

CESAME

Centre for Systems Engineering and Applied Mechanics

ACTIVITY REPORT

1998

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FOREWORD

The Centre for Systems Engineering and Applied Mechanics (CESAME) was founded in 1990 as an interdepartmental Research Centre of the School of Engineering at the Université Catholique de Louvain. Its research activity ranges from the more theoretical to the very applied projects. The major disciplines covered are mathematical modelling and numerical simulation of a wide range of physical and human-made systems and of production processes, the monitoring and control of dynamical systems, as well as the numerical and computational complexity aspects related to these areas. The applications activities of CESAME cover a spectrum too broad to be listed, ranging from the modeling of eye movements to the industrial production of crystals.

In 1998, CESAME has pursued its three fundamental missions which are

- the development of fundamental research in its core disciplines;
- the transfer of technology to the private and public sectors;
- the training of young researchers through the organization of postgraduate schools and seminars, and the invitation of international scholars.

The fundamental research activity at CESAME has been supported in 1998 by some important public research funding programmes, including two Interuniversity Poles of Attraction (IPA) of the Belgian Federal Government, two Concerted Research Actions of the French Community Government, and a range of European programmes. The output of this research activity is essentially to be seen in the publications section of this report. In a nutshell, let us just state that in 1998 CESAME has produced 2 books (as editor), 10 book chapters, 32 journal papers and 61 published conference papers.

Our activity in technology transfer is evidenced by the 13 industrial research contracts listed in Section 7 of this report. In addition, in 1998 CESAME was active in seven European research programmes involving industrial partners.

The training component of our activity consists in the first place of the day to day contacts between the PhD students and their supervisors. But in addition, CESAME endeavours to create a research environment that is both stimulating and formative. The year 1998 has been highlighted by the creation, under CESAME's leadership, of a second interuniversity post-graduate school named GRASCOM, for Graduate School in Computational Mechanics. Just like the existing Graduate School in Systems and Control, it is organized on a national level. In addition, in 1998 CESAME has organized an impressive list of seminars, which are listed in Section 5 of this report. Finally, CESAME has continued to be a focal point for visitors with about 50 visits received for periods ranging from one or two days to a full year.

A special event worth mentioning in 1998 has been the opening up of CESAME to a limited number of international level researchers from other Belgian universities. As a result, Professors Vincent Blondel and Rodolphe Sepulchre, both from the Université de Liège, have become full-fledged members of CESAME in 1998.

Michel Gevers
Chairman of CESAME

1. Personnel

1 Academic staff

BASTIN Georges
BLONDEL Vincent
CAMPION Guy
CROCHET Marcel
DOCHAIN Denis
DOGHRI Issam
DUPRET François
GENIN Yves
GEVERS Michel, President of CESAME
GOREZ Raymond
INSTALLE Michel
KEUNINGS Roland
LEFEVRE Philippe
LEGAT Vincent
MUND Ernest
NESTEROV Yurii
SEPULCHRE Rodolphe
VAN DEN BOGAERT Nathalie
VAN DOOREN Paul
WERTZ Vincent
WILLEMS Pierre Yves
WINCKELMANS Grégoire

2 Academic and post-doctoral visitors

ACHHAB Elarbi	04/05/98 - 31/12/98
BERNARD Olivier	
EL GHAOUI Laurent	21/04/98 - 19/05/98
GOMEZ Guillermo	12/08/98 - 31/12/98
KLAN Peter	01/10/98 - 31/12/98
PENGOV Marco	01/09/98 - 31/12/98
REGNIER Vincent	
ZEALOUK Lahbib	15/09/98 - 31/12/98
WAPPEROM Peter	01/07/98 - 31/12/98

3 Temporary scientific staff

ANSAY Pierre (External member)	
BENAYAD Mohammed	01/01/98 - 01/06/98
BEN NAOUM Lamia	01/03/98 - 30/06/98
BOMBOIS Xavier	
BRASSEUR Eric	
CHEN Libei	
CODRONS Benoît	
DANTINNE Gary	
DAUTREBANDE Nathalie	
DAVID Benoît	
de BROUWER Sophie	
GALLEZ Xavier	
GIRAUD Laurent	01/01/98 - 31/10/98
GROGNARD Frédéric	

GROSSO Massimiliano	01/01/98 - 31/10/98
HADJILI Mohamed	
HENRY Philippe	
HALIN Pierre	
JACMIN Pierre	01/01/98 - 01/03/98
JEANMART Hervé	
JEGGY Cécile	
JOPART Xavier	01/01/98 - 30/06/98
LECOMTE Christophe	01/11/98 - 31/12/98
LENDASSE Amaury	01/09/98 - 31/12/98
LIELENS Gregory	
MAGOTTE Olivier	
MOENS Luc	
MOTTE Isabelle	
MUNHOVEN Serge	
NIKOLOV Svetoslav	
OLIVARI Elisabetta	01/01/98 - 15/09/98
OLIVIERS Matthieu	01/01/98 - 20/04/98
OMNES Thierry	01/01/98 - 30/09/98
OUAAR Amine	
PARRINI Simone	
PLOUMHANS Paul	
SIZAIRE Renault	
STANCIULESCU Cristina	
THIRIFAY François	01/09/98 - 31/12/98
VAN RUTTEN Natasha	01/01/98 - 31/08/98
VERMAUT Vincent	01/01/98 - 31/03/98

4 Administrative and technical staff

DE BOECK Lydia	Secretary (half-time)
DE RUYVER Michel	Technician (half-time)
DE WAN Michel	Technician
DONDERS Guido	Computer analyst
HISSETTE Isabelle	Secretary (half-time)
LAMISSE Laurence	Adm. Assistant
LOOCKX Edward	Technician
MULEMANGABO Edmond	Computer scientist
SERGANT Michèle	Secretary
TERMOLLE Michèle	Secretary
VERMEULEN Victor	Technician

2. Research activities

The reference numbers at the bottom of each activity refer to the publications lists in Chapter 4 of this report.

1 Linear systems and control design

1.1 Autotuning of PID controllers

(R. Gorez)

This research, initiated by a SSTC fellowship given to Dr. G. Calcev, was pursued in the frame of a Copernicus project funded by the European Commission.

Keyword : Control

Reference : 98.60

1.2 Iterative controller tuning

(B. Codrons, F. De Bruyne, M. Dewan, M. Gevers)

A state of the art paper on the Iterative Feedback Tuning scheme, developed at CESAME in 1994, covering both the theory and applications, has been published as an invited paper in the IEEE Control Systems Magazine. This iterative controller tuning scheme has also been applied to the tuning of a non linear controller for an inverted pendulum with a flexible transmission.

Keyword : Control

References : 97.86, 98.65

2 Predictive and LQG control

(P. Ansay, F. De Bruyne, M. Gevers, V. Wertz)

Using the Youla-Kucera parametrization of all stabilizing controllers of a given plant as a technical tool, the continuity of the Linear Quadratic Gaussian (LQG) controllers with respect to small changes in the model has been studied in the context of iterative identification and control design, where typically a sequence of small model changes results in a sequence of corresponding controller changes. This continuity result has been exploited in a procedure developed for the enhancement of the robustness of Generalized Predictive Controllers (GPC) using this Youla-Kucera parametrization.

In a completely different vein, we have observed some interesting similarities between some predictive control formulas used in GPC and formulas that occur in subspace identification. On the basis of this observation we have been able to derive a method for the direct calculation of GPC or LQG controller gains directly from input-output data, without the use of a model. This work has been performed in collaboration with the ESAT team at KUL within the framework of our IUAP-4/2.

Keywords : Identification, control

References : 96.47, 97.98, 98.70, 98.92

3 Nonlinear dynamics and control

3.1 Stabilization of feedforward systems

(G. Bastin, F. Grogard, R. Sepulchre)

The global stabilization of nonlinear systems has been the subject of an important literature over the last decade and significant progress has been made towards the development of systematic design methods. Most of the results have been obtained by exploiting certain triangularity properties of the considered systems. Namely systems which are in a lower triangular feedback form and systems which are in an upper triangular feedforward form. We have shown that the semi global stabilization of a large class of feedforward nonlinear systems is achieved by low-gain linear feedback provided that the separation of the

gains is sufficient. Particular situations have been identified where the tuning of the gains only requires increasing powers of a single parameter.

We have also shown that the global stabilization of a class of feedforward systems having an exponentially unstable Jacobian linearization may be achieved with a high-gain feedback saturated at a low level. The control law forces the derivatives of the state variables to small values along the closed loop trajectories.

Keyword : Control systems.

References : 98.2, 98.119, 97.12, 98.22, 98.54

3.2 Wiener Hammerstein and polynomial nonlinear systems

(D. Netic, G. Bastin)

The algorithmic approach to testing properties of polynomial systems is general but computationally expensive. By using the structure of the system one may obtain much simpler conditions and tests for different system properties. Moreover, simpler systems often give a very good insight into the difficulties that one may face when investigating properties of more general systems.

We have established necessary and sufficient conditions for the existence of stabilizing time-optimal dead-beat controllers for planar systems and simple Wiener-Hammerstein systems.

References : 95.56, 95.07, 97.85, 97.78, 98.08

3.3 Modelling and control of nonholonomic systems

(G. Bastin, G. Campion, I. Motte, A. Benayad)

Most control laws for wheeled mobile robots are based on the rather unrealistic assumption that ideal kinematic constraints are satisfied. It is possible however to analyse the robustness of the closed-loop performance when ideal model based control laws are applied to realistic models of the robot. The analysis tool is the singular perturbation theory. We address the problem of modifying the ideal model based laws in order to take into account the dynamics relative to the contact ground/wheels, which are neglected in the ideal model. The results we have achieved are the following : - For any control law there exists an attractive invariant "slow manifold" - There exists a feedback control law achieving input-output linearization of the system on the associated slow manifold. - There exists a feedback control achieving asymptotic stability for the tracking error dynamics. This law takes into account the characteristics of the full robot model but does not require explicit measurement of the slipping velocities. We have also addressed the problem of selection of the optimal velocity profile for a mobile robot following a given geometric path. Different performance indices are considered (minimum time, minimization of the centripetal acceleration, ...) Using the "differential flatness" property these problems reduce to the selection of an optimal function of the curvilinear coordinate along the path.

Keywords : Modelling, control

References : 98.56, 98.81

4 System Identification

4.1 Identification and validation for robust control design

(P. Ansay, X. Bombois, B. Codrons, F. De Bruyne, M. Gevers, C. Kulcsar, G. Scorletti, V. Wertz)

The pioneering work of CESAME on system identification for robust control has continued in 1999 with progress made on a broad range of questions. The main novelty in 1999 has been the development of a control-oriented model validation theory. A new validation tool, initially developed by L. Ljung for the validation of open-loop models, has been extended to closed-loop validation and to controller validation. A thorough analysis of the connections between the validated sets (in the sense of set membership identification and validation) and robust stability and robust performance analysis tools have led to propose validation design guidelines. A key technical tool in this context is the new ν -gap, which measures the distance between two systems. This tool has been extended to the concept of worst case gap, which

measures the worst possible distance between a model and a set of validated plants. Our results now allow one to select the best among a set of validated model sets, or to determine a priori whether a specific controller stabilizes all models in a validated model set.

In addition to these new results on model validation for control, our work in 1999 has produced the following advances :

- Our study of iterative identification and control design has allowed us to propose some experiment design guidelines that will safeguard against instability mechanisms or unacceptable transient behaviour.
- The connections have been established between model or controller reduction and control design based on the identification of a low order model.
- In the context of identification for control, various techniques for closed-loop identification have been developed or studied, including a technique that is applicable to nonlinear systems or systems under nonlinear control.

Keywords : Identification, control

References : 98.23, 98.28, 98.32, 98.33, 98.48, 98.69, 98.72, 98.73, 98.91, 98.106.

4.2 Identification of non linear systems

(G. Bastin, B. David)

An original method based on the maximum likelihood framework is used for parameter estimation in nonlinear dynamical systems with highly autocorrelated output errors. The method relies on an exact formula of the inverse covariance matrix of an autoregressive stochastic process which uses the Goberg-Semencul explicit inverse of a Toeplitz matrix. It is shown that the statistical properties of the estimated parameters are greatly improved with this method.

Keyword : Identification

References : 98.94

4.3 Nonlinear identification using fuzzy models

(V. Wertz, M. Hadjili, A. Lendasse)

Non linear identification is still a widely open research area, when no specific nonlinear model structure can be obtained from prior analysis. Neural networks or Fuzzy Models are appealing model classes since they can capture most of the nonlinear effects in a model. However, a great number of design choices still need to be made, and there is still little understanding of the influence of these design choices on the performance of the model. For a particular class of fuzzy models, namely linear Takagi-Sugeno fuzzy models, a study of those design choices has been performed in collaboration with Prof. S. Yurkovich (Ohio State University, Columbus, OH)

Keyword : Identification

References : 98.50, 98.09

5 Fuzzy control

5.1 Fuzzy predictive control

(V. Wertz, M. Hadjili, G. Scorletti)

Linear predictive control is by now a standard tool in many industrial control softwares. The extension of predictive control ideas to nonlinear models is still a lively research area. An interesting extension is to consider predictive control applied to linear TS fuzzy models. This class of fuzzy models basically consists in defining a nonlinear model as a smooth interpolation between linear submodels. For this class of fuzzy

models, we have previously derived stabilizing fuzzy state feedback controllers. Now, we investigate the stability and performance of several scenarios for predictive control of linear TS fuzzy models.

Keyword : Control

References : 98.25

6 Analysis and control of infinite-dimensional systems

(S. Bourrel, D. Dochain, P. Ligarius, R. Sepulchre)

Research in the field of infinite-dimensional systems, and more specifically in the field of distributed parameter systems, is becoming a research activity of growing importance in the CESAME. Presently a large part of the activity is dedicated to the modelling, dynamical analysis, monitoring and control of a class of distributed parameter systems, namely chemical and biochemical processes in tubular reactors. This research activity is carried out partially in collaboration with the following partners : Joseph Winkin (FUNDP), Jean-Pierre Babary (LAAS-CNRS, Toulouse), Elarbi Achhab (El Jadida, Maroc).

The following topics are under study and have been the object of publications :

- Dynamical analysis (stability, approximate observability and reachability) of plug flow and axial dispersion tubular reactors for sequential reactions, and of nonlinear non isothermic tubular reactors.
- Sensor location in axial dispersion tubular reactors, via observability of the distributed model and the conditioning number of the observability matrix of lumped approximation of the tubular reactor model.
- Dynamical modelling and analysis of settlers and fluidized bed reactors.
- Design of monitoring and control algorithms for tubular reactors. Application to a denitrifying biofilter for drinkable water treatment.

Keyword : Control

References : 97.03, 97.07, 98.01, 98.29, 98.49, 98.61, 98.83, 98.95, 98.108, 98.112.

7 Biomedical engineering.

(Ph. Lefèvre, S. de Brouwer, P.Y. Willems)

Our approach to biomedical engineering focuses on the application of systems analysis methodologies to the investigation of the neural control of movement.

7.1 Gaze orientation

This project aims at studying the mechanisms underlying the neural control of movement, interacting with vision. This research investigates the cooperation between stabilizing reflexes and pure orienting mechanisms, with particular attention to the coordination of imbedded platforms. During the year 98, we pursued the ongoing projects and started new studies.

The oculomotor system is characterized by the interaction between peripheral reflexes and central motor commands of visual origin. The dynamical properties of the oculomotor plant are very simple, thus it is a good testing bench for studying interfaces between sensory and motor systems in the brain. Moreover, in gaze orientation, combined eye and head motions are good examples of the control of imbedded platforms. In more details, we extended the development of a new two-dimensional model of the gaze control system, including the Superior Colliculus (SC) and the Cerebellum (CBLM). At the same time, we started a new project on the experimental and theoretical study of the interaction between saccadic and smooth pursuit eye movements. This was investigated in the cat and we plan to try to extend our findings to the human.

References : 98.125, 98.126

7.2 Analysis of pathological human gait

New results have been obtained in the modelling of human body joints. In particular an involute-plane model has been developed for the knee joints; this completes the kinematic description of the synovial joints of the limbs. Further, the parameters appearing in the various models can now be estimated by non-invasive methods by use of the SELSPOT system and the obtained accuracy is fully compatible with the requirements of the gait investigations.

Improvements have been obtained for the modelling of the neuro-muscular system. In particular, the model we developed for pseudo-static movement (and the investigation of its stability), has been extended and it now permits to consider the effect of energy storage in the muscle itself when large changes of movement are occurring.

References : 98.99, 98.100

8 Multicriteria decision support tools with applications to sustainable development issues

(M. Installé, C. Stanciulescu)

Sustainable development issues often require the processing of not well defined mathematical models with qualitative/quantitative criteria of various aspects : economic, social, ecological,... Such models are needed in order to assess the long-term impact of various strategies - i.e. dynamic resources allocation schemes - on the above-mentioned criteria. The criteria themselves are often difficult to describe in a precise way because of the lack of knowledge about, for example, the technological progress in the future. Hence, the present (doctoral) research explores new ways to integrate those lacks of knowledge in the models through the use of fuzzy concepts (fuzzy numbers, fuzzy relationships, ...). As an application, the issue of land allocation strategies in order to develop sustainable agricultural activities - i.e. strategies that minimize the loss of nitrogen in the aquifers while insuring a suitable income for the producers - has been analyzed through the (partially) implemented decision support tools and discussed with agricultural scientists.

Keywords : Modeling, numerical methods and algorithms, applied mathematics, environment.

References : 98.140, 98.141, 98.142, 98.143, 98.144, 98.145

9 Applications of modeling, identification and control

9.1 Chemical processes

(G. Bastin)

The design of new state feedback algorithms for exothermic chemical processes with saturated control has been carried out. These algorithms are robust against partial modelling uncertainties in the chemical kinetics. A major achievement was to extend these algorithms to the output feedback regulation of minimum phase reactors, under a full kinetic modelling uncertainty.

Reference : 98.34

9.2 Biochemical processes

(G. Bastin, O. Bernard, S. Bourrel, D. Dochain, P. Ligarius, D. Nestic, P. Van Rollegem)

During the last few decades the science of industrial biotechnology has undergone rapid development. The scope of the field includes biotechnological production processes or fermentation processes, in which a considerable diversity of products are produced (e.g. food products and components, pharmaceutical products), as well as biological wastewater treatment processes, the most important of which is the activated sludge process.

The activity concentrates mainly on model-based optimization and control of microbial conversion processes, as well as on water and wastewater treatment (anaerobic digestion, activated sludge, lagoons) processes. Part of this latter activity is related to distributed parameter systems. The motivation for model-based optimization and control is that model-based solutions to process optimization and control

problems are superior in performance and robustness as compared to plain heuristic approaches. Process optimization is aimed at by creating optimal environmental conditions for the cell. Therefore, this line of research is fully complementary to process optimization by genetically modifying the cell itself. As for wastewater treatment, anaerobic digestion (in the context of soil decontamination) and activated sludge processes have been the object of the development of software sensors to predict the time evolution of toxic matter in the first instance, and the pollutant concentration (BOD) and biomass concentration in the second instance. For the lagoons, we have a dynamical model based on three populations (micro-algae, aerobic bacteria, sulfato-reducing bacteria) in order to predict the behaviour of the process, in particular with the objective to detect and prevent odours due to the unbalance between the populations and the subsequent emission of H_2S .

The optimization of the operation of bioreactors is an interesting open problem with great potential economic benefit. To solve this problem, we have shown that a peak seeking method can be applied to approach the maximum production rate in continuous stirred tank reactors. The steady state of the process can be characterized by a non-monotonic map relating the biomass production to the dilution rate which is the control input. The purpose of the peak seeking method is to iteratively adjust the dilution rate in order to steer the process to the maximum of the map which corresponds to a maximum productivity.

In the model identification problem for bioprocesses, the most difficult task is the structural modelling of the reaction rates. A new methodology has been proposed to address this problem. A structural criterion is proposed to test structural assumptions against experimental data. As a benchmark for modelling studies in biotechnology, a mechanistic model for the production in a bioreactor of vanillin by the fungus *Pycnoporus cinnabarinus* has been developed.

Keyword : Optimization

References : 95.78, 95.79, 97.84, 98.90, 98.51, 98.79, 98.110, 98.111, 98.77, 97.63, 97.74, 97.80, 98.52, 98.78, 98.82, 98.35, 98.123, 98.124.

9.3 Nonlinear multivariable control of cement mills

(G. Bastin, V. Wertz, R. Sepulchre, F. Grogard)

In this application, we study multivariable nonlinear control strategies for a cement grinding circuit. We have shown why nonlinear control is required in order to deal with typical unmeasured perturbations (hardness change of the clinker). A nonlinear model based on material balances has been developed and shown to reproduce correctly the effect of hardness changes. Subsequently we have compared two alternative strategies: a nonlinear predictive controller and a state feedback controller based on Lyapunov design. The first control strategy is similar to the LQG controller which has now been in operation for several years on some industrial grinding circuits, but avoids destabilization due to hardness changes (plugging). The second strategy aims at finding a controller with global stabilizing properties.

Keyword : Control application

References : 98.24, 98.55, 97.20

9.4 Electrical, mechanical and electromechanical systems

(G. Campion, R. Gorez)

Investigations on sliding mode control of robots have led to new results on PID-like control of mechanical systems.

References : 98.04, 98.60, 98.62, 98.113

9.5 Fault diagnosis and identification for gas turbine engines

(M. Gevers, G. Campion, P. Willems, G. Gomez)

In the framework of a Brite Euram project we have developed a methodology for fault diagnosis and isolation for gas turbine engines. The engine is described by a complex steady state model involving more than 20 state variables, and characterized by 11 "health parameters". The problem is to detect, from

measured data, possible changes of these parameters from their nominal values. We are now developing a statistical detection/isolation procedure based on the local asymptotic approach.

10 Numerical methods in systems and control

10.1 Periodic systems

(J. Sreedhar, P. Van Dooren)

Dynamical systems with periodic coefficients are very similar to time invariant systems and yet numerical techniques that try to exploit this have only recently been developed. In this project we exploit the periodic Schur form of a sequence of matrices and develop several new numerical techniques for periodic systems. We derive minimal order representations of periodic systems and show how to characterize periodic deflating subspaces. We also discuss their relevance in controlling periodic systems.

Keywords : Periodic systems, deflating subspaces, numerical methods

References : 98.03, 98.67, 98.105

10.2 Robustness measures

(Y. Genin, Y. Nesterov, P. Van Dooren, R. Stefan)

Robustness of dynamical systems is often linked to structured perturbations. In such cases one wants to compute exact bounds for such structured perturbations before stability is lost. This problem is shown to be a non convex optimisation problem but for a large class of problems the exact bound can be reduced to the computation of the H_∞ norm of an associated transfer function. We then develop quadratically convergent schemes for computing these norms. When the structure becomes more complex the computation of these norms turns out to be NP complete but we develop polynomial time schemes to approximate these norms. We consider convex optimization problems over positive polynomials and show their relevance in systems and control.

Keywords : Robust control, convex optimization, numerical methods

References : 98.59, 98.66, 98.88

10.3 Model reduction

(P. Van Dooren)

Large scale models of dynamical systems typically come from discretisations of continuum problems and often have a particular sparsity structure. This project develops schemes that construct lower order models at low computational cost and exploit the sparsity of the original large scale model. We analyse the stability of the lower order models and show how to build good approximations for particular frequency ranges of the corresponding transfer function. These schemes are particularly suited for parallel implementation and are important for fast simulation of large scale systems as encountered in models of solid state devices or power plants.

Keywords : Model reduction, Krylov methods, large scale systems

References : 98.68, 98.6, 98.18

10.4 Orthogonal transformations and invariants

(P. Van Dooren, R. Sepulchre)

Orthogonal transformations play an important role in system analysis of state-space models. We give a survey of the (orthogonal) singular value decomposition and its use in systems and control. We also show the relevance of orthogonal transformations in the solution of two point boundary value problems with periodic solutions. We finally show how to interpret the shift policy in the (orthogonal) QR algorithm as a particular control problem.

Keywords : Orthogonal decomposition, eigenvalue problems

References : 98.07, 98.12, 98.105

11 Complexity of dynamical systems and control

(V. Blondel)

Many crucial questions in systems and control are simple to state in mathematical terms but are as yet unsolved. In this long-term project we investigate systems and control questions in the framework of computational complexity. The project has thus both a theoretical flavour (from the computer science side) and strong practical motivations (from the engineering side). This research direction was launched in 1994 and has since then led to significant developments.

In 1998, we have put significant efforts on attempts to prove Sontag's conjecture that the stability of systems with componentwise nonlinearities is undecidable. These attempts have resulted in a preliminary result for piecewise affine systems. The more important case of *continuous* piecewise affine systems is now under investigation and it seems that we are close to proving the conjecture.

Efforts have also been made to collect, unify and synthesize the presently available results on complexity of control problems. These efforts have allowed us to identify central unsolved problems that have implications for many problems in control. In particular, it came as a surprise that the decidability and complexity of several questions on *linear* systems are in fact unsettled. This has resulted in a 50 page survey paper which has been widely distributed and has been downloaded more than 200 times from our publication website.

It is fair to say that during the last five years the field of complexity of control has grown into a discipline that tends to have its own consistence and coherence, and that has started generating meaningful difficult questions.

References : 98.116, 98.117, 98.118, 99.70, 99.41

12 Automata and the partial realization problem

(V. Blondel).

Discrete Event Systems (DESs) are dynamical systems whose dynamics is event-driven as opposed to time-driven. An event corresponds to the start or the end of an activity. Typical examples of DESs are telecommunication networks, parallel processing systems and flexible manufacturing systems. In general, models that describe DESs are nonlinear. This is the case of Petri net models for example. There exists, however, subclasses of DESs for which the model becomes linear when formulated in a particular algebra. The basic operations of the max-plus algebra are maximization (represented by \oplus) and addition (represented by \otimes). Event graphs are particular DESs that can be described by a state space model of the following form:

$$x(k+1) = A \otimes x(k) \oplus B \otimes u(k), \quad y(k) = C \otimes x(k), \quad (1)$$

where the vector x represents the state, u the input vector and y the output vector of the system. The minimal realization problem for max-linear DESs can then be formulated as follows:

Given the impulse response of a max-linear DES, find matrices A , B and C with the size of A as small as possible such that the model (1) describes the input-output behavior of the max-linear DES.

In spite of this simple formulation and of numerous attempts to find a simple solution to the problem, the minimal realization problem in the max-plus algebra is still an open problem. Together with Natacha Portier we have proved in 1998 that the problem is NP-hard, thus implying that it is doubtful that a polynomial time solution to the problem exists.

References : 98.115

13 Open problems in mathematical systems and control

(V. Blondel)

Open problems in mathematical systems and control was the topic of the First workshop on dynamical systems in Liège. This workshop was well attended and has attracted the attention of the control community. We have pursued our initiative on open problems by organizing a special session at the Conference on Decision and Control, December 1998, Florida, USA and by coediting a book with a list of more than fifty open problems:

V. Blondel, E. Sontag, M. Vidyasagar and J. Willems
Open problems in Mathematical Systems Theory
Springer Verlag, London-Berlin, 1999.

We have set up a website that contains the list of the problems of the book together with follow-up information, comments and, in some cases, (partial) solutions to the problems. The site is regularly updated. It has been accessed more than 400 times during the last three months.

References : 98.116, 98.133

14 Micro-Macro Approach in Computational Rheology

(R. Keunings, V. Legat, X. Gallez, M. Grosso, P. Halin, G. Lielens, R. Sizaïre)

The main new developments in this area have been the following:

(i) development and evaluation in rheometrical flows of new 1d and 3d closure approximations to the kinetic theory of non-linear dilute polymer solutions, (ii) a detailed theoretical study of hysteretic behavior in transient extensional flows of dilute polymer solutions [Sizaïre et al 1999], (iii) development, implementation, and validation of Lagrangian particle methods for the micro-macro simulation of transient flows in complex geometries, (iv) simulation of non-homogeneous flows of liquid crystal polymers using the exact and approximated Doi theory [98.58]

Keywords : Polymers, viscoelastic models, continuum mechanics, mathematical modeling, numerical simulation

References : 97.59, 98.45, 98.21, 98.86, 98.44, 98.58

15 Crystal Growth

(F. Dupret, N. Van den Bogaert, E. Olivari, R. Assaker, P. Jacmin, V. Wertz, V. Regnier)

The most important directions of the activity of this group have been (i) to analyze the effect of magnetic fields in semi-conductor growth, (ii) to investigate efficient methods to predict the influence of flow turbulence upon the global heat transfer in the furnace, (iii) to start developing a 3D software in order to analyse the melt flow, (iv) to start the setup of an experimental apparatus devoted to analyse the 3D transient melt flow, (v) to develop a viscoplastic model for calculating dislocation density and residual stresses in the crystal, (vi) to investigate defect formation in silicon crystals, (vii) to start developing an integrated software devoted to predicting the entire growth process (from seeding to tail-end and after growth stages), and (ix) to investigate regulation methods to control the Czochralski growth process. The research in (ix) has been performed within the frame of a contract with Wacker Siltronic company with the aim of developing a real-time control strategy. The FEMAG software is presently licensed to major crystal growth companies (Shin-Etsu Handotai, Komat'su Electronic Metals, Mitsubishi Materials, in Japan, and Wacker Siltronic, in Germany). FEMAG is also licensed to the strategic Japanese super-silicon research consortium (growth of 40 cm diameter crystals), and to INPACT company, in France (for indium phosphide growth, with an industrial thesis co-supervised by Dr. Van den Bogaert).

Keywords : Bulk crystal growth, numerical simulation, modeling

References : 98.157, 98.20, 98.159

16 Injection Molding

(F. Dupret, O. Mal, N. Van Rutten, C. Jeggy, O. Magotte)

As producing industrial moulds is very expensive and time-consuming, computer-aided engineering tools are becoming increasingly popular. This group has developed the MOLDSYS software, which is devoted to predicting the injection moulding process and its main variants on the basis of the lubrication approximation. A peculiar feature of the approach is to accurately track the flow front(s) and to handle the fountain flow effect during filling, even in the presence of geometrical singularities.

Part of the research effort has borne on enhancing the thermo-chemical module in MOLDSYS, and on developing a module for the simulation of Structural Reaction Injection Moulding, taking the effects of permeability and mechanical dispersion into account. At the same time, work has been going on concerning other main research topics : modelling and optimisation of the gate and runner system, prediction of fibre orientation (including closure approximations), transient temperature distribution in the tool, ... The extension of MOLDSYS to micro-injection, i.e. the injection of small or very small parts, with a tolerance in the micron range, has become a major goal. The BRITE European project started in 1997 ("The integration of computer modelling, mould design and the LIGA process for the micro-injection moulding of plastic parts") has been pursued. A general algorithm devoted to solve the flow and heat transfer problem on the evolving 3D domain has been designed, and a first version of the software has been developed to solve the Stokes problem.

References : 96.27, 96.57, 96.63, 96.56, 98.10, 98.11, 98.19, 98.155, 98.158

17 h-p Finite Element Method

(V. Warichet, V. Legat)

The goal of h-p adaptive finite element methods is to obtain an accurate approximate solution of differential equations within a preset error tolerance at the least computational cost. There are two major questions that must be solved in order to reach this goal. One is how to estimate the accuracy of approximate solutions when exact solutions are not available; the other concerns the control of computational cost to obtain the specified error tolerance. Warichet and Legat have considered, as the first part of this project, the issue of estimating the error of approximate solutions for viscoelastic flows in complex geometries. During the year 1995, they explored the performances of such an approach for the so-called FENE models and the free surface problems. In both cases, the challenge requires to adapt an approach mainly developed for linear problems to highly non-linear problems.

This requires both theoretical and numerical research. Finally, to control computational cost, one needs to develop an efficient adaptive strategy for obtaining near-optimal adaptive h-p meshes. The payoff is already considerable: exponential rates of convergence.

Reference : 97.31

18 Deformation, damage and fracture of engineering materials

(I. Doghri, R. Knockaert, S. Nikolov, S. Munhoven, L. Zealouk, A. Ouaar)

General research area : Mathematical modelling and numerical simulation - via the finite element method - of the deformation, damage and fracture of engineering materials in the non-linear regime.

Recent research projects : Development of a new computational algorithm for a family of metal plasticity models (Doghri). Investigation of strain localization due to damage for a class of elasto-plastic metals (Doghri and Billardon). Experimental and numerical study of fracture in double-edge notched steel plates (Knockaert, Doghri, Marchal, Pardoen and Delannay). Experimental and numerical analysis of damage and fracture in round, notched copper bars (Pardoen, Doghri, Knockaert and Delannay). Modelling and simulation of glass fracture by laser beams (Bousez, Doghri, Dupret). Analysis of an impact test using Wavelets and finite elements (Van Vyve, Antoine, Doghri, Goldberg). Development

of nonlocal, higher-order gradient theories in order to find a work around ill-posed strain localization problem (Knockaert and Doghri).

Current research projects : Development of micro-mechanically based constitutive equations for (1) and (2) fiber-reinforced concrete (Doghri, Ouaar, Thimus) semi-crystalline polymers (Doghri, Nikolov, Munhoven, Zealouk).

Keywords : Solid materials, modeling, simulation

References : 96.86, 97.113, 97.114

19 Micro-tip forming

(F. Dupret, S. Clain)

The research activity has been started in 1997, in order to investigate the formation of micro-tips and micro-blades by chemical erosion has been pursued. The theoretical analysis of the static stability of the planar or axisymmetric menisci that separate the eroding fluid from the atmosphere has been completed in the planar case. A publication is in preparation, and this research will be pursued to solve the axisymmetric case.

20 Lagrangian simulation of bluff-body flows

(G. Winckelmans, P. Ploumhans)

The numerical simulation of 2-D and 3-D flows past bluff bodies still constitutes a major challenge in Computational Fluid Dynamics (CFD): these flows are highly separated and unsteady, even at moderate Reynolds numbers. The aim of this research effort is the direct numerical simulation (DNS) of such flows, in 2-D and in 3-D, using the lagrangian vortex particle method combined with the boundary element method. These methods are ideal for such flows because computational elements are only required where vorticity is non-zero (i.e., near the boundaries of the body and in its wake). A second aim of the effort is the simulation of bluff-body flows at higher Reynolds number leading to turbulence, by adding some large eddy simulation (LES) capabilities to the above vortex method. At every time step, the velocity field induced by the vorticity field is computed using the Biot-Savart law. For N vortex particles, the classical approach requires $O(N^2)$ operations per time step. We have developed, both in 2-D and in 3-D, fast solvers based on multipole expansions and tree codes that have $O(N \log N)$ operations and run on parallel computers, thus allowing for very large problems. The treatment of the no-slip boundary condition at solid boundaries has been implemented in 2-D and is in the process of being implemented in our fast 3-D parallel code. This research project is done in close collaboration with the California Institute of Technology (Prof. A. Leonard and Dr. J. K. Salmon), Université Joseph Fourier, Grenoble (Prof. G.-H. Cottet) and ETH Zurich (Dr. P. Koumoutsakos). Access to parallel computing (on Deepflow: 16 processors Dec Alpha 533 Mhz) is provided locally by the ARC of Profs. R. Keunings and V. Legat.

Keywords : Numerical simulation, fluid mechanics, numerical methods and algorithms, applied mathematics, modelling

Reference : 98.149

21 Large Eddy Simulation (LES) of turbulent flows

(G. Winckelmans, V. Legat, H. Jeanmart, G. Dantinne)

The simulation of turbulent flows at moderate to high Reynolds numbers, and with interest in resolving the large-scale time-dependent coherent structures of turbulence, requires that methods be developed and validated that allow to capture as much as possible of the complexity associated with the Navier-Stokes equations in turbulent regime, while maintaining the computational grid at a level that can be handled by computers (memory, CPU time). The simulation of turbulent flows using the LES approach requires filtering of the Navier-Stokes equations and the use of a model to represent the effect of the small unresolved scales, lost through filtering. This project aims at developing subgrid-scale models that

are more universal than those existing, and at validating them in generic flows: isotropic turbulence: decaying or forced with white noise; non-isotropic turbulence: periodic unidirectional forcing (Kolmogorov flows), channel flow, sudden expansion flow, etc. The numerical techniques used are pseudo-spectral methods combined either with finite difference methods or with finite element methods. New LES models (such as the tensor diffusivity models) are being developed and validated for both the velocity-pressure and the vorticity-velocity formulations of the Navier-Stokes equations. The dynamic procedure is also developed for both formulations. This project is conducted in close collaboration with Dr. D. Carati of ULB, Prof. C. Lacor of VUB, Prof. P. Moin and associated researchers of the Center for Turbulence Research of Stanford University and NASA Ames Research Center, and Prof. A. Leonard of the Graduate Aeronautical Laboratories, California Institute of Technology.

Keywords : Numerical simulation, fluid mechanics, modelling, numerical methods and algorithms, applied mathematics

References : 98.146, 98.150, 98.147, 98.148, 98.151, 98.152

22 Lagrangian simulation of shear flows with combustion

(G. Winckelmans, F. Thirifay)

The numerical simulation of 2-D and 3-D reacting shear flows, at moderate to high Reynolds number still constitutes a major challenge in engineering and in CFD. The aim of this research effort is to develop and validate, both in 2-D and in 3-D, fully lagrangian methods to simulate such flows. Cases of interest are the space-developing shear layer and jet, in the regime of diffusion flames. Such flows are formed by the mixing of two streams (one with fuel, one with oxidizer) at different velocity. The chemical reaction occurs in the mixing region, where the fuel and oxidizer streams meet. This region is thus characterized by vorticity and chemical reaction. The lagrangian particule method is used here: particles carry information concerning both the local vorticity and the local fluid dilation (due to heat released by the chemical reaction). The thermodynamic pressure is assumed uniform (i.e., assumption of weakly compressible flow), but there are gradients of dynamic acceleration that are responsible for the baroclinic generation of vorticity within the flow. A method with non-uniform spatial resolution is developed, in order to minimize the number, N , of required particles. Moreover, fast codes, that are $O(N \log N)$ in computational cost are also developed. Finally, the 3-D codes are developed so as to also run on parallel computers. For high Reynolds number flows, the turbulence modeling is done through Large Eddy Simulation (LES) approaches. This research is conducted in collaboration with H. Najm of Sandia National Laboratories, California.

Keywords: Numerical simulation, fluid mechanics, numerical methods and algorithms, modelling, applied mathematics.

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- 98.56** BENAYAD M.A., G. CAMPION, V. WERTZ, M.E. ACHHAB, “Steering a mobile robot : selection of a velocity profile satisfying dynamical constraints”, submitted in *International Journal of Control*, 1998.
- 98.61** BOURREL S., D. DOCHAIN, “Dynamical Analysis of Distributed Parameter Bioprocess Models”, submitted to *Mathematical Modelling of Systems*, 1998.
- 98.62** GOREZ R., “Globally stable PID-like control of mechanical systems”, submitted to *Systems and Control Letters*, 1998.
- 98.63** FERRERES G., G. SCORLETTI, “Robustness analysis in the presence of time delays”, Submitted to *Automatica*, 1998.

- 98.64** SCORLETTI G., G. DUC, "An LMI Approach to Decentralized Ho Control", submitted to International Journal of Control (IJC), 1998.
- 98.70** W. FAVOREEL, B. DE MOOR, M. GEVERS AND P. VAN OVERSCHEE, "Model-free subspace-based LQG-design", submitted to IEEE Transactions on Automatic Control.
- 98.78** BERNARD O., G. BASTIN, C. STENTELAIRE, L. LESAGE-MEESSEN, M. ASTHER, "Mass balance modelling of vanillin production from vanillic acid by cultures of the fungus *Pycnoporus cinnabarinus* in bioreactors", submitted to Biotechnology and Bioengineering, 1998.
- 98.87** ACHHAB M.E., LAABISSI M., "Feedback stabilization of a class of distributed parameter systems with control constraints", submitted for publication in IEEE Transactions on Automatic Control, 1998.
- 98.90** PERRIER M., S. FEYO DE AZEVEDO, E. FERREIRA, D. DOCHAIN, "Tuning of observer-based estimators: theory and application to the on-line estimation of kinetic parameters", submitted to Control Engineering Practice, 1998.
- 98.93** NIKOLOV S., I. DOGHRI, "A micro/macro constitutive model for the small-deformation behavior of polyethylene", 1998.
- 98.94** DAVID B, G. BASTIN, "Maximum Likelihood Parameter Estimation in Dynamical Systems with Correlated Modeling Uncertainty", submitted to Automatica, 1998.
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- 98.96** PENGOV M., E. RICHARD, J.C. VIVALDA, "On global stabilization of nonlinear systems with continuous-discrete observers", submitted to Automatica, 1998.
- 98.97** KULCZYCKI P., R. GOREZ, "Almost certain time-optimal control via random differential inclusions", submitted for publication in Automatica, 1998.
- 98.99** BAO H., P.Y. WILLEMS, "On the kinematic modelling and the parameter estimation of the human shoulder", submitted to Journal of Biomechanics, 1998.
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- 98.120** AERNOUTS W., R. SEPULCHRE, D. ROOSE, "Delayed control of axial compressors", submitted to International Journal of Bifurcations and Chaos, 1998.
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- 97.12** GROGNARD F., R. SEPULCHRE, G. BASTIN, L. PRALY, "Nested linear low-gain design for semiglobal stabilization of feedforward systems", *Proc. IFAC NOLCOS Symposium*, Enschede, The Netherlands, pp. 829-834, July 1998.
- 97.48** BOURREL S., D. DOCHAIN, I. QUEINNEC, J.P. BABARY, "Adaptive linearizing control of a denitrifying biofilter", *Proc. CAB7*, pp. 579-584, 1998.
- 97.63** BERNARD O., G. BASTIN, "Modelling of biological kinetics using a new structural criterion", *Proc. CAB7*, Osaka, Japan, pp. 95-100, May 1998.
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- 97.78** NESIC D., G. BASTIN, "Stabilizing dead-beat controllers for two classes of Wiener-Hammerstein systems", *Proc. of IFAC Conference on System Structure and Control*, Nantes, France, pp. 345-350, July 1998.

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- 98.04** GOREZ R., "Sliding Mode Control as a First Step to Cascaded Control of Mechanical Systems", *CESA '98- IMACS Multiconference on Computational Engineering in Systems Applications*, Nabeul-Hammamet, Tunisia, CD Rom, April 1-4, 1998.
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- 98.08** BERNARD O., G. BASTIN, "Structural identification of nonlinear mathematical models for bioprocesses", *Proc. IFAC NOLCOS Symposium*, Enschede, The Netherlands, pp. 448-453, July 1998.
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- 98.113** YALA S., D. GRENIER, F. LABRIQUE, D. DOCHAIN, E. MATAGNE, “Compensation of the discretization effects in the control in park reference frame of VSI fed PM motors”, *proc. of the 8th International Power Electronics and Motion Control Conference (PEMC'98)*, Prague, Czech Republic, Vol. 5, pp. 36-41, September 1998.
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- 98.131** SEPULCHRE R., M. ARCAK, “On the stabilization of nonlinear cascade systems with right-half plane zeros”, *Proc. NOLCOS IFAC Symposium*, Enschede, in press, July 1998.
- 98.132** ABSIL P.A., R. SEPULCHRE, A. BILGE, R. POIRRIER, “Sleep apnea syndrome diagnosis by analysis of the cardiac interbeat RR time series”, *Proc. International Workshop on Advanced Black-Box Techniques for Nonlinear Modeling*, Leuven, Belgium, July 1998.
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- 98.138** RYCKAERT V.G., T. BOELEN, R. SEPULCHRE AND J.F. VAN IMPE, "Robustness of nonlinear observers", In: H.J.C. Huijberts, H. Nijmeijer, A.J. van der Schaft, J.M.A. Scherpen (Eds.), *Preprints of the 4th IFAC Nonlinear Control Systems Design Symposium NOLCOS'98*, pp. 812-817, 1998. [IFAC Nonlinear Control Systems Design Symposium NOLCOS'98, Enschede (The Netherlands), July 1-3, 1998]
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Accepted Conference Papers

- 98.140** INSTALLÉ M., "Engineering education for a more sustainable development", to appear in the Proceedings International Conference on Industrial Ecology and Sustainability, Troyes, France, September 1999.
- 98.141** STANCIULESCU C. ET INSTALLÉ M., "Multicriteria decision-making for agro-ecosystems planning under risk using fuzzy concepts", 50th Meeting of European Working Group 'Multicriteria aid for decisions', 28 septembre-2 octobre 1999, Cerisy-la-Salle, France.
- 98.142** INSTALLÉ M., "Introducing sustainability concepts in engineering curricula : a review and a synthesis of some implementations in European universities", to appear in the Proceedings of ENTREE '99 Conf. on "Sustainable use of natural resources - cooperative planning and actions", Tampere, Finland, November 99.
- 98.143** GAILLY B., M. INSTALLÉ, CH. SAUBOIN, "A new decision support tool for the choice of incentive strategies in multicriteria and multiactor decision problems", communication presented at the 3rd DAS Workshop and 8th Workshop of the DGOR Working Group of the IIASA, Laxenburg, Austria, February 1998.
- 98.144** INSTALLÉ M. ET D. DAUE, "Implementation and application of a negotiation support software that uses multi-objective programming techniques", Third Int'l Conf. on Multi-Objective Programming and Goal Programming : Theory and Applications", Québec, Canada, June 1998.
- 98.149** PLOUMHANS P., G.S. WINCKELMANS, J. K. SALMON, "Vortex particles and tree codes: I. flows with arbitrary crossing between solid boundaries and particle redistribution lattice; II. vortex ring encountering a plane at an angle", accepted for Proc. *Third International Workshop on Vortex Flows and Related Numerical Methods*, 24-27 August, 1998, Toulouse, France. To appear.

Submitted Conference Papers

- 98.48** BOMBOIS X., M. GEVERS, G. SCORLETTI, "Controller validation for a validated model set", Submitted to ECC 99, Karlsruhe, Germany, July 99.

- 98.54** BASTIN G., L. PRALY, “Feedback stabilisation with positive control of a class of dissipative mass-balance systems”, Submitted for presentation at Congress IFAC 99, Beijing, July 99.
- 98.66** GENIN Y., Y. NESTEROV, P. VAN DOOREN, “Positive transfer functions and convex optimization”, Submitted to ECC 97, Karlsruhe, Germany, 31 August 3 - September 99.
- 98.67** LIN W-W, P. VAN DOOREN, XU Q-F, “Periodic Invariant Subspaces in Control”, Submitted to ILAS 99, Barcelona, July 99.
- 98.70** FAVOREEL W., B. DE MOOR, M. GEVERS, P. VAN OVERSCHEE, “ Model-free subspace-based LQG-design, Submitted to ACC 99, San Diego, USA.
- 98.72** GEVERS M., B. CODRONS, F. DE BRUYNE, “Model Validation in Closed-Loop”, Submitted to ACC 99, San Diego, USA.
- 98.73** ANSAY P., M. GEVERS, V. WERTZ, “Identification with the Youla parametrization in identification for control”, Submitted to ACC 99, San Diego, USA.
- 98.74** FROMION V., G. SCORLETTI, “The behaviour of incrementally stable discrete time systems”, Submitted to ACC 99, San Diego, USA, June 99.
- 98.75** FROMION V., G. SCORLETTI, J.P. BARBOT, “Quadratic Observers for Estimation and Control in Induction Motors”, submitted to ACC 99 , San Diego, USA, June 99.
- 98.77** BERNARD O., Z. HADJ-SADOK, D. DOCHAIN, “Dynamical Modelling and State Estimation of Anaerobic Wastewater Treatment Plants”, submitted to ECC 99, Karlsruhe, Germany, July 99, 1998.
- 98.80** ACHHAB E., “On reachable states of a class of distributed parameter systems with control constraints”, submitted to ECC 99, Karlsruhe, Germany, July 99, 1998.
- 98.81** BENAYAD M.A., G. CAMPION, V. WERTZ, M.E. ACHHAB, “Time optimal steering for a mobile robot along a given path”, submitted at ECC 99, Karlsruhe, Germany.
- 98.83** BOUREL S. , D. DOCHAIN, “Dynamical Analysis of Tubular Bioreactor Models”, Submitted to ECC 99, Karlsruhe, Germany.
- 98.84** CORON J.M., B. D’ANDRÉA-NOVEL, G. BASTIN, “A Lyapunov approach to control irrigation canals modeled by Saint-Venant equations”, submitted to ECC 99, Karlsruhe, Germany.
- 98.88** GENIN Y., Y. NESTEROV, P. VAN DOOREN, “The central point of LMI’s and Riccati Equations”, submitted to ECC 99, Karlsruhe, Germany.
- 98.91** ANSAY P., M. GEVERS, V. WERTZ, “Closed-loop or open-loop models in identification for control”, submitted to ECC 99, Karlsruhe, Germany.
- 98.92** FAVOREEL W., B. DE MOOR, M. GEVERS, P. VAN OVERSCHEE, “ Closed loop model-free subspace-based LQG-design”, submitted to IEEE Mediteranean Conference on Control and Automation, Haifa, Israël, June 28-30, 1999.
- 98.105** VAN DOOREN P., “Two point boundary value and periodic eigenvalue problems”, submitted at CACSD Conference, Hawaii, August 99.
- 98.151** WINCKELMANS G. S., A. A. WRAY, O. V. VASYLIEV AND H. JEANMART, “New mixed models for LES in the velocity-pressure and vorticity-velocity formulations: truncated Leonard expansion supplemented by a dynamic Smagorinsky term”, submitted Nov. 1998 for *Isaac Newton Institute Symposium & Third ERCOFTAC Workshop on “Direct and Large-Eddy Simulation”*, May 12-14, 1999, University of Cambridge, England.
- 98.152** CARATI D., G. S. WINCKELMANS AND H. JEANMART, “Exact expansions for filtered-scales modelling with a wide class of LES filters”, submitted Nov. 1998 for *Isaac Newton Institute Symposium & Third ERCOFTAC Workshop on “Direct and Large-Eddy Simulation”*, May 12-14, 1999, University of Cambridge, England.

4. Teaching activities

1 Undergraduate and Graduate Teaching

1.1 Applied Mathematics

Numerical Methods

(R. Keunings, A. Laloux)

Errors and stability of computation - Roots of non linear equations and polynomials - Linear algebra : system solution; eigenvalue and eigenvector calculation - Interpolation - Numerical quadrature - Solution of ordinary differential equations.

Mathematics 1 to 4

(F. Dupret, V. Wertz, P. Habets, J. Boel, Ph. Delsarte, K. Peiffer, J.R. Roisin, J.P. Tignol)

This set of courses covers the basics of mathematics (mathematical analysis and algebra) for the first two years of the engineering degree.

Applied Mathematics

(R. Gorez, A. Laloux)

Continuous and discrete-time signals and systems. Fourier and Laplace transforms. z-transform and discrete Fourier transform. Linear systems analysis. Optimisation and linear programming.

Stochastic processes and estimation theory

(M. Gevers, L. Vandendorpe)

This course contains four parts : 1) a review of probability theory and random variables, 2) random processes, their properties and the modeling of such processes, 3) estimation theory and 4) the application of estimation theory to random processes (Wiener filters and Kalman filters).

Modelling and Analysis of Dynamical Systems

(G. Bastin, V. Wertz)

One of the basic courses in systems theory. Methods of mathematical modelling and analysis of dynamical systems are described with applications in various fields including electricity, mechanical systems, chemical, biotechnological and environmental processes.

Scientific computing on Parallel Computers

(R. Keunings)

Architectures, basic algorithms, applications in scientific computing.

Numerical algorithms

(B. Danloy, P. Van Dooren)

Introduction to numerical algorithms including aspects of round-off analysis, numerical stability, conditioning, convergence, complexity and parallelism.

Complexity of algorithms

(B. Danloy, P. Van Dooren)

This course develops techniques for analyzing the complexity of algorithms, emphasis is put on non-numerical algorithms such as sorting, pattern matching, divide and conquer and dynamic programming.

Numerical analysis Ia, Ib and II

(A. Magnus, P. Van Dooren)

These three courses cover a wide range of topics in numerical analysis : approximation theory, orthogonal polynomials, linear systems, complex analysis, ordinary and partial differential equations, finite element techniques.

Matrix theory

(P. Van Dooren)

This course covers the theoretical and numerical aspects of matrix theory. Topics include : Jordan and Schur forms of real and complex matrices, the singular value decomposition and its applications, perturba-

tion and localisation theorems, orthogonal transformations and decompositions, polynomial matrices and the Smith form, positive matrices and Perron Frobenius theory.

1.2 Mechanics

Physics I - Mechanics

(G. Champion, J. Govaerts)

Basic notions - Kinematics - Dynamics - Equations of motion - Statics, Energy considerations - Applications : gravitation and orbits, elementary fluid mechanics.

Physics II - Mechanics

(G. Champion, J.C. Samin, D. Johnson)

Statics(Beams, trusses) - Rigid bodies: mass geometry - Equations of motion. D'Alembert mechanics: principle of potential power (and virtual work) - Lagrange equations - Constraints.

Elasticity I

(I. Doghri)

The aim of this course is to show how the theory of elasticity is able to rigorously solve a large number of problems posed by equipment and structural design. While the majority of industrial problems are presently solved with numerical programs, it is essential for the student to learn how to solve a number of simple problems with analytical means and to understand the underlying physics. The course will develop problems related to torsion, bending, thermal stresses, etc...

Elasticity II : Finite elements methods

(V. Legat)

While the basic course of elasticity is limited to analytical solutions, the present course is devoted to the principles and the application of numerical methods for solving such problems. After preliminary chapters devoted to variational principles in elasticity, the course develops the contents of the finite element method. It is examined in some detail: selection of elements, numerical integration, solution, algorithms, etc. The course requires a number of hands-on applications and problem solving.

Non-linear mechanics of deformable solids

(I. Doghri)

Modeling and simulation of plasticity, visco-plasticity, non-linear elasticity, large deformations, etc...

Continuum mechanics

(F. Dupret)

This course develops the foundations of continuum mechanics. After a brief introduction including elements of tensor calculus, the principles governing the kinematics, dynamics and thermodynamics of continuous media are presented. The two following chapters are devoted to linear thermo-elasticity, and viscid and inviscid fluid mechanics.

Simulation of transfer phenomena in industrial processes

(F. Dupret)

- Numerical analysis of the heat equation with transport (finite element method). Stability of time integration. Problems related to the resolution of an advection-diffusion problem.
- Detailed modelling of a particular process (the choice varies from year to year : polymer injection; crystal growth ...). Simplification of the equations through dimensional analysis. Boundary layers and singular perturbation problems.
- Preparation of the student to the use of integrated softwares in industry.

Mechanics of composite materials

(R. Keunings)

Properties, processing, analysis and design.

Computer Aided Design in Mechanical engineering

(R. Keunings, V. Legat)

Computer Aided Design in Mechanical Engineering : computer graphics, CAD Systems, solid modeling, analysis software.

Fluid Mechanics I

(F. Dupret, G. Winckelmans)

General considerations about fluids and flows. The Navier-stokes equations for an ideal gas. Dimensionless equations and numbers. Irrotational planar flows of inviscid fluids. Conformal mapping. Joukowski profile . Kutta-Joukowski condition. Force and moment applied to an airfoil. Boundary layer : Prandtl equations. Blasius solution. Irrotational isentropic flow of an ideal gas. Perturbation potential. Pressure coefficient. Flow in a convergent - divergent geometry. Subsonic and supersonic flow around a thin profile. Transition. Description of turbulence Reynolds stresses. Mixing length. Universal velocity profile. Turbulent flow in a smooth cylindrical pipe.

Fluid Mechanics II

(F. Dupret, G. Winckelmans)

Similarity in fluid mechanics. Dimensional analysis. Vaschy-Buckingham theorem. Second law of thermodynamics for Newtonian fluids. Vorticity dynamics. Equation of the circulation. Vorticity production over a fixed wall. Three dimensional effects in inviscid fluids flows. Analysis of airplane stability in horizontal flight. Lift and drag. Optimal profile of circulation. Further considerations about the laminar boundary layer. The von Karman integral equation. Approximate solution by Polhausen. Friction coefficients along cylindrical obstacles. Control of the boundary layer in laminar flow. Detailed analysis of compressible perfect fluids. Characteristics surfaces in supersonic flow. The hodograph plane. Simple waves. Shock waves : Rankine-Hugoniot condition, shock polar. Turbulence. Mathematical approach of transition. Classical models of turbulence. Turbulent boundary layer. Truckenbrodt method.

Rheology

(R. Keunings)

Phenomenology of non-Newtonian flow. Constitutive equations for rheologically-complex fluids. Molecular kinetic theory of polymeric fluids. Introduction to computational rheology.

Numerical Methods in Fluid Mechanics

(G. Winckelmans)

Classification of partial differential equations (PDE) and of systems of PDEs: hyperbolic (including the characteristics with examples in gasdynamics), parabolic, elliptic, hybrid. Spatial discretization and finite differences. Integration schemes for ordinary differential equations (ODE) and discretized PDEs: stability, consistency, convergence, explicit and implicit schemes. Diffusion and convection equations: explicit and implicit schemes (ADI schemes), centered and upwind differences. Nonlinear convection: Burgers equation including capture of discontinuities. Hyperbolic systems, including the compressible Euler equations: capture of discontinuities (chocs), explicit schemes (Lax-Wendroff, Mac Cormack), implicit schemes, transformation from physical space to computational space, finite volumes. Numerical methods for incompressible flows: velocity-pressure formulation, staggered mesh, boundary conditions, artificial compressibility method, methods for unsteady flows; vorticity-velocity formulation: boundary conditions, methods for steady and unsteady flows, including the lagrangian method of vortex particles combined with the boundary element method.

1.3 Systems and Control

Automatic Control : Fundamentals

(R. Gorez, M. Installé)

This basic course is taught to engineering undergraduate students. It consists in classical automatic control theory (Nyquist, root locus, lead-lag compensators) and in an introduction to state variable feedback control.

Linear circuits and systems theory

(M. Installé)

This basic course is taught to electrical engineering undergraduate students. It is dedicated to classical network theory, including two-port network analysis.

Adaptive systems

(M. Installé)

The aim of this course is two-fold. First, to show what are the specifics of the adaptive approach through a number of examples in the fields of estimation, pattern classification and automatic control. Secondly, to study the performances of algorithms that are commonly used in such an adaptive approach (recursive least squares, stochastic approximation, random search, LMS, FIR and AR filters, MLP neural networks,)

Systems analysis applied to agriculture and environment

(M. Installé)

This course is taught to students in agronomy and shows how modelling and simulation techniques may be used to analyze agroecosystems in order to evaluate and improve their management strategies.

Calculus of variations and optimal control theory

(V. Wertz, M. Installé)

The first part of this course reviews some important results of variational calculus. Necessary conditions of Euler, of Weierstrass, sufficient conditions. The second part is devoted to optimal control theory. The general problem of Bolza without constraints is first dealt with, then the maximum principle, the Hamilton Jacobi theory and dynamic programming. Particular cases as e.g. linear quadratic optimal control are then studied.

Aerospace dynamics

(P.Y. Willems)

Review of mechanics : variable mass systems. Aerodynamical interactions. Aircraft kinematics and dynamics. Flight stability and control. Launchers and satellites.

Modelling of Biological Systems

(G. Bastin, P.Y. Willems)

Introduction to the analysis of nonlinear compartmental systems, illustrated with applications from biomedical engineering and biotechnology (insulin-glucose metabolism, microbial growth processes, enzymatic catalysis, pharmaco-kinetics). The following issues are addressed : analysis of algebraic properties of compartmental models, calculation and stability analysis of equilibrium states, design of observers, state feedback control.

Simulation of processes

(D. Dochain, F. Thyrion)

The objective of this course is to give the opportunity to the student to be able to use techniques for the numerical simulation of processes. The objective will therefore be twofold. The first objective is aimed at the knowledge of some basic techniques useful for process simulation. The second objective is aimed at the study of practical cases.

Nonlinear control

(G. Bastin, G. Campion, P. Willems)

This courses is devoted to the analysis and control of nonlinear dynamic systems. Several tools and control design methods are discussed, with applications to engineering problems.

System identification

(M. Gevers, G. Bastin)

This course develops a methodology for the identification (i.e. structure and parameter estimation) of a dynamical model of a system on the basis of measurements obtained from that system.

Control of industrial processes

(M. Gevers, R. Gorez)

Computer controlled systems. Analysis and design of sampled data systems. Direct digital control algorithms. Nonlinear problems in control engineering.

Regulation and Automatic control

(R. Gorez, M. Installé)

Process monitoring and control. Process modeling. Analysis of feedback systems. Design of control systems. Instrumentation. Fundamentals of computer control and modern control methods.

Introduction to robotics

(R. Gorez, J.C. Samin)

Structures and performances of industrial robots. Analysis of robots (actuators, transmission mechanisms, control systems) and of end-effectors. Robot programming and trajectory generation. Exteroceptive sensors and vision systems. Task oriented programming.

1.4 Other

Seminar on ethics, environment and technology

(M. Installé)

The first part of this seminar consists in various conferences/debates arousing the consciousness that the roads towards the solution of many "technical" problems not only involve applied sciences but also the simultaneous consideration of juridical, social, economic and biological aspects of the studied reality together with the ethical challenges that are induced by this approach. The second part consists in students projects works about various themes requiring an interdisciplinary approach to be properly analyzed (example : ethical issues related with the progress of medical imagery).

2 Post-Graduate Training

2.1 The Graduate School in Systems and Control

The Graduate School in Systems and Control was started in the Spring of 1992 at the initiative of the subnetwork Modelling and Control of IUAP 17, jointly with the groups PMA (KUL) and the Dienst Elektriciteit (VUB) of the IUAP 50. Within the framework of the new IUAP's the Graduate School in Systems and Control is organized jointly by the five teams of IUAP IV/02 and by two teams of IUAP IV/24 on "Intelligent Mechatronics Systems".

The aim is to provide advanced courses in systems and control theory and to give an overview of recent research developments in this field. The school has been primarily intended for doctoral students, although a number of engineers from industry and academics have also taken the courses. They have been widely publicized in all centers that are active in systems and control in Belgium. The courses can now be taken as partial fulfillment of the PhD programme in several universities in Belgium. In 1998, the Graduate School was officially accredited as one of the first two doctoral schools at UCL.

The following courses took place in 1998.

1. Spring session, Louvain-la-Neuve

- **Theory and Application of Fuzzy Control**

Lecturers : Prof. S. Yurkovich (The Ohio State University, Columbus, USA)

Prof. V. Wertz (CESAME, UCL)

Participants : 24

- **Semidefinite Programming and Applications**

Lecturers : Prof. L. El Ghaoui (ENSTA, France)

Prof. Y. Nesterov (CORE, UCL)

Participants : 25

The participants came from the following institutions : ULB, K.U.Leuven, ULg, UCL, VUB, FAPOM, FUNDP.

2. Fall session, Heverlee

- **Modeling and Regulation of Biochemical Processes**

Lecturers : Prof. D. Dochain (CESAME, UCL)

Prof. J. Van Impe (KULeuven, Belgium)

Participants : 58

The participants came from the following institutions : ULB, K.U.Leuven, RUG, UCL, VUB, FUNDP, IUT Nancy, INRIA Sophia Antipolis, EPFL Lausanne, TU Delft, INRA Montpellier, Univ. do Minho Portugal, Politecnico di Milano Italie, ENSISC Toulouse, FPMS Stuttgart.

- **Polynomial methods for controller design**

Lecturers : Prof. H. Kwakernaak (Twente University of Technology, The Netherlands)

Prof. M. Sebek (Academy of Sciences, The Czech Republic)

Participants : 21

The participants came from the following institutions : ULB, K.U.Leuven, RUG, UCL, VUB, FUNDP, IUT Nancy.

2.2 The Graduate School in Computational Mechanics (GRASCOM)

Organized under the auspices of the National Committee on Theoretical and Applied Mechanics.

The participants came from the following institutions : Katholieke Universiteit Leuven, Université Catholique de Louvain, Université de Liège, Université Gent, Université Libre de Bruxelles, Von Karman Institute, Vrije Universiteit Brussel.

The purpose of the Graduate School is to organise courses in the field of Computational Mechanics, on a third cycle level, to all Belgian graduate students, in compliance with the rules of the parent institution of the student. The field of science in "Computational Mechanics" is very wide.

Five subgroups are identified :

- solid mechanics and acoustics item materials processing
- fluid mechanics item rheologically complex materials
- numerical aspects and programming

The school is primarily intended for doctoral students and researchers. Engineers from industry and professors from other educational institutions are also welcome.

First semester 3 courses :

1. Advanced continuum mechanics,

Lecturers : Prof. F. Dupret (UCL), J.-P. Ponthot (ULg), M. Hooge (ULg)

Participants : 29

2. Numerical linear algebra

Lecturers : Prof. R. Beauwens (U.L.B.), Y. Notay (ULB)

Participants : 26

3. Solution of the time dependent RANS equations with the finite volume method

Lecturers : C. Lacor (V.K.I.)

Participants : 24

2.3 Graduate course on Iterative Methods for Large Scale Systems and Eigenvalue Problems

The course comprised a total of 15 hours of lectures, and consisted of a sequence of seven seminars given at both universities. A detailed list of subjects and speakers is given below. The first two lectures were devoted to iterative methods for linear systems. The third and fourth lectures dealt with eigenvalue problems. The fifth one discussed implementation aspects, while the last two dealt with particular applications.

Programme:

20/2/98 14h-17h30 (UCL)	
Krylov subspace methods: an introduction	<i>Sleypen-van der Vorst, Universiteit Utrecht</i>
<i>Van der Vorst, Universiteit Utrecht</i>	24/4/98 14h-16h30 (KUL)
6/3/98 14h-16h30 (KUL)	Implementation aspects and parallelism in Krylov methods
Preconditioning techniques for iterative methods	<i>Eric de Sturler, Erdg. Techn. Hochsch. Zurich</i>
<i>Notay, Univ. Libre Bruxelles</i>	8/5/98 14h-16h30 (UCL)
20/3/98 14h-16h30 (KUL)	Krylov methods for ODE's
Arnoldi methods and applications	<i>Marlis Hochbruck, Univ. Tuebingen</i>
<i>Karl Meerbergen, NT-LMS Leuven</i>	14/5/98 14h-16h30 (KUL)
3/4/98 14h-16h30 (UCL)	Algebraic multilevel preconditioning
The Davidson-Jacobi method for eigenvalue problems	<i>Arnold Reusken, Univ. Aachen</i>

2.4 Graduate course on Developing countries, demography and environmental issues (M. Installé et al.)

This graduate course analyzes the interactions between demographic issues, environmental issues and the gap between industrialized/non industrialized countries in the context of the sustainable development paradigm such as stated at the Rio conference (1992).

2.5 Graduate course on Sustainable management and technology

This graduate course which is on the web is taught through Internet with students/teacher interactivity implemented by electronic mail. Its load represents 7.5 credits (within the ECTS) and the material on the web is equivalent to a 200 pages textbook. This course is a component of 4 "euro-courses" developed in a project entitled "Environmental Life-Cycle Engineering towards 2000 - ELCE2000 - involving 8 European universities (TUDelft, KULeuven, UCLouvain, EMParis, NTNUTrondheim, RWTHAachen, ICLondon) that was financed through the Socrates European Programme.

2.6 Graduate course on European CLUSTER Postgraduate Programme on Environmental Technologies and Engineering" (CLUSTER consortium of European universities : EPFLausanne, PoliTorino, UCL/FSA, TUDarmstadt)

M. Installé is the coordinator of this new graduate programme involving various graduate courses taught at UCLouvain by M. Installé et al.

3 Other teaching activities

- **Analyse des Systèmes et Environnement**, Fondation Universitaire Luxembourgeoise, 20h. - G. Bastin
- **Systèmes Nonlinéaires Appliqués**, Ecole des Mines de Paris 15h. - G. Bastin
- **Software Sensors and Adaptive Linearizing Control of Bioreactors**, NATO Advanced Study Institute on Nonlinear Model Based Process Control, 10-20 août 1997, Antalya, Turquie - D. Dochain

- **Polymer and Composites Engineering** Post-graduate programme EUPOCO, 60h. - F. Dupret, R. Keunings, A. Couniot, V. Legat, F. Dubois
- **Modélisation mathématique et simulation numérique en plasturgie** Pôle Européen de Plasturgie, (Oyonnax, France) 120h. - F. Dupret, R. Keunings.
- **Computer Simulation of Viscoelastic Flows**, COSMASE - *Computation in Sciences : Methods and Algorithm in Super Computing for Engineering*, Ecole Polytechnique de Lausanne, 10 h - V. Legat
- **Summer School on Identification for Control**, (Laboratoire d'Automatique de Grenoble), 5 days.
M. Gevers was the scientific coordinator and one of five lecturers.
- **Postgraduate Course on System Identification** at the Dutch Institute on Systems and Control, 16h - M. Gevers.

5. Seminars at CESAME

Seminars

- P. VANVUCHELEN (ESAT/KULeuven) "RaPID, an integrated tool for Robust advanced PID control", February 3, 1998.
- V. BLONDEL (Ulg/CESAME) "Stability of nonlinear systems cannot always be decided", February 10, 1998.
- H. STIGTER (Dept. of Food and Microbial Techn., KULeuven) "A few notes on the applicability and development of a continuous-discrete type of recursive prediction error algorithm", February 17, 1998.
- B. CODRONS (CESAME) "La réduction de modèle comme aide à l'identification", February 24, 1998.
- M. HADJILI (CESAME) "Fuzzy model-based predictive control", March 10, 1998.
- E. MUND (ULB/CESAME) "Un élément fini nodal composite pour problèmes de diffusion en géométrie hexagonale", March 17, 1998.
- B. DAVID (CESAME) "Modélisation et identification des caractéristiques thermiques de la peau humaine par thermométrie à haute résolution", March 24, 1998.
- F. GROGNARD (CESAME) "Nested linear low-gain design for semiglobal stabilization of feedforward systems", March 31, 1998.
- F. BAAIJENS (Eindhoven Technical University, The Netherlands) "Recent Advances in Viscoelastic Flow Simulations", April 2, 1998.
- H. BERSINI (IRIDIA/ULB) "Lazy Learning for Local Modelling and Control Design", April 21, 1998.
- P. PLOUMHANS (CESAME) "Méthodes lagrangiennes pour écoulements externes 2-D/3-D de fluides newtoniens avec parois", April 21, 1998.
- F. MEFTAH (Ecole Normale Supérieure de Cachan) "Modélisation à la rupture des structures en béton et béton armé sous sollicitations statiques, dynamiques et thermo-mécaniques couplées", April 23, 1998.
- R. GOREZ (CESAME) "Analysis of Antireset-Windup (AW) Techniques", April 28, 1998.
- V. FROMION (Universita di Roma) "Commande non falsifiée : quelques principes et une application", May 5, 1998.
- N. VAN DEN BOGAERT (CESAME) "Simulation numérique de la croissance de cristaux par la méthode Czochralski", May 12, 1998.
- B. CODRONS (CESAME) "La réduction de modèle comme aide à l'identification", May 19, 1998.
- C. STANCIULESCU (CESAME) "Multicriteria decision-making for agro-ecosystem planning using fuzzy concept", June 1, 1999.
- V. REGNIER (CESAME) "Etude non linéaire de l'instabilité thermoconvective de Rayleigh-Marangoni", June 2, 1998.
- M. A. BENAYAD (CESAME) "Suivi optimal de trajectoires pour un robot mobile", June 9, 1998.
- J-B. CAILLAU et J. NOAILLES (INP/ENSEEIH, Toulouse) "Transfert d'orbite en temps minimal", June 16, 1998.
- L. M. OPTICAN (National Eye Institute, NIH Bethesda MD, USA) "The use of a 2-D controller to drive 3-D eye movements", June 18, 1998.
- C. STANCIULESCU (CESAME) "Algorithmes génétiques parallèles pour la supervision du trafic dans les réseaux téléphoniques", June 23, 1998.
- M. E. ACHHAB (Université El Jadida, Maroc/CESAME) "On a feedback stabilization of distributed systems with control constraints", June 24, 1998.
- Y. ORLOV (Electronics and Telecommunication Department, CICESE, Mexico) "Adaptive control of distributed parameter Ssystems", June 25, 1998.
- S. MARSILI-LIBELLI (University of Florence) "Fuzzy control applied to wastewater processes", June 30, 1998.

- M. PENGOV (INRIA-Metz, CESAME) "Sur la stabilisation des systèmes non linéaires en utilisant des observateurs continu-discrets", October 6, 1998.
- W. FAVOREEL (KULeuven - ESAT/SISTA) "Model free subspace based LQG-design", October 13, 1998.
- E. MUND (ULB/CESAME) "A survey on some implementation techniques of high-order methods in engineering applications", October 13, 1998.
- B. NINNESS (Univ. of Newcastle, Australia) "Improved variance results for open loop system identification", October 14, 1998.
- J. SUYKENS (KULeuven - ESAT/SISTA) "Nlq neural control theory", October 27, 1998.
- F. LABRIQUE and H. BUYSE (LEI/UCL) "Power electronic systems dynamic behaviour analysis by using recurrence theory", November 3, 1998.
- M. BASSEVILLE (INRIA-IRISIA, Rennes) "Surveillance de machines ou procédés en fonctionnement usuel", November 9, 1998.
- A. FRADKOV (Russian Academy of Sciences, St Petersburg) "Control of nonlinear oscillations and partial stabilization", November 10, 1998.
- L. DE LATHOUWER (KULeuven) "Independent component analysis", November 17, 1998.
- R. MAHONY (Centre de Recherche de Royallieu, Compiègne) "Convergence of analytic gradient flows and related numerical approximations", November 19, 1998.
- I. BOTTEMANNE (NEFY/LEW) "La fusion des capteurs dans le système oculomoteur", November 24, 1998.
- M. FLIESS (Ecole Normale Supérieure de Cachan) "Poursuite de trajectoires et p-liberté de systèmes linéaires de dimension infinie", December 1, 1998.
- R. HANUS (ULB) "Dissertation upon different anti-windup techniques : essay of a state of the art in the field", December 8, 1998.
- A. COIMBRA (UCL/MD/NEFY): "Experimental test of the feedback loop controlling eye-head movements", December 15, 1998.
- I. MOTTE (CESAME) "Linearising control of mobile robots not satisfying the kinematic constraints: a slow manifold approach", December 22, 1998.

6. National or international contacts

Visits received

13-01-98	22-01-98	William C. Cabot	Center for Turbulence Research Stanford University and NASA Ames Research Center, California
19-01-98	23-01-98	Benhammou A.	Univ. Cadi Ayyad, Marrakech, Maroc
27-01-98	30-01-98	Julien Sabine	LAAS, Toulouse
29-01-98	18-03-98	Ganovski Latechzar	Académie des Sciences, Sofia, Bulgarie
02-02-98	06.02.98	Woe-Chul Park	Pukyong National University, Corée
02-02-98	30-03-98	Karama Asma	Université Cadi Ayyad, Marrakech, Maroc
03-02-98		Vanvuchelen P.	ESAT-KULeuven, Belgium
05-02-98	24-02-98	Kulczycki Piotr	Cracow University of Technology, Pologne
17-02-98		Stigter H.	Dept. of Food and Microbial Techn., KULeuven
09-03-98	21-03-98	Magni Lalo	Universita di Pavia, Italie
23-03-98	30-03-98	Yurkovich Steve	Ohio State University, Columbus, USA
02-04-98		Baaijens F.	Eindhoven Technical University, The Netherlands
21-04-98		Bersini H.	IRIDIA-ULB
23-04-98		Meftah F.	Ecole Normale Supérieure de Cachan
30-04-98	28-05-98	Boivin Michel	Université de Laval, Québec
05-05-98		Fromion Vincent	Universita di Roma
11-05-98	31-05-98	Antonelli Gianluca	Universita Frederico II, Napoli
15-05-98	15-07-98	Hadj-Sadok M.	INRIA, Sophia Antipolis
18-05-98	19-06-98	De Bruyne Franky	Australian National University
26-05-98	29-05-98	Babary Jean-Pierre	LAAS, Toulouse
28-05-98		Favoreel Wouter	ESAT/KUL
02-06-98	05-06-98	El Ghaoui Laurent	ENSTA, France
16-06-98		Caillaud J-B/Noailles J.	INP/ENSEEIH, Toulouse
16-06-98	19-06-98	Optican Lance M.	National Eye Institute, NIH Bethesda, USA
30-06-98		Marsili-Libelli S.	University of Florence
01-07-98	06-07-98	Bitmead Robert	Australian National University
06-07-98	10-07-98	Sylvain Gondet	Grenoble
29-07-98		Antoulas A.	Rice University, Huston, USA
03-08-98	07-09-98	Gallivan Kyle	Florida State University, Tallahassee
25-08-98	20-11-98	Filali Salim	Université de Constantine
21-09-98	30-11-98	Rizzio Piero	Universita di Pavia
13-10-98		Favoreel W.	ESAT/KULeuven
07-10-98	23-10-98	Ninness Brett	University of Newcastle, Australia
26-10-98	27-10-98	Doyle Pat	Stanford and Institut Curie, Paris, France
27-10-98		Suykens J.	ESAT/KULeuven
09-1-98	10-11-98	Basseville Michèle	INRIA/IRISA, Rennes
09-11-98	11-11-98	Fradkov Alexander	Russian Academy of Sc., St Petersburg
17-11-98		De Lathouwer L.	ESAT/KUL
16-11-98	20-11-98	Mahony Robert	Centre de Recherche de Royallieu, Compiègne
23-11-98	02-12-98	Kulczycki Piotr	Cracow Univ. of Technology, Poland
24-11-98		Bottemanne Ignace	NEFY/UCL
30-11-98	01-12-98	Fliess Michel	Ecole Normale Sup. de Cachan
04-12-98		Chefneux Luc	CEDAM/Cockerill Sambre
07-12-98	10-12-98	Perrier Michel	Ecole Polytechnique de Montreal
08-12-98	11-12-98	Benhammou A.	Université Cadi Ayyad, Marrakech, Maroc
08-12-98		Hanus R.	ULB, Belgium
14-12-98	15-12-98	Golub Gene	Stanford University
15-12-98		Coimbra A.	NEFY/UCL

Scientific missions

Achhab Elarbi

02/12 04/12 Workshop about “Systèmes différentiels fractionnaires”, Ecole nationale des Télécommunications, Paris.

Ansay Pierre

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).

Bastin Georges

01/05 04/06 Workshop CAB7 on “Computer Applications in Biotechnology” and presentation of a poster about “Modelling of biological kinetics using a new structural criterion”, Osaka, Japon.

01/07 03/07 Participation at NOLCOS Workshop, Enschede.

08/07 10/07 Participation at IFAC Meeting about “Commande et structure des systèmes”.
09/09 Doctoral thesis committee at Institut d’Automatique de l’Ecole Polytechnique de Lausanne and presentation of a seminar.

15/09 20/09 Congress ESBES’98, 2nd European Symposium on biochemical Engineering Science and presentation of a seminar, Porto.

21/10 22/10 President of the doctoral thesis committee of Denis Guillaume, Ecole des Mines de Paris.

23/10 Meeting of evaluation of the European project Agro-Vanillin, INRA, Nantes.

14/12 18/12 Participation at the 37th IEEE Conference on Decision and Control (CDC), Tampa, Floride.

Benayad Mohammed Abdou

13/01 14/01 Participation meeting “Robots mobiles”, Institut Poincaré, Paris.

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).

Bernard Olivier

18/02 20/02 Study day on “Bioréacteurs et eau”, INRIA, Metz.

23/02 24/02 Congress “Biodecisions’98” Montpellier and presentation of a communication and a poster.

25/02 27/02 “Waste Decisions’98, Narbonne and presentation of a communication.

02/03 06/03 Workshop on “Observateurs non linéaires”, Institut Poincaré, Paris.

22/04 24/04 Visit to INRIA and presentation of a seminar: “Construction et comparaison des daptateurs logiciels pour des bioprocédés”, Sophia Antipolis.

31/05 04/06 Workshop CAB7 on “Computer Applications in Biotechnology” and presentation of a poster about “Modelling of biological kinetics using a new structural criterion”, Osaka, Japon.

23/06 25/06 Working day for the contract “Agro Vanillin”, Milan.

01/07 05/07 Meeting for the AMOCO project, Porto.

08/07 10/07 Participation at IFAC Meeting about “Commande et structure des systemes”.

09/08	17/08	Meeting at INRIA Sophia-Antipolis for the TOURNESOL contract.
21/10		Doctoral thesis committee of Denis Guillaume, Ecole des Mines de Paris.
23/10		Meeting of evaluation of the european project Agro-Vanillin, INRA, Nantes.
10/11	17/11	Visit at the University Cadi Ayyad and collaboration with Prof. A. Benhammou , Cooperation between Maroc and Communauté française de Belgique, Marrakech.
23/11	25/11	Visit at Imperial College to meet Prof. A. Astolfi and presentation of a seminar about :“Qualitative dynamics of a class of nonlinear biological systems” and collaboration with F. Mazenc, Londres.
26/11	02/12	Visit at INRIA de Sophia Antipolis and presentation of a seminar about:“Modelisation et controle du metabolisme de champignons filamenteux” and collaboration with J-L. Gouze.

Blondel Vincent

04/01	8/01	Invited speaker at a workshop on Learning, Control and Hybrid Systems. Title of the presentation: <i>How difficult are linear and hybrid control problems?</i> , Centre for Artificial Intelligence and Robotics, Bangalore, India.
11/01		Presentation of a seminar (invited by Dr R. Shankar), Indian Institute of Science, Bangalore, India.
12/01	13/01	Scientific visit to Prof. M. Vidyasagar, Centre for Artificial Intelligence and Robotics, Bangalore, India.
10/02		Presentation of a seminar, Title of the presentation: <i>Stability of nonlinear systems cannot always be decided</i> . Université catholique de Louvain, Louvain-la-Neuve, Belgium.
02/03		One-day participant and chairman of a session at a workshop, Journées Monitoises d’Informatique Théorique, Université de Mons-Hainaut, Belgium.
16/03		Scientific visit to Prof. S. Boyd, Stanford University, Stanford, California, USA.
17/03	25/03	Scientific visit to Prof. J. Tsitsiklis, University of California, Berkeley, California, USA.
01/04	30/05	Invited Professor, Ecole Nationale Supérieure de Lyon, France.
30/04		Presentation of a seminar (invited by Prof. B. Poizat), Title of the presentation: <i>Décidabilité et complexité de problèmes en théorie des systèmes et du contrôle</i> . University of Lyon I, France
13/05		Presentation of a seminar, Title of the presentation: <i>Stabilité de systèmes et problème de l’arrêt global</i> . Ecole Nationale Supérieure de Lyon (ENS Lyon), France.
14/05		Presentation of a seminar (invited by Dr O. Maler), Title of the presentation: <i>Stability of dynamical systems and global halting problem</i> , Research center VERIMAG, ENSIMAG, Grenoble, France.
6/07	10/07	Chairman of a session (Hybrid Systems) and speaker at a conference, Mathematical Theory of Networks and Systems, Padova, Italy.
13/07		Organizer (with Prof. R. Sepulchre) of a workshop (20 participants) and presentation at the workshop, Workshop on The Dynamics of Computing, Title of the presentation: <i>Modelling Turing machines with dynamical systems</i> , University of Liege, Liege, Belgium.
26/08	28/08	Participant in a conference, 4th International workshop on discrete event systems, Cagliari, Sardinia, Italy
29/08	30/08	Invited speaker at a convention, Alapedes convention, Title of the presentation: <i>Elementary systems that simulate Turing machines</i> , Cagliari, Sardinia, Italy
7/12	10/12	PhD thesis jury meeting and scientific visit, Université de Lyon 1, Lyon, France.
14/12	15/12	Scientific visit to Prof. M. Overton and Dr. F. Oustry, Courant Institute for Mathematical Sciences, New York University, NY, USA.

16/12 18/12 Chairman of a session, organizer of a session and speaker at a conference, 37th Conference on Decision and Control, Tampa, Florida, USA.

Bombois Xavier

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
28/09 30/09 Workshop ERNSI : European Research Network on System Identification", Vienne.
28/10 01/11 Visit at LAP-ISMRA, Caen, France and collaboration with G. Scorletti, Caen.

Campion Guy

19/02 20/02 Kickoff meeting of BRITE EURAM project "On board identification diagnosis and control for gas turbine engines", Techspace Aero (Liège).
04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
15/05 Working day for the contract Brite Euram, Heathrow.
18/05 20/05 Participation at a meeting ICRA'98 and co-chairman for 3 sessions, Leuven.
03/09 04/09 Progress meeting of the european contract BRITE EURAM : "OBIDICOTE", Paris.

Chen Libei

08/07 10/07 Participation at the International workshop on "Advanced Black Box Techniques for Nonlinear Modelling", Leuven.
03/12 Meeting about the european project MONNET, Rheinberg, Allemagne.

Codrons Benoît

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
01/09 04/09 Conference IEEE/CCA'98 and presentation of a communication about "Iterative feedback tuning of a nonlinear controller for an inverted pendulum with a flexible transmission", Trieste, Italie.
28/09 30/09 Workshop ERNSI : European Research Network on System Identification", Vienne.
14/12 18/12 Participation at the 37th IEEE Conference on Decision and Control (CDC) and presentation of a communication about : "Control oriented low-order modelling of a complex PWR plant : a comparison between openloop and closed loop methods", Tampa, Floride.

Dautrebande Nathalie

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).

David Benoît

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
08/07 10/07 Participation at the International workshop on "Advanced Black Box Techniques for Nonlinear Modelling", Leuven.

de Brouwer Sophie

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
03/06 Participation at a mini symposium organised by the Laboratory of Neurophysiology (NEFY) and presentation of a communication, Woluwé.
06/11 12/11 Participation at the 28th Annual Congress of "Society for Neuroscience" and presentation of a communication about : "Saccades during pursuit maintenance use both position error and retinal slip velocity, Los Angeles.

Dochain Denis

15/01		Participation in a doctoral thesis, Virginie Otton, Grenoble.
18/02		Study day on "Bioréacteurs et eau", INRIA, Metz.
25/02	27/02	"Waste Decisions'98, Narbonne and presentation of a plenary session.
04/03	06/03	17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
22/04	26/04	Meeting action COST 682 "Integrated Wastewater Management", Ljubljana, Slovenia.
12/05	18/05	Visit of the LAAS (Toulouse) for the project CNRS/FNRS.
31/05	04/06	Workshop CAB7 on "Computer Applications in Biotechnology" and presentation of a poster about "Adaptive linearizing control of a Denitrifying biofilter", Osaka, Japon.
06/06	11/06	Workshop "DYCOPS'5" and presentation of a communication about "State observer for tubular reactors with unknown kinetics", Corfu, Greece.
1/07	5/07	Meeting for the AMOCO project, Porto.
29/09	09/10	Visit at the Ecole Polytechnique de Montreal work with M. Perrier in the framework of the cooperation agreement Québec-CGRI.
10/11	17/11	Visit at the University Cadi Ayyad Marrakech and collaboration with prof. A. Benhammou in the framework of the cooperation agreement between Morocco and the CGRI.
02/12		Visit at Lehrstuhl für Prozesstechnik (RWTH), Aix la Chapelle.

Doghri Issam

12/03		Participe à la journée du groupe de contact du FNRS sur "La déformation et la rupture des matériaux", Ulg.
29/06	2/07	Participe au "4th World Congress on Computational Mechanics", Buenos Aires, Argentina. Présente 2 communications.
07/09	11/09	Participe au "19th Riso International symposium on materials science (Modelling of structure and mechanics of materials from microscale to product), Roskilde, Denmark. Présente une communication.

Dupret François

12/01		Visite de Wacker pour discussions (projet contrôle de croissance du silicium)
22/01	23/01	Réunion BRITE à Mainz (All.) : assemblée générale du consortium (Oxley, IMM, Phillips, UCL, avec K. Price)
27/01		Président du jury de thèse d'E. Pichelin à l'Ecole des Mines de Paris (Sofia-Antipolis, France)
3/02	5/02	Cours au Pôle Européen de Plasturgie (Oyonnax, France) (ESP3)
5/03		Membre du jury de thèse de G.H. Haagh à la T.U. Eindhoven (NL)
9/03		Visite à Shell LLN : discussions projet " stretch blow molding "
16/03	18/03	Participation à la première conférence ESAFORM : 2 communications, dont une comme conférencier invité (F. Dupret, V. Verleye, B. Languillier : " Numerical Prediction of the Moulding of Short-Fiber Reinforced Composite Parts ", et O. Verhoyen, N. Van Rутten, R. Legras, F. Dupret : " Prediction of the Crystallinity Degree in Injection Moulded PET Plates ")
19/03	20/03	Cours au Pôle Européen de Plasturgie (Oyonnax, France) (ESP4)
7/04	9/04	Cours au Pôle de Plasturgie (Oyonnax, France)
17/04		Visite de St. Clain (Université de Clermont-Ferrand, Fr.) : discussions scientifiques ; préparation d'un article (" Stability analysis of the capillary erosion process for a two-dimensional geometry")

23/04 Journée PAI IV-06 à Bruxelles (ULB)

2/05 6/05 Participation au 8th Int. Symposium on Silicon Materials Science and Technology, 193rd Meeting of The Electrochemical Society, San Diego, USA : 2 communications, dont une comme conférencier invité (F. Dupret, N. Van den Bogaert, R. Assaker, V. Regnier : " Mathematical Modeling of the Growth of Large Diameter Czochralski Silicon Crystals Considering Melt Dynamics " et E. Dornberger, J. Esfandyari, J. Vanhellemont, D. Gräf, U. Lambert, F. Dupret, W. von Ammon : " Simulation of Non-Uniform Grown-in Defect Distributions in Czochralski Silicon-Crystals ")

7/05 8/05 Visite à V. Prasad (University of Stony Brooke, New York, USA) : discussions scientifiques et séminaire (" Dynamic Modeling of the Growth of Large Diameter Czochralski Silicon Crystals Considering Melt Dynamics ")

08/05 10/05 Visite à Sh. Motakef (Cape Simulations Co.) : discussions projet de collaboration

25/05 26/05 Visite à Wacker (Burghausen, Allemagne) pour discussions (projet simulation et contrôle de la croissance de mono-cristaux de silicium)

27/05 Défense préliminaire de la thèse de R. Assaker (promoteur)

12/06 Visite de MM. Yamagishi et Kijima (SSI consortium, Japon) : discussions scientifiques (croissance des cristaux de silicium)

16/06 Défense publique de la thèse de R. Assaker (" Magnetohydrodynamics in Crystal Growth ").

19/06 Visite à Phillips (Kallo, Beveren) : discussions dans le cadre du projet BRITE (micro-moulage)

24/06 Participation à la Conférence NUMIFORM à l'Université de Twente (NL) : une communication (N. Van Rutten and F. Dupret : " Experimental and numerical study of the delivery system in thermoplastics injection ")

29/06 30/06 Réunion BRITE à Phillips (Kallo, Beveren) : assemblée générale du consortium (Oxley, IMM, Phillips, UCL, avec K. Price)

02/07 Visite à UMH (J. Platten) : discussions sur la modélisation et l'expérimentation des écoulements en milieu poreux (dans le cadre du PAI IV-06)

03/07 Visite à Union Minière (discussions contractuelles)

06/07 10/07 Visite de S. Gondet (INPACT, France) : discussions sur la génération de dislocations dans les mono-cristaux d'InP

24/07 Visite de M. Watanabe (NEC, Japon) : discussions scientifiques sur la croissance de cristaux et l'écoulement dans le bain de semi-conducteur ; discussions contractuelles

28/08 Participation au jury de maîtrise de B. Hoevenaars à T.U. Eindhoven (NL) (co-promoteur).

07/09 13/09 Participation au ISCGT-1 meeting (First International School on Crystal Growth Technology) à Beatenberg, Suisse : 1 communication comme conférencier invité (F. Dupret, N. Van den Bogaert, R. Assaker, V. Regnier, B. Hoevenaars, S. Kruk : " Modeling and Numerical Simulation of Bulk Crystal Growth Considering Melt Dynamics ") et un poster (N. Van den Bogaert, F. Dupret, R. Assaker, V. Regnier, B. Hoevenaars " Simulation of bulk crystal growth and evolution of point defects and dislocations in the crystal ")

15/09 Participation à la journée de discussions à Franc-Waret dans le cadre du projet Candis 2000

21/09 Participation à l'assemblée du board of directors de la Société scientifique ESAFORM à Paris (Fr.)

22/09 Discussions à Liège avec MM. Hogge et Ponthot (Ulg) dans le cadre de l'école doctorale GRASCOM (Graduate School in Computational Mechanics) : préparation du cours de 3e cycle " Advanced Continuum Mechanics "

28/09 Visite de MM. Hogge et Ponthot (Ulg), dans le cadre de l'école doctorale GRASCOM : préparation du cours " Advanced Continuum Mechanics "

30/09 Participation au jury de thèse de F. Théodore au CEREM-CEA (Grenoble, Fr.) et à l'Institut National Polytechnique de Grenoble (INPG-ENEESG)

01/10 Premier cours de 3e cycle GRASCOM : " Advanced continuum mechanics " (avec J.Ph. Ponthot, Ulg)

02/10 Discussions avec L. Vanderschuren (Shell, LLN) : discussions projet " stretch blow molding "

09/10 Visite à Wacker (Allemagne) : discussions contractuelles.

12/10 Participation en tant que membre du jury à la défense préliminaire de thèse de M. Dobre (unité TERM, UCL)

15/10 Membre d'un jury FRIA (19ème jury ingénierie)

16/10 17/10 Visite au CEREM-CEA (Grenoble, Fr.) : participation au jury d'habilitation de J.P. Garandet ; discussions avec la Société INPACT, et visite à F. Louchet à Grenoble (INPG-ENEESG)

22/10 Deuxième cours de 3e cycle GRASCOM : " Advanced continuum mechanics " (avec J.Ph. Ponthot, Ulg)

29/10 Réunion PAI IV-06 à l'UCL, sur le thème " Flows in Porous Media "

05/11 Visite à Shell LLN : discussions projet " stretch blow molding "

06/11 08/11 Participation au Workshop en l'honneur de M.J. Crochet, Bodysghalen, Pays de Galles

09/11 Cours de Maîtrise EUPOCO à la KUL (module 3C)

12/11 Troisième cours de 3e cycle GRASCOM : " Advanced continuum mechanics " (avec J.Ph. Ponthot, Ulg)

17/11 20/11 Cours au Pôle Européen de Plasturgie (Oyonnax, France) (ESP4)

25/11 Aller-retour Paris : interviews

30/11 Visite de K. Price (EOS dev.) : discussions évolution et commercialisation du logiciel FEMAG

01/12 02/12 Réunion BRITE (préparation mid-term review) avec A. Bell (Oxley), K. Price (Eos dev.), O. Kemmann (IMM), S. Van Hecke (Phillips)

03/12 Quatrième cours de 3e cycle GRASCOM : " Advanced continuum mechanics " (avec J.Ph. Ponthot, Ulg)

04/12 Visite de M. Chefneux (Cockerill-Usinor) : discussions

11/12 Déplacement à Paris pour la remise du Prix Colombo : avec P. Wauters (Président département MECA), S. Colombo, D. Berghezan (lauréat), D. Sindayihebura (lauréat)

17/12 Cinquième cours de 3e cycle GRASCOM : " Advanced continuum mechanics " (avec J.Ph. Ponthot, Ulg)

18/12 Visite de St. Clain (Université de Clermont-Ferrand, Fr.) : discussions scientifiques ; préparation d'un article (" Stability analysis of the capillary erosion process for a two-dimensional geometry ")

22/12 Visite du Dr Ph. Marty du LEGI-IMG (laboratoire des écoulements géophysiques et industriels de l'institut de Mécanique de Grenoble) : discussions scientifiques sur la magnétohydrodynamique et les champs magnétiques tournants

Gevers Michel

19/02 20/02 Kickoff meeting of BRITE EURAM project about "On board identification diagnosis and control for gas turbine engines", Techspace Aero (Liège).

04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).

27/05 Visit at Springer-Verlag, Paris, for the European Union Control Association (EUCA).

29/06 Participation at a workshop about "Perspectives in Control : theory and applications" , Paris.

04/07 EUCA Council meeting in Brussels

30/07 02/08 Participation at RIC'98 "Robustness in Identification and Control" and presentation of a conference "On the role of experimental conditions in identification for control", Sierra, Italy

31/08	04/09	Summer School on Identification for Control at Laboratoire d'Automatique de Grenoble, organized by M. Gevers.
28/09	30/09	Workshop ERNSI : European Research Network on System Identification", Vienna.
14/09		Course at Dutch Institute on Systems and Control, (DISC) Utrecht.
05/10		Course at Dutch Institute on Systems and Control, (DISC) Utrecht.
12/10		Course at Dutch Institute on Systems and Control, (DISC) Utrecht.
13/10		Doctoral thesis committee at University of Delft.
26/10		Course at Dutch Institute on Systems and Control, (DISC) Utrecht.
14/12	18/12	Participation at the 37th IEEE Conference on Decision and Control (CDC) Tampa, Florida.

Gomez Guillermo

03/09	04/09	Progress meeting of the european contract BRITE EURAM : "OBIDICOTE", Paris.
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Gorez Raymond

27/01		Workshop on "Non linear systems", Institut Poincaré, Paris.
13/03		Meeting of the Commission Mécanique, Electricité du FNRS.
30/03		Meeting IBRA, Bruxelles.
31/03	04/04	Symposium on Modeling, Analysis and Control, IMACS-IEEE CESA'98 and presentation of a communication : "Sliding Mode Control as a First Step to Cascaded Control of Mechanical Systems", Tunisie.
16/05	20/05	Participation at ICRA'98 : "IEEE International Conference on Robotics and Automation", Leuven.
13/05		Committee member for a doctoral thesis about "Decentralized adaptive control of robot manipulators", KULeuven.
16/05		Meeting of the conseil d'administration de l'IBRA.
08/09	15/09	Participation at "CONTROLO'98" : 3rd Portugese Conference on Automatic Control. Co-chairman of a session "Adaptive control" and presentation of a communication about "Iterative tuning of PID controllers via relay experiments" ; presentation of a poster (+video) "Sliding mode control of robot manipulators", University of Coïmbra (Portugal).
20/09	24/09	IFAC Workshop on "Motion Control" and presentation of a communication : "Globally stable dual mode control of robots", Grenoble.

Grognard Frédéric

26/01	30/01	Workshop on "Nonlinear systems", Institut Poincaré, Paris, France.
04/03	06/03	17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
01/07	03/07	Participation at NOLCOS Workshop, Enschede.
21/07	24/07	Visit at Ecole des Mines de Paris.
14/12	18/12	Participation at the 37th IEEE Conference on Decision and Control (CDC) and presentation of a communication about : "Slow control for global stabilization of feedforward systems with exponentially instable Jacobian linearization", Tampa, Floride.

Hadjili Mohamed

04/03	06/03	17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
18/05	20/05	Participation at a meeting ICRA'98, Leuven.
14/12	18/12	Participation at the 37th IEEE Conference on Decision and Control (CDC) and presentation of a communication about : "Fuzzy model-based predictive control", à Tampa, Floride.

Henry Philippe

04/02	08/02	Visit to Wacker in the framework of the joint research project on the control of crystal growth processes.
21/04	30/04	idem
19/05	27/05	idem
20/07	30/07	idem
24/09	29/09	idem
07/12	10/12	idem

Installe Michel

15/01	16/01	Working session of the project “Environmental Life-Cycle Engineering towards 2000”, Leuven.
03/02	10/02	Participation at a meeting about “Développement durable” project ALFA, Salvador.
22/01	23/01	Participation at a meeting Consortium CLUSTER, Darmstadt.
20/02	21/02	Meeting CLUSTER in Ecole polytechnique, Turin.
24/02	01/03	Third DAS Workshop and Eighth Workshop of the DGOR Working group on “Decision Theory and Decision Support”, ILASA, Autriche. Presentation of a communication “A new decision support tool for the choice of incentive strategies in multicriteria and multiactor decision problems”.
16/03	18/03	Courses “Sustainable Management and technology”, with the project ATHENS, Ecole des Mines, Paris.
22/05	25/05	Participation at a meeting about European Project “ELCE 2000”, Trondheim, Norvege.
29/05	07/06	Workshop (Third International Conference) on “Multiobjective Programming and Goal Programming : Theory and applications” and presentation of a communication, Quebec.
17/08	18/08	Meeting consacre au programme d’ingénierie environnementale, développe sur Internet, Ecole des Mines de Paris, Fontainebleau.
07/09	13/09	Visit at the University of Bucharest, Department of systems ecology and sustainable management of the natural and mandominated ecological systems, Bucharest, Romania.

Jeanmart Hervé

20/05		Participation in the meeting of the Belgian LES research group organised by Prof. Chris Lacor at the Vrije Universiteit Brussels, and presentation of a seminar.
08/10	10/12	Participation in two GRASCOM graduate courses: “Numerical linear algebra” and “Solution of time-dependent RANS equations with the finite volume method”.
18/11		Participation in the meeting of the Belgian LES research group organised by Dr. Daniele Carati at the Université Libre de Bruxelles, and presentation of a seminar.
22/11	24/11	Participation in the 51st Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Philadelphia, Pennsylvania, and presentation of a communication: “DNS and LES of Kolmogorov flows”.
04/12		Participation in the ERCOFTAC One-Day Seminar on “Modeling and CFD in Process Industry”, UCL, organised by the ERCOFTAC Belgian Pilot Center.

Keunings Roland

14/01		Exposé sur la rhéologie des polymères à FINA Research
17/02	20/02	Enseigne à l'Ecole Supérieure de Plasturgie (Oyonnax, France)
17/03	18/03	Participation à la 1rst ESAFORM Conference, Sophia Antipols, France. Il a présenté une communication sur les travaux de l'ARC (en collaboration avec P. Halin, I. Jaumain, G. Lielens et V. Legat)
16/04		participation au kick-off meeting du réseau européen TMR "Dynamics of polymeric liquids: relation between fluid structure, properties and performance".
28/04		Participation à la réunion annuelle du Belgian Group of Rheology, à la KU Leuven.
6/05	8/05	Welsh Institute of Non-Newtonian Fluid Mechanics, Aberystwyth Wales (Prof. K. Walters)
17/05	19/05	Réunion conjointe des projets BRITE/EURAM ART et MPFLOW (Valence, Espagne).
26/05	29/05	Enseigne à l'Ecole Supérieure de Plasturgie (Oyonnax, France)
08/06		Participation au jury de thèse de doctorat de Mette Kolte (DTU), Copenhagen.
20/06	26/06	Participe au IUTAM Symposium on Molecular Modeling of Polymetric Liquids, Stanford, USA, présente une conférence invitée.
29/08	30/08	Participe à la "General Assembly de l'Int. Union of Theoretical and Applied Mechanics", Stuttgart.
31/08	03/09	Conférence invitée au "2nd Meeting of the Hellenic Society of Rheology and Int. Symposium", Heraklion, Crete.
30/09	01/10	Keynote Lecture à la Conférence "Applied Mathematics for Flow Problems" organisée par la European Science Foundation, San Felui, Espagne.
23/10		Défense publique thèse Mme Danielle Coulon, Université de Liège.
07/11		Participation à l'International Workshop on the Dynamics of Polymetric Liquids, Bodysgamme, hall, North Wales.
24/11		Présentation d'habilitation à diriger des recherches du Dr. Gilmar Mompean, Université Claude Bernad.
27/11		Réunion du projet BRITE/EURAM MPFLOW, Londres.
11/11		Participe à une réunion du groupe de travail "doctorats" du CREF au FNRS, Bruxelles.

Lefèvre Philippe

04/03	06/03	17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
03/06		Participation at a mini symposium organised by the Laboratory of Neurophysiology (NEFY) and presentation of a communication, Woluwé.
06/11	12/11	Participation at the 28th Annual Congress of "Society for Neuroscience" and presentation of a communication, Los Angeles, USA.
12/11	21/11	Visit at National Institutes of Health, Bethesda, USA.

Legat Vincent

03/04		Réunion de travail du réseau Brite-Euram Menusim (CEE) intitulé : "Polymer Processing : measurements and numerical simulation"
02/10	09/10	Participation at the 70th Annual Meeting of the Rheology Society at Monterey, Californie.

Motte Isabelle

04/03	06/03	17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
18/05	20/05	Participation at a meeting ICRA'98, Leuven.

Nesterov Yurii

22/01 23/01 Workshop on “Numerical methods for systems and control, IUAP 4/02, Leuven.

Omnes Thierry

22/01 23/01 Workshop on “Numerical methods for systems and control, IUAP 4/02, Leuven.

29/01 Forum ORAP at EDF, Clamart.

08/08 21/08 Participation at a course intutiled “Error control and adaptivity in scientific computing” organized by NATO Advanced Study Institute, Antalya, Turquie.

Ploumhans Paul

21/04 Presentation of a CESAME Seminar: “Lagrangian methods for 2-D and 3-D external flows with solid boundaries”.

24/08 27/08 Participation in the “Third International Workshop on Vortex Flows and Related Numerical Methods”, Toulouse, France, and presentation of a paper: P. Ploumhans, G. S. Winckelmans, J. K. Salmon, “Vortex particles and tree codes: I. flows with arbitrary crossing between solid boundaries and particle redistribution lattice; II. vortex ring encountering a plane at an angle”.

08/10 10/12 Participation in two GRASCOM graduate courses on “Numerical linear algebra” and ”Solution of time-dependent RANS equations with the finite volume method”.

18/11 Participation in the meeting of the Belgian LES research group organised by Dr. Daniele Carati at the Université Libre de Bruxelles.

22/11 24/11 Participation in the 51st Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Philadelphia, Pennsylvania, and presentation of a communication: “DNS of 2-D and 3-D vortex flows with boundaries using fast vortex methods”.

04/12 Participation in the ERCOFTAC One-Day Seminar on “Modeling and CFD in Process Industry”, UCL, organised by the ERCOFTAC Belgian Pilot Center.

Regnier Vincent

23/04 Journée PAI IV-06 à Bruxelles (ULB)

25/05 26/05 Visite à Wacker (Burghausen, Allemagne) pour discussions (projet simulation et contrôle de la croissance de mono-cristaux de silicium)

12/06 Visite de MM. Yamagishi et Kijima (SSI consortium, Japon) : discussions scientifiques (croissance des cristaux de silicium)

24/07 Visite de M. Watanabe (NEC, Japon) : discussions scientifiques sur la croissance de cristaux et l'écoulement dans le bain de semi-conducteur ; discussions contractuelles

29/10 Réunion PAI IV-06 à l'UCL, sur le thème ” Flows in Porous Media ”

30/11 Visite de K. Price (EOS dev.) : discussions évolution et commercialisation du logiciel FEMAG

22/12 Visite du Dr Ph. Marty du LEGI-IMG (laboratoire des écoulements géophysiques et industriels de l'institut de Mécanique de Grenoble) : discussions scientifiques sur la magnétohydrodynamique et les champs magnétiques tournants

Scorletti Gérard

- 29/01 Course at Université de Paris Sud, DEA Automatique et traitement du signal, about “Outils pour la robustesse : applications de l’optimisation LMI”.
- 04/02 08/02 Visit to Wacker.
- 12/02 Course at Université de Paris Sud, DEA Automatique et traitement du signal, about “Outils pour la robustesse : applications de l’optimisation LMI”.
- 04/03 06/03 17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
- 25/05 26/05 Visit to Wacker.

Stanciulescu Cristina

- 24/02 01/03 Third DAS Workshop and Eighth Workshop of the DGOR Working group on Decision Theory and Decision Support”, ILASA, Autriche.
- 12/07 15/07 Participation at 16th European Conference on Operational Research (EURO XVI), Bruxelles.
- 07/09 18/09 Visit at the University of Bucharest, Department of systems ecology and sustainable management of the natural and mandominated ecological systems, Bucharest, Romania.
- 27/11 Participation at the seminar organized by Institut de Statistique et de recherche opérationnelle, Bruxelles.

Thirifay François

- 24/08 27/08 Participation in the “Third International Workshop on Vortex Flows and Related Numerical Methods”, Toulouse, France.
- 08/10 10/12 Participation in three GRASCOM graduate courses: “Numerical linear algebra”, ”Solution of time-dependent RANS equations with the finite volume method” and “Advanced continuum mechanics”.
- 18/11 Participation in the meeting of the Belgian LES research group organised by Dr. Daniele Carati at the Université Libre de Bruxelles.
- 04/12 Participation in the ERCOFTAC One-Day Seminar on “Modeling and CFD in Process Industry”, UCL, organised by the ERCOFTAC Belgian Pilot Center.

Van den Bogaert Nathalie

- 11/03 13/03 Visite à Grenoble dans le cadre d’une collaboration avec le CEA/CEREM et la société InPact sur le sujet de la simulation de la croissance de mono-cristaux de phosphore d’indium (InP) et du calcul de dislocations dans le cristal
- 23/04 Journée PAI IV-06 à Bruxelles (ULB)
- 25/05 26/05 Visite à Wacker (Burghausen, Allemagne) pour discussions (projet simulation et contrôle de la croissance de mono-cristaux de silicium)
- 27/05 Défense préliminaire de la thèse de R. Assaker (membre du comité d’encadrement et du jury)
- 12/06 Visite de MM. Yamagishi et Kijima (SSI consortium, Japon) : discussions scientifiques (croissance des cristaux de silicium)

16/06		Défense publique de la thèse de R. Assaker (" Magnetohydrodynamics in Crystal Growth ") (membre du comité d'encadrement et du jury)
02/10		Visite à UMH (J. Platten) : discussions sur la modélisation et l'expérimentation des écoulements en milieu poreux (dans le cadre du PAI IV-06)
06/10		Visite de S. Gondet (INPACT, France) : discussions sur la génération de dislocations dans les mono-cristaux d'InP
24/10		Visite de M. Watanabe (NEC, Japon) : discussions scientifiques sur la croissance de cristaux et l'écoulement dans le bain de semi-conducteur ; discussions contractuelles
28/08		Participation au jury de maîtrise de B. Hoevenaars à T.U. Eindhoven (NL.) (co-promoteur)
7/09	10/09	Participation au ISCGT-1 meeting (First International School on Crystal Growth Technology) à Beatenberg, Suisse : présentation de poster (N. Van den Bogaert, F. Dupret, R. Assaker, V. Regnier, B. Hoevenaars " Simulation of bulk crystal growth and evolution of point defects and dislocations in the crystal ")
29/10		Réunion PAI IV-06 à l'UCL, sur le thème " Flows in Porous Media "
30/11		Visite de K. Price (EOS dev.) : discussions évolution et commercialisation du logiciel FEMAG
22/12		Visite du Dr Ph. Marty du LEGI-IMG (laboratoire des écoulements géophysiques et industriels de l'institut de Mécanique de Grenoble) : discussions scientifiques sur la magnétohydrodynamique et les champs magnétiques tournants

Van Dooren Paul

22/01	23/01	Workshop on "Numerical methods for systems and control, IUAP 4/02, Leuven.
06/02		Meeting with chiefs editors of SIAM, Philadelphia.
24/04		Participation at a seminar about "Large Scale Systems", Leuven.
27/04		Committee member for a doctoral thesis about:"Efficient Kalman Filtering Algorithms for Hydrodynamic models", Technische Universiteit Delft.
15/05	29/05	Visit at National Tsing Hua University during the International conference on "Computation Mathematics" and presentation of a mini course about "Numerical methods for systems and control", Taipei, Taïwan.
18/06	19/06	Meeting of the European project NICONET, Chemnitz (Allemagne).
18/06	26/06	Meeting à Coïmbra (Portugal).
05/07	10/07	Participation at MTNS'98 "Mathematical theory of networks and systems".
08/08	21/08	Course intitulée "Error control and adaptivity in scientific computing" organized by NATO Advanced Study Institute, Antalya, Turquie.
13/09	27/09	Participation DLR, Oberpfaffenhafen, Deutschland.
28/09	12/10	Sabbatical stay at Purdue University.
13/10	26/10	Sabbatical stay at North Carolina State University.
27/10	30/11	Sabbatical stay at Florida State University.
01/12	05/12	Participation the NICONET Workshop on "Numerical Software in Control Engineering" at the Université Polytechnique de Valencia.

Wertz Vincent

04/03	06/03	17th Benelux meeting on Systems and Control, Mierlo (The Netherlands).
27/04	28/04	Meeting at Wacker.
12/05		Visit at "Air Liquide", Paris.
25/05	26/05	Visit to Wacker in the framework of the joint research project on the control of crystal growth processes.

03/06	05/06	Workshop on “Non linear model predictive control” and presentation of a communication, Ascona (Suisse).
10/06		Meeting at “Air Liquide”, Paris.
11/06		Meeting organized by “Institut du verre français” sur la commande avancée dans les fours de verrerie”.
08/07	10/07	Participation at the International workshop on “Advanced Black Box Techniques for Nonlinear Modelling”, and presentation of a plenary lecture : “Non-linear identification based on fuzzy models”, Leuven.
22/07	30/07	Visit to Wacker in the framework of the joint research project on the control of crystal growth processes.
01/09	04/09	Conference IEEE/CCA’98 and presentation of a communication about “Identification of fuzzy models for a glass furnace process”, Trieste, Italie.
09/10		Study day at Wacker, Munich.
11/11	26/11	Visit at Ohio State University and collaboration with S. Yurkovich.
07/12	10/12	Visit to Wacker in the framework of the joint research project on the control of crystal growth processes..

Willems Pierre-Yves

19/02	20/02	Kickoff meeting of BRITE EURAM project about “On board identification diagnosis and control for gas turbine engines”, Techspace Aero (Liège).
15/05		Working day for the contract Brite Euram, Heathrow.
03/09	04/09	Progress meeting of the european contract BRITE EURAM : “OBIDICOTE”, Paris.

Winckelmans Grégoire

20/05		Participation in the meeting of the Belgian LES research group organised by Prof. Chris Lacor at the Vrije Universiteit Brussels, and presentation of a seminar.
05/07	31/07	Participation in the “1998 Summer Research Program”, Center for Turbulence Research, Stanford Univ. and NASA Ames Research Center, California.
24/08	27/08	Participation in the “Third International Workshop on Vortex Flows and Related Numerical Methods”, Toulouse, France. Also co-author of a paper.
02/09		Seminar in the Division of Thermodynamics and Turbomachines, Department of Mechanical Engineering, UCL: “Some new developments in large-eddy simulation of turbulent flows”.
08/10	09/10	Participation in the progress meeting of the Consortium members of the project on BIOMass GASification Modelling for Energy Systems (BIOGAMES) at UCL.
18/11		Participation in the meeting of the Belgian LES research group organised by Dr. Daniele Carati at the Université Libre de Bruxelles, and presentation of a seminar.
22/11	24/11	Participation in the 51st Annual Meeting of the Division of Fluid Dynamics, American Physical Society, Philadelphia, Pennsylvania, and presentation of a communication: “Dynamic LES using a mixed Leonard-Smagorinsky model”. Also co-author of three other communications.
04/12		Participation in the ERCOFTAC One-Day Seminar on “Modeling and CFD in Process Industry”, UCL, organised by the ERCOFTAC Belgian Pilot Center. Also organiser of the meeting at UCL.

7. Research funding

1 Federal Office for Scientific, Technical & Cultural Affairs

Interuniversity Attraction Pole IV/02

CESAME is the pilot team of IUAP IV/02.

- *Project title* : Modelling, Identification, Simulation and Control of Complex Systems.
- *Promotor* : M. Gevers
- *Partners* : KUL/ESAT, Dept Elektrotechniek, Groep SISTA, (B. De Moor) - KUL/CS, Dept of Computer Science (D. Roose) - RUG, Group Systems (D. Aeyels) - VUB, Department ELEC (R. Pintelon) -

Interuniversity Attraction Pole IV/06

- *Project title* : Fundamental Aspects of Hydrodynamic Instabilities in Multiphase and Multicomponent Systems.
- *Promotor* : F. Dupret
- *Partners* : ULB (pilot team), Service de Chimie-Physique E.P. (J.Cl. Legros) - ULG, Département de Physique, Unité de Thermodynamique des Phénomènes Irréversibles (G. Lebon) - VUB, Dienst Stromingsmechanica (Ch. Hirsch) - UMH, Unité de Chimie Générale (J. Platten).

Action de Recherche Concertée ARC 97/02-210

- *Project title* : Micro-Macro Approach in Computational Rheology
- *Promotors* : R. Keunings, V. Legat

Action de recherche concertée: ARC 95/00-189

- *Project title* : Spatial localization and temporal distribution of cerebral activities in visual processes.
- *Partner* : Ph. Lefevre

2 European Programmes

Human Capital and Mobility

- *Project title* : European Robotics Network (ERNET)
- *Promotor* : R. Gorez
- *Partners* : University degli Studi di Bologna, Italy - Institut National Polytechnique de Grenoble, France - Technische Hochschule Darmstadt, Germany - Technische Universiteit Delft, The Netherlands - ISR, Portugal - Univ. Politecnica de Cataluna, Spain - Univ. of Strathclyde, U.K.

Human Capital and Mobility

- *Project title* : Chemical Process Control
- *Promotor* : D. Dochain
- *Partners* : Abo Akademi, Finland - Instituttet for Kemiteknik, Lyngby, Denmark - Ecole des Mines de Paris, France - RWTH, Aachen, Germany - University Stuttgart, Germany - University of Exeter, U.K. - University of Newcastle Upon Tyne, U.K. - Imperial College, London, U.K. - Aristotle University of Thessaloniki, Greece - University of Trondheim, Norway - Universidade do Porto, Portugal - Ecole Polytechnique Fédérale de Lausanne, Switzerland.

Training and Mobility of Researchers

- *Project title* : System identification
- *Promotor* : M. Gevers

- *Partners* : University of Groningen, The Netherlands - Technische Universität Wien, Austria - INRIA, Sophia Antipolis, France - University of Cambridge, U.K. - CNR, Padova, Italy - University of Linköping, Sweden - Royal Institute of Technology, Stockholm, Sweden - INRIA, IRISA, Rennes, France.

Cooperation and Coordination in the Field of Scientific and Technical Research (COST)

- *Project title* : Mechanical properties of complex polymer composite moulded parts.
- *Promotors* : R. Keunings, F. Dupret
- *Partners* : Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland - Swedish Institute of Composites (SICOMP), Sweden - University of Newcastle-Upon-Tyne, U.K.

Cooperation and Coordination in the Field of Scientific and Technical Research (COST)

- *Project title* : Optimizing the design and operation of biological wastewater treatment plants through the use of computer programmes based on a dynamic modelling of the process
- *Promotor* : D. Dochain
- *Partners* : Technical Univ. Denmark, DTH, Denmark - Helsinki Univ. of Technology, Espoo, Finland - Water Research Institute C.N.R., Rome, Italy - Aquateam-Norwegian Water Technology Center, Oslo, Norway - C.E.I.T. Research Center, San Sebastian, Spain - E.A.W.A.G., Dübendorf, Switzerland - Lund Institute of Technology, Lund, Sweden.

BRITE-EURAM

- *Project title* : The integration of computer modelling, mould design and the LIGA process for the micro-injection moulding of plastic parts
- *Promotor* : F. Dupret
- *Partners* : Oxley Developments Ltd (UK, coordinator) - Institut für Mikrotechnik Mainz GMBH (Germany) - Phillips Petroleum Chemicals NV/SA (Belgium).

BRITE-EURAM

- *Project title* : Molecular based approach to the simulation of Polymer Fluid Flows in Processing Operations
- *Promotor* : R. Keunings
- *Partners* : Univ. Polyt. Madrid, DOW Benelux, Repsol SA (Spain), Shell Research (The Netherlands), Argo (Greece), T.U. Delft, ETH Zürich

BRITE-EURAM

- *Project title* : Numerics in Control Network(NICONET)
- *Promotor* : P. Van Dooren
- *Partners* : KUL-SISTA(BE), TU-Eindhoven(NL), TU-Delft (NL), DLR(DE), NAG(GB), TU-CZ(DE), U-Bremen(DE), INRIA(FR), U-Leicester(GB), TBZ-Pariv(DE), LMS(BE), UP-Valencia (ES), U-Umea(SE), Aspentech(NL), SFIM-EA(FR), Omron(ES).

BRITE-EURAM

- *Project title* : Polymer processing : measurements and numerical simulation
- *Promotor* : V. Legat
- *Partners* : Univ. Pierre et Marie Curie (LRMOP)(FR), U-Loughborough(RuPC)(UK), Albert-Ludwig Univ. Freiburg (FMF)(D), Univ. do Minho (P), Solvay (B), Hutchinson (F), SPEC Process Services (GR), Pirelli Coordinamento Pneumatici (I), VTT Chemical Technology (F), Deutsches Institut für Kautschuktechnologie (G), Arttic (FR), MET (F),

BRITE-EURAM

- *Project title* : On-board diagnosis and control of gas turbine engines

- *Promotors* : G. Campion, M. Gevers, P. Willems
- *Partners* : NTVA (Greece), TU München (D), Chalmers University (SW), Snecma (F), Rolls Royce (GB), MTU (D), Volvo (SW), Fiat Avio (I), Techspace Aero (B), Lufthansa (D).

COPERNICUS

- *Project title* : Microcontroller framed innovative technology - Instruments for adaptive process control
- *Promotor* : R. Gorez
- *Partners* : ZPA, Research for Indus.& Automation, Nova Paka, Czech Rep.- Academie of Sciences, UTIA, Praha, Cezech Rep.- University of Strathclyde, ICC, Glasgoww, U.K.

AIR

- *Project title* : Design and scale-up of a bioprocess for the production of natural vanillin from agricultural by products (AGROVANILLIN)
- *Promotor* : G. Bastin
- *Partners* : Pernod-Ricard, France - Ricordatin, Italie. Pharmacia, Sweden. University of Nowich, U.K. INRA, France.

FAIR

- *Project title* : Advanced moitoring and control of the operation of wastewater treatment processes of the wood industry in order to improve the process affliency
- *Promotor* : D. Dochain
- *Partners* : Tofisa, Cidac Hydroquinica, LBE-INRA (Narbonne, France), CNRS (Perpignan, France), Univ. Santiago de Compostella (Espagne), Univ. porto (Portugal)

SOCRATES

- *Project title* : Environmental life-cycle engineering towards 2000
- *Promotor* : M. Installé
- *Partners* : TU Delft, KULeuven, EMParis, NTNU Trondheim, RWTH Aachen, IC London.

3 Regional Programmes

Fonds de la Recherche Fondamentale Collective (FRFC)

- *Project title* : Equipment for a precise measure of eye movements in humans.
- *Promotor* : P. Lefèvre

Service d'Etudes Hydrologiques (SETHY)

- *Project title* : Application of mathematical models for riverflow forecasting
- *Promotor* : G. Bastin

FNRS (crédit aux chercheurs)

- *Project title* : Optimization, theoretical systems and numerical analysis
- *Promotor* : P. Van Dooren
- *Partners* : Y. Nesterov (CORE/CESAME), Y. Genin (CESAME)

FNRS, Fonds de la Recherche Fondamentale Collective (FRFC) - Initiative des chercheurs, and Loterie Nationale

- *Project title* : Modelling of the small scales and of the near-wall phenomena in turbulent flows; application to large-eddy simulations in complex geometrics.
- *Promotors* : D. Carati (ULB), G. Winckelmans and V. Legat (UCL).

4 Special Research Fund (UCL)

- *Project title* : Development of micro/macro constitutive equations for the modelling and simulation of the deformation, damage and fracture of polyethylene
- *Promotor* : I. Doghri

- *Project title* : Simulation of high Reynolds number bluff body flows using the vortex particle and boundary elements methods.
- *Promotor* : G. Winckelmans

- *Project title* : Numerical simulation, using Lagrangian particle methods, of 3-D shear flows at high Reynolds number and with combustion.
- *Promotor* : G. Winckelmans

- *Project title* : Numerical simulation and modelling of turbulence.
- *Promotor* : V. Legat

- *Project title* : Sustainable development indicators for firms : implementation and testing.
- *Promotor* : M. Installé

- *Project title* : Commande avancée de systèmes électromécaniques non linéaires
- *Promotor* : D. Dochain

- *Project title* : Experimental and theoretical study of the synergy between saccadic and pursuit eye movements
- *Promotor* : P. Lefèvre

5 Industrial Contracts

- **WACKER-SILTRONIC** - Germany
 - *Project title* : Simulation and Control of Czochralski Silicon Growth
 - *Promotors* : F. Dupret, V. Wertz

- **SOLVAY**
 - *Project title* : Modelling and control of an epichlorhydrin production process
 - *Promotors* : G. Bastin, V. Wertz

- **SOLVAY**
 - *Project title* : Modelling and simulation of the small-deformation of polyéthylène with a micro/macro approach
 - *Promotor* : I. Doghri

- **SABCA**
 - *Project title* : Modeling of the caloduc evaporator for a two-phase flow cooling loop.

- *Promotors* : G.Winckelmans and J.-M. Seynhaeve
- **THERMIBEL** : with partial support of the Division Générale Technologie, Recherche et Energie (DGTRE), Région Wallonne
 - *Project title* : Preliminary study for modelling of the mechanical and thermal behavior of thermometric probes;
 - *Promotors* : G.Winckelmans and J.-M. Seynhaeve
- **SUPER SILICON CONSORTIUM**
 - *Project title* : Numerical simulation of 40 cm diameter silicon crystals
 - *Promotors* : F. Dupret, N. Van den Bogaert
- **INPACT, CEREM-CEA**
 - *Project title* : Numerical simulation of indium phosphide growth
 - *Promotors* : F. Dupret, N. Van den Bogaert
- **UNION MINIERE, EUREKA**
 - *Project title* : Detailed study of a Germanium crystal furnace.
 - *Promotors* : F. Dupret, N. Van den Bogaert
- **ELECTRICITE DE FRANCE, EDF**
 - *Project title* : Identification, model and controller reduction for a thermal power plant.
 - *Promotor* : M. Gevers
- **FONDATION ROI BAUDOIN**
 - *Project title*: Implementation of decision-aid tools for the management of a small, socially-oriented enterprise.
 - *Promotor* : M. Installé
- **KOMAT'SU**
 - *Project title*: Numerical simulation of silicon growth
 - *Promotor* : F. Dupret, N. Van den Bogaert
- **MITSUBISHI MATERIALS**
 - *Project title*: Numerical simulation of silicon growth
 - *Promotor* : F. Dupret, N. Van den Bogaert
- **SHELL (Louvain-la-Neuve)**
 - *Project title*: Modelling of stretch blow molding
 - *Promotor* : F. Dupret
- **IBA (Louvain-la-Neuve)**
 - *Project title* : Commande d'une structure mécanique mobile GANTRY
 - *Promotor* : D. Dochain

6 Other international contracts

- NSF grant CCR-9619596

- *Project title:* Lower order modelling and projection techniques in Scientific Computing
- *Promotor:* Paul Van Dooren (UCL)
- *Partners:* Kyle Gallivan (Florida State Univ.), Ahmed Sameh (Purdue Univ.)

8. Scientific awards and responsibilities

Scientific Awards

Michel Gevers

Distinguished lecturer of the IEEE Control Systems Society (1998-2000)

Grégoire Winckelmans

“Pentium Pro inside: I. A treecode at 430 Gigaflops on ASCII Red; II. Price/performance of \$50/Mflop on Loki and Hyglac”, Proc. *Supercomputing 97*, Nov. 15-21, 1997, San Jose, California. Winners of both 1997 Gordon Bell prizes *In recognition of their superior effort in practical parallel-processing research*: winner on *Performance* and winner on *Price/Performance* ratio.

Responsibilities

BASTIN Georges

- Associate Editor “IEEE Transactions on Automatic Control”, “Journal of Forecasting (Wiley)” and “Electronic Journal of Control, Optimization and Calculus of Variations , European Series in Applied and Industrial Mathematics (ESAIM) ”.

BLONDEL Vincent

- Associate editor of the journals :
European Journal of Control (Springer Verlag)
Systems and Control Letters (Elsevier Science)
Bulletin of the Belgian Mathematical Society
Mathematics of Control, Signals, and Systems (Springer Verlag)

DUPRET François

- Head of Laboratory (Unité de Mécanique Appliquée)
- Member of Directors board of scientific association ESAFORM
- Member of the Board editorial of the ”Int. Journal of Forming processes”
- Conference ICCG - convenor session modelling

GEVERS Michel

- Associate Editor of Mathematics of Control, Signals and Systems
- Editor at Large of the European Journal of Control
- President of the European Union Control Association
- Member of the Board of Governors of the Control Systems Society of the IEEE
- Chairman of the International Committee of the IEEE Control Systems Society
- Chairman of the Young Author Prize Committee of IFAC (International Federation of Automatic Control).
- Member of the IFAC Awards Committee
- Member of the IFAC Technical Committee on Modelling, Identification and Signal Processing
- Member of the Comité Scientifique du Laboratoire Heudiasyc, CNRS, Compiègne, France

INSTALLE Michel

- M. Installé was elected representative of the french-speaking Belgian universities at the Conseil Wallon de l’Environnement pour le Développement Durable (CWEDD). As a member of the Council, he contributed to the writing of an important report entitled ”De la protection de l’Environnement au Développement Durable”.
- M. Installé is the manager/coordinator of various postgraduate programmes at UCL in the field of environment sciences.

KEUNINGS Roland

- Member of the Editorial Board of the Journal of Non-Newtonian Fluid Mechanics. President of the National Committee of Theoretical and Applied Mechanics, Royal Academy of Belgium.

WINCKELMANS Grégoire

- UCL Representative for the European Community on Flow, Turbulence and Combustion (ERCOFTAC), including the ERCOFTAC Belgian Pilot Center (BPC).
- Member of the organisation committee for the BPC ERCOFTAC One-Day Seminar on “Modeling and CFD in Process Industry” held at UCL, Dec. 4, 1998.