BULLETIN

INTERNACIONAL CENTER FOR MATHEMATICS

June 1998

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In this issue we start the publication of small cartoons with some mathematical content. Collaboration from our readers to this section will be most welcome.

## Activities in 1998

### Linear Algebra and Control Theory: Thematic Term

As announced in the last Bulletin, the Thematic Term on Linear Algebra and Control Theory began on May 11th, and the first participants have already arrived. Amongst them are guest researchers Prof. Paul Fuhrmann (Ben Gurion University of Negev), Prof. Jean Jacques Loiseau (CNRS, Nantes), Prof. Itziar Baragaña (Universidad del País Vasco), Prof. Vladimir Kučera (Academy of Sciences, Czech Republic) and the postdoctoral fellows for the Term, Dr. Adam Czornik (Silesian Technical University, Poland) and Dr. Marko Huhtanen (Helsinki University of Technology, Finland).

The Thematic Term opened with a research seminar given by Prof. Vladimir Kučera on "A Bridge between State-space and Transfer-function Methods". There are also many activities planned for the following two weeks, including, from May 21st to 29th, the two courses of the first School, on Structure and Design of Linear Systems, given by Prof. Jean Jacques Loiseau and Prof. Petr Zagalak (Academy of Sciences, Czech Republic). The course programmes are as follows:

Structural Properties of Linear Systems (J. J. Loiseau)

1. Examples of linear systems.
2. Realization of linear systems.
3. Basic control I: Stabilization.
4. Structure of linear systems. Geometric tools.
5. Multivariable Control II: Exact problems.
6. Pole placement and related topics.
7. Time-delay systems.

Linear Systems and Control (P. Zagalak)

1. Representations of linear systems.
2. Structure of linear systems: basics.
3. Basic control II: Regulation.
4. Structure of linear systems: Polynomial tools.
5. Multivariable Control I: LQ control and Kalman filtering.
6. Robust Control I.
7. Robust Control II.

The courses will take place from 9.30 am to 1 pm (except for the first day, when they will be after lunch). This will leave the afternoon free for other activities such as seminars or lectures. So far, three seminars have been programmed: Linear Systems with Prescribed Similarity Invariants (I. Baragaña), Observers and Conditioned Subspaces (P. Fuhrmann) and Nearest Pair with more non-constant Invariant Factors: Pseudospectrum (Juan M. Gracia, Universidad del País Vasco).

The second School, which takes its title from the name of the Term (Linear Algebra and Control Theory), will be held from 15th to 23rd June. It will consist of two courses given by Prof. Paul Fuhrmann and Prof. Peter Lancaster (University of Calgary, Canada). The programmes of these courses are as follows:

Algebraic System Theory (P. Fuhrmann)

1. Polynomial and rational models. Factorizations and invariant subspaces. Intertwining maps. Canonical forms. Polynomial matrix interpolation.
2. Linear systems. Shift realization theory. Reachability observability and coprimeness. Polynomial system matrices and system equivalence. Doubly coprime factorizations.
3. Feedback, output injection and duality in the model context.
4. Factorization theory and geometric control.
5. Hankel norm approximation, scalar case.
6. Spectral factorization. The regular case. DSS factorizations. Parametrization of the set of minimal spectral factors.
7. Spectral factorization. The rectangular case.

Linear Algebra Stability and Control (P. Lancaster)

1. Basic material: Ideas from linear algebra. The continuous and discrete LQR problems.
2. Stability and canonical forms: Stability of continuous and discrete systems. Stabilizing a controllable dissipative system. BIBO stability. Canonical forms for matrices and pencils.
3. Realization of rational functions: Transfer functions for filters and systems. Existence, minimality. Pencil realizations. Realizations for functions with symmetries.
4. Balanced realization: Hankel singular values. Balanced realization. All-pass transfer functions.
5. Continuous algebraic Riccati equations: Examples and motivation. The role of the Hamiltonian. Direct solution methods. Concerns of numerical analysis.
6. Discrete algebraic Riccati equations: The role of symplectic pencils. Direct solution methods. Numerical solution of CARE and DARE in the singular cases.
7. Stability under perturbations: Strong stability. Higher order systems. Parametric perturbations. Analytic perturbation theory. Application to gyroscopic systems.

These courses will also be given in the morning, and the afternoons will be occupied by seminars and lectures. These will include a series of 3 or 4 seminars on Linear Systems over Finite Fields and Coding Theory given by Prof. Joachim Rosenthal (University of Notre Dame, Indiana) between June 16th and 19th, plus other seminars which have been programmed but which as yet have not been scheduled.

The International Center for Mathematics (CIM) will be visited in the second half of June by many researchers, come to attend the workshop that will take place from 24th to 26th of that month. During the first ten days of July, however, most of these will leave in order to attend meetings elsewhere (MTNS in Padua, IFAC on Linear System Structure and Control, etc.). Therefore, the regular activities of the Term will resume on July 11th to continue until the end of the month.

Up-to-date information about the Thematic Term can be obtained at our web site:

http://hermite.cii.fc.ul.pt/lin98/

or by sending an e-mail to:
lin98@hermite.cii.fc.ul.pt.

## Optimal Shape Design School

In cooperation with CIME (Centro Internazionale Matematico Estivo, Florence, Italy) – maybe the oldest european organization dedicated to summer schools in Mathematics – CIM will organize in Tróia, Portugal, from 1 to 6 June 1998, a summer school on "Optimal Shape Design", i.e., determination of optimal forms for the construction of structures. By optimal we mean the best possible according to criteria seemingly appropriate, in general associated to a cost – be it of manufacturing, of utilization, of maintenance, or mixed. By structures, in particular we intend applications to naval and aerospatial engineering. For example, to determine the best form that the hull of a ship should have in order to fulfill its duty. Or to compute the optimal form for an airplane or a spaceship so that its fuel consumption is minimal.

This summer school is supported by the european union through the TMR programme. Its lecturers are five of the most famous world researchers in this area:

Bernd Kawohl (Köln, Germany),
Some nonconvex shape optimization problems
Olivier Pironneau (Paris, France),
Mesh adaptation for optimal shape design
Luc Tartar (Pittsburgh, USA),
Homogenization methods in optimal shape design
Piero Villaggio (Pisa, Italy),
Explicit solutions in elastic optimization
Jean Paul Zolesio (Nice, France),
Optimal shape design: theory, models, numerical algorithms.

At the meeting on 19th April 1998 the CIM Scientific Council gave their approval to the following events:

## Debate on University teaching of Mathematics in Portugal

Organizers

João Filipe Queiró - Universidade de Coimbra
Luís Trabucho - Universidade de Lisboa

Date: 6, 7 February 1999

Structure

CIM has decided to organize a debate on University teaching of Mathematics in Portugal, to discuss the new problems and challenges to Mathematics and its teaching in our country.

Possible subjects for discussion are the following:

- The teaching of mathematics for applications: relevant problems, employment issues, organization of undergraduate and graduate studies. The teaching of mathematics for Science and Engineering.

- The teaching of mathematics for teacher training.

- The use of technology in mathematics teaching at all levels.

- Institutional matters: University organization in Portugal. The organization of the mathematical community in Portugal.

The debate will consist of sessions by subject, with invited presentations followed by open discussion.

## Geometric and Combinatorial Methods in the Selfadjoint Spectral Sum Problem

Organizers

Ana Paula Santana - Universidade de Coimbra
E. Marques de Sá - Universidade de Coimbra
João Filipe Queiró - Universidade de Coimbra

Date: Spring 1999

Structure

Meeting or sequence of lectures gathering experts from different fields who have worked on the problem.

## Thematic Term on Theoretical and Computational Fluid Dynamics

Observatório Astronómico, Coimbra, Portugal

Organizing Committee

Adélia Sequeira, I. S. T., Lisbon (Portugal)
Hugo Beirão da Veiga, Universidade de Pisa, (Italy)
Juha Videman, I. S. T., Lisbon (Portugal)

Period: May, June and July, 1999.

Main Topics

Mathematical modeling, analysis and numerical simulation of fluid flows including:

Compressible and incompressible viscous flows;
Viscoelastic and non-Newtonian fluid flows;
Free-surface flows;
Turbulent flows;
Polymeric liquid crystals;
Applications to industrial problems.

Scientific Objectives

The main objective of the trimester is to promote research and to establish scientific contacts between foreign and portuguese specialists working in this area. Some of the activities of the Thematic Term are further aimed to encourage young doctoral and post-doctoral students in developing investigation in this challenging field. In order to reach these goals we plan to:

- Maintain a group of researchers (portuguese and foreign) working together in the premises of the Centro Internacional de Matemática in Coimbra during the entire trimester. Their results will be discussed in a weekly seminar.

- Organize in Coimbra an International Workshop on Mathematical and Numerical Modeling of Non-Newtonian Fluids with Applications to Liquid Crystals in the end of July, 1999.

- Organize three Summer Schools probably in the region of Lisbon on the following topics:

Computational Fluid Dynamics
(Chairman: A. Quarteroni);
Theoretical Navier-Stokes Equations
(Chairman: H. Beirão da Veiga);
Industrial Mathematics
(Chairmen: A. Anile and A. Fasano).

Each school has one week duration and includes 20 hours of lectures divided among 4 specialists suggested by the chairmen.

- Offer 30 scholarships, in particular to portuguese post-graduate students, to attend the Summer Schools.

## Summer School on Differential Geometry

Organizers

Joana M. Nunes da Costa - Univ. de Coimbra
F. J. Craveiro de Carvalho - Univ. de Coimbra
A. M. d'Azevedo Breda - Universidade de Aveiro
Bernd Wegner - Technische Universität Berlin

Date: 3/7 September 1999

Structure

12 hour course on Geometry of Submanifolds by Dirk Ferus - Technische Universität Berlin

12 hour course on Poisson and Symplectic Geometry by I. Vaisman - Haifa

Four 1 hour conferences, one per day, by

David R. J. Chillingworth - Southampton
Sheila Carter - Leeds
Jean Pierre Françoise - Paris
Bernd Wegner - Berlin

Sessions where participants can talk on their own work.

## Workshop on Statistical Modelling: Extreme Values and additive Laws

ORGANIZERS

M. Ivette Gomes - Universidade de Lisboa
Dinis Pestana - Universidade de Lisboa

DATE: 4/7 October 1999

STRUCTURE

The scientific programme will include three or four invited papers, three intensive courses (6 hours each) on areas relevant to the topic of the Workshop and several contributed papers.

The courses are

Extremes and Exceedance Measures for Stochastic Processes by M. R. Leadbetter
Semi-parametric Inference by L. de Haan
Regular Variation and Applications by J. Teugels

The invited papers are

Generalized Convolutions and Domains of Attraction by N. H. Bingham
Applications of Extremes to Climatology by J. Tawn
Analytic Tools in Probability Research by D. N. Shanbhag.

The following two proposals are still under consideration by the Scientific Council due to some lack of information at the time of the meeting.

## Singularities in Algebraic Geometry and String Theory

ORGANIZERS

Carlos Florentino - Inst. Superior Técnico, Lisbon
Margarida Mendes Lopes - Universidade de Lisboa
José Cidade Mourão - Inst. Sup. Técnico, Lisbon
Orlando Neto - Universidade de Lisboa
João Pimentel Nunes - Inst. Sup. Técnico, Lisbon

DATE: 12 - 23 July 1999

STRUCTURE

Six courses, three per week, as follows:

Introduction to Singularities and their Resolution
Toric Varieties and Mirror Symmetry
3-Folds and Classification of Varieties
Moduli Spaces of Vector Bundles
The Role of Singularities in Quantum Field Theory and in Superstring Theory (2 courses)

## Summer School on Category Theory

ORGANIZERS

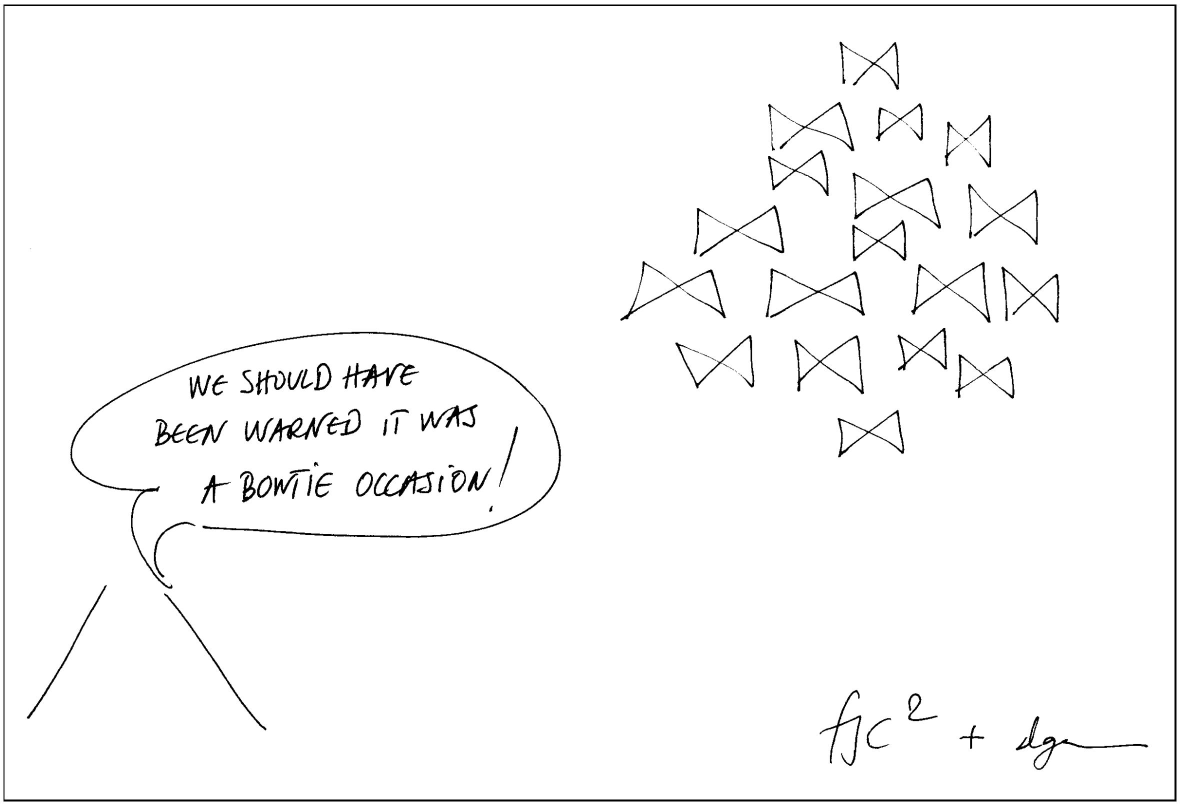
Manuela Sobral - Universidade de Coimbra
Maria Manuel Clementino - Univ. de Coimbra
Jorge Picado - Universidade de Coimbra
Lurdes Sousa - Instituto Politécnico de Viseu

DATE: 6 - 10 July 1999

STRUCTURE

Three 7 hour courses on the following topics:

Theoretical Aspects of Computing
n-Categories
Algebraic Theories



J. A. Green was born 1926 in Rochester N.Y., U.S.A. (his parents were both Scottish). He went to school in Toronto and Cambridge (England). Studied at St Andrews (1942-44 and 1946-47) and Cambridge (1947-50), Ph.D. 1951. Taught at the universities of Manchester (1950-63), Sussex (1963-65) and Warwick (1965-91). Retired 1991 as Professor Emeritus; since then he has lived in Oxford.

Professor J. A. Green, you had a magnificent career topped with a number of honours. The Senior Berwick Prize in 1984, an R. S. Fellowship, to mention just two. Surely now when you look back you must have a feeling of achievement.

How and when did it all begin? Is there anything you regret not having done?

'My father was a professor of French literature, and I always expected to have an academic career. My boyhood interests were in science, particularly chemistry, and I applied to St Andrews to study chemistry. But by the time I arrived at university I had decided that mathematics was my true vocation. Fortunately there was no difficulty in changing my course, because the curriculum in the Scottish universities is quite flexible.

By the time I went to Cambridge I had decided I wanted to do research in algebra. At Cambridge I was much influenced by the lectures of Philip Hall on various algebraic topics (as was a whole generation of British algebraists). I wrote my Ph D thesis on semigroups. My first teaching appointment was at Manchester, and there I learnt from G.E. Wall (whom I already knew as fellow-student at Cambridge) about the work of Richard Brauer on modular representations. Although I did not meet Brauer until 1961, I have always regarded him as one of my teachers.

The 1950s and 1960s saw the flowering of the great French school of post-war mathematics, the famous Chevalley seminars on algebraic groups, and the revolution of geometry and analysis by topological methods at the hands of Serre, Hirzebruch and many others. Among my mathematical regrets is that I did not become more closely involved in these new methods, and especially that I did not become more expert in algebraic geometry. Because algebraic geometry has provided powerful techniques and insights in algebra; perhaps the most striking example of this is the work of George Lusztig, which has completely transformed the representation theory of the classical groups.'

You are a frequent visitor to Portugal. Some of your former students live here.

How was this connection established? Did it just start because you happened to have a first portuguese student?

'Yes. I first came to Portugal in 1984 to attend a meeting in Coimbra, and I know that the initiative for that invitation came from my former student Teresa Martins. Subsequent visits to Lisbon and Coimbra have given me the pleasure of seeing also my two other Portuguese former students Teresa Nogueira and Ana Paula Santana, and I have been happy to get to know some of their colleagues in both universities.

I greatly value my connections with Portugal and with Portuguese algebraists; I am always glad to come and sorry to leave!'

We know that you were actively involved in the war effort, at Bletchley we think, during World War II. Despite the hardship of war conditions it must have been an exciting time to be alive.

What kind of mathematical work were you doing? Would you regard it as mathematical research and publishable as such if circumstances allowed it?

'You must remember that I was very young (only 18 years of age) when I went to Bletchley Park. Moreover I arrived in August 1944, and the war in Europe was in its final phase. By that time M.H.A. Newman's plan, to use specially designed electronic computers to assist in the decypherment of the "Fish" series of coded messages, was well advanced. I was one of a number of new recruits to Newman's section (which was called the "Newmanry"), and our main task was to operate these "Colossus" computers, using well-establishment routines. It was beside one of these machines that I first met my future wife Margaret – she was in the WRNS, the women's branch of the Navy. Of course Bletchley is not near the sea, but anomalies of this kind were normal in wartime! However I certainly did nothing at Bletchley which could be called research. There were others in this section who had been at Bletchley much longer, and who had made important contributions to the breaking of enemy cyphers. A statistical "significance test" invented by I. J. Good for use with the Colossus was, I think, published after the war.

Since security restrictions have been lifted, several books about Bletchley Park have appeared. From one of these (*Code Breakers*, edited by F. H. Hinsley and A. Stripp, Oxford University Press, 1993) I have learnt a great deal which I certainly did not know while I was there! The chapter by Jack Good describes The "Newmanry" very well.'

Many of your colleagues are highly critical of the Thatcherian and Post-Thatcherian eighteen year period and the effects its policy had on British education as a whole and on universities in particular.

Do you share their views? What changes can be expected now, May 97, that Labour has come to power?

'On your last question: I think that British government policy on universities will not change very much. Most of Western Europe (in fact, most of the world) faces the problems which result from a huge increase in the number of students in higher education. In Britain, even the Conservative administration did not try to meet this by encouraging private universities. Instead, a large number of existing colleges were renamed "universities". It will take quite a long time for many of these new universities to reach the standards of the old ones, but I think that the government's Teaching Assessment and Research Assessment "Exercises" attempt to provide a uniform standard against which all universities can measure themselves.

In the golden years of Britain's "welfare state" (1960s and 1970s) every student who was offered a university place, received a grant sufficient to cover his/her tuition and living expenses for the three years of the normal first degree course. It will never be the same again! Present plans are for the state to provide loans to students, to be paid back when the graduate is earning a salary above a certain level.

I did not like Mrs Thatcher. Her aggressive attitude to trade unions, for which she was much praised, seemed to me to be the wrong approach to labour-management relations. It will be interesting to see if New Labour can think of something better. But I suspect that New Labour will not change the British educational system very much.'

Recently 4 year degrees were introduced in British Universities. Also many people think that for most mathematical fields the normal 3/4 year Ph D period is not enough to produce original work of some quality. Mathematics is becoming a more and more demanding subject.

Is there a way out? Will curricula have to be revised possibly implying earlier and further specialisation? What is your opinion?

'The 4-year option for a mathematics degree in Oxford is just beginning. But it will be hard for the student to decide (as he must do, I think, early in his second year) whether to take the 3-year or the 4-year degree. Also there is a "quota" or "numerus clausus" for the 4-year degree, which may lead to difficult decisions if too many students opt for this.

I think that this is not a very good plan. I would prefer something like the Scottish system: the degree would take 4 years, the first year course being more elementary than the first year of a normal English university course, but less specialized; the student would take 3 or 4 subjects at first year level (e.g. physics, chemistry, mathematics) and would enter a specialized honours course in one of these subject only in the second year. Many students at school really do not know what subject suits them best, and there is a great advantage in delaying the choice until they have a year's experience of university work.

Regarding Ph D's, it is true that 3 years is often not enough, especially if it takes at least a year to acquire the specialized knowledge to understand the research problem! I do not know how to get round this within the British system, except by spending more money on Ph D grants.'

You are now retired and seem to be enjoying it. You go on giving plenty of invited talks, publishing research papers and we have seen some texts you wrote recently.

Would you mind telling us about your present experience?

'Well, yes, I am! I remember being surprised that when Philip Hall retired, he stopped doing mathematics – he said he wanted to pursue his interests in history. In my case I have had no doubts that I want to go on doing mathematics, and being a part of the international mathematical scene, as long as possible.

Sometimes I am surprised that I am so busy in retirement. But I should not be surprised; this happens because I wish it to be so. It is important to me to keep in contact with other mathematicians, and so I go to more meetings now than I did when I was teaching. I am still very interested in the development of mathematics.

I have read that Marcel Proust approved of the motto "Travaillez pendant que vous avez la lumière". I have a wife who refuses to grow old. These are examples which I want to follow.'

## Gallery

### José Sebastião e Silva

Sebastião e Silva was born in Mértola in the Alentejo on 12th December 1914. He was awarded a degree in Mathematical Sciences from the Faculty of Sciences in Lisbon in 1937, in which he gained high marks; nevertheless, it was only in 1942 that he was taken on as Assistant Lecturer in that Faculty. A five-year delay at this very important period in the research career could have had serious consequences, but its effects were mitigated by the support he received from António Aniceto Monteiro, at that time Director of the Centre of Mathematical Studies in Lisbon. It was as a collaborator with this Centre that Sebastião e Silva published his first articles in the journal *Portugaliæ Mathematica* in 1940 and 1941 (thirty years later, some of these articles, on the solution of algebraic equations, became the starting-point for famous specialists in the area of Numerical Analysis, and continued to be quoted in 1996 and 1997).

José Sebastião e Silva

With a grant from the Instituto de Alta Cultura, he was able to work in Rome for four years (1943-46). Despite the war and Nazi occupation, Sebastião e Silva considered this to be a very important period of his life, in both scientific and human terms. He had the opportunity to meet respected Italian mathematicians – F. Henriques, G. Castelnuovo, F. Severi, M. Picone, L. Fantappié – and other great names of science, literature and the arts.

His research in Italy resulted in various articles, and two large-scale works of great depth and breadth, one in the area of Mathematical Logic, and the other in Functional Analysis. Both of these had originally been intended as a Doctorate Thesis. The former, *Towards a General Theory of Homomorphisms*, was only published posthumously, forty years after being written, but is, in the recent opinion of scholars, a work of great originality, containing a wealth of ideas, which continue to be of interest today. It was his second work, *Analytic Functions and Functional Analysis*, which was, for circumstantial reasons, eventually presented as a Doctorate Thesis at the Faculty of Sciences in Lisbon, in 1949. Published later in the *Portugaliæ Mathematica* in Portuguese, it aroused great interest and led to important work by G. Köthe, A. Grothendieck, and others.

He was appointed Full Professor of the Instituto Superior de Agronomia, where he remained for 10 years, teaching General Mathematics and Infinitesimal Calculus and Probabilities always with the interests of this institution at heart. This decade was a period of intense research, during which he gained international renown as an analyst, receiving many invitations from prestigious universities (Rome, Oxford, Heidelberg, Maryland, etc). His most significant contributions (which were in the theories of analytic functionals and distributions, and Symbolic Calculus) influenced the development of Functional Analysis during at least two decades, and some of his concepts (Silva spaces, ultradistributions etc) have an established place in this branch of Mathematics. In the meantime, he had become director of the Centre for Mathematical Studies in Lisbon, where he trained many researchers. In 1960 he was appointed, by invitation, Full Professor of the Faculty of Sciences in Lisbon, where he remained until the end of his life, teaching the History of Mathematical Thought (a course that was much admired due to his vast culture and exceptional teaching abilities) and Higher Analysis. He revolutionized the syllabus, introducing new teaching methods and preparing texts that were considered exemplary in both content and form.

He also restructured the teaching of Mathematics during the final years of the pre-university course, which had great repercussions upon the public at large. Recognising the importance of this task on the national level, he devoted much effort to it in the last years of his life, with admirable results. However, unfortunately, the great advances he had made in this area were distorted by subsequent generations.

Sebastião e Silva died in the Portuguese Cancer Institute on 25th May 1972 at the age of 57. In the opinion of A. Aniceto Monteiro, he was the greatest Portuguese mathematician (cf. Ruy Luís Gomes, Boletim da S.P.M., nº 6). Those who were fortunate enough to be amongst his disciples were impressed not only by his rare professional stature, but also by his character, his generosity in helping and stimulating students at the beginning of his career, and the immense courage he revealed at the end of his life, working with enthusiasm despite suffering. Sebastião e Silva was truly a great man.

Lisbon, September 1997

J. Campos Ferreira
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