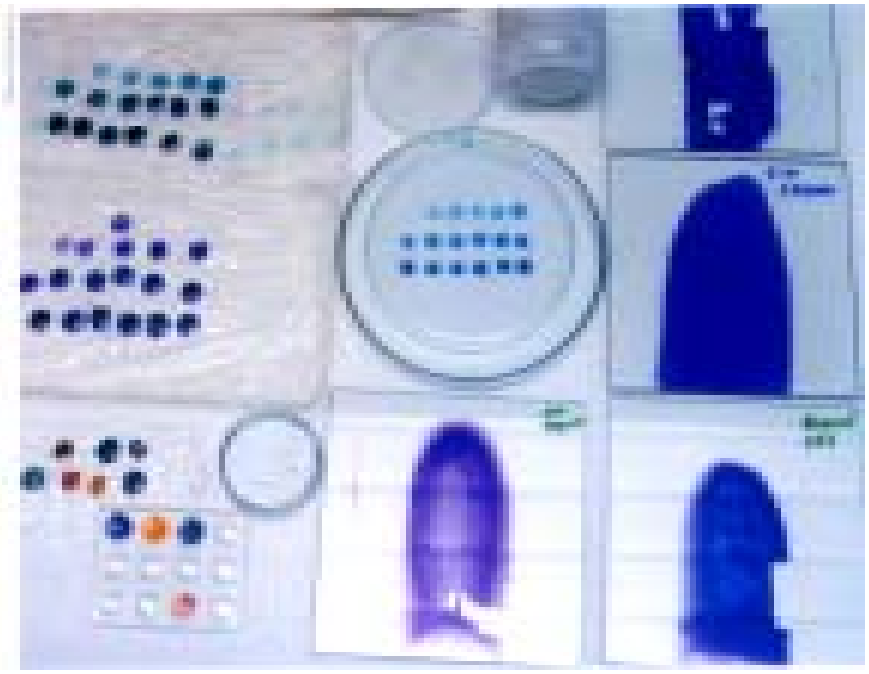
Cooperation and synergism within the Institute.

This aimed at solving some current organizational problems in Brazilian R&D&I, associated to its present historical moment. Brazilian scientific activity grew within a competitive environment (*e.g.* during PADCT I and II) that was the result of adequate policies for the environment of that (1980-1990) period. This competition led to the formation of many groups showing a high quality and productivity, but working on very specific topics. The current situation in Brazil is changed: there is now a fast-growing number of researchers, which can thus consider broad and

ambitious innovation targets, but this requires some changes in the researchers' behavior. The main required change is a greater availability for cooperation.

This is being exercised and reached in this Institute, as evidenced by the following examples:

i) The supramolecular chemistry group in the University of São Paulo is solving a long-standing problem in confirming the chemical structures of large coordination clusters (porphyrin, ftalocyanin and poly-immine complexes) designed for various functions in molecular electronics. This difficulty is now being overcome thanks to the use of contemporary mass spectroscopy techniques, which is being done in cooperation with the group directed by Marcos Eberlin, in Campinas. Henrique Toma defines these results as "surprising", and this is motivating further joint activities of members of the two groups. ii) The group directed by Gilberto Sá in Recife has some local access to electron microscopy facilities, but this is limited in many respects. Ph.D. students from Recife are using using the facilities in Campinas, which offer usual electron microscopy techniques added to micro-analytical techniques, as well as a range of scanning probe techniques. iii) The automation and instrumentation group in Analytical Chemistry at Unicamp, directed by Celio Pasquini, is planning with the Unicamp genomic group new work aiming at the development of quantum-dot sensors capable to detect specific genetic materials, specially designed for food monitoring. iii) The materials synthetic facilities at Unicamp at the Solid-State Chemistry Lab (LQES) are been shared to make solid thin films, mesoporous solids, glasses and nanoparticles within the interests of other groups. The expertise of this laboratory has already contributed to the preparation of nanocomposites and integrated chemical systems, as in the case of the controlled immobilization of mesoionic compounds with high non-linear refractive index (synthesized in the Recife laboratories) into porous glass.



Increased cooperation with industry

One of the objectives of this Institute is to create new products and processes contributing to an increase in the industrial output of products of increased unit value. Five patents were deposited in the first year, and one of them is now the basis for two joint projects with local chemical companies, which are now being submitted to Fapesp. Another project, on hybrid nanocomposites, is also based in a recent patent, and it is the basis for an ongoing project (now completing its second year) with one of the larger PET producers in the world.

Researchers of the Millennium Institute are also participating from joint projects with companies in the areas of paints, coatings, adhesives, high-refractive index glasses, carbon fibers composites and UV-light environmental monitors. Know-how for the production of a near-infrared spectrophotometer based on the advanced acoustic-optic tunable filter technology is being transferred to a Brazilian industry of analytical instruments, and it should lead to a new type of instrument within a class having a very high demand.

Several members of Millennium Institute are advising or consulting for a number of small, medium and large companies. An important case is the cooperation with the growing Brazilian pharmaceutical industry to solve problems related to the physico-chemical characterization of solid raw-materials, as well as the solid state transformations caused by grinding during the fabrication of tablets and powders.

Increased cooperation with other groups

This is also being actively done and a few examples are given ahead. i) The Physics Department of the Federal University of Ceará (which is not one of the four universities on which this Millennium Institute is based) acquired a new scanning probe microscope, and it asked for help in putting this instrument to work. An assistant professor from this department spent five weeks in Campinas, doing hands-on learning on microscope operation and sample preparation, which is now helping his own Department to take full benefit from their instrument. ii) A Ph.D. student from the Campinas group spent ten days in UFRJ (Rio de Janeiro), to get one of their scanning probe units started. This unit was out of action since its acquisition, a few years ago, resisting the efforts of the local as well as the supplier (an American company)

crews. In a similar case, analogous work is now planned in the Biology Department at the University of Brasilia (UnB). iii) Work function measurements are being done using the scanning electric probe microscopy technique, in ion-implanted copper samples developed for plasma torch electrodes by a group in the Institute of Physics, in USP. iv) The transmission electron microscopy and microanalysis facilities have been used by many other groups not formally associated to the Millennium Institute, and using the expertise accumulated in this Institute. Most samples examined are nanoparticle catalysts and carbon nanotubes, originated from different groups. The plasmon imaging techniques developed here are proving especially useful, with these samples.

Infra-structure improvement

A first set of state-of-the art equipment has been bought and is now being received (or already installed) in all the participating universities, as follows: i) The Chemistry Institute of USP has just received its first scanning probe microscope, which was a request of the supramolecular chemistry group from this Institute. ii) Most of the instrumentation needed for assembling a spectrometer to study ionic desorption stimulated by electron impact has been received. We expect the spectrometer to be operative around March 2003, at the Federal University of Rio de Janeiro. An electron gun, which also a component of that spectrometer, is in Campinas waiting for the fiscal authorities' authorization to be sent to Rio de Janeiro. iii) A Maldi-TOF mass spectrometer in being installed in Campinas. This instrument is especially important, because it will place all the work on polymers and particles in a new standard, in Brazil. To put it short: any R&D in polymer and particles depends critically on an accurate, statistically significant and detailed evaluation of macromolecule and particle weights, often from very small samples. Mass spectrometry is a new and the most powerful way to do this, with a great advantage over any competing techniques.

Traveling support

Significant funds were used for traveling, allowing participating researchers to attend important conferences, which is an absolute need for researchers. This was especially valuable in the current year, when travel funds were scarce in Brazilian agencies.

A few negative points.

The economic turbulence in Brazil took its toll in every program of the Ministry of Science and Technology, and at the same time researchers in São Paulo state felt, for the first time in 50 years, problems in fund disbursement and in the importation of research equipment and consumables by Fapesp. The devaluation of the Real is now a major problem for the Millennium Institutes, and its consequences are still unclear to all the participating researchers.

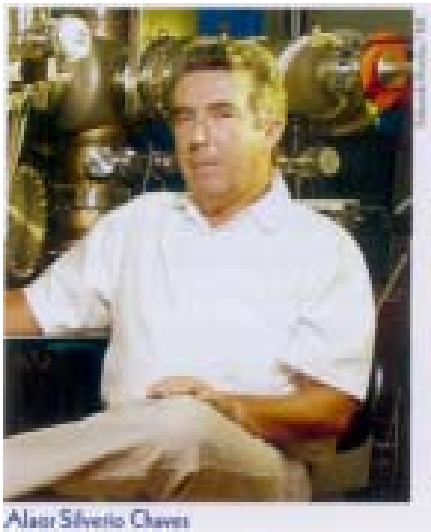
The Ministry of Science and Technology has been making a remarkable effort to publicize science, technology and innovation, and it is achieving a great change in the public views on these topics and especially on the entrepreneurs' interest in innovative products and processes of any kind. Unfortunately, this effort is sometimes hindered by the low quality of Brazilian scientific media personnel. This can be seen in a beautiful folder issued by MCT, were the lemma of this project ("A Força da Transformação", or "The Power to Transform") was unduly altered to "A Forçada Transformação", or "The Enforced Transformation".

Conclusion

The objectives of this Millennium Institute are being reached and often exceeded. It is bringing large organizational and behavioral changes, which would not have taken place in its absence.

Institute of Nanosciences

The development of atomic-resolution microscopy and nano-fabrication techniques over the last 20 years, together with the current prediction that microelectronics is approaching its miniaturization limits, have led to an increasing interest in nanoscience and nanotechnology. Our proposal to create the Institute for Nanosciences is to congregate part of the Brazilian researchers working on nanosciences in an interdisciplinary network. In this way, the scarce financial resources can be used more efficiently, benefiting a larger number of researchers. The Institute is formed by 65 researchers working on the following topics in nanosciences: (i) carbon nanotubes and related systems; (ii) nanostructured magnetic systems; (iii) biological and organic/inorganic nanosystems; (iv) semiconductor, superconductor, and metallic nanostructures. Most of the researchers in the Institute have a large expertise in the characterization, modeling and fabrication of nanostructured materials. The researchers are distributed among 16 Institutions and Research Centers from different States in the Country. Some of those Institutions are already highly qualified research centers, with a well-established infrastructure. The main objectives of the Institute are: (i) to foster the interaction between researchers (ii) to foster the development of emerging research centers in nanoscience; (iii) to investigate physical and chemical properties and to develop new types of nanostructured materials; and (iv) to promote the formation and the absorption of highly qualified young researchers. The funds will be used to improve scientific exchanges, maintenance of existing laboratories and equipment, fellowships, and to purchase shared facilities. A Steering Committee will be responsible for the allocation of funds, for the assessment of progress reports, and for organizing internal meetings in which the participants will be able to exchange ideas.


Alair Silverio Chaves

Brief description

The Institute congregates 65 scientists, plus students and technicians, from 14 Brazilian institutions. Its research focuses on four areas, namely: Carbon nanotubos and correlated systems

Nanostructured magnetic systems; Biological and organic/ inorganic nanosystems; Semiconductor, superconductor and metallic nanostructures

About two thirds of the institute members are experimental scientists, mostly physicists, and the remaining are theoretical physicists. The laboratory infrastructure is worth about ten million dollars and includes facilities for Production of semiconductor heterostructures by Molecular Beam Epitaxy (MBE); Production of carbon nanotubos and synthesis of other advanced materials ; Nanoscopy: Atomic Force Microscope (AFM) and Scanning Electron Microscope (SEM); Micro- and Nanofabrication: optical and electron beam lithography; Magnetometry down to 1,5 kelvin and magnetic fields up to 10 tesla

Magneto transport down to 20 milikelvin and magnetic fields up to 17 tesla; Micro-Raman with CCD high sensibility detection; Photoluminescence with CCD high sensibility detection; Infrared spectroscopy; Electron paramagnetic resonance; Photoconductivity, and others.

The Institute members share all the main facilities.

Most Institute members maintain strong collaborations with external scientists in Brazil and abroad, and significant part of their scientific production comes from collaborations with institutions in Europe, Europe, Japan and other countries of Latin America.

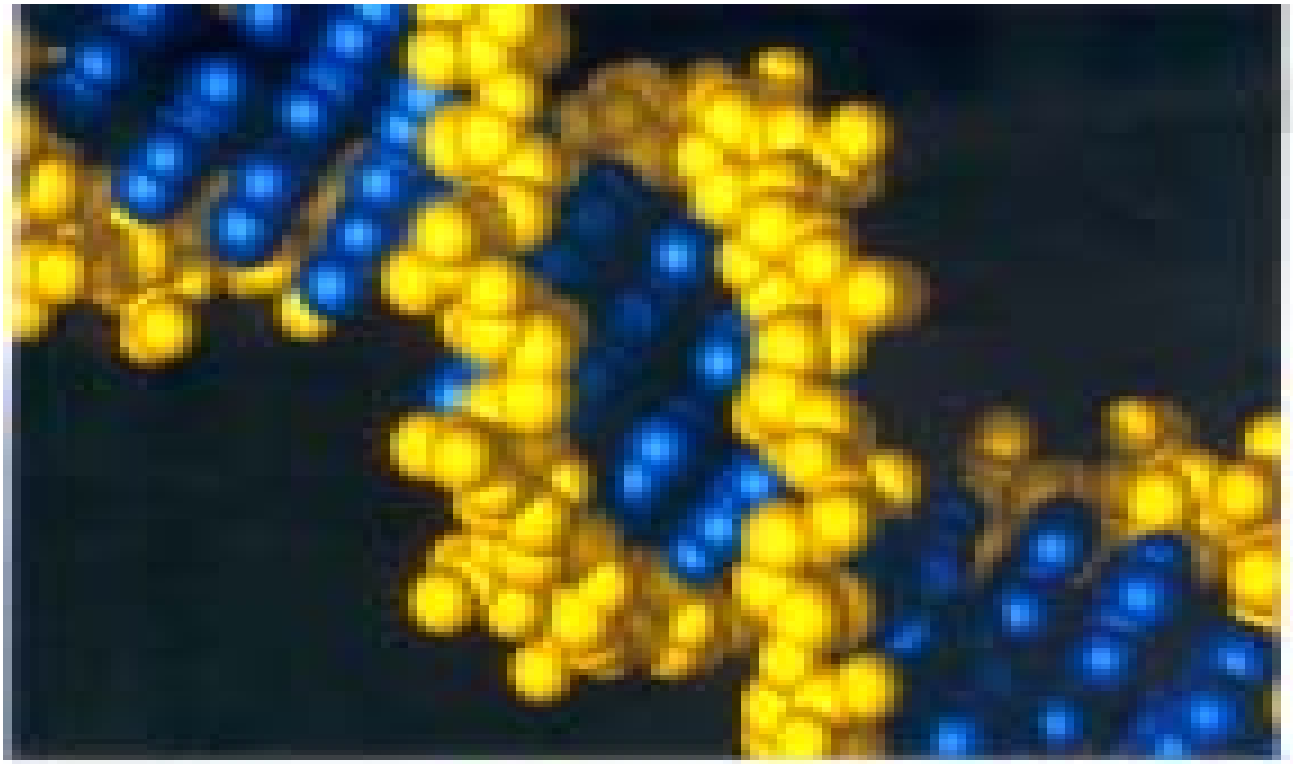
The institute goals include extension of its present activities, mainly concentrated in nanosciences, such that in a few years considerable part of the efforts will be dedicated to nanotechnology. The extension of this shift will critically depend on funding for expansion of the laboratory facilities. Collaboration with the local industries is also considered an essential motivation for the activities in nanotechnology.

Main results obtained in 2002

With the present activity mostly focused in science, the main outcomes of the Institute activities are training of graduate students and research results reported in technical publications. In the year of 2002, the Institute members published about 80 articles in journals indexed in ISI. Some selected articles are listed below

An adiabatic pump of spin polarized current, E. R. MUCCIOLO, C. CHAMON E C. M. MARCUS, *Physical Review Letters* **89**, 146802 (2002).

Exchange in Silicon-Based Quantum Computer Architecture B.



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Water: A Mineral Approach

Brief description

The project proposes an original approach, distinct from the one usually adopted national and internationally for water management in mining activities. Such operations will be changed from consumers to suppliers of quality water, integrating all the mining processes and the environment. The project will form competencies in the area of management of water resources in mining, which is lacking in the country. Also, it will consolidate, through a national net of competencies interacting with international groups, the excellence in the mineral area, that is strategic and of competitive advantage to the country, here addressing the challenges of the shortage of water in Brazil and in the world.

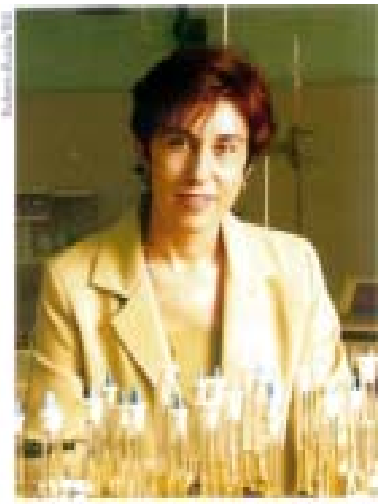
The process to develop the whole project concept involved, initially, a reflection on the main competencies existing in the leading institution as well as a survey focusing the industry needs. The final challenge was to put together the existing competencies (in Brazil as a whole - not confined to our group) and to identify a national theme that could bring significant benefits to the mining area as an integrating subject. The survey consisted in asking representatives of mining corporations what would be the *Xylella* for this field (a reference to the successful Genoma project in Brazil). The unanimous answer was: water is the theme to be highlighted.

The motivation for the project was empowered by a series of circumstances: the energy crisis (which was in fact a water crisis); the recent legislation on water resources (the establishment of fees for water consumption and "bacias" agencies) and finally the growing emphasis on the social component. In reality, water is one of the main issues in the interface of mining operations with their neighbor communities.

The Agenda for the start-up year included:

2 workshops in Belo Horizonte – Brazil (one with the entire group, including the international members);

Participation in round tables to discuss "water in mining operations" in the main events of our area in 2002 (Open Pit/Underground Mining



Virginia Sampaio Teixeira Ciminelli

Congress, organized by the Brazilian Institute of Mining, Belo Horizonte, May, 2002 and the XIX Meeting on Mineral Processing and Extractive Metallurgy, Recife, Nov., 2002).

The preparation of the Institute logo, stationary and the website structure (to be launched in December 2002).

The establishment of the first contracts with industries (Anglo Corp. on recycling of cyanide from gold plants; Leme/ Cemig Enga. on Acid Mine Drainage; and others).

The purchase of laboratory equipments.

The interest and repercussion of the project is indicated by:

The discussion of the project in the main events of our area;

The increasing demand for services, courses, projects by the industry;

The interest for interaction by other research groups in Brazil and overseas. An example is the invitation by the director of the NSF superfund Water Center for a formal cooperation between the two centers.

The main challenges for the next year are:

To strengthen the cooperation among the various groups, creating conditions for a full synergism and integrated network activities, avoiding the common compartmentalization existing in academic research;

To expand the university-industry cooperation, making it compatible with the industry expectation and the features of the University's activities;

To implement thinstallation and operation of the laboratory equipments;

To develop solutions that balance the strong and diversified demands over the chairpersons : managerial, academic and entrepreneurial;

To raise funds for scholarships (technicians and doctors with advanced experience). The participation of professionals with

Água contaminada pelo processo de mineração

these profiles are essential to the Institute's objectives.

Main Impacts:

Mineral processing and water competencies in Brazil (most of them represented in this project) are now linked in a national and international network and reoriented to the challenges of water supply. This was never done before.

The gains with the synergism of this network. This is a reality observed in our own group with a very positive contribution from the basic sciences.

The project has opened a new segment of opportunities for professionals in the mining sector. The importance of the topics selected for investigation became evident in the XIX Meeting of Mineral Processing and Extractive Metallurgy, in Recife, by the significant number of papers (from non-participants of the project) addressing water-related topics.

Mining companies gain with the established and available competency. The recently established cooperation projects reflect this need; demand is greater than our possibilities to respond.

Significant improvement of our laboratory facilities, thus opening new frontiers for the research in water-related topics. The Inductively Coupled Plasma-Mass Spectrometer (ICP-MS), the first one in the Minas Gerais State, for example, allows the identification of trace elements in a ppb (parts per billion) range.

Instituto Multidisciplinar de Materiais Poliméricos IMMP

Roberto Mendonça Faria

In the early 1970s polymers were used owing to their mechanical and insulating properties, together with the low cost of production. They already dominated sectors such as packaging, tyres, and textiles. Since then, new discoveries associated with already known or newly synthesized polymers changed the scene. For instance, polymers were found to be capable of storing large amounts of electrical charge in a stable manner, and of exhibiting ferroelectricity. Towards the end of the 1970-decade, some polymers were also found to exhibit electrical conductivity and optical properties similar to the inorganic semiconductors. The latter has been a turning point for the polymers to assume the status of materials for the high technology industry. Today, polymers are already being used in several devices. However, their great technological potential is still to be fully exploited. Fifteen years ago there was practically no research centers dedicated to investigating the novel properties exhibited by semiconducting polymers, such as electronic, optical, optoelectronic and photonic properties. This scenario has changed completely and now international companies are investing heavily on research and development of new polymers for a variety of applications. Owing to the interdisciplinary nature of the research and development to be carried out, the Multidisciplinar Institute of Polymeric Materials proposed here has formed a multidisciplinary team. This proposal encompasses four subprojects: 1) Electronic and Optoelectronic Polymers, 2) Optical Polymers, 3) Insulating Polymers, and 4) Ferroelectric Polymers and biopolymers. The projects were conceived in such a way to maximize interaction between the members of the team. In The IMMP also there is the participation of two Institutions that operate in transfer of technology

A brief description

It is my pleasure to comment on our experience in coordinating the Institute for Polymer Materials, i.e. *Instituto Multidisciplinar de Materiais Poliméricos-IMMP.* The following points I would like to emphasize.

IMMP is forging the required connections among research and development (R&D) groups to establish a network in the sub-area of organic polymeric materials. This network is formed by professionals with varied expertise, including organic chemists, physical chemists, experimental and theoretical physicists, materials engineers and electronic engineers, from 17 research groups. Some of these groups are in centers of excellence in Brazil, while some others come from universities where there is practically no tradition in R&D. The synergistic interaction that results from the activities at IMMP is perhaps a visible asset that we hope to help consolidate research in the less privileged centers. Encouraging results have already been obtained within IMMP in this context.

In our first Workshop the strategies for managing IMMP both scientifically and administratively were established. In this exercise of setting up the strategies we could note how advantageous it is to work in a network such as that of IMMP, for we could capitalize on the efforts and competences from the various groups and researchers. The final result is

certainly the optimization of the financial resources, in addition to being highly motivating for the participants.

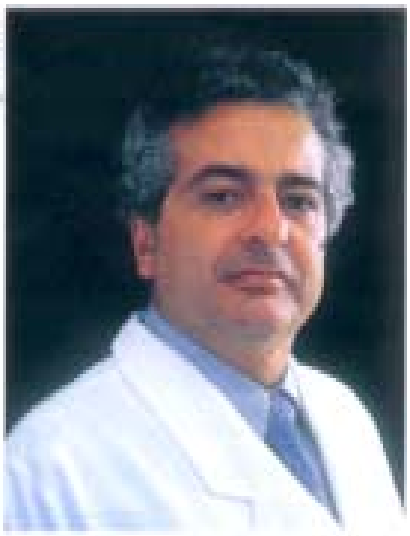
There are a growing number of young scientists interested in working with polymer materials, which is reflected in the several groups of IMMP being approached by undergraduate and post-graduate students as well as post-docs.

As a result from the dissemination of the activities of IMMP, we were contacted recently by a multinational company that is prepared to invest in projects for technological applications in polymers. Another meeting with the leaders of the R&D department of the company has been scheduled for December, 2002, in which we shall identify our mutual interests.

We must admit, nevertheless, that the activities developed in 2002 were below our initial expectation, for 2 reasons: First, we did not have previous experience in working in such a large network, with 17 institutions and more than 140 researchers. It took a lot of discussion to establish common grounds on which to base our R&D strategies. The experience accumulated has been rewarding as the first concrete results from the interaction among groups are already occurring. The second reason was the release of financial resources behind the expected schedule.

Based on the achievements in this first year of the IMMP, in spite of the difficulties mentioned, we may conclude that IMMP is likely to be a driving force for the development of electronic, opto-electronic and photonic devices from polymer materials in Brazil. This opens up good prospects for generating high technology at a competitive cost, which is essential for a developing country like Brazil.

Institute for Immunological Investigation



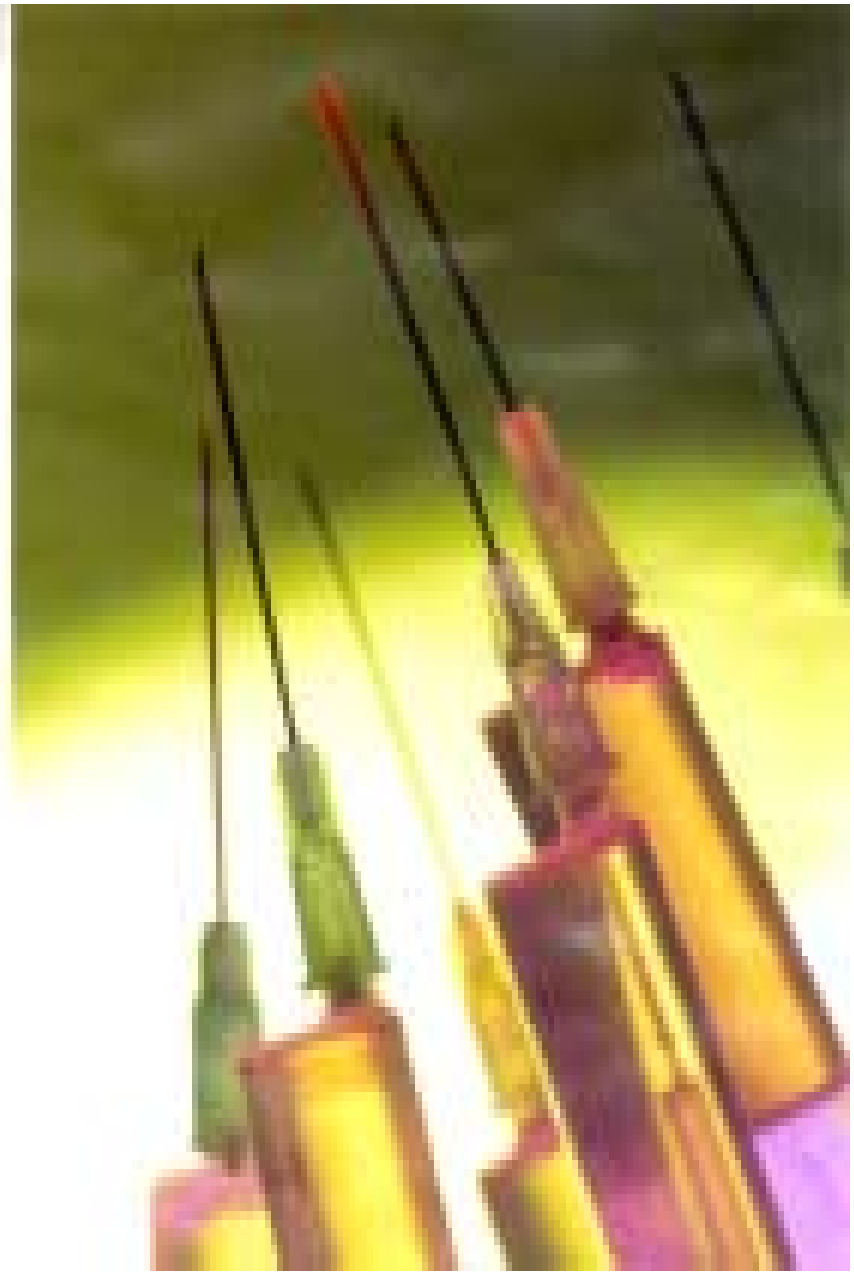
Jorge Kalil

Immunology has benefited greatly, in the last years, from employment of modern Cellular and Molecular Biology techniques, leading to better understanding of disease mechanisms and opening the way for intervention with new drugs and biological agents. As a result, it has become necessary, more than ever, to train professionals qualified in Molecular Medicine, working at the interface of Basic Science and Medicine. Immunology, due to its characteristics and significant number of qualified Brazilian physicians and scientists, is well adapted to this end. We have formed a group of immunologists and researchers from closely related areas, aiming to extend activities and create a network of medical services and research laboratories. The group proposes the Institute for Investigation in Immunology - iii - whose main goal is to "upgrade Brazilian Clinical Immunology to an international level of excellence". We chose 6 main themes based on their medical and socio-economic interest, and also for presenting complementary technical and scientific challenges: allergy, transplant, cancer, infection, autoimmunity and immunodeficiency. Genomic, physiopathologic, pharmacologic and epidemiologic tools will be employed in order to respond to our queries, contributing with novel scientific information, evaluating status of the population in different regions throughout the country, proposing new forms of treatment and prophylaxis, and qualifying medical and research personnel capable of performing in this diverse and complex area. Once the initial proposal of iii is set up, it will then become possible to expand its aims to other groups, by means of the various actions by the personnel formed within the Institute. The actions will then be focus on generating original information in science and in diagnosis and treatment of the diseases studied, preparing science-trained physicians and researchers with medical knowledge, and thus, renew the scope of relations between science, medicine

Description

According to our stated mission to raise the standards of Brazilian clinical immunology to an international level, in these first twelve months we have endeavored to put in place the tools to be used by the whole network of researchers. We have established the basic/clinical immunology interface by means of a universal electronic medical file, which is being presently tested in three different Clinical Immunology Services, and also the communication channels that will permit continuous work in a multi and interdisciplinary network. The basic technical improvements have been set up. The iii has presently operating two proteomics facilities, two full-scale recombinant DNA units, peptide synthesis and micro-array technology, and advanced technical training has been started.

The 2-D electrophoresis system was standardized to optimal conditions to handle Hymenoptera venom proteins, being applied to the study of two important social wasps in southeast Brazil that have great medical relevance due to stinging accidents that are followed by severe immune reactions. After gel staining and protein spot scanning, the gel submitted to Western Blotting with PVDF membranes. The membrane was then submitted to incubation with human IgE (human blood plasma from allergic patients) followed by a solution of fluorescent IgG (anti-IgE), to reveal those antigenic proteins. Antigenic proteins were then excised, submitted to trypsin digestion and the tryptic fragments were derivatized with the CAF-MALDI reagent kit, followed by mass spectrometric analysis for peptide sequencing. The primary sequences of the tryptic digests were used in a protein engine search with BLAST tools to identify the antigenic proteins. Thus, up to now phospholipase A_2, hyaluronidase, acid phosphatase and antigen 5 venom proteins from wasps were identified. In the second proteomic unit other studies on the venom of the native wasp *Agelaia pallipes* have also begun, as well as the refine identification of antigen targets for a T cell vaccine against Rheumatic Fever. As regards our major plan for a vaccine against Rheumatic Fever, during this first year, we subcloned the gene encoding the M1 protein of *Streptococcus pyogenes* (M1) into the pMAL-c2 expression system and produced it as a fusion protein in *Escherichia coli* . Expression was induced with IPTG and purified by affinity chromatography using an amylose resin. To confirm the



recombinant protein produced we performed a Western blot using anti-MBP antibodies directed to the fusion protein. Recently, we cloned the protein M5 from a *Streptococcus pyogenes* (M5) isolated in Brazil. We will produce M5 recombinant protein using the same system and evaluate the reactivity of T cells from patients to these molecules. Recombinant proteins are being produced for the different projects. Whole human Hsp60 and N-terminal, C-terminal and intermediate fragments in a purified, endotoxin-free form (efficiency of 7mg / liter of culture) are being employed in studies of tolerance in transplant subjects and in a experimental heart transplant model.

A humanized form of a monoclonal anti-CD18 antibody has been engineered and has been proven to show results equal to the original. Clinical trials for prophylaxis of rejection are being prepared. The first trials for treatment of head and neck type of cancer with GM-CSF contained

in capsules have obtained permission from the Ministry of Health and are under way.

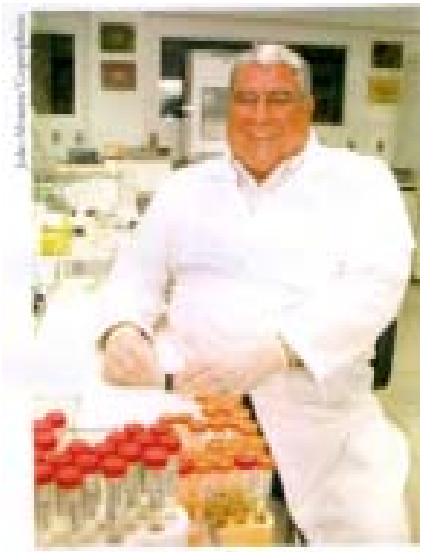
Studies on cytokine gene polymorphism were developed within the scope of the 13th International Histocompatibility Workshop and are well under way on the issue of chronic rejection and in Chagas' disease, and will soon be extended to studies in leishmaniasis and in Rheumatic Heart Disease. In Chagas' disease, TNF-alpha gene polymorphism has been linked to higher mortality in severe cardiomyopathy patients. An experimental model, in hamsters, that mimics the human disease with its diverse clinical forms, was perfected and is being used for drug trials aiming to ameliorate symptoms or even prevent Chagas' cardiomyopathy. The results from a recently finished micro-array analysis of heart biopsies from control, mild and severe Chagas' cardiomyopathy and idiopathic dilated cardiomyopathy patients are presently being evaluated. This first study will soon be followed by micro-array analysis of long-term non-progressor HIV patients.

Clinical and molecular description of our cohort of primary immunodeficiency patients is practically complete and several molecular diagnostic techniques are being routinely applied. The clinical evaluation of asthma patients living in a polyhelminthic endemic area aims to characterize the *D. pteronyssinus*-specific immune response *in vitro* by measuring cytokines, especially IL-10. We have 27 individuals enrolled. Preliminary results show that the patients failed to produce Der p 1-specific IL-5, while those from the non-endemic area produced high levels of this cytokine. In contrast, IL-10 levels were high in patients from the polyhelminthic endemic area, but were undetectable in the control asthma patients from non-endemic areas. The degree of *S. mansoni* infection correlated with Der p 1-specific IL-10 levels, and addition of rhIL-10 to PBMC cultures of control subjects stimulated with Der p 1 led to down regulation of IL-5 production. In light of these data, the identification of a novel mechanism of modulation of the response to aeroallergens may create new options for prevention and treatment of allergic disease. Meanwhile, ongoing epidemiological studies are mapping work exposure to relevant native indoor allergens.

The group has had success in its efforts to develop human resources and to establish new expertise. The first Annual Meeting took place in Salvador, Bahia, end of October, where state of the art presentations were given and the issues on skill development and medical and biomedical teaching were discussed in detail. However, the economic difficulties in Brazil and in financing by the Brazilian National Research Council have also affected the overall efficiency of the project and were also highlighted in this meeting. During this year a training course in Clinical Immunology took place in Mangaratiba, Rio de Janeiro, with the presence of invited professors and researchers of international renown like F Sinigaglia, CG Fathman, A Abbas, Y Shoenfeld, JF Bach and M Chapman.

Meanwhile, over 15 papers have been published or are being submitted on subjects related to the project of the Institute for Investigation in Immunology.

Tissue Bioengineering: Cell Therapies for Chronic Degenerative Diseases



Ricardo Ribeiro dos Santos

The main goal of this project is to establish in Brazil basic scientific and technological skills to introduce and develop a new medical field - REGENERATIVE MEDICINE - which deals with cell and tissue therapy to treat patients suffering from chronic-degenerative and traumatic diseases. The increasing importance of regenerative medicine is due to social and demographic changes in post-industrial society. The progressive increase in the mean age of human population creates the need to improve medical care to patients whom in old age are preferential targets of chronic-degenerative diseases. In addition, youngs leaving in areas of high population density, in urban settings, are more exposed to traumatic lesions, due to accidents and/or violence, that have a high social and economic cost. Both situations demand therapies that may preserve, improve and/or restore lost tissue functions. The currently available option, organ transplants, is obviously not an appropriate, due to the shortage of donnors. Cell and/ or tissue therapy is certainly a viable alternative. Tissue engineering is still incipient among us. The creation of a Millenium Institute in this area will provide a strong incentive for the Brazilian health system to offer our population alternative and individualized treatments such as those currently generated by knowledge in this new scientific field.

Description

The main purpose of our project is to provide operational structures and efficient procedures to use accumulated and newly developed academic and scientific knowledge and technologic competence in Brazil, in the rapidly growing field of regenerative medicine. This should grant the transfer of acquired knowledge and technologies to medical assistance in public and private medical institutions. The rationale is to generate a common set of technologies and procedures bridging the fundamental research with clinical applications. Within these objectives we can report significant accomplishments during the first year of our Millenium Institute.

Skin replacement therapies are in course at a public Air-Force Hospital in Rio de Janeiro (HFAG) and the techniques for producing a square meter of skin from a one centimeter square biopsy are fully established. New dermo-epidermal skin substitutes are being developed at the Rio de Janeiro Federal University, using organ-donor's a cellular dermis in combination with autologous epidermal cells. Pre-clinical trials have been done with success, and these skin substitutes are being now applied in treatment of a controlled series of patients at the HFAG and the Hospital of Bonsucesso, Rio de Janeiro, a national reference center for organ transplantation. The use of cultured autologous oral mucosa for treatment of leukoplasia has been successfully implanted at the Federal University of Juiz de Fora, and the results are being published. A new protocol of palatal cleft surgery in children using a biometrial scaffold and autologous *in vitro* expanded mucosa has receive approval of the Ethical Committee of the Brazilian Health Ministry (CONEP), and is being implanted at the Baurú Dentistry and Maxillo-Facial surgery of the University of São Paulo. Similar procedures will be developed in Salvador, Bahia, in collaboration with Dr. Geza Urmenyi, a plastic surgeon that specializes in skin reconstitution surgery in children.

Cartilage cell culture from patient biopsy samples has been set up in

order to treat ulcerated articular lesions. The protocol for cartilage repair surgery using the cultured condrocytes has been approved by the CONEP. We hope to be performing the first surgery before the end of the year, at the National Institute of Traumato-Orthopedics (INTO). Along this line, bone reconstitution procedures are also being developed at INTO, the School and the Institute of Chemistry of the Federal University of Rio de Janeiro and the Brazilian Center for Physical Sciences (CBPF). Production of a new compound associating bovine collagen and sytherized granular bovine bone-derived hydroxyapatite has been fully developed and characterized, and is already experimentally used in dentistry and oral surgery. Crystalization of hydroxyapatite or organic scaffolds is being studied, with biogenous and synthetic polymers. A new approach to prepare hydroxiapatite for use in dentistry, surgery, and controlled drug-delivery has been developed, and its full description is being completed in order to submit it to the National Institute of Industrial Property (INPI) for patenting purposes. Related to this theme, at least 4 publications, from basic science laboratories, have been made.

Regarding the neurodegenerative diseases, we have opted to concentrate in two diseases: stroke and Parkinson. In both cases experimental models are being developed and preliminary experiments have been performed. Stroke was chosen due to its high incidence in the population. In the experimental model developed – occlusion of the common carotid arteries in the rat – we have evidence suggesting that the blood-brain barrier is permeable to bone marrow derived cells, allowing their migration to the nervous parenchyma during the first hours after the stroke. These results along with a published work suggesting an improvement in a rat stroke model treated with bone marrow cells, have encouraged us to start writing a experimental protocol

for the treatment of ischemic stroke patients. This protocol should be submitted to the CONEP in the first trimester of 2003. Parkinson was the other neurodegenerative disease that we chose to study because a specific cell type is destroyed in the central nervous system, rendering the chances of a successful treatment higher. In fact, the Swedish group led by Bjorklund has transplanted fetal dopaminergic neurons in Parkinson patients with success. The limited availability of fetal tissue renders this therapy impossible for practical reasons even in countries where abortion is legal. We, and others, are attempting to use bone marrow derived cells in the treatment of this disease. The experimental model being developed uses primates treated with drugs known to destroy the dopaminergic neurons in the substantia nigra, and at the moment drug dosage is being adjusted to produce the desired effect. These studies are being conducted in the Federal University of Pará, Federal University of Rio de Janeiro and Federal University of São Paulo.

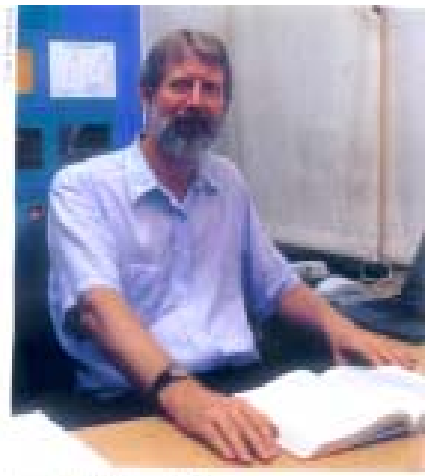
Certainly the area where we have progressed more rapidly is that related to cardiovascular diseases. Experimental models in rodents for myocardial infarct and Chagas disease where already established in our laboratories and we could therefore rapidly test the efficacy of the bone marrow cell therapies in these models. In both cases the results were extraordinary. The Chagasic mice had a stunning improvement in the cardiac inflammation and fibrosis that accompanies the chronic Chagasic cardiomyopathy leading us to submit an experimental protocol for the treatment of Chagasic patients with severe cardiomyopathy to the CONEP. This protocol is in its final phase of approval and we should shortly receive authorization from the Health Ministry to enroll the first five patients in the protocol. A scientific paper has been written reporting these results and is submitted to publication. In the rat model of myocardial infarct the bone marrow cell therapy was able recover much of the lost cardiac function. Our experimental data along with other published results, allowed

a relatively fast approval of the experimental protocol submitted to the CONEP and the first infarcted patients where injected with autologous bone marrow cells in December 2001. We have now treated 14 patients and have established the safety of the procedure. One patient died two months after the procedure; death was caused by another myocardial infarction and not related to the procedure. The other 13 patients are well and the medical exams performed show and improvement in cardiac performance. A number of these patients were waiting for a heart transplant and are now out of the transplant list (one patient has been out of the list for one year after the bone marrow cell therapy). One scientific paper is submitted to publication reporting the results in the experimental animals and the paper reporting the results in the patients should be submitted to publication in January. This work is being developed in collaboration between the Federal University of Rio de Janeiro, the Fiocruz Foundation (Centro de Pesquisas Gonçalo Muniz) and the Pró-Cardíaco Hospital (a private Hospital in Rio de Janeiro). Public Hospitals will soon be involved in these studies in Rio de Janeiro, Salvador and Belo Horizonte.

This progress report is not a list of all publications and thesis related to the project. Due to the short notice we had no time to request this information from the one hundred PhDs participating in our Millenium Institute. We also understand this was not the goal of the requested progress report, which wanted more of a qualitative than quantitative picture of the progress made. We feel that in one year we have succeeded in fulfilling some of the objectives that we proposed. In fact progress in some areas was so fast that we have run into financial problems sooner than expected. Clinical trials are expensive and we had not planned to reach this phase so soon, as happened in the cardiovascular area. Unfortunately, the Health Ministry in Brazil has not grasped the importance of cell therapies yet and we have been unsuccessful in getting support from it for the clinical trials.

Before concluding this report we should add that we have just finished a workshop on Cell Based Therapies in Salvador. Nearly 30 students attended this two weeks workshop and during this time we had the chance to discuss with colleagues from Brazil and abroad the necessity of expanding cell based therapies to other disease states. Integrating cell and gene-based therapies was also discussed and we view this integration as essential in future medical treatments. We believe that we have currently the expertise in both areas in Brazil and plan to start some specific projects in this area.

Research Network on System-on-Chip, Microsystems and Nanoelectronics



Jacobus Willibrordus Swart

Incorporation of specialized IC's is crucial for development of novel products providing innovation and a distinct competitive advantage. Electronic components are becoming major items in importation, leading to an unsustainable balance in a long term. These facts prove the importance to have local production of components and activity in the IC's design. Local industrial microelectronics is extremely reduced, while at universities, there is a number of experienced research groups active in various specific fields of microelectronics, but generally working isolated. The present project aims to intensify and integrate the research, summing up activities, making the best use of existing experience and joining all the relevant topics in an integrated research network. The main objectives are research on: materials and processes for CMOS, microsystems and nanoelectronics; process integration for CMOS and microsystems; modeling of devices; CAD tools for IC's and microsystems; design and test methodology for digital, analogical and RF devices and IC's; validation and integration of the project activities. As justifying factors, we have: the dominant technology is CMOS which is being developed through a continuos reduction of its critical dimensions; an increasing importance of microsystems (sensors and actuators); a tendency and demand to: use complete systems on a chip, co-integrate distinct functions; reduce the dissipated power and rise frequency; new precise models adequate for new devices and polarizations; novel efficient and precise CAD tools applicable for design of microstructures, devices and circuits; new methodologies for CI's design, facilitating the design and resulting in more efficient, high-performance, low-consumption circuits; efficient testing methods for characterization of devices and circuits.

The SCMN has created an opportunity to join the efforts of different groups in the field of microelectronics throughout the country, for common objectives covering the different aspects involved in technology, devices, modeling, CAD tools, IC design and testing.

The main activities during the first year can be classified in the following groups:

- Specification and ordering of research tool (processing, design, software and measurement).
- Hiring new members to the project (students and pos-docs).
- Study and discussions to develop specifications for the system on chip, aimed to control irrigation systems.
- Study and development of the specific topics of the project.
- Organization of workshops.
- Formation of students.
- Publications.

A short description of the technical activities is given below.

Irrigation Control System – SCI

Contacts were established with EMBRAPA, a company specialized on agricultural research and development and applications in precision agriculture. EMBRAPA is working on sensing soil humidity and is interested in development of a wireless sensing network, connected to a central control unit. Several meetings have been held together with studies to develop the system architecture and specifications of the composing blocs. This task is close to conclusion. The main details of the design are as follows:

- Development of SCI's general specification, comprising: data acquisition, data communication and control, energy supply, operating conditions, field application (a pilot citrus plantation, where soil moisture levels will be monitored and controlled through an array of autonomously powered units, or nodes).
- Each node will contain a moisture sensor (tensiometer/integrated semiconductor pressure sensor) and an integrated CMOS system on a chip, with local data acquisition/processing capability, as well as a wireless communication link with a remote Data Collecting Platform.
- A design team with members from all Institutions involved in SCMN was formed, and a preliminary Project Schedule was established. A detailed system specification and a design effort are under way. The first set of subsystem designs is scheduled to be sent for prototyping in the first quarter of 2003.
- A pressure sensor based on the piezoresistive approach is being developed for soil humidity measurements. It is being modeled through finite elements method in order

to optimize it for this specific application.

Study and development of the specific topics of the project.

Design of Active Pixel Sensors and Microsystem Design Methodologies

The APS Design activity involves the design of APS arrays based on conventional CMOS technologies, fabricated through international MPC service. Two classes of APS arrays have been examined: conventional structures and radiation hardened structures. The first IC is a test circuit containing four types of APS pixels in two versions and several Rad-Hard transistors and protection structures for electrical characterization and modeling. The second IC is a Rad-Hard 64x64 APS array which is currently under test. Also a new Rad-Hard transistor structure enabling to increase considerably the fill factor of the arrays is under test.

In addition, APS pixels were also designed and fabricated based on an in-house CMOS process at UNICAMP. Results of the first fabrication run, show well functioning devices, with reasonable dark current and signal linearity with the light intensity.

In the Microsystems Design Methodologies, a first test circuit containing infra-red sensors based on thermopiles was fabricated to characterize the efficiency of several pixel geometries. The task aimed primarily to establish a unified design environment containing the simulation tools necessary for the mechanic, electric and post-processing of the microsensors.

Design of Analog IC's and Interface Block and Modeling.

These research activities encompass modeling, characterization, and design of analog integrated circuits with a strong emphasis on transistor level analog CMOS design. Our current research in analog circuits focuses on basic building blocks for low-voltage and low-power applications. One of our recent accomplishments is ACM, a compact physics-based MOSFET model in which one equation covers all the operating regions. Based on this model, both a systematic analog design and a design reuse methodology are under development.

Some of the most important achievements are: inclusion of the ACM model in SMASH, a commercial circuit simulator; a simplified procedure for extracting the parameters of the ACM model; characterization and modeling of deep submicron MOSFETs (0.12 and 0.09 um) with special emphasis on low-frequency noise; methodologies for both analog design and analog design reuse; design, prototyping and testing of analog integrated circuits.

Modeling, Methodologies and Design of RF blocks:

The design, implementation, and tests of the basic CMOS RF blocks are the main goals in this activity. The blocks addressed initially are Low Noise Amplifier (LNA), Mixers, Oscillators, and Power Amplifier (PA), but other blocks will also be designed/ implemented, like A/D and D/A converters and signal synthesizer. A test chip for these blocks will be concluded in January 2003 (in the AMS 0.35 μm CMOS process). Integrated inductors have been studied and modeled to integrate them on chips; a test chip with several inductor structures was sent to fabrication (STM 0.18 μm CMOS).

The following actions are being developed concerning RF design:

- CMOS RF transceiver design, with a focus on low power consumption solutions, due to irrigation control system's (SCI) specifications.
- Design of an EMC (electromagnetic compatibility) analysis tool (CAD) that could help the designer in the evaluation of the EMI (electromagnetic interference) levels related to the various structures inside the chip.
- Identification and modeling of RF devices for the desired CMOS applications.
- Identification and/or adaptation of a communication protocol that allows the full implementation of the wireless communication network required for SCI.

CAD and Methodologies for Microsystem Testing.

Microsystems are mixed-mode electronic devices that integrate on the same substrate two or more of the following domains: digital, analog, electro-mechanical, optical and fluidic. The complexity of such systems requires that the design is planned for testing, otherwise their production will not be feasible. Besides the standard procedures for digital testing, in this project other topics specific to the analog and the non-electrical domains are investigated: test generation, routing and analysis of signals inside the integrated system (and also ways to get them outside the system), all of them ensuring controllability and observability features needed for test application. This kind of partitioning will allow for each module with different nature (non-electrical, i.e. mechanical, optical and fluidic, both analog or digital) to have the most suitable treatment from the testing point of view, leading to a decrease of complexity in the generation of test sequences and to an improvement in terms of defects covered by these sequences.

CMOS SOI Models:

This activity focuses the development of new analytical models for describing the current-bias characteristics and to assist the device parameter extraction of MOSFETs made in Silicon-On-Insulator (SOI) material. Intrinsic problems associated to the SOI MOSFET such as the parasitic bipolar action or the floating body are topics to be addressed by these new analytical models in order to allow reliable device/circuit simulation.

The new developed models are being compared to numerical bidimensional simulations (PISCES simulator) in order to help the model refinement. After the model check, the set of resulting equations is compared to experimental results.

CMOS and MEMS Processing and Processing Modules:

In plasma etching, the main objective is to develop processes with high etch profile anisotropy, high selectivity for etching of Si, SiO_2, and SiN_x over other materials, as well as low plasma-induced defects density compatible with the following process steps. For this, various plasma sources, both high- and low-density ones, are employed. For the selective nitride processing, RIE (reactive ion etching) and ECR (electron cyclotron resonance) plasmas are being compared. Best results in terms of etch selectivity to SiO_2 (up to 30-50) and to Si (up to 5-15) have been obtained with the ECR plasma using a new process chemistry: gas mixtures rich in O_2 and N_2 with only small additions of etching gas (SF_6).

In the area of deep etching for MEMS applications, comparative studies of different etching chemistries are under development. Anisotropy factors as high as 0.9-0.95 have been obtained, with etch depths of 30 µm. Currently, the main research efforts are focused on the problem of plasma-induced damages (surface roughness) and on development of technologies for post-process surface cleaning/smoothing.

Optical and electron-beam lithography studies are focused on optimization of existing equipment and technologies, with the main emphasis on reduction of the critical dimensions. The first run of a basic 2 µm CMOS technology has recently been carried out, with the second run currently being under way. The electron-beam technology to produce policristalline Si features with minimum sizes of 0.25 µm is now being tested. For etching of sub-micron structures, RIE and ECR sources are used. By using complex plasma chemistries (gas mixtures containing fluorine, chlorine, carbon and oxygen), it was possible to produce almost vertical etch profiles. Another approach, with thinning of etched features during etching, is currently being tested as well. Structures with widths smaller than 0.2 µm have been obtained.

Wet etching is an important step for the release of micromechanical structures where the front side bulk Si micromachining is employed. Silicon nitride layers were deposited on Si substrate by PECVD, followed by anisotropic etching in aqueous KOH solutions. The etch rate dependencies on temperature and concentration of KOH solution were analyzed. Special attention was placed on the development of convex corner compensation techniques to obtain the micro-mechanical structures for the fabrication of the silicon light deflector actuated by electromagnetic induction. The results obtained have shown that well defined corner structure with smooth high quality sidewalls can be obtained by wet anisotropic etching with 28 % wt KOH concentration.

The technology of hard thin film deposition to be used as a corrosion mask material and as device passivation layers, are under development. This kind of mask material is of extreme importance, in particular, for the purposes of deep etching KOH-based wet etching. Diamond-like film deposition (CVD) using carbon-containing gases are being investigated.

In the area of shallow contacts, p-type junctions of 60 nm have been obtained, by performing silicon

preamorphisation with F^+ ions followed by 60 keV B^+ implantation. The mechanisms of the shallow contact formation are not completely clear yet and are under study now. Fluorine seems to promote an uphill diffusion effect, shrinking the junction depth after rapid thermal annealing. In addition, electrical activation values are better compared with the case of direct boron implantation in silicon.

The process of nickel silicide deposition and the autocatalytic deposition process to obtain copper and nickel thin films are under study. We also investigate the process of Ti, Ni and Ni(Pt) alloy silicides formation for advanced MOS structures. The Ni(Pt)Si presents low surface precipitate formation, very smooth surface with rms roughness of 1.6 nm and low sheet resistance of 5Ω/Sq. The NiSi showed different characteristics, exhibiting sheet resistance of 7Ω/Sq, high surface roughness, and high thermal stability problem. While the Ni(Pt)Si can be formed at temperatures from 450 up to 820ºC, NiSi formation is limited to the temperature range of 450-700ºC. The results observed indicate that NiSi and Ni(Pt)Si presents adequate characteristics to be used as interconnect and contacts in sub-micron CMOS devices.

For the LOCOS application, silicon nitride (SiN_x) insulators deposited by ECR–CVD. Optical and scanning electron microscopy analyses were used to investigate the silicon nitride resistance to thermal oxidation, made at high temperature (1000ºC), and the bird's beak in the obtained LOCOS structures, respectively. These analyses reveal that SiNx insulating films, performed with N_2 flows higher than 2.5sccm, presented high quality for LOCOS isolation technology, indicating that these nitrides can be used to CMOS device manufacturing..

In the activity of integrated optics, where the final aim is to integrate all the processes necessary for the fabrication of a pressure optical sensor. In particular, a silicon nitride is used as an optical conduction medium and a silicon oxide as isolation and buffer layers. These processes are being developed to meet the specific requirements of this application, with the main challenge being to provide a uniformity better than 99% in the film thickness in order to have low light losses in the optical wave guide.

In the area of nanotechnologies, the following activities are under way: modeling of electron transport, fabrication and characterization of nanodevices and synthesis of carbon nanotubes, using remote plasma enhanced CVD.

Organization of Workshops

Two workshops have been held during 2002 (February and September).

Formation of Students:

With the support of the SCMN the following student research projects are being performed:

36 undergraduate students
44 master degree students
26 PhD degree students

Publications:

During the year of 2002, the members of SCMN author the following number of publications:

23 Papers in International Journals
02 - Papers in National Journals
60 - Papers in International Conference Proceedings
13 - Papers in National Conference Proceedings
07 - Chapters in Books
03 - Editing of Books
04 - PhD Thesis
15 - MSc Thesis

Millennium Institute of the Semi-Arid: Biodiversity, Bio-Prospecting and Conservation Natural Resources

Ana Maria Giulietti

The semi-arid covers 11.5% of the land area of Brazil but its populations have the lowest social indexes in the country. In attempting to offer solutions for improving their living standards, research and teaching institutions have sought to develop their physical infrastructure, have attracted qualified professionals, and participated in cooperative projects. The affirmative actions and the know-how produced up until now have been only incipient and immediate support is needed in order to strengthen these institutions. This proposal seeks to create a virtual institute uniting these institutions into a large network of mutual help interaction. Taking as the start point the data available in the literature on regional biodiversity, intensive collection programs are planned aiming to elaborate checklists of the native flora and fauna, emphasizing their traditional, particularly, therapeutic. This will be the base for research on the chemical composition of natural products and their pharmacologically active substances, looking for discover new products to be used against the major endemic diseases. The promising species will be studied in regard of their propagation and ex-situ conservation. At the same time, studies concerning the water resources will be combined with data on biodiversity in order to construct models for the use and management of regional watersheds, as well as projects for the recuperation of these seriously damaged areas. This program then envisions the development of four basic lines of research: Biodiversity, Bio-prospecting, Conservation of Genetic Resources, and Conservation of Water Resources. These will be integrated through virtual links to maximize the effective use of equipment, information, and human resources, as well as formation and fixing of qualified professionals in the region. The ultimate goal of this project is to ensure the rational use of the natural resources and the improvement of the quality of life of the local people.

Brief description

The proposal to implant Institutos do Milênio in certain strategic regions of Brazil: the Semi-arid, Amazonia and the Oceans, was undoubtedly due to the recognition, on the part of the MCT, that the regions chosen shared a backwardness in relation to other regions of the country, in terms of their scientific and technological development, while at the same time, displaying a significant lack of basic information on the potential of their rich natural resources.

With respect to the Milenium Institute of the Semi-arid, the 23 collaborating institutions met to consider what were the major problems affecting the 30 million inhabitants of the region, and the best means at their disposal, in terms of scientific research, to address such problems. Two of the greatest challenges are the degradation of the environment, due to inappropriate and uncontrolled land-use, coupled with a serious lack of knowledge of the biodiversity of the Caatinga Biome of the Northeast, with its highly specialized environmental factors, where the majority of the inhabitants make a living. Water resources and their rational utilization can help to combat the fragile nature of agriculture in the region, while a better understanding of the region´s unique biota and its sustainable use, especially to combat disease, can also provide a rich source of income for, as well as promoting the health of, local communities, and at the same time helping to preserve the environment.

The project for the Semi-arid has two major foci of research. The first of

these has been to gather information on, to catalogue and map the biodiversity of the Caatinga Biome, as well as detecting the hotspots of biodiversity in the region and those endemic species that are threatened by extinction. This has gone hand in hand with a major programme of Bioprospection, to assay this biodiversity in a search for phytotherapies to tackle some of the major diseases of the region, such as cutaneous and visceral Leishmaniasis, Chagas´ disease, Schistostomiasis and Malaria. The third part of this strategy is to characterize those more significant species in terms of their genetic make-up and molecular biology and to conserve them "ex situ", by means of seed collection, propagation and the formation of germplasm banks.

The second focus of the Milenium Institute of the Semi-arid is the study of different aspects of the hydrology of two large river basins, which feed the caatinga region in North-east Brasil: the Rio São Francisco and the Rio de Contas. Studies on the former involve remote orbital sensing in order to analyse the process of sedimentation which is a serious problem at present occurring along the river bed. In the Rio de Contas, the phyto- and zoo-plankton is being studied and monitored, from its source near the Serra do Barbado (c. 2000m alt.) to the middle reaches of the river, where it crosses various types of caatinga. Also being studied are the dimensions of the subterranean water table known to exist in the South of Piauí, the largest in North-east Brasil, and its potential for utilization. Such studies should make a major contribution to the politics of the distribution and conservation of water in the dry North-east.

An important component of all aspects of the above project has been to reinforce local institutions with the purchase of the latest generation equipment, some of which has not been previously available in the region, allowing research to proceed using the most up-to-date methodologies. Such equipment will be at the disposal of all collaborating institutions. At the same time, the project provides a strong incentive to intensify the development of human resources in North-east Brasil, in terms of the formation of a new generation of scientists, trained in modern techniques.

In spite of the relatively short period of existence of IMSEAR, which was initiated 12 months ago, the still uncompleted process of the importation of equipment and consumables, essential for the execution of the project, and the 2nd and 3rd year elements of the project that still have not commenced, it is still possible to list some very positive results. The website, still in process of development, has provided a communication network that has allowed collaborating institutions instant access to high-quality scientific data, relevant to the project. This has ensured, for example that duplication of effort in the collection of material is avoided among all the participating institutions.

As regards new data on the biodiversity of the semi-arid, 32 expeditions within the Caatinga Biome were planned and executed. This resulted in the collection of some 3000 plant and fungal specimens, representing about 1000 species, from the states of Alagoas, Bahia, Ceará, Paraíba, Piaui and Pernambuco, all accurately located using GPS. This material is now being actively determined, with the help of a body of specialists, or by means of "identification workshops" which have been organized with the participation of all the collaborating groups. All this reference material, a rich source of information on the biodiversity of the semi-arid, and deposited in various herbaria, will be made available on the web in the form of databases, lists of exsiccata and photographs of selected specimens.

Parallel with the collection of herbarium material, which provides essential, named voucher material, fresh flowers were collected for palynological studies and fresh leaves, collected in silica gel, were subsequently stored at sub-zero temperatures for DNA analysis. About 500 samples have already been assembled in what will be the first DNA bank of native plant species in the Brazil.

In relation to the study of animal groups: Anurans (frogs and toads), birds and insects, these have been restricted to field observations and the study of specimens from museums principally localized outside North-east Brasil. These have produced many new records for the region as well as new and endemic species of the Caatinga Biome.

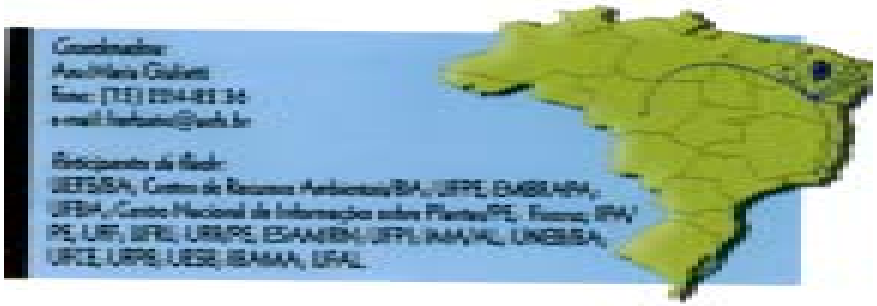
About 500 plant samples (200gr of dried leaf and stem material), representing about 200 species from the region, were collected for phytochemical screening and pharmacological studies. Hexane and methanol extracts of 64 species were subsequently prepared, of which 32 showed immunoregulatory activity of over 80%. These species are now undergoing further analysis, involving the collection of additional material for phytochemical characterization of the active components, as well as new pharmacological, toxicological and immunological tests. Concurrently, seed material is being collected for propagation experiments with an aim to conservation "ex situ" and genetic and molecular characterization.

The results so far obtained are still very provisional, but appear to demonstrate that plant species from the semi-arid show an immunoregulatory activity significantly greater than that obtained from species (tested using similar methodology) from other biomes such as the Amazon and Atlantic forests.

Studies on water resources of the region have already been initiated, and results from the limnological investigation, involving the characterization and monitoring of plankton in 22 sites along the Rio de Contas basin, are now being analyzed.

This suite of activities, involving all aspects of the project, has permitted the implementation of 36 scholarships of Scientific Initiation, while in the second phase of the project it is hoped to double this number. The majority of the award-holders are involved in studies on different plant, fungal and animal groups of the semi-arid: areas of study where the need for this level of research is greatest. On the other hand, of the six grants to "Recem-Doutores" which have been awarded in the first year, only one was in the area of biodiversity (a specialist of birds), the remaining being awarded in the areas of phytochemistry and water resources. These latter disciplines are poorly represented in the North-east and need to be strengthened and amplified. The presence of professionals from outside the region, supervising a new generation of young researchers, will ensure the future implantation of these subjects in north-eastern institutions.

The lively interest sparked by the activities of IMSEAR has been considerable, as much in the media coverage, with interviews in the newspapers and on television, as in scientific meetings and especially in the local communities who accompany our activities.



Use and Appropriation on Coastal Resources

Jorge Pablo Castello

Covering over 8,500 km, the coastal zone comprises a huge diversity of resources and about 70 % of the country's population. Its occupation has generated conflicts between preservation and development imperatives. There is an ongoing clash between activities of use and appropriation of natural resources, businesses, land policies, recreation, and so on. One proof of the negative effects is the loss of certain habitats, lowered water standards in the coastal zone and the water table, algal blooms, a decline in fishing, a reduction in stocks of living and non-living resources, beach pollution, an increase in the occurrence of erosion and coastal floods, etc. The right development, based on premises of sustainability and social and economical integration, constitutes a challenge to be faced. This requires an integrated monitoring system providing data and knowledge for: protecting the populations and contributing for the improvement of their quality of life and the safety of the human activities in coastal regions; managing and restoring healthy coastal systems and their resources; predicting and mitigating the effects of natural hazards and detecting changes in associated to global phenomena. The group may address these issues, establishing a diagnosis of its current standing and offering protocols for a more rational monitoring and management of the conflict situations, through a project called: "USE AND APPROPRIATION OF COASTAL RESOURCES ". This proposal resulted from the decision of several Universities to form a consortium to start joint work in Ocean Sciences. The group understood that such problems could be addressed, with the formation of a network of researchers/ institutions. The proposed strategy implies the realization of standard studies of several coastal systems, connected by an observation network, with the objective of monitoring, understanding, and predicting problems related to fishing, mariculture, biodiversity, environmental quality, erosion and coastal land use and occupation.

Brief description

We divide this report in three parts, the fist of which deals with the antecedents of the project, the second one with its conception and formulation, and the third one with its impementation and management, during the first year of activity. We emphasize that this very short report is not exhaustive, but we think that it adequately reflects the main aspects of our experience, including both the positive and the negative ones.

Antecedents

During the last quarter of 2000, six presidents of federal universities agreed, through informal talks, to put together a research network and an exchange program of students (both graduate and undergraduate) and professors of Oceanography. The six universities were the University of Rio Grande (state of Rio Grande do Sul), Federal University of Paraná, Federal University of Espírito Santo, Federal University of Pernambuco, Federal Rural University of Pernambuco and Federal University of Pará, all of them with different degrees of experience in oceanographic research and teaching. The University of Rio Grande was the first one to develop this area.

During the first quarter of 2001, we learnt about the Millenium Institute proposal. We realized that our initiative regarding the research network and exchange program in Oceanography fitted very well the Millenium Institute format. An important advantage, in our case, was the previously taken decision to operate in a network format, within a framework of cooperative work.

Conception and formulation of the project

To some degree, the six universities had previous cooperative experience, be it through research efforts under national sponsorship (e.g. REVIZEE - Live Resources in the Exclusive Economic Zone, Permanent Studies Group of the Brazilian Environment Institute - IBAMA, of the Environment Ministry, Workforce on Policies for Marine Science and Technology, of the Ministry of Science and Technology) , under international sponsorship (World Ocean Circulation Experiment - WOCE, Harmful Algal Blooms - HAB, Global Ocean Information Systems -GOOS, etc), or through individual exchange activities. Though the initiative to start the research network and exchange project was taken at the university president level, it was supported by the rich and diverse previous contacts at the personal level, built during a long time by the researchers and professors of those universities. This was a fundamental aspect of our project.

Two technical meetings took place between April and August 2001 in the Federal University of Espírito Santo among representatives of the six universities. The first one was devoted to the determination of the breadth of the proposal to be submitted to the Millennium Institute project. After long debates, taking into account specially the feasibility issues, it was agreed to focus on the four following thematic areas, related to the Brazilian coastal region:

1. Fishery management models.
2. Biodiversity and environmental quality.
3. Sustainable sea harvesting.
4. Monitoring, modeling, erosion and occupation of coastal regions.

A preliminary diagnosis was prepared for each one of the four "themes", based upon the best available information at that time, and focused on an expected "product" with actual applicability capabilities. We viewed the public sector and the society at large as our main "customers".

We understand that coastal region management requires public policies which answer the demands to conciliate development and conservation, from a sustainability perspective.

The preparation of the project, based upon the aforementioned "themes", was a very rich and productive experience, where there was, in fact, a deep interaction among all participants. This discussion generated a new view of the problem, since the proposal includes a large diversity of eco-systems and problems along a 8500 km coastline.

On the one hand, it is necessary to look for those issues which are common to the different situations-systems; on the other hand, it is essential to acknowledge the differences and individualities. The RECOS project is based upon the comparison among the different systems on a latitude axis. This demands right choices in terms of hypotheses, methodology and standarization criteria. We comment, for instance, on the difficulties genetared in the formulation of item 4 above.

A oligo-haline estuary like the one in Patos Lagoon, in the South, is very different from the mix-haline one in Paranaguá Bay, and even more different from the Amazonas River estuary, which for all practical purposes is located on the continental platform. This is a general situation, and the four thematic groups had to deal, to some degree, with this diversity component, and to adopt, consequently, a methodological and sample strategy.

Each researcher tends to reflect his/her personal experiences, based upon the knowledge acquired in his/her customary working environment, but he/she seldom has the opportunity to change his/her approach and enlarge his/her comprehension horizon. In this sense, RECOS offers an extraordinary opportunity. Another relevant aspect led us to think in terms of the "expected product". It was clear that the traditional approach of the "expected product", in the form of a series of academic reports, which would become in term publications, books and other traditional

forms, would not be sufficient. We looked for something beyond that stage. We intended to focus on one or more problems, and after, a competent diagnosis of their causes, to offer solutions, having, therefore, a pro-active attitude toward such problems. In this sense, we found a very useful document from the Intergovernment Oceanographic Commission (GOOS Report No. 90, IOC/INF-1146, 2000), under the sponsorship of UNESCO. This document analyzes the advantages of placing the generated knowledge ("product"), and its applications ("services"), in the context of the modern society.

Changes in the coastal environment are related to a complex hierarchy of interactions both inside and outside the system. Despite this fact, there is a small number of key variables which, if they are observed with the due accuracy, can provide the required information basis for the detection and prediction of changes in the coastal area, for the benefit of a large number of users, and of the public sector as a manager. A careful raiding and discussion of the proposals in this document, duly adapted to the Brazilian reality, led us to a better formulation and visualization of the "expected product". This was a team work, started in the meetings in Vitória, and followed through the intensive use of electronic mail.

During the whole formulation process, new researchers joined the initial group. Thus, the final project includes more that 200 researchers from 17 institutions. An important aspect of this process, basically under the responsibility of the project coordinator, was the rejection of "centrifugal" proposals, which were germane to the spirit of the Millenium Institute or alien to the research network philosophy.

Project implementation and management.

After the approval of our project, a technical meeting was held in Rio Grande. Different operative and financial issues were discussed (the granted resources were less than requested) and it was needed to modify the schedules of the four thematic groups. Standarized administrative procedures (essential for a project of this nature) were adopted, in agreement with the regulations of Support Foundation of the University of Rio Grande. Each thematic coordinator studied the details of the required specification for equipment imports (according to the PADCT and BIRD regulations). Different aspects of intra-theme and inter-theme coordination were also discussed, as well as detailed schedule adjustments and evaluation indicators.

Once again, the team spirit, an essential ingredient for the execution of a project with network architecture, became evident. However, it should be mentioned that, though the Millenium Institute proposal was innovative in the sense that it promoted the constitution of the network, this did not translate to the administrative sector. In this sense, the structure imposed by the PADCT is fully centralized, orthodox, rather inflexible and inadequate for a network project . This seems to be a contradiction, because it goes against the spirit of the Millenium proposal. PADCT seems to be unsufficiently prepared for this kind of project.

My experience after one year is that the time and effort required to take care of the administrative aspects of the network were (and still are) excessive, even with the efficient help of an administrative secretary, and the support of the Foundation.

Another aspect, resulting from the coordinator life experience, is that there exists a large distance between the theory and practice of research networks. When the team members stay in their respective institutions, they tend to isolate themselves from the network and to let their time be absorbed by the day-to-day demands of their individual research activities. The role of the coordinator, in constant interaction (mainly through e-mail) with the four thematic coordinators, is essential to keep the schedules and to attend the academic and operative requests from all participants.

The proposal includes the realization of several sectorial workshops to deal with data analysis and discussion of joint results. Up to now, we have held a specific workshop for each thematic group. These meetings are essential and productive. Additionally, we had planned an innovative instrument: the implementation of a tele-conference network. The budget cuts made this proposal unfeasible (only two of the universities have currently installed and operating teleconference facilities).

In sumary, I emphasize the following positive items:

1. Personal and academic integration.
2. Change in the perception of the problems, in a geographic scale previously unheard of in Brazil.

3. Integration of studies and solution proposals, focuses on the “expected products”.
4. Reinforcement in terms of both material and human means (e.g. Scholarships), and also in terms of experience (workshops), for all participants, particularly for the emergent groups from less developed institutions.

I mention also the following negative items, which must be addressed:

1. Lack of compliance with the financial schedule (aggravated by the Brazilian currency devaluation).
2. Lack of a technical/consulting follow-up by the PADCT.
3. Low BRD’s values, inadequate for attracting enough candidates willing to work together with the emergent groups in locations far away from the coast.
4.Lack of flexibility for switching between capital and current expenditures (though the
5. PELD coordinators enjoy the right to perform such switches, the Millenium Institute coordinators do not).